

Proofs for file C:\Escher\Customers\prang\prang.c

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Escher Verification Studio file versions

EscherTool 7.00

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Proved 172 of 179 verification conditions.

Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (47,22)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap}_{\text{funcstart_724,1}}.\text{p1}$

Given:

$\text{\$heap}_{\text{init}}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{\text{init}}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{\text{init}}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{\text{init}}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{\text{init}}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{\text{init}}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{\text{init}}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{\text{init}}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{\text{init}}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{\text{init}}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$

$\text{\$heap}_{\text{init}}.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$

$\text{\$heap}_{\text{init}}.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$

$\text{\$heap}_{\text{init}}.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$

$\text{\$heap}_{\text{init}}.\text{p1} == \text{asType}<\text{short int}>((\text{int})1)$

$\text{\$heap}_{\text{init}}.\text{p2} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{\text{init}}.\text{p3} == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}})$

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)
→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < **asType**<**integer**>(\$heap_funcstart_724,1.p1)) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p1) <
asType<**integer**>(\$heap_funcstart_724,1.M1))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p2) <
asType<**integer**>(\$heap_funcstart_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))
→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<**integer**>(\$heap_funcstart_724,1.M1))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p2) <
asType<**integer**>(\$heap_funcstart_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<**integer**>(\$heap_init.M1))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p2) <
asType<**integer**>(\$heap_funcstart_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<**integer**>(**asType**<**short int**>((**int**)30269)))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p2) <
asType<**integer**>(\$heap_funcstart_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <

$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
 $[\text{Work on sub-term 4 of conjunction in term 5.40}]$

[8.0] $0 < \text{\$heap}_{funcstart_724,1}.p1$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq \text{\$heap}_{funcstart_724,1}.p1$

\rightarrow [simplify]

[1.3] $-32769 < \text{\$heap}_{funcstart_724,1}.p1$

\rightarrow [from term 8.0, $\text{literal} < \text{\$heap}_{funcstart_724,1}.p1$ is true whenever $(-1 + \text{literal}) < 0$]

Proof of rule precondition:

[1.3.0] $(-32769 + -1) < 0$

\rightarrow [simplify]

[1.3.2] **true**

[1.4] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (47,22)

Condition defined at:

To prove: $\text{\$heap}_{funcstart_724,1}.p1 \leq \text{maxof}(\text{int})$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\text{\$heap}_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\text{\$heap}_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\text{\$heap}_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\text{\$heap}_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

Proof:

[Take given term]

[5.0] $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] $(((((0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p1)) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p1) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M1))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M2))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M3)))$

→ [simplify]

[5.3] $(((((0 < \$heap_{funcstart_724,1}.p1) \ \&\& (\$heap_{funcstart_724,1}.p1 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M1))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M2))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M3)))$

→ [const static or extern object]

[5.4] $(((((0 < \$heap_{funcstart_724,1}.p1) \ \&\& (\$heap_{funcstart_724,1}.p1 < \text{asType}<\text{integer}>(\$heap_{init}.M1))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M2))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M3)))$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] $(((((0 < \$heap_{funcstart_724,1}.p1) \ \&\& (\$heap_{funcstart_724,1}.p1 < \text{asType}<\text{integer}>(\text{asType}<\text{short int}>((\text{int})30269)))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p2) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M2))) \ \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3))) \ \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p3) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.M3)))$

```

asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>(asType<short
int>((int)30323)))

```

\rightarrow [simplify]
 [5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
 [Work on sub-term 3 of conjunction in term 5.40]
 [7.0] $-30269 < -\$heap_{funcstart_724,1}.p1$
 [Take goal term]
 [1.0] $\$heap_{funcstart_724,1}.p1 \leq \mathbf{maxof(int)}$
 \rightarrow [simplify]
 [1.9] $-32768 < -\$heap_{funcstart_724,1}.p1$
 \rightarrow [from term 7.0, literal $a < -\$heap_{funcstart_724,1}.p1$ is true whenever $(-1 + literal) < -30269$]
Proof of rule precondition:
 [1.9.0] $(-32768 + -1) < -30269$
 \rightarrow [simplify]
 [1.9.2] **true**
 [1.10] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (47,31)

Condition defined at:

To prove: $\mathbf{minof(int)} \leq \$heap_{funcstart_724,1}.a1$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType<short int>}((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType<short int>}((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType<short int>}((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType<short int>}((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType<short int>}((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType<short int>}((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType<short int>}((\mathbf{int})176)$
 $\$heap_{init}.b2 == \mathbf{asType<short int>}((\mathbf{int})35)$

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)

```

Proof:

```

[Take goal term]
[1.0] minof(int) ≤ $heapfuncstart_724,1.a1
→ [simplify]
[1.1] -32768 ≤ $heapfuncstart_724,1.a1
→ [const static or extern object]
[1.2] -32768 ≤ $heapinit.a1
→ [expand definition of constant 'a1' at prang.c (16,20)]
[1.3] -32768 ≤ asType<short int>((int)177)
→ [simplify]
[1.6] true

```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (47,31)

Condition defined at:

To prove: \$heap_{funcstart_724,1}.a1 ≤ maxof(int)

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)

```



```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)

```

Proof:

[Take goal term]

[1.0] \$heap_{funcstart_724,1}.a1 ≤ maxof(int)

→ [const static or extern object]

[1.1] \$heap_{init}.a1 ≤ maxof(int)

→ [expand definition of constant 'a1' at prang.c (16,20)]

[1.2] asType<short int>((int)177) ≤ maxof(int)

→ [simplify]

[1.6] true

Proof of verification condition: Precondition of 'div' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (47,18)

Condition defined at: C:\Escher\ecv\standard\stdlib.h (94,10)

To prove: 0 < asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a1))

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)

```

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)

```

Proof:

[Take goal term]

[1.0] 0 < asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a1))

→ [const static or extern object]

[1.1] 0 < asType<integer>(asType<int>(\$heap_{init}.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[1.2] 0 < asType<integer>(asType<int>(asType<short int>((int)177)))

→ [simplify]

[1.7] true

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (48,48)

To prove: (asType<integer>(\$heap_{funcstart_724,1}.a1) ≤
asType<integer>(\$heap_{funcstart_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)

```

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart}_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart}_724,1.p1)) &&
(asType<integer>(\$heap_{funcstart}_724,1.p1) <
asType<integer>(\$heap_{funcstart}_724,1.M1))) && (0 <
asType<integer>(\$heap_{funcstart}_724,1.p2))) &&
(asType<integer>(\$heap_{funcstart}_724,1.p2) <
asType<integer>(\$heap_{funcstart}_724,1.M2))) && (0 <
asType<integer>(\$heap_{funcstart}_724,1.p3))) &&
(asType<integer>(\$heap_{funcstart}_724,1.p3) <
asType<integer>(\$heap_{funcstart}_724,1.M3))

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<**integer**>(**asType**<**short int**>((**int**)30307)))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(**asType**<**short**
int>((**int**)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)

[Work on sub-term 4 of conjunction in term 5.40]

[8.0] 0 < \$heap_funcstart_724,1.p1

[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<**int**>(\$heap_funcstart_724,1.p1),
asType<**int**>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$

[Take goal term]

[1.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.a1}) \leq$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1})) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div1.quot}))$

→ [const static or extern object]

[1.1] $(\text{asType<integer>}(\$ \text{heap_init.a1}) \leq$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1})) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div1.quot}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[1.2] $(\text{asType<integer>}(\text{asType<short int>}((\text{int})177)) \leq$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1})) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div1.quot}))$

→ [simplify]

[1.8] $(176 < \$ \text{heap_funcstart_724,1.p1}) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div1.quot}))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177)$]

[1.9] $(176 < \$ \text{heap_funcstart_724,1.p1}) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot}))$

→ [simplify]

[1.13] $!(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot}) \vee (-177 < -\$ \text{heap_funcstart_724,1.p1})$

→ [negate goal and search for contradiction]

[1.14] $(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot}) \wedge !(-177 < -\$ \text{heap_funcstart_724,1.p1})$

→ [simplify]

[1.17] $(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot}) \wedge (176 < \$ \text{heap_funcstart_724,1.p1})$

→ [separate conjunction and work on first sub-term]

[1.18] $0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) /$
 $\text{asType}\langle\text{integer}\rangle(177)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs}$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot})$

→ [simplify]

[14.2] $(\$heap_funcstart_724,1.p1 / 177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs}$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] $([\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177), []:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] $([\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177),$
 $[\!(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot})$

→ [simplify]

[14.7] $([0 < -\$heap_funcstart_724,1.p1]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177),$
 $[\!(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot})$

→ [from term 8.0, $\text{literal}a < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0$
 $+ \text{literal}a)$]

Proof of rule precondition:

[14.7.0] $-2 < (0 + 0)$

→ [simplify]

[14.7.2] **true**

[14.8] $([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177),$
 $[\!(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot})$

→ [simplify]

[14.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) / 177)$, $[(0 < -\$heap_funcstart_724,1.p1)]: \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) / 177$)
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot})$
 \rightarrow [from term 8.0, $\text{literal} < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[14.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.11.2] **true**

[14.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) / 177)$,
[!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) / 177$)
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot})$

\rightarrow [simplify]

[14.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot} + (\$heap_funcstart_724,1.p1 / 177))$

\rightarrow [from term 1.18, $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}$ is equal to 0]

[14.18] $0 == (-0 + (\$heap_funcstart_724,1.p1 / 177))$

\rightarrow [simplify]

[14.20] $0 == (\$heap_funcstart_724,1.p1 / 177)$

[Work on sub-term 2 of conjunction in term 1.17]

[25.0] $176 < \$heap_funcstart_724,1.p1$

[Create new term from term 14.20 using rule: condition for equality of division]

[26.0] $((0 * 177) < (1 + \$heap_funcstart_724,1.p1)) \wedge (\$heap_funcstart_724,1.p1 < (177 * (0 + 1)))$

\rightarrow [simplify]

[26.3] $(-1 < \$heap_funcstart_724,1.p1) \wedge (\$heap_funcstart_724,1.p1 < (177 * (0 + 1)))$

\rightarrow [from term 25.0, $\text{literal} < \$heap_funcstart_724,1.p1$ is true whenever $(-1 + \text{literal}) < 176$]

Proof of rule precondition:

[26.3.0] $(-1 + -1) < 176$

\rightarrow [simplify]

[26.3.2] **true**

[26.4] **true** \wedge ($\$heap_{funcstart_724,1}.p1 < (177 * (0 + 1))$)

\rightarrow [simplify]

[26.9] **true** \wedge ($-177 < -\$heap_{funcstart_724,1}.p1$)

\rightarrow [from term 25.0, *literal* $a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (176 + \text{literal})$]

Proof of rule precondition:

[26.9.0] $-2 < (-177 + 176)$

\rightarrow [simplify]

[26.9.2] **true**

[26.10] **true** \wedge **false**

\rightarrow [simplify]

[26.11] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (48,20)

To prove: (**asType**<**integer**>($\$heap_{funcstart_724,1}.p1$) <

asType<**integer**>($\$heap_{funcstart_724,1}.a1$)) \Rightarrow

(**asType**<**integer**>($\$heap_{funcstart_724,1}.p1$) ==

asType<**integer**>(div1.rem))

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

```

$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <

```

asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <

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$\$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \&\&$
 $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_{init}.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 <$
 $-\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 <$
 $\$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \&\&$
 $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 <$
 $-\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 <$
 $\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 <$
 $\$heap_{funcstart_724,1}.p3)$
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] $0 < \$heap_{funcstart_724,1}.p1$
[Take given term]
[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 \rightarrow [simplify]
[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 \rightarrow [const static or extern object]
[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{init}.a1))$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$
 \rightarrow [simplify]
[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
[Take goal term]
[1.0] $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a1)) ==>$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1}.rem))$
 \rightarrow [simplify]
[1.1] $(\$heap_{funcstart_724,1}.p1 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a1))$

$\Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$
 $\rightarrow [\text{const static or extern object}]$
 $[1.2] (\$heap_{funcstart_724,1}.p1 < \text{asType}\langle\text{integer}\rangle(\$heap_{init}.a1)) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[1.3] (\$heap_{funcstart_724,1}.p1 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}177))) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$
 $\rightarrow [\text{simplify}]$
 $[1.10] (-177 < -\$heap_{funcstart_724,1}.p1) \Rightarrow (\$heap_{funcstart_724,1}.p1 == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)}]$
 $[1.11] (-177 < -\$heap_{funcstart_724,1}.p1) \Rightarrow (\$heap_{funcstart_724,1}.p1 == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$
 $\rightarrow [\text{simplify}]$
 $[1.17] (0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)) \vee (176 < \$heap_{funcstart_724,1}.p1)$
 $\rightarrow [\text{negate goal and search for contradiction}]$
 $[1.18] !(0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)) \wedge !(176 < \$heap_{funcstart_724,1}.p1)$
 $\rightarrow [\text{simplify}]$
 $[1.20] !(0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)) \wedge (-177 < -\$heap_{funcstart_724,1}.p1)$
 $\rightarrow [\text{separate conjunction and work on first sub-term}]$
 $[1.21] -177 < -\$heap_{funcstart_724,1}.p1$
 $[\text{Assume known post-assertion, class invariant or type constraint for term 11.6}]$
 $[15.0] (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% \text{asType}\langle\text{integer}\rangle(177)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$
 $\rightarrow [\text{simplify}]$
 $[15.2] (\$heap_{funcstart_724,1}.p1 \% 177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$
 $\rightarrow [\text{expand definition of operator '.*' in class 'int' at built in declaration}]$

[15.3] ([asType<integer>(\$heap_funcstart_724,1.p1) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p1) % 177), []:
 asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] ([asType<integer>(\$heap_funcstart_724,1.p1) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p1) % 177),
 [!(asType<integer>(\$heap_funcstart_724,1.p1) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).rem)

→ [simplify]

[15.7] ([0 < -\$heap_funcstart_724,1.p1]:
 -(-asType<integer>(\$heap_funcstart_724,1.p1) % 177),
 [!(asType<integer>(\$heap_funcstart_724,1.p1) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).rem)

→ [from term 8.0, literal < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0
 + literal)]

Proof of rule precondition:

[15.7.0] -2 < (0 + 0)

→ [simplify]

[15.7.2] true

[15.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p1) % 177),
 [!(asType<integer>(\$heap_funcstart_724,1.p1) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).rem)

→ [simplify]

[15.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p1) % 177), [!(0
 < -\$heap_funcstart_724,1.p1): asType<integer>(\$heap_funcstart_724,1.p1) %
 177) == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).rem)

→ [from term 8.0, literal < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0
 + literal)]

Proof of rule precondition:

[15.11.0] -2 < (0 + 0)

\rightarrow [simplify]
 [15.11.2] **true**
 [15.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) \% 177)$,
 [!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) \% 177$) ==
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem})$
 \rightarrow [simplify]
 [15.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem} + (\$heap_{funcstart_724,1} \cdot p1 \% 177))$
 [Work on sub-term 2 of conjunction in term 1.20]
 [24.0] $!(0 == (\neg \$heap_{funcstart_724,1} \cdot p1 + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}))$
 [Copy term 24.0]
 [25.0] $!(0 == (\neg \$heap_{funcstart_724,1} \cdot p1 + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}))$
 \rightarrow [from term 15.17, $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}$ is equal to $\$heap_{funcstart_724,1} \cdot p1 \% 177$]
 [25.1] $!(0 == (\neg \$heap_{funcstart_724,1} \cdot p1 + (\$heap_{funcstart_724,1} \cdot p1 \% 177)))$
 \rightarrow [remainder with larger divisor]
Proof of rule precondition 1:
 [25.1.0.0] $\text{literal}d < \neg \$heap_{funcstart_724,1} \cdot p1$
 \rightarrow [unify with term 1.21]
 [25.1.0.1] **true**
Proof of rule precondition 2:
 [25.1.1.0] $\text{literal}c < \$heap_{funcstart_724,1} \cdot p1$
 \rightarrow [unify with term 8.0]
 [25.1.1.1] **true**
Proof of rule precondition 3:
 [25.1.2.0] $\neg 177 \leq 177$
 \rightarrow [simplify]
 [25.1.2.2] **true**
Proof of rule precondition 4:
 [25.1.3.0] $-2 < 0$
 \rightarrow [simplify]

[25.1.3.1] **true**
 [25.2] $!(0 == (-\$heap_{funcstart_724,1}.p1 + \$heap_{funcstart_724,1}.p1))$
 \rightarrow [simplify]
 [25.5] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (49,26)

To prove: $!(0 == \text{asType}\langle\text{integer}\rangle(\text{div1.rem})) \parallel !(0 == \text{asType}\langle\text{integer}\rangle(\text{div1.quot}))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) /$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1.quot})$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \%$


```

asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <

$\neg \text{heap_funcstart_724,1.p1}) \wedge (0 < \text{heap_funcstart_724,1.p1}) \wedge (0 < \text{heap_funcstart_724,1.p2}) \wedge (0 < \text{heap_funcstart_724,1.p3})) \&\&$
 $(\text{heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323))))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\text{heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{heap_funcstart_724,1.p1}) \wedge (0 < \text{heap_funcstart_724,1.p1}) \wedge (0 < \text{heap_funcstart_724,1.p2}) \wedge (0 < \text{heap_funcstart_724,1.p3})$
 $[\text{Work on sub-term 4 of conjunction in term 5.40}]$
 $[8.0] 0 < \text{heap_funcstart_724,1.p1}$
 $[\text{Take given term}]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{asType<int>}(\text{heap_funcstart_724,1.p1}), \text{asType<int>}(\text{heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{simplify}]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{heap_funcstart_724,1.p1}, \text{asType<int>}(\text{heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{heap_funcstart_724,1.p1}, \text{asType<int>}(\text{heap_init.a1}))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177))))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{heap_funcstart_724,1.p1}, 177)$
 $[\text{Take goal term}]$
 $[1.0] !(0 == \text{asType<integer>}(\text{div1.rem})) \parallel !(0 == \text{asType<integer>}(\text{div1.quot}))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs heap_funcstart_724,1, heap_funcstart_724,1.p1, 177)}]$
 $[1.1] !(0 == \text{asType<integer>}(\text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{heap_funcstart_724,1.p1}, 177).\text{rem})) \parallel !(0 == \text{asType<integer>}(\text{div1.quot}))$
 $\rightarrow [\text{simplify}]$
 $[1.2] !(0 == \text{div}(\text{heapIs } \text{heap_funcstart_724,1}, \text{heap_funcstart_724,1.p1}, 177).\text{rem}) \parallel !(0 == \text{asType<integer>}(\text{div1.quot}))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs heap_funcstart_724,1,$

$\$heap_{funcstart_724,1} \cdot p1, 177]$
 $[1.3] \text{ !(0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)$
 $\text{ || !(0 == asType<integer>(div(heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1} \cdot p1, 177).quot))$
 $\rightarrow [simplify]$
 $[1.5] \text{ !(0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).quot) \vee !(0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).rem)$
 $\rightarrow [negate\ goal\ and\ search\ for\ contradiction]$
 $[1.6] \text{ (0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot)$
 $\wedge \text{ (0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)$
 $\rightarrow [separate\ conjunction\ and\ work\ on\ first\ sub-term]$
 $[1.7] \text{ 0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot$
 $[Work\ on\ sub-term\ 2\ of\ conjunction\ in\ term\ 1.6]$
 $[26.0] \text{ 0 == div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem$
 $[Take\ given\ term]$
 $[24.0] \text{ (asType<integer>(\$heap_{funcstart_724,1} \cdot p1) <$
 $\text{ asType<integer>(\$heap_{funcstart_724,1} \cdot a1)) =>$
 $\text{ (asType<integer>(\$heap_{funcstart_724,1} \cdot p1) ==}$
 $\text{ asType<integer>(div1.rem))}$
 $\rightarrow [simplify]$
 $[24.1] \text{ (\$heap_{funcstart_724,1} \cdot p1 < asType<integer>(\$heap_{funcstart_724,1} \cdot a1))}$
 $\text{ => (asType<integer>(\$heap_{funcstart_724,1} \cdot p1) ==}$
 $\text{ asType<integer>(div1.rem))}$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[24.2] \text{ (\$heap_{funcstart_724,1} \cdot p1 < asType<integer>(\$heap_{init}.a1)) =>$
 $\text{ (asType<integer>(\$heap_{funcstart_724,1} \cdot p1) ==}$
 $\text{ asType<integer>(div1.rem))}$
 $\rightarrow [expand\ definition\ of\ constant\ 'a1'\ at\ prang.c\ (16,20)]$
 $[24.3] \text{ (\$heap_{funcstart_724,1} \cdot p1 < asType<integer>(asType<short$
 $\text{ int>((int)177))) => (asType<integer>(\$heap_{funcstart_724,1} \cdot p1) ==}$
 $\text{ asType<integer>(div1.rem))}$
 $\rightarrow [simplify]$
 $[24.10] \text{ (-177 < -\$heap_{funcstart_724,1} \cdot p1) => (\$heap_{funcstart_724,1} \cdot p1 ==}$
 $\text{ asType<integer>(div1.rem))}$
 $\rightarrow [from\ term\ 11.6,\ div1\ is\ equal\ to\ div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1} \cdot p1, 177)]$

[24.11] $(-177 < -\$heap_funcstart_724,1.p1) \Rightarrow (\$heap_funcstart_724,1.p1 == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))$

→ [simplify]

[24.17] $(0 == (-\$heap_funcstart_724,1.p1 + \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})) \vee (176 < \$heap_funcstart_724,1.p1)$

→ [from term 26.0, $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}$ is equal to 0]

[24.18] $(0 == (-\$heap_funcstart_724,1.p1 + 0)) \vee (176 < \$heap_funcstart_724,1.p1)$

→ [simplify]

[24.19] $(0 == -\$heap_funcstart_724,1.p1) \vee (176 < \$heap_funcstart_724,1.p1)$

→ [from term 8.0, $-\$heap_funcstart_724,1.p1 == \text{literal}_a$ is false whenever $-1 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[24.19.0] $-1 < (0 + 0)$

→ [simplify]

[24.19.2] **true**

[24.20] **false** $\vee (176 < \$heap_funcstart_724,1.p1)$

→ [simplify]

[24.21] $176 < \$heap_funcstart_724,1.p1$

[Take given term]

[25.0] $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.a1) \leq \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1)) \Rightarrow !(0 == \text{asType}\langle\text{integer}\rangle(\text{div}1.\text{quot}))$

→ [const static or extern object]

[25.1] $(\text{asType}\langle\text{integer}\rangle(\$heap_init.a1) \leq \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1)) \Rightarrow !(0 == \text{asType}\langle\text{integer}\rangle(\text{div}1.\text{quot}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[25.2] $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)) \leq \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1)) \Rightarrow !(0 == \text{asType}\langle\text{integer}\rangle(\text{div}1.\text{quot}))$

→ [simplify]

[25.8] $(176 < \$heap_funcstart_724,1.p1) \Rightarrow !(0 == \text{asType}\langle\text{integer}\rangle(\text{div}1.\text{quot}))$

→ [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1,$

$\$heap_{funcstart_724,1}.p1, 177]$

[25.9] $!(0 == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$

$\text{asType}<\text{integer}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot}))$

$\rightarrow [\text{simplify}]$

[25.13] $!(0 == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot}) \vee (-177 < -\$heap_{funcstart_724,1}.p1)$

$\rightarrow [\text{from term 24.21, literal } a < -\$heap_{funcstart_724,1}.p1 \text{ is false whenever } -2 <$
 $(176 + \text{literal})]$

Proof of rule precondition:

[25.13.0] $-2 < (-177 + 176)$

$\rightarrow [\text{simplify}]$

[25.13.2] **true**

[25.14] **false** $\vee !(0 == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot}))$

$\rightarrow [\text{from term 1.7, div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot} \text{ is equal to } 0]$

[25.15] **false** $\vee !(0 == 0)$

$\rightarrow [\text{simplify}]$

[25.18] **false**

Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (51,22)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$heap_{funcstart_724,1}.p2$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart}_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart}_724,1.p1)) &&
(asType<integer>(\$heap_{funcstart}_724,1.p1) <
asType<integer>(\$heap_{funcstart}_724,1.M1))) && (0 <
asType<integer>(\$heap_{funcstart}_724,1.p2))) &&
(asType<integer>(\$heap_{funcstart}_724,1.p2) <
asType<integer>(\$heap_{funcstart}_724,1.M2))) && (0 <
asType<integer>(\$heap_{funcstart}_724,1.p3))) &&

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&

```


$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [simplify]
[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_funcstart_724,1.p2$
[Take goal term]
[1.0] $\text{minof}(\text{int}) \leq \$heap_funcstart_724,1.p2$
 \rightarrow [simplify]
[1.3] $-32769 < \$heap_funcstart_724,1.p2$
 \rightarrow [from term 9.0, literal $a < \$heap_funcstart_724,1.p2$ is true whenever $(-1 +$
 $\text{literal}) < 0]$

Proof of rule precondition:

[1.3.0] $(-32769 + -1) < 0$

\rightarrow [simplify]

[1.3.2] **true**

[1.4] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (51,22)

Condition defined at:

To prove: $\$heap_{funcstart_724,1}.p2 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1),$

$\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1)) /$

$\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))) ==$

```

asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <

```

$\neg \text{\$heap_funcstart_724,1.p1} \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3}) \ \&\& (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < \neg \text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < \neg \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < \neg \text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < \neg \text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < \neg \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$
[Work on sub-term 2 of conjunction in term 5.40]
[6.0] $-30307 < \neg \text{\$heap_funcstart_724,1.p2}$
[Take goal term]
[1.0] $\text{\$heap_funcstart_724,1.p2} \leq \text{maxof(int)}$
 \rightarrow [simplify]
[1.9] $-32768 < \neg \text{\$heap_funcstart_724,1.p2}$
 \rightarrow [from term 6.0, literal $a < \neg \text{\$heap_funcstart_724,1.p2}$ is true whenever $(-1 + \text{literal}) < -30307$]
Proof of rule precondition:
[1.9.0] $(-32768 + -1) < -30307$
 \rightarrow [simplify]
[1.9.2] **true**
[1.10] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (51,31)

Condition defined at:

To prove: $\text{minof(int)} \leq \text{\$heap_funcstart_724,1.a2}$

Given:

$\text{\$heap_init.LIMIT} == (\text{int})80$

$\text{\$heap_init.M1} == \text{asType<short int>}((\text{int})30269)$

```

$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

```

Proof:

[Take goal term]

[1.0] minof(int) ≤ \$heap_{funcstart}_724,1.a2

\rightarrow [simplify]
 [1.1] $-32768 \leq \$heap_{funcstart_724,1}.a2$
 \rightarrow [const static or extern object]
 [1.2] $-32768 \leq \$heap_{init}.a2$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
 [1.3] $-32768 \leq \text{asType}<\text{short int}>((\text{int})176)$
 \rightarrow [simplify]
 [1.6] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (51,31)

Condition defined at:

To prove: $\$heap_{funcstart_724,1}.a2 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

```

asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

```

Proof:

[Take goal term]

[1.0] \$heap_funcstart_724,1.a2 ≤ maxof(int)

→ [const static or extern object]

[1.1] \$heap_init.a2 ≤ maxof(int)

→ [expand definition of constant 'a2' at prang.c (21,20)]

[1.2] asType<short int>((int)176) ≤ maxof(int)

→ [simplify]

[1.6] true

Proof of verification condition: Precondition of 'div' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (51,18)

Condition defined at: C:\Escher\ecv\standard\stdlib.h (94,10)

To prove: 0 < asType<integer>(asType<int>(\$heap_funcstart_724,1.a2))

Given:

\$heap_init.LIMIT == (int)80

\$heap_init.M1 == asType<short int>((int)30269)

\$heap_init.r1 == asType<short int>((int)171)

\$heap_init.a1 == asType<short int>((int)177)


```

$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

```

Proof:

[Take goal term]

[1.0] 0 < asType<integer>(asType<int>(\$heap_{funcstart}_724,1.a2))

→ [const static or extern object]

[1.1] 0 < asType<integer>(asType<int>(\$heap_{init}.a2))

\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
 [1.2] $0 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})176)))$
 \rightarrow [simplify]
 [1.7] **true**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (52,48)

To prove: $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a2) \leq \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)) \Rightarrow !(0 == \text{asType}\langle\text{integer}\rangle(\text{div2.quot}))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1), \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) / \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) == \text{asType}\langle\text{integer}\rangle(\text{div1.quot})$

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <

```

asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧

```

$(0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} <$
 $\text{asType<integer>}(\text{asType<short int>}((\text{int})30307)))) \ \&\& \ (0 <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\textit{simplify}]$
 $[5.30] \ ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\textit{const static or extern object}]$
 $[5.31] \ ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 $\rightarrow [\textit{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] \ ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short}$
 $\text{int>}((\text{int})30323)))$
 $\rightarrow [\textit{simplify}]$
 $[5.40] \ (-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 <$
 $-\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p3})$
 $[\textit{Work on sub-term 5 of conjunction in term 5.40}]$
 $[9.0] \ 0 < \text{\$heap_funcstart_724,1.p2}$
 $[\textit{Take given term}]$
 $[27.0] \ \text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$
 $\rightarrow [\textit{simplify}]$
 $[27.1] \ \text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$
 $\rightarrow [\textit{const static or extern object}]$
 $[27.2] \ \text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 → [simplify]
 [27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Take goal term]
 [1.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.a2}) \leq$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2})) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div2.quot}))$
 → [const static or extern object]
 [1.1] $(\text{asType<integer>}(\$ \text{heap_init.a2}) \leq$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2})) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div2.quot}))$
 → [expand definition of constant 'a2' at prang.c (21,20)]
 [1.2] $(\text{asType<integer>}(\text{asType<short int>}((\text{int})176)) \leq$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2})) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div2.quot}))$
 → [simplify]
 [1.8] $(175 < \$ \text{heap_funcstart_724,1.p2}) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div2.quot}))$
 → [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p2}, 176)$]
 [1.9] $(175 < \$ \text{heap_funcstart_724,1.p2}) \Rightarrow !(0 ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p2},$
 $176).\text{quot}))$
 → [simplify]
 [1.13] $!(0 == \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p2},$
 $176).\text{quot}) \vee (-176 < -\$ \text{heap_funcstart_724,1.p2})$
 → [negate goal and search for contradiction]
 [1.14] $(0 == \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p2},$
 $176).\text{quot}) \wedge !(-176 < -\$ \text{heap_funcstart_724,1.p2})$
 → [simplify]
 [1.17] $(0 == \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p2},$
 $176).\text{quot}) \wedge (175 < \$ \text{heap_funcstart_724,1.p2})$
 → [separate conjunction and work on first sub-term]
 [1.18] $0 == \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p2}, 176).\text{quot}$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] (**asType**<**integer**>(\$heap_funcstart_724,1.p2) /
asType<**integer**>(176)) == **asType**<**integer**>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)

→ [simplify]

[30.2] (\$heap_funcstart_724,1.p2 / 176) == **asType**<**integer**>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)

→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] ([**asType**<**integer**>(\$heap_funcstart_724,1.p2) < 0]:
–(–**asType**<**integer**>(\$heap_funcstart_724,1.p2) / 176), []:
asType<**integer**>(\$heap_funcstart_724,1.p2) / 176) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).quot)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] ([**asType**<**integer**>(\$heap_funcstart_724,1.p2) < 0]:
–(–**asType**<**integer**>(\$heap_funcstart_724,1.p2) / 176),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p2) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p2) / 176) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).quot)

→ [simplify]

[30.7] ([0 < –\$heap_funcstart_724,1.p2]:
–(–**asType**<**integer**>(\$heap_funcstart_724,1.p2) / 176),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p2) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p2) / 176) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).quot)

→ [from term 9.0, literal < –\$heap_funcstart_724,1.p2 is false whenever -2 < (0
+ literal)]

Proof of rule precondition:

[30.7.0] -2 < (0 + 0)

→ [simplify]

[30.7.2] **true**

[30.8] ([**false**]: –(–**asType**<**integer**>(\$heap_funcstart_724,1.p2) / 176),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p2) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p2) / 176) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).quot)

→ [simplify]

[30.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) / 176)$, $[(0 < -\$heap_funcstart_724,1.p2)]: \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) / 176$)
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot})$
 \rightarrow [from term 9.0, $\text{literal} < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[30.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.11.2] **true**

[30.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) / 176)$,
[!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) / 176$)
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot})$

\rightarrow [simplify]

[30.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot} + (\$heap_funcstart_724,1.p2 / 176))$

\rightarrow [from term 1.18, $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}$ is equal to 0]

[30.18] $0 == (-0 + (\$heap_funcstart_724,1.p2 / 176))$

\rightarrow [simplify]

[30.20] $0 == (\$heap_funcstart_724,1.p2 / 176)$

[Work on sub-term 2 of conjunction in term 1.17]

[41.0] $175 < \$heap_funcstart_724,1.p2$

[Create new term from term 30.20 using rule: condition for equality of division]

[45.0] $((0 * 176) < (1 + \$heap_funcstart_724,1.p2)) \wedge (\$heap_funcstart_724,1.p2 < (176 * (0 + 1)))$

\rightarrow [simplify]

[45.3] $(-1 < \$heap_funcstart_724,1.p2) \wedge (\$heap_funcstart_724,1.p2 < (176 * (0 + 1)))$

\rightarrow [from term 41.0, $\text{literal} < \$heap_funcstart_724,1.p2$ is true whenever $(-1 + \text{literal}) < 175$]

Proof of rule precondition:

[45.3.0] $(-1 + -1) < 175$

\rightarrow [simplify]

[45.3.2] **true**

[45.4] **true** \wedge ($\$heap_{funcstart_724,1}.p2 < (176 * (0 + 1))$)

\rightarrow [simplify]

[45.9] **true** \wedge ($-176 < -\$heap_{funcstart_724,1}.p2$)

\rightarrow [from term 41.0, *literal* $a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (175 + \text{literal})$]

Proof of rule precondition:

[45.9.0] $-2 < (-176 + 175)$

\rightarrow [simplify]

[45.9.2] **true**

[45.10] **true** \wedge **false**

\rightarrow [simplify]

[45.11] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (52,20)

To prove: (**asType**<**integer**>($\$heap_{funcstart_724,1}.p2$) <

asType<**integer**>($\$heap_{funcstart_724,1}.a2$)) \Rightarrow

(**asType**<**integer**>($\$heap_{funcstart_724,1}.p2$) ==

asType<**integer**>(div2.rem))

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

```

$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart}_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart}_724,1.p1)) &&
(asType<integer>(\$heap_{funcstart}_724,1.p1) <
asType<integer>(\$heap_{funcstart}_724,1.M1))) && (0 <
asType<integer>(\$heap_{funcstart}_724,1.p2))) &&
(asType<integer>(\$heap_{funcstart}_724,1.p2) <

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <

```

$\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{init}.M2))) \ \&\& \ (0 <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.p3))) \ \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] \ (((-30269 < -\text{\$heap}_{funcstart_724,1}.p1) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p1) \wedge$
 $(0 < \text{\$heap}_{funcstart_724,1}.p2)) \ \&\& \ (\text{\$heap}_{funcstart_724,1}.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \ \&\& \ (0 <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.p3))) \ \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] \ ((-30307 < -\text{\$heap}_{funcstart_724,1}.p2) \wedge (-30269 <$
 $-\text{\$heap}_{funcstart_724,1}.p1) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p1) \wedge (0 <$
 $\text{\$heap}_{funcstart_724,1}.p2) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p3)) \ \&\&$
 $(\text{\$heap}_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] \ ((-30307 < -\text{\$heap}_{funcstart_724,1}.p2) \wedge (-30269 <$
 $-\text{\$heap}_{funcstart_724,1}.p1) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p1) \wedge (0 <$
 $\text{\$heap}_{funcstart_724,1}.p2) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p3)) \ \&\&$
 $(\text{\$heap}_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{init}.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] \ ((-30307 < -\text{\$heap}_{funcstart_724,1}.p2) \wedge (-30269 <$
 $-\text{\$heap}_{funcstart_724,1}.p1) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p1) \wedge (0 <$
 $\text{\$heap}_{funcstart_724,1}.p2) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p3)) \ \&\&$
 $(\text{\$heap}_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323))))$
 $\rightarrow [\text{simplify}]$
 $[5.40] \ (-30323 < -\text{\$heap}_{funcstart_724,1}.p3) \wedge (-30307 <$
 $-\text{\$heap}_{funcstart_724,1}.p2) \wedge (-30269 < -\text{\$heap}_{funcstart_724,1}.p1) \wedge (0 <$
 $\text{\$heap}_{funcstart_724,1}.p1) \wedge (0 < \text{\$heap}_{funcstart_724,1}.p2) \wedge (0 <$
 $\text{\$heap}_{funcstart_724,1}.p3)$
 $[\text{Work on sub-term 5 of conjunction in term 5.40}]$
 $[9.0] \ 0 < \text{\$heap}_{funcstart_724,1}.p2$
 $[\text{Take given term}]$
 $[27.0] \ \text{div2} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.p2),$
 $\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.a2))$
 $\rightarrow [\text{simplify}]$

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 \rightarrow [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
[Take goal term]

[1.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < \text{asType<integer>}(\$ \text{heap_funcstart_724,1.a2})) \Rightarrow (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) == \text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [simplify]

[1.1] $(\$ \text{heap_funcstart_724,1.p2} < \text{asType<integer>}(\$ \text{heap_funcstart_724,1.a2})) \Rightarrow (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) == \text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [const static or extern object]

[1.2] $(\$ \text{heap_funcstart_724,1.p2} < \text{asType<integer>}(\$ \text{heap_init.a2})) \Rightarrow (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) == \text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]

[1.3] $(\$ \text{heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{asType<short int>}((\text{int})176))) \Rightarrow (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) == \text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [simplify]

[1.10] $(-176 < -\$ \text{heap_funcstart_724,1.p2}) \Rightarrow (\$ \text{heap_funcstart_724,1.p2} == \text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.11] $(-176 < -\$ \text{heap_funcstart_724,1.p2}) \Rightarrow (\$ \text{heap_funcstart_724,1.p2} == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))$
 \rightarrow [simplify]

[1.17] $(0 == (-\$ \text{heap_funcstart_724,1.p2} + \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1.p2}, 176).rem)) \vee (175 < \$heap_{funcstart_724,1.p2})$
 \rightarrow [negate goal and search for contradiction]
[1.18] $!(0 == (-\$heap_{funcstart_724,1.p2} + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem)) \wedge !(175 < \$heap_{funcstart_724,1.p2})$
 \rightarrow [simplify]
[1.20] $!(0 == (-\$heap_{funcstart_724,1.p2} + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem)) \wedge (-176 < -\$heap_{funcstart_724,1.p2})$
 \rightarrow [separate conjunction and work on first sub-term]
[1.21] $-176 < -\$heap_{funcstart_724,1.p2}$
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% \text{asType}\langle\text{integer}\rangle(176)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))$
 \rightarrow [simplify]
[31.2] $(\$heap_{funcstart_724,1.p2} \% 176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))$
 \rightarrow [expand definition of operator ‘.’ in class ‘int’ at built in declaration]
[31.3] $([\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% 176), []:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] $([\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% 176),$
 $!([\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))$
 \rightarrow [simplify]
[31.7] $([0 < -\$heap_{funcstart_724,1.p2}]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% 176),$
 $!([\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))$
 \rightarrow [from term 9.0, literal $a < -\$heap_{funcstart_724,1.p2}$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.7.2] **true**

[31.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
 $!(\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) < 0)$):
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$

\rightarrow [simplify]

[31.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$, $!(0$
 $< -\text{\$heap_funcstart_724,1.p2})$): $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \%$
 $176) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem})$

\rightarrow [from term 9.0, *literal* $< -\text{\$heap_funcstart_724,1.p2}$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.11.2] **true**

[31.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
[false]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$

\rightarrow [simplify]

[31.17] $0 == (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem} + (\text{\$heap_funcstart_724,1.p2} \% 176))$

[Work on sub-term 2 of conjunction in term 1.20]

[40.0] $!(0 == (\neg \text{\$heap_funcstart_724,1.p2} + \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem}))$

[Copy term 40.0]

[44.0] $!(0 == (\neg \text{\$heap_funcstart_724,1.p2} + \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem}))$

\rightarrow [from term 31.17, $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem}$ is equal to $\text{\$heap_funcstart_724,1.p2} \% 176]$

[44.1] $!(0 == (\neg \text{\$heap_funcstart_724,1.p2} + (\text{\$heap_funcstart_724,1.p2} \% 176)))$

\rightarrow [remainder with larger divisor]

Proof of rule precondition 1:

[44.1.0.0] literald < - $\text{\$heap}_{funcstart_724,1} \cdot p2$

→ [unify with term 1.21]

[44.1.0.1] **true**

Proof of rule precondition 2:

[44.1.1.0] literalc < $\text{\$heap}_{funcstart_724,1} \cdot p2$

→ [unify with term 9.0]

[44.1.1.1] **true**

Proof of rule precondition 3:

[44.1.2.0] $-176 \leq 176$

→ [simplify]

[44.1.2.2] **true**

Proof of rule precondition 4:

[44.1.3.0] $-2 < 0$

→ [simplify]

[44.1.3.1] **true**

[44.2] $!(0 == (-\text{\$heap}_{funcstart_724,1} \cdot p2 + \text{\$heap}_{funcstart_724,1} \cdot p2))$

→ [simplify]

[44.5] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (53,26)

To prove: $!(0 == \text{asType}\langle \text{integer} \rangle(\text{div2.rem})) \parallel !(0 == \text{asType}\langle \text{integer} \rangle(\text{div2.quot}))$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType}\langle \text{short int} \rangle((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType}\langle \text{short int} \rangle((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType}\langle \text{short int} \rangle((\text{int})172)$

$\text{\$heap}_{init}.a2 == \text{asType}\langle \text{short int} \rangle((\text{int})176)$


```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

```

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>(asType<short
int>((int)30323)))

```

\rightarrow [simplify]
[5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_{funcstart_724,1}.p2$
[Take given term]
[27.0] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.p2), \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a2))$
 \rightarrow [simplify]
[27.1] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a2))$
 \rightarrow [const static or extern object]
[27.2] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, \mathbf{asType}<\mathbf{int}>(\$heap_{init}.a2))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})176)))$
 \rightarrow [simplify]
[27.6] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$
[Take goal term]
[1.0] $!(0 == \mathbf{asType}<\mathbf{integer}>(div2.rem)) \parallel !(0 == \mathbf{asType}<\mathbf{integer}>(div2.quot))$
 \rightarrow [from term 27.6, div2 is equal to $div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[1.1] $!(0 == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)) \parallel !(0 == \mathbf{asType}<\mathbf{integer}>(div2.quot))$
 \rightarrow [simplify]
[1.2] $!(0 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) \parallel !(0 == \mathbf{asType}<\mathbf{integer}>(div2.quot))$
 \rightarrow [from term 27.6, div2 is equal to $div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[1.3] $!(0 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) \parallel !(0 == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot))$

→ [simplify]

[1.5] $!(0 == \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot) \vee !(0 == \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem)$

→ [negate goal and search for contradiction]

[1.6] $(0 == \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot) \wedge (0 == \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem)$

→ [separate conjunction and work on first sub-term]

[1.7] $0 == \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot$

[Work on sub-term 2 of conjunction in term 1.6]

[42.0] $0 == \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem$

[Take given term]

[40.0] $(\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2) < \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.a2)) \Rightarrow (\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2) == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2}.rem))$

→ [simplify]

[40.1] $(\$heap_{funcstart_724,1}.p2 < \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.a2)) \Rightarrow (\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2) == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2}.rem))$

→ [const static or extern object]

[40.2] $(\$heap_{funcstart_724,1}.p2 < \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{init}.a2)) \Rightarrow (\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2) == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2}.rem))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[40.3] $(\$heap_{funcstart_724,1}.p2 < \mathbf{asType}\langle\mathbf{integer}\rangle(\mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})176))) \Rightarrow (\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2) == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2}.rem))$

→ [simplify]

[40.10] $(-176 < -\$heap_{funcstart_724,1}.p2) \Rightarrow (\$heap_{funcstart_724,1}.p2 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2}.rem))$

→ [from term 27.6, div2 is equal to $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176)$]

[40.11] $(-176 < -\$heap_{funcstart_724,1}.p2) \Rightarrow (\$heap_{funcstart_724,1}.p2 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem))$

→ [simplify]

[40.17] $(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)) \vee (175 < \$heap_{funcstart_724,1}.p2)$
 \rightarrow [from term 42.0, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem$ is equal to 0]
[40.18] $(0 == (-\$heap_{funcstart_724,1}.p2 + 0)) \vee (175 < \$heap_{funcstart_724,1}.p2)$
 \rightarrow [simplify]
[40.19] $(0 == -\$heap_{funcstart_724,1}.p2) \vee (175 < \$heap_{funcstart_724,1}.p2)$
 \rightarrow [from term 9.0, $-\$heap_{funcstart_724,1}.p2 == \text{literal}_a$ is false whenever $-1 < (0 + \text{literal}_a)$]
Proof of rule precondition:
[40.19.0] $-1 < (0 + 0)$
 \rightarrow [simplify]
[40.19.2] **true**
[40.20] **false** $\vee (175 < \$heap_{funcstart_724,1}.p2)$
 \rightarrow [simplify]
[40.21] $175 < \$heap_{funcstart_724,1}.p2$
[Take given term]
[41.0] $(\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.a2) \leq \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2)) \Rightarrow !(0 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2.quot}))$
 \rightarrow [const static or extern object]
[41.1] $(\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{init}.a2) \leq \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2)) \Rightarrow !(0 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2.quot}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[41.2] $(\mathbf{asType}\langle\mathbf{integer}\rangle(\mathbf{asType}\langle\mathbf{short int}\rangle((\mathbf{int})176)) \leq \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{funcstart_724,1}.p2)) \Rightarrow !(0 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2.quot}))$
 \rightarrow [simplify]
[41.8] $(175 < \$heap_{funcstart_724,1}.p2) \Rightarrow !(0 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div2.quot}))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[41.9] $(175 < \$heap_{funcstart_724,1}.p2) \Rightarrow !(0 == \mathbf{asType}\langle\mathbf{integer}\rangle(\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot))$

→ [simplify]

[41.13] $!(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) \vee (-176 < -\$ \text{heap_funcstart_724,1.p2})$

→ [from term 40.21, $\text{literal} < -\$ \text{heap_funcstart_724,1.p2}$ is false whenever $-2 < (175 + \text{literal})$]

Proof of rule precondition:

[41.13.0] $-2 < (-176 + 175)$

→ [simplify]

[41.13.2] **true**

[41.14] $\text{false} \vee !(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [from term 1.7, $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$ is equal to 0]

[41.15] $\text{false} \vee !(0 == 0)$

→ [simplify]

[41.18] **false**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (55,22)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap_funcstart_724,1.p3}$

Given:

$\$ \text{heap_init.LIMIT} == (\text{int})80$

$\$ \text{heap_init.M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\$ \text{heap_init.r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\$ \text{heap_init.a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\$ \text{heap_init.b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\$ \text{heap_init.M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\$ \text{heap_init.r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\$ \text{heap_init.a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\$ \text{heap_init.b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\$ \text{heap_init.M3} == \text{asType}<\text{short int}>((\text{int})30323)$

$\$ \text{heap_init.r3} == \text{asType}<\text{short int}>((\text{int})170)$

```

$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==

```



```

asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

```

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$

[5.40] $(-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \text{\$heap_funcstart_724,1.p3}$

[Take goal term]

[1.0] **minof(int)** $\leq \text{\$heap_funcstart_724,1.p3}$

\rightarrow [simplify]

[1.3] $-32769 < \text{\$heap_funcstart_724,1.p3}$

\rightarrow [from term 10.0, *literal* $< \text{\$heap_funcstart_724,1.p3}$ is true whenever $(-1 + \text{literal}) < 0$]

Proof of rule precondition:

[1.3.0] $(-32769 + -1) < 0$

\rightarrow [simplify]

[1.3.2] **true**

[1.4] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (55,22)

Condition defined at:

To prove: $\text{\$heap_funcstart_724,1.p3} \leq \text{maxof(int)}$

Given:

$\text{\$heap_init.LIMIT} == (\text{int})80$

$\text{\$heap_init.M1} == \text{asType<short int>}((\text{int})30269)$

$\text{\$heap_init.r1} == \text{asType<short int>}((\text{int})171)$

$\text{\$heap_init.a1} == \text{asType<short int>}((\text{int})177)$

$\text{\$heap_init.b1} == \text{asType<short int>}((\text{int})2)$

$\text{\$heap_init.M2} == \text{asType<short int>}((\text{int})30307)$

$\text{\$heap_init.r2} == \text{asType<short int>}((\text{int})172)$

$\text{\$heap_init.a2} == \text{asType<short int>}((\text{int})176)$

$\text{\$heap_init.b2} == \text{asType<short int>}((\text{int})35)$

$\text{\$heap_init.M3} == \text{asType<short int>}((\text{int})30323)$

```

$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

```

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a2) \leq$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)) \Rightarrow !(0 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div2.quot}))$
 $!(0 == \text{asType}\langle\text{integer}\rangle(\text{div2.rem})) \parallel !(0 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div2.quot}))$

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1)$) &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M1)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M2)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M1)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M2)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{init}.M1)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M2)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30269)))$ && (0 <
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)))$ &&
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) <$

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>(asType<short
int>((int)30323)))

```

\rightarrow [simplify]
 [5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
 \rightarrow [separate conjunction and work on first sub-term]
 [5.41] $-30323 < -\$heap_{funcstart_724,1}.p3$
 [Take goal term]
 [1.0] $\$heap_{funcstart_724,1}.p3 \leq \mathbf{maxof(int)}$
 \rightarrow [simplify]
 [1.9] $-32768 < -\$heap_{funcstart_724,1}.p3$
 \rightarrow [from term 5.41, literal $a < -\$heap_{funcstart_724,1}.p3$ is true whenever $(-1 + literal) < -30323$]
Proof of rule precondition:
 [1.9.0] $(-32768 + -1) < -30323$
 \rightarrow [simplify]
 [1.9.2] **true**
 [1.10] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (55,31)

Condition defined at:

To prove: $\mathbf{minof(int)} \leq \$heap_{funcstart_724,1}.a3$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType<short int>}((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType<short int>}((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType<short int>}((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType<short int>}((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType<short int>}((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType<short int>}((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType<short int>}((\mathbf{int})176)$
 $\$heap_{init}.b2 == \mathbf{asType<short int>}((\mathbf{int})35)$

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==

```



```

asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

```

Proof:

```

[Take goal term]
[1.0] minof(int) ≤ $heap_funcstart_724,1.a3
→ [simplify]
[1.1] -32768 ≤ $heap_funcstart_724,1.a3
→ [const static or extern object]
[1.2] -32768 ≤ $heap_init.a3
→ [expand definition of constant 'a3' at prang.c (26,20)]
[1.3] -32768 ≤ asType<short int>((int)178)
→ [simplify]
[1.6] true

```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (55,31)

Condition defined at:

To prove: \$heap_funcstart_724,1.a3 ≤ maxof(int)

Given:

```

$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)

```

```

$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

```

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a2) \leq$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2)) \Rightarrow !(0 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div2.quot}))$
 $!(0 == \text{asType}\langle\text{integer}\rangle(\text{div2.rem})) \parallel !(0 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div2.quot}))$

Proof:

[Take goal term]

[1.0] $\$heap_{funcstart_724,1}.a3 \leq \text{maxof}(\text{int})$

→ [const static or extern object]

[1.1] $\$heap_{init}.a3 \leq \text{maxof}(\text{int})$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[1.2] $\text{asType}\langle\text{short int}\rangle((\text{int})178) \leq \text{maxof}(\text{int})$

→ [simplify]

[1.6] **true**

Proof of verification condition: Precondition of 'div' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (55,18)

Condition defined at: C:\Escher\ecv\standard\stdlib.h (94,10)

To prove: $0 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a3))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

```

$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)

div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==

```

asType<integer>(div2.quot))

Proof:

[Take goal term]

[1.0] 0 < asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a3))

→ [const static or extern object]

[1.1] 0 < asType<integer>(asType<int>(\$heap_{init}.a3))

→ [expand definition of constant 'a3' at prang.c (26,20)]

[1.2] 0 < asType<integer>(asType<int>(asType<short int>((int)178)))

→ [simplify]

[1.7] true

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (56,48)

To prove: (asType<integer>(\$heap_{funcstart_724,1}.a3) ≤
asType<integer>(\$heap_{funcstart_724,1}.p3)) => !(0 ==
asType<integer>(div3.quot))

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

```

$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p3),

```

```

asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) ==>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <

`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] `(((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <`
`asType<integer>(asType<short int>((int)30269)))) && (0 <`
`asType<integer>($heap_funcstart_724,1.p2))) &&`
`(asType<integer>($heap_funcstart_724,1.p2) <`
`asType<integer>($heap_funcstart_724,1.M2))) && (0 <`
`asType<integer>($heap_funcstart_724,1.p3))) &&`
`(asType<integer>($heap_funcstart_724,1.p3) <`
`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [simplify]
[5.16] `((((-30269 < -$heap_funcstart_724,1.p1) \wedge (0 < $heap_funcstart_724,1.p1) \wedge`
`(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <`
`asType<integer>($heap_funcstart_724,1.M2))) && (0 <`
`asType<integer>($heap_funcstart_724,1.p3))) &&`
`(asType<integer>($heap_funcstart_724,1.p3) <`
`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [const static or extern object]
[5.17] `((((-30269 < -$heap_funcstart_724,1.p1) \wedge (0 < $heap_funcstart_724,1.p1) \wedge`
`(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <`
`asType<integer>($heap_init.M2))) && (0 <`
`asType<integer>($heap_funcstart_724,1.p3))) &&`
`(asType<integer>($heap_funcstart_724,1.p3) <`
`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] `((((-30269 < -$heap_funcstart_724,1.p1) \wedge (0 < $heap_funcstart_724,1.p1) \wedge`
`(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <`
`asType<integer>(asType<short int>((int)30307)))) && (0 <`
`asType<integer>($heap_funcstart_724,1.p3))) &&`
`(asType<integer>($heap_funcstart_724,1.p3) <`
`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [simplify]
[5.30] `(((-30307 < -$heap_funcstart_724,1.p2) \wedge (-30269 <`
`-$heap_funcstart_724,1.p1) \wedge (0 < $heap_funcstart_724,1.p1) \wedge (0 <`
`$heap_funcstart_724,1.p2) \wedge (0 < $heap_funcstart_724,1.p3)) &&`
`($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [const static or extern object]
[5.31] `(((-30307 < -$heap_funcstart_724,1.p2) \wedge (-30269 <`
`-$heap_funcstart_724,1.p1) \wedge (0 < $heap_funcstart_724,1.p1) \wedge (0 <`
`$heap_funcstart_724,1.p2) \wedge (0 < $heap_funcstart_724,1.p3)) &&`
`($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))`

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < **asType<integer>**(**asType<short int>**((**int**)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] 0 < \$heap_funcstart_724,1.p3

[Take given term]

[43.0] div3 == div(**heapIs** \$heap_funcstart_724,1, **asType<int>**(\$heap_funcstart_724,1.p3), **asType<int>**(\$heap_funcstart_724,1.a3))

→ [simplify]

[43.1] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, **asType<int>**(\$heap_funcstart_724,1.a3))

→ [const static or extern object]

[43.2] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, **asType<int>**(\$heap_init.a3))

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, **asType<int>**(**asType<short int>**((**int**)178)))

→ [simplify]

[43.6] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)

[Take goal term]

[1.0] (**asType<integer>**(\$heap_funcstart_724,1.a3) ≤ **asType<integer>**(\$heap_funcstart_724,1.p3)) ==> !(0 == **asType<integer>**(div3.quot))

→ [const static or extern object]

[1.1] (**asType<integer>**(\$heap_init.a3) ≤ **asType<integer>**(\$heap_funcstart_724,1.p3)) ==> !(0 == **asType<integer>**(div3.quot))

→ [expand definition of constant 'a3' at prang.c (26,20)]

$[1.2] \text{ (asType<integer>(asType<short int>((int)178)) \leq}$
 $\text{asType<integer>}(\$heap_{funcstart_724,1} \cdot p3)) \Rightarrow !(0 ==$
 $\text{asType<integer>}(div3.quot))$
 $\rightarrow [simplify]$
 $[1.8] (177 < \$heap_{funcstart_724,1} \cdot p3) \Rightarrow !(0 ==$
 $\text{asType<integer>}(div3.quot))$
 $\rightarrow [from \text{ term } 43.6, \text{ div3 is equal to } div(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1} \cdot p3, 178)]$
 $[1.9] (177 < \$heap_{funcstart_724,1} \cdot p3) \Rightarrow !(0 ==$
 $\text{asType<integer>}(div(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).quot))$
 $\rightarrow [simplify]$
 $[1.13] !(0 == div(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).quot) \vee (-178 < -\$heap_{funcstart_724,1} \cdot p3)$
 $\rightarrow [negate \text{ goal and search for contradiction}]$
 $[1.14] (0 == div(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).quot) \wedge !(-178 < -\$heap_{funcstart_724,1} \cdot p3)$
 $\rightarrow [simplify]$
 $[1.17] (0 == div(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).quot) \wedge (177 < \$heap_{funcstart_724,1} \cdot p3)$
 $\rightarrow [separate \text{ conjunction and work on first sub-term}]$
 $[1.18] 0 == div(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot$
 $[Assume \text{ known post-assertion, class invariant or type constraint for term } 43.6]$
 $[46.0] (\text{asType<integer>}(\$heap_{funcstart_724,1} \cdot p3) /$
 $\text{asType<integer>}(178)) == \text{asType<integer>}(div(\text{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot)$
 $\rightarrow [simplify]$
 $[46.2] (\$heap_{funcstart_724,1} \cdot p3 / 178) == \text{asType<integer>}(div(\text{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot)$
 $\rightarrow [expand \text{ definition of operator '.'/ in class 'int' at built in declaration}]$
 $[46.3] ([\text{asType<integer>}(\$heap_{funcstart_724,1} \cdot p3) < 0]:$
 $-(\neg \text{asType<integer>}(\$heap_{funcstart_724,1} \cdot p3) / 178), []:$
 $\text{asType<integer>}(\$heap_{funcstart_724,1} \cdot p3) / 178) ==$
 $\text{asType<integer>}(div(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).quot)$
 $\rightarrow [explicitly \text{ assert falsehood of skipped guards in subsequent guards}]$
 $[46.4] ([\text{asType<integer>}(\$heap_{funcstart_724,1} \cdot p3) < 0]:$

$\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[46.7] ([0 < -\$heap_funcstart_724,1.p3]:$
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
 $\rightarrow [\text{from term } 10.0, \text{literal } a < -\$heap_funcstart_724,1.p3 \text{ is false whenever } -2 <$
 $(0 + \text{literal } a)]$

Proof of rule precondition:

$[46.7.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[46.7.2] \text{ true}$

$[46.8] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[46.11] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178), [\neg(0 <$
 $-\$heap_funcstart_724,1.p3)]: \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178)$
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{quot})$
 $\rightarrow [\text{from term } 10.0, \text{literal } a < -\$heap_funcstart_724,1.p3 \text{ is false whenever } -2 <$
 $(0 + \text{literal } a)]$

Proof of rule precondition:

$[46.11.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[46.11.2] \text{ true}$

$[46.12] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$

\rightarrow [simplify]
 [46.17] $0 == (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).\text{quot} + (\$heap_{funcstart_724,1}.p3 / 178))$
 \rightarrow [from term 1.18, $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).\text{quot}$ is equal to 0]
 [46.18] $0 == (-0 + (\$heap_{funcstart_724,1}.p3 / 178))$
 \rightarrow [simplify]
 [46.20] $0 == (\$heap_{funcstart_724,1}.p3 / 178)$
 [Work on sub-term 2 of conjunction in term 1.17]
 [57.0] $177 < \$heap_{funcstart_724,1}.p3$
 [Create new term from term 46.20 using rule: condition for equality of division]
 [64.0] $((0 * 178) < (1 + \$heap_{funcstart_724,1}.p3)) \wedge (\$heap_{funcstart_724,1}.p3 < (178 * (0 + 1)))$
 \rightarrow [simplify]
 [64.3] $(-1 < \$heap_{funcstart_724,1}.p3) \wedge (\$heap_{funcstart_724,1}.p3 < (178 * (0 + 1)))$
 \rightarrow [from term 57.0, $\text{literal}_a < \$heap_{funcstart_724,1}.p3$ is true whenever $(-1 + \text{literal}_a) < 177$]

Proof of rule precondition:

[64.3.0] $(-1 + -1) < 177$
 \rightarrow [simplify]
 [64.3.2] **true**
 [64.4] **true** $\wedge (\$heap_{funcstart_724,1}.p3 < (178 * (0 + 1)))$
 \rightarrow [simplify]
 [64.9] **true** $\wedge (-178 < -\$heap_{funcstart_724,1}.p3)$
 \rightarrow [from term 57.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p3$ is false whenever $-2 < (177 + \text{literal}_a)$]

Proof of rule precondition:

[64.9.0] $-2 < (-178 + 177)$
 \rightarrow [simplify]
 [64.9.2] **true**
 [64.10] **true** \wedge **false**
 \rightarrow [simplify]
 [64.11] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (56,20)

To prove: $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a3)) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) == \text{asType}\langle\text{integer}\rangle(\text{div3.rem}))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1), \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) / \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) == \text{asType}\langle\text{integer}\rangle(\text{div1.quot})$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \% \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem})$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a1)) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) ==$

```

asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <

```

asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

```

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(asType<short int>((int)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] 0 < \$heap_funcstart_724,1.p3

[Take given term]

[43.0] div3 == div(heapIs \$heap_funcstart_724,1, asType<int>(\$heap_funcstart_724,1.p3), asType<int>(\$heap_funcstart_724,1.a3))

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Take goal term]

[1.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < \text{asType<integer>}(\$ \text{heap_funcstart_724,1.a3})) => (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) == \text{asType<integer>}(\text{div3.rem}))$

→ [simplify]

[1.1] $(\$ \text{heap_funcstart_724,1.p3} < \text{asType<integer>}(\$ \text{heap_funcstart_724,1.a3})) => (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) == \text{asType<integer>}(\text{div3.rem}))$

→ [const static or extern object]

[1.2] $(\$ \text{heap_funcstart_724,1.p3} < \text{asType<integer>}(\$ \text{heap_init.a3})) => (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) == \text{asType<integer>}(\text{div3.rem}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[1.3] $(\$ \text{heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})178))) => (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) == \text{asType<integer>}(\text{div3.rem}))$

→ [simplify]

[1.10] $(-178 < -\$ \text{heap_funcstart_724,1.p3}) => (\$ \text{heap_funcstart_724,1.p3} == \text{asType<integer>}(\text{div3.rem}))$

→ [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$]

[1.11] $(-178 < -\$ \text{heap_funcstart_724,1.p3}) => (\$ \text{heap_funcstart_724,1.p3} == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$

→ [simplify]

[1.17] $(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)) \vee (177 < \$heap_funcstart_724,1.p3)$
 \rightarrow [negate goal and search for contradiction]

[1.18] $!(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)) \wedge !(177 < \$heap_funcstart_724,1.p3)$
 \rightarrow [simplify]

[1.20] $!(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)) \wedge (-178 < -\$heap_funcstart_724,1.p3)$
 \rightarrow [separate conjunction and work on first sub-term]

[1.21] $-178 < -\$heap_funcstart_724,1.p3$
[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] $(\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% \mathbf{asType<integer>}(178)) == \mathbf{asType<integer>}(\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [simplify]

[47.2] $(\$heap_funcstart_724,1.p3 \% 178) == \mathbf{asType<integer>}(\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [expand definition of operator `'.%'` in class `'int'` at built in declaration]

[47.3] $([\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) < 0]:$
 $-(\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178), []:$
 $\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178) ==$
 $\mathbf{asType<integer>}(\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] $([\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) < 0]:$
 $-(\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178),$
 $!(\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) < 0]):$
 $\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178) ==$
 $\mathbf{asType<integer>}(\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [simplify]

[47.7] $([0 < -\$heap_funcstart_724,1.p3]:$
 $-(\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178),$
 $!(\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) < 0]):$
 $\mathbf{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178) ==$
 $\mathbf{asType<integer>}(\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [from term 10.0, $\text{literal } a < -\$heap_funcstart_724,1.p3$ is false whenever $-2 <$

(0 + literal_a)

Proof of rule precondition:

[47.7.0] -2 < (0 + 0)

→ [simplify]

[47.7.2] true

[47.8] ([false]: -(¬asType<integer>(\$heap_funcstart_724,1.p3) % 178),
[!(asType<integer>(\$heap_funcstart_724,1.p3) < 0)]:
asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [simplify]

[47.11] ([false]: -(¬asType<integer>(\$heap_funcstart_724,1.p3) % 178), [!(0
< - \$heap_funcstart_724,1.p3): asType<integer>(\$heap_funcstart_724,1.p3) %
178) == asType<integer>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem)

→ [from term 10.0, literal_a < - \$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literal_a)]

Proof of rule precondition:

[47.11.0] -2 < (0 + 0)

→ [simplify]

[47.11.2] true

[47.12] ([false]: -(¬asType<integer>(\$heap_funcstart_724,1.p3) % 178),
[false]: asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [simplify]

[47.17] 0 == (-div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem + (\$heap_funcstart_724,1.p3 % 178))

[Work on sub-term 2 of conjunction in term 1.20]

[56.0] !(0 == (- \$heap_funcstart_724,1.p3 + div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem))

[Copy term 56.0]

[63.0] !(0 == (- \$heap_funcstart_724,1.p3 + div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem))

→ [from term 47.17, div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem is equal to \$heap_funcstart_724,1.p3 % 178]

[63.1] !(0 == (- \$heap_funcstart_724,1.p3 + (\$heap_funcstart_724,1.p3 % 178)))

→ [remainder with larger divisor]

Proof of rule precondition 1:

[63.1.0.0] literald < -\$heap_funcstart_724,1.p3

→ [unify with term 1.21]

[63.1.0.1] **true**

Proof of rule precondition 2:

[63.1.1.0] literalc < \$heap_funcstart_724,1.p3

→ [unify with term 10.0]

[63.1.1.1] **true**

Proof of rule precondition 3:

[63.1.2.0] --178 ≤ 178

→ [simplify]

[63.1.2.2] **true**

Proof of rule precondition 4:

[63.1.3.0] -2 < 0

→ [simplify]

[63.1.3.1] **true**

[63.2] !(0 == (-\$heap_funcstart_724,1.p3 + \$heap_funcstart_724,1.p3))

→ [simplify]

[63.5] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (57,26)

To prove: !(0 == asType<integer>(div3.rem)) || !(0 == asType<integer>(div3.quot))

Given:

\$heap_init.LIMIT == (int)80

\$heap_init.M1 == asType<short int>((int)30269)

\$heap_init.r1 == asType<short int>((int)171)

\$heap_init.a1 == asType<short int>((int)177)

\$heap_init.b1 == asType<short int>((int)2)

\$heap_init.M2 == asType<short int>((int)30307)

\$heap_init.r2 == asType<short int>((int)172)

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <

```

asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] (((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] (((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] (((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <

```

`asType<integer>(asType<short int>((int)30307))) && (0 <`
`asType<integer>($heap_funcstart_724,1.p3))) &&`
`(asType<integer>($heap_funcstart_724,1.p3) <`
`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [simplify]
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType<integer>}(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType<integer>}(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType<integer>}(\text{asType<short$
 $\text{int>}((\text{int})30323)))$
 \rightarrow [simplify]
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
[Work on sub-term 6 of conjunction in term 5.40]
 $[10.0] 0 < \$heap_funcstart_724,1.p3$
[Take given term]
 $[43.0] \text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\text{asType<int>}(\$heap_funcstart_724,1.p3),$
 $\text{asType<int>}(\$heap_funcstart_724,1.a3))$
 \rightarrow [simplify]
 $[43.1] \text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $\text{asType<int>}(\$heap_funcstart_724,1.a3))$
 \rightarrow [const static or extern object]
 $[43.2] \text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $\text{asType<int>}(\$heap_init.a3))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]

$[43.3] \text{ div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$
 $\rightarrow [\text{simplify}]$
 $[43.6] \text{ div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
 $[\text{Take goal term}]$
 $[1.0] !(0 == \text{asType<integer>}(\text{div3.rem})) \parallel !(0 ==$
 $\text{asType<integer>}(\text{div3.quot}))$
 $\rightarrow [\text{from term 43.6, div3 is equal to div(heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p3}, 178)]$
 $[1.1] !(0 == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p3}, 178).\text{rem})) \parallel !(0 == \text{asType<integer>}(\text{div3.quot}))$
 $\rightarrow [\text{simplify}]$
 $[1.2] !(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 $\parallel !(0 == \text{asType<integer>}(\text{div3.quot}))$
 $\rightarrow [\text{from term 43.6, div3 is equal to div(heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p3}, 178)]$
 $[1.3] !(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 $\parallel !(0 == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p3}, 178).\text{quot}))$
 $\rightarrow [\text{simplify}]$
 $[1.5] !(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{quot}) \vee !(0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{rem})$
 $\rightarrow [\text{negate goal and search for contradiction}]$
 $[1.6] (0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 $\wedge (0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 $\rightarrow [\text{separate conjunction and work on first sub-term}]$
 $[1.7] 0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$
 $[\text{Work on sub-term 2 of conjunction in term 1.6}]$
 $[58.0] 0 == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$
 $[\text{Take given term}]$
 $[56.0] (\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) <$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.a3})) =>$
 $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) ==$
 $\text{asType<integer>}(\text{div3.rem}))$
 $\rightarrow [\text{simplify}]$

[56.1] $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a3)) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) == \text{asType}\langle\text{integer}\rangle(\text{div3.rem}))$
 \rightarrow [const static or extern object]

[56.2] $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_{init}.a3)) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) == \text{asType}\langle\text{integer}\rangle(\text{div3.rem}))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]

[56.3] $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}178)))) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) == \text{asType}\langle\text{integer}\rangle(\text{div3.rem}))$
 \rightarrow [simplify]

[56.10] $(-178 < -\$heap_{funcstart_724,1}.p3) \Rightarrow (\$heap_{funcstart_724,1}.p3 == \text{asType}\langle\text{integer}\rangle(\text{div3.rem}))$
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)$]

[56.11] $(-178 < -\$heap_{funcstart_724,1}.p3) \Rightarrow (\$heap_{funcstart_724,1}.p3 == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))$
 \rightarrow [simplify]

[56.17] $(0 == (-\$heap_{funcstart_724,1}.p3 + \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem})) \vee (177 < \$heap_{funcstart_724,1}.p3)$
 \rightarrow [from term 58.0, $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}$ is equal to 0]

[56.18] $(0 == (-\$heap_{funcstart_724,1}.p3 + 0)) \vee (177 < \$heap_{funcstart_724,1}.p3)$
 \rightarrow [simplify]

[56.19] $(0 == -\$heap_{funcstart_724,1}.p3) \vee (177 < \$heap_{funcstart_724,1}.p3)$
 \rightarrow [from term 10.0, $-\$heap_{funcstart_724,1}.p3 == \text{literal}$ is false whenever $-1 < (0 + \text{literal})$]

Proof of rule precondition:

[56.19.0] $-1 < (0 + 0)$
 \rightarrow [simplify]

[56.19.2] **true**

[56.20] **false** $\vee (177 < \$heap_{funcstart_724,1}.p3)$
 \rightarrow [simplify]

[56.21] $177 < \$heap_{funcstart_724,1}.p3$

[Take given term]

[57.0] **asType**<integer>(\$heap_funcstart_724,1.a3) ≤
asType<integer>(\$heap_funcstart_724,1.p3) ==> !(0 ==
asType<integer>(div3.quot))

→ [const static or extern object]

[57.1] **asType**<integer>(\$heap_init.a3) ≤
asType<integer>(\$heap_funcstart_724,1.p3) ==> !(0 ==
asType<integer>(div3.quot))

→ [expand definition of constant 'a3' at prang.c (26,20)]

[57.2] **asType**<integer>(**asType**<short int>((int)178)) ≤
asType<integer>(\$heap_funcstart_724,1.p3) ==> !(0 ==
asType<integer>(div3.quot))

→ [simplify]

[57.8] (177 < \$heap_funcstart_724,1.p3) ==> !(0 ==
asType<integer>(div3.quot))

→ [from term 43.6, div3 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178)]

[57.9] (177 < \$heap_funcstart_724,1.p3) ==> !(0 ==
asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot))

→ [simplify]

[57.13] !(0 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot) ∨ (-178 < -\$heap_funcstart_724,1.p3)

→ [from term 56.21, literal < -\$heap_funcstart_724,1.p3 is false whenever -2 <
(177 + literal)]

Proof of rule precondition:

[57.13.0] -2 < (-178 + 177)

→ [simplify]

[57.13.2] **true**

[57.14] **false** ∨ !(0 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [from term 1.7, div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot is equal to 0]

[57.15] **false** ∨ !(0 == 0)

→ [simplify]

[57.18] **false**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq \text{div1.rem}$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==

```

```

asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

```

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <

`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [simplify]
[5.16] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [const static or extern object]
[5.17] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3)))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323))))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$

$\neg \text{\$heap_funcstart_724,1.p2} \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1} \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3}))$
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] $0 < \text{\$heap_funcstart_724,1.p1}$
[Take given term]
[11.0] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.p1}), \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 \rightarrow *[simplify]*
[11.1] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 \rightarrow *[const static or extern object]*
[11.2] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_init.a1}))$
 \rightarrow *[expand definition of constant 'a1' at prang.c (16,20)]*
[11.3] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177)))$
 \rightarrow *[simplify]*
[11.6] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% \text{asType<integer>}(177)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow *[simplify]*
[15.2] $(\text{\$heap_funcstart_724,1.p1} \% 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow *[expand definition of operator '.*' in class 'int' at built in declaration]*
[15.3] $([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) < 0]: \neg(\neg \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% 177), []: \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow *[explicitly assert falsehood of skipped guards in subsequent guards]*
[15.4] $([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) < 0]: \neg(\neg \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% 177), [! (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) < 0)]:$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[15.7] ([0 < -\$heap_{funcstart_724,1}.p1]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 $\rightarrow [\text{from term 8.0, literal } a < -\$heap_{funcstart_724,1}.p1 \text{ is false whenever } -2 < (0$
 $+ \text{literal})]$

Proof of rule precondition:

$[15.7.0] -2 < (0 + 0)$
 $\rightarrow [\text{simplify}]$
 $[15.7.2] \text{ true}$
 $[15.8] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[15.11] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177), [!(0$
 $< -\$heap_{funcstart_724,1}.p1)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \%$
 $177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})$
 $\rightarrow [\text{from term 8.0, literal } a < -\$heap_{funcstart_724,1}.p1 \text{ is false whenever } -2 < (0$
 $+ \text{literal})]$

Proof of rule precondition:

$[15.11.0] -2 < (0 + 0)$
 $\rightarrow [\text{simplify}]$
 $[15.11.2] \text{ true}$
 $[15.12] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[15.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$

$177).rem + (\$heap_{funcstart_724,1}.p1 \% 177))$
[Assume known post-assertion, class invariant or type constraint for term 15.17]
 $[22.0] \text{ minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem$
 $\rightarrow [simplify]$
 $[22.3] -32769 < \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem$
[Take goal term]
 $[1.0] \text{ minof}(\text{short int}) \leq \text{div1}.rem$
 $\rightarrow [simplify]$
 $[1.1] -32768 \leq \text{div1}.rem$
 $\rightarrow [from \text{ term } 11.6, \text{ div1 is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$
 $[1.2] -32768 \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem$
 $\rightarrow [simplify]$
 $[1.4] -32769 < \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem$
 $\rightarrow [from \text{ term } 22.3, \text{ literal } a < \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem \text{ is true whenever } (-1 + \text{literal}) < -32769]$
Proof of rule precondition:
 $[1.4.0] (-32769 + -1) < -32769$
 $\rightarrow [simplify]$
 $[1.4.2] \text{ true}$
 $[1.5] \text{ true}$

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)

Condition defined at:

To prove: $\text{div1}.rem \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

```

$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <

```

asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

```

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(\$heap_init.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(**asType<short int>**((**int**)30307)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(**asType<short
int>**((**int**)30323)))
→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)
[Work on sub-term 4 of conjunction in term 5.40]

[8.0] 0 < \$heap_funcstart_724,1.p1
[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>($heap_funcstart_724,1.a1))`

→ [const static or extern object]

[11.2] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>($heap_init.a1))`

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>(asType<short int>((int)177)))`

→ [simplify]

[11.6] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)`

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[11.0] `(asType<integer>($heap_funcstart_724,1.p1) % asType<integer>(177)) == asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)`

→ [simplify]

[15.2] `($heap_funcstart_724,1.p1 % 177) == asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)`

→ [expand definition of operator '.*' in class 'int' at built in declaration]

[15.3] `([asType<integer>($heap_funcstart_724,1.p1) < 0]:
 -(-asType<integer>($heap_funcstart_724,1.p1) % 177), []:
 asType<integer>($heap_funcstart_724,1.p1) % 177 ==
 asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)`

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] `([asType<integer>($heap_funcstart_724,1.p1) < 0]:
 -(-asType<integer>($heap_funcstart_724,1.p1) % 177),
 [!(asType<integer>($heap_funcstart_724,1.p1) < 0]):
 asType<integer>($heap_funcstart_724,1.p1) % 177 ==
 asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)`

→ [simplify]

[15.7] `([0 < -$heap_funcstart_724,1.p1]:
 -(-asType<integer>($heap_funcstart_724,1.p1) % 177),
 [!(asType<integer>($heap_funcstart_724,1.p1) < 0]):
 asType<integer>($heap_funcstart_724,1.p1) % 177 ==
 asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)`

→ [from term 8.0, *literal* $< -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$

→ [simplify]

[15.7.2] **true**

[15.8] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177)$,
 $!(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0)$):
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$

→ [simplify]

[15.11] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177)$, $!(0$
 $< -\$heap_funcstart_724,1.p1)$): $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \%$
 $177 == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{rem})$

→ [from term 8.0, *literal* $< -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$

→ [simplify]

[15.11.2] **true**

[15.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177)$,
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$

→ [simplify]

[15.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem} + (\$heap_funcstart_724,1.p1 \% 177))$

[Assume known post-assertion, class invariant or type constraint for term 15.17]

[23.0] $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} \leq$
 $\text{maxof}(\text{int})$

→ [simplify]

[23.9] $-32768 < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem}$

[Take goal term]

[1.0] $\text{div1.rem} \leq \text{maxof}(\text{short int})$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[1.1] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.10] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}$

→ [from term 23.9, $\text{literal}_a < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}$ is true whenever $(-1 + \text{literal}_a) < -32768$]

Proof of rule precondition:

[1.10.0] $(-32768 + -1) < -32768$

→ [simplify]

[1.10.2] **true**

[1.11] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{asType}(\text{short int})(\text{div1.rem})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}(\text{short int})((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}(\text{short int})((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}(\text{short int})((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}(\text{short int})((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}(\text{short int})((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}(\text{short int})((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}(\text{short int})((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}(\text{short int})((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}(\text{short int})((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}(\text{short int})((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}(\text{short int})((\text{int})178)$

```

$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

```

```

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}<\text{integer}>(\$heap_funcstart_724,1.M3))$

→ [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}<\text{integer}>(\$heap_init.M3))$

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}<\text{integer}>(\text{asType}<\text{short int}>((\text{int})30323)))$

→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 4 of conjunction in term 5.40]

[8.0] $0 < \$heap_funcstart_724,1.p1$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}<\text{int}>(\$heap_funcstart_724,1.p1), \text{asType}<\text{int}>(\$heap_funcstart_724,1.a1))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}<\text{int}>(\$heap_funcstart_724,1.a1))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}<\text{int}>(\$heap_init.a1))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[15.0] (**asType**<integer>(\$heap_funcstart_724,1.p1) %
asType<integer>(177)) == **asType**<integer>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [simplify]

[15.2] (\$heap_funcstart_724,1.p1 % 177) == **asType**<integer>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [expand definition of operator '.%' in class 'int' at built in declaration]

[15.3] ([**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]:
–(–**asType**<integer>(\$heap_funcstart_724,1.p1) % 177), []:
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] ([**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]:
–(–**asType**<integer>(\$heap_funcstart_724,1.p1) % 177),
[!(**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]):
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)

→ [simplify]

[15.7] ([0 < –\$heap_funcstart_724,1.p1]:
–(–**asType**<integer>(\$heap_funcstart_724,1.p1) % 177),
[!(**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]):
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)

→ [from term 8.0, literal < –\$heap_funcstart_724,1.p1 is false whenever -2 < (0
+ literal)]

Proof of rule precondition:

[15.7.0] -2 < (0 + 0)

→ [simplify]

[15.7.2] **true**

[15.8] ([**false**]: –(–**asType**<integer>(\$heap_funcstart_724,1.p1) % 177),
[!(**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]):
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)

→ [simplify]

[15.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) \% 177)$, [!(0 < $\neg \$heap_funcstart_724,1.p1$): $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) \% 177$) == $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})$)
 \rightarrow [from term 8.0, $\text{literal} < \neg \$heap_funcstart_724,1.p1$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[15.11.2] **true**

[15.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) \% 177)$, [!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p1) \% 177$) == $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})$)

\rightarrow [simplify]

[15.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} + (\$heap_funcstart_724,1.p1 \% 177))$

[Assume known post-assertion, class invariant or type constraint for term 15.17]

[22.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}$

\rightarrow [simplify]

[22.3] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq \text{asType}\langle \text{short int} \rangle (\text{div1}.\text{rem})$

\rightarrow [simplify]

[1.1] $-32768 \leq \text{asType}\langle \text{short int} \rangle (\text{div1}.\text{rem})$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$]

[1.2] $-32768 \leq \text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})$

\rightarrow [simplify]

[1.5] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}$

\rightarrow [from term 22.3, $\text{literal} < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32769$]

Proof of rule precondition:

[1.5.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.5.2] **true**

[1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)

Condition defined at:

To prove: $\text{asType}\langle\text{short int}\rangle(\text{div1.rem}) \leq \text{maxof}(\text{int})$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\text{\$heap}_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\text{\$heap}_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\text{\$heap}_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\text{\$heap}_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\text{\$heap}_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\text{\$heap}_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\text{\$heap}_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\text{\$heap}_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\text{\$heap}_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \text{\$heap}_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.p1),$

$\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.a1))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.p1)) /$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.a1))) ==$


```

asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <

$\neg \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3}) \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323))))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$
 $[\text{Work on sub-term 4 of conjunction in term 5.40}]$
 $[8.0] 0 < \text{\$heap_funcstart_724,1.p1}$
 $[\text{Take given term}]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.p1}), \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{simplify}]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_init.a1}))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177))))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$
 $[\text{Assume known post-assertion, class invariant or type constraint for term 11.6}]$
 $[15.0] (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% \text{asType<integer>}(177)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[15.2] (\text{\$heap_funcstart_724,1.p1} \% 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$
 $\rightarrow [\text{expand definition of operator ' \% ' in class 'int' at built in declaration}]$
 $[15.3] ([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) < 0]: -(\neg \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% 177), []: \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) \% 177) ==$

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] ([**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p1) % 177),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]):
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [simplify]

[15.7] ([0 < -\$heap_funcstart_724,1.p1]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p1) % 177),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]):
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [from term 8.0, literal a < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[15.7.0] -2 < (0 + 0)

→ [simplify]

[15.7.2] **true**

[15.8] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p1) % 177),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]):
asType<integer>(\$heap_funcstart_724,1.p1) % 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [simplify]

[15.11] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p1) % 177), [!(0 < -\$heap_funcstart_724,1.p1): **asType<integer>**(\$heap_funcstart_724,1.p1) % 177) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)

→ [from term 8.0, literal a < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[15.11.0] -2 < (0 + 0)

→ [simplify]

[15.11.2] **true**

[15.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) \% 177),$
 [!false]: $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem})$
 → [simplify]
 [15.17] $0 == (-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem} + (\text{\$heap_funcstart_724,1.p1} \% 177))$
 [Assume known post-assertion, class invariant or type constraint for term
 15.17]
 [23.0] $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem} \leq$
 $\text{maxof}(\text{int})$
 → [simplify]
 [23.9] $-32768 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem}$
 [Take goal term]
 [1.0] $\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{rem}) \leq \text{maxof}(\text{int})$
 → [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177)]$
 [1.1] $\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{rem}) \leq \text{maxof}(\text{int})$
 → [simplify]
 [1.11] $-32768 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem}$
 → [from term 23.9, literal $a < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32768]$
Proof of rule precondition:
 [1.11.0] $(-32768 + -1) < -32768$
 → [simplify]
 [1.11.2] **true**
 [1.12] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,10)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{\$heap_funcstart_724,1.r1}$

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)
$heap_init.r3 == asType<short int>((int)170)
$heap_init.a3 == asType<short int>((int)178)
$heap_init.b3 == asType<short int>((int)63)
$heap_init.p1 == asType<short int>((int)1)
$heap_init.p2 == asType<short int>((int)2)
$heap_init.p3 == asType<short int>((int)3)
invariant1(heapIs $heap_funcstart_724,1)
div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))
(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take goal term]

[1.0] minof(int) ≤ \$heap_funcstart_724,1.r1

\rightarrow [simplify]
 [1.1] $-32768 \leq \$heap_{funcstart_724,1}.r1$
 \rightarrow [const static or extern object]
 [1.2] $-32768 \leq \$heap_{init}.r1$
 \rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
 [1.3] $-32768 \leq \text{asType}\langle \text{short int} \rangle((\text{int})171)$
 \rightarrow [simplify]
 [1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,10)

Condition defined at:

To prove: $\$heap_{funcstart_724,1}.r1 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle \text{short int} \rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle \text{short int} \rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle \text{short int} \rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle \text{short int} \rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle \text{short int} \rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle \text{short int} \rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle \text{short int} \rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle \text{short int} \rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle \text{short int} \rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle \text{short int} \rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle \text{short int} \rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

```

asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==

```

```

asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

```

[Take goal term]
[1.0] $heap_funcstart_724,1.r1 ≤ maxof(int)
→ [const static or extern object]
[1.1] $heap_init.r1 ≤ maxof(int)
→ [expand definition of constant 'r1' at prang.c (15,20)]
[1.2] asType<short int>((int)171) ≤ maxof(int)
→ [simplify]
[1.6] true

```

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,13)

Condition defined at:

To prove: minof(int) ≤ (asType<int>(asType<short int>(div1.rem)) * asType<int>(\$heap_funcstart_724,1.r1))

Given:

```

$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)

```

```

$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(**asType<short int>**((**int**)30307)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(**asType<short
int>**((**int**)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)

[Work on sub-term 4 of conjunction in term 5.40]

[8.0] 0 < \$heap_funcstart_724,1.p1

[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\$ \text{heap_init.a1}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq (\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}))$

→ [simplify]

[1.1] $-32768 \leq (\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[1.2] $-32768 \leq (\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}))$

→ [simplify]

[1.4] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}))$

→ [const static or extern object]

[1.5] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_init.r1}))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[1.6] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\text{asType<short int>}((\text{int})171))))$

→ [simplify]

[1.11] $-32769 < (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$

→ [literal comparison of product]

[1.12] $([171 < 0]: (-32769 / -171) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}, [0 < 171]: (-32769 / 171) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}, [0 == 171]: -32769 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.13] $([171 < 0]: (-32769 / -171) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1} \cdot p1, 177).rem, [(0 < 171) \wedge !(171 < 0)]: (-32769 / 171) <$
 $div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem, [(0 == 171)$
 $\wedge !(0 < 171) \wedge !(171 < 0)]: -32769 < 0)$
 $\rightarrow [simplify]$
 $[1.21] -192 < div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem$
 $\rightarrow [negate\ goal\ and\ search\ for\ contradiction]$
 $[1.22] !(-192 < div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).rem)$
 $\rightarrow [simplify]$
 $[1.24] 191 < -div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).rem$
 $[Assume\ known\ post-assertion,\ class\ invariant\ or\ type\ constraint\ for\ term\ 11.6]$
 $[15.0] (\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \%$
 $\mathbf{asType}<\mathbf{integer}>(177)) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)$
 $\rightarrow [simplify]$
 $[15.2] (\$heap_{funcstart_724,1} \cdot p1 \% 177) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)$
 $\rightarrow [expand\ definition\ of\ operator\ '.\%' \text{ in class 'int' at built in declaration}]$
 $[15.3] ([\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) < 0]:$
 $-(\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \% 177), []:$
 $\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \% 177) ==$
 $\mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).rem)$
 $\rightarrow [explicitly\ assert\ falsehood\ of\ skipped\ guards\ in\ subsequent\ guards]$
 $[15.4] ([\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) < 0]:$
 $-(\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \% 177),$
 $!([\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) < 0]):$
 $\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \% 177) ==$
 $\mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).rem)$
 $\rightarrow [simplify]$
 $[15.7] ([0 < -\$heap_{funcstart_724,1} \cdot p1]:$
 $-(\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \% 177),$
 $!([\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) < 0]):$
 $\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1} \cdot p1) \% 177) ==$
 $\mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $177).rem)$

→ [from term 8.0, $\text{literal}_a < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$

→ [simplify]

[15.7.2] **true**

[15.8] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177)$,
 $!(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) < 0)$):
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$

→ [simplify]

[15.11] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177)$, $!(0$
 $< -\$heap_funcstart_724,1.p1)$): $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \%$
 $177 == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{rem})$

→ [from term 8.0, $\text{literal}_a < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$

→ [simplify]

[15.11.2] **true**

[15.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177)$,
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p1) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$

→ [simplify]

[15.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem} + (\$heap_funcstart_724,1.p1 \% 177))$

[Create new term from terms 1.24, 15.17 using rule: transitivity 15]

[69.0] $(0 + 191) < -(\$heap_funcstart_724,1.p1 \% 177)$

→ [simplify]

[69.2] **false**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,13)

Condition defined at:

To prove: $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) \leq \text{maxof}(\text{int})$

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)
$heap_init.r3 == asType<short int>((int)170)
$heap_init.a3 == asType<short int>((int)178)
$heap_init.b3 == asType<short int>((int)63)
$heap_init.p1 == asType<short int>((int)1)
$heap_init.p2 == asType<short int>((int)2)
$heap_init.p3 == asType<short int>((int)3)
invariant1(heapIs $heap_funcstart_724,1)
div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
```

```

asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧

$(0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.M2})) \ \&\& \ (0 <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] \ ((((-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge$
 $(0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} <$
 $\text{asType<integer>}(\text{\$heap_init.M2})) \ \&\& \ (0 <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] \ ((((-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge$
 $(0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} <$
 $\text{asType<integer>}(\text{asType<short int>}((\text{int})30307)))) \ \&\& \ (0 <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{simplify}]$
 $[5.30] \ ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] \ ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] \ ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short$
 $\text{int>}((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] \ (-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 <$
 $-\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p3})$

[Work on sub-term 4 of conjunction in term 5.40]

[8.0] $0 < \text{\$heap_funcstart_724,1.p1}$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p1}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{\$heap_init.a1}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$

[Take goal term]

[1.0] $(\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\text{\$heap_funcstart_724,1.r1})) \leq \text{maxof(int)}$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$]

[1.1] $(\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\text{\$heap_funcstart_724,1.r1})) \leq$
 maxof(int)

→ [simplify]

[1.3] $(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\text{\$heap_funcstart_724,1.r1})) \leq \text{maxof(int)}$

→ [const static or extern object]

[1.4] $(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\text{\$heap_init.r1})) \leq \text{maxof(int)}$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[1.5] $(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\text{asType<short int>}((\text{int})171))) \leq \text{maxof(int)}$

→ [simplify]

[1.18] $-32768 < (-171 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$

$\$heap_funcstart_724,1 \cdot p1, 177).rem)$
 \rightarrow [literal comparison of product]
[1.19] $([-171 < 0]: (-32768 / 171) < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem, [0 < -171]: (-32768 / -171) < div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem, [-171 == 0]: -32768 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[1.20] $([-171 < 0]: (-32768 / 171) < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem, [(0 < -171) \wedge !(-171 < 0)]: (-32768 / -171) < div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem, [(-171 == 0) \wedge !(-171 < 0) \wedge !(0 < -171)]: -32768 < 0)$
 \rightarrow [simplify]
[1.24] $-192 < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem$
 \rightarrow [negate goal and search for contradiction]
[1.25] $!(-192 < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)$
 \rightarrow [simplify]
[1.28] $191 < div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem$
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] $(\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) \% \mathbf{asType}<\mathbf{integer}>(177)) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)$
 \rightarrow [simplify]
[15.2] $(\$heap_funcstart_724,1 \cdot p1 \% 177) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)$
 \rightarrow [expand definition of operator '.*' in class 'int' at built in declaration]
[15.3] $([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) < 0]:$
 $-(-\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) \% 177), []:$
 $\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) \% 177) ==$
 $\mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] $([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) < 0]:$
 $-(-\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) \% 177),$
 $!([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) < 0]):$
 $\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1 \cdot p1) \% 177) ==$
 $\mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1,$

177).rem)
 → [simplify]
 [15.7] ([0 < - $\$heap_funcstart_724,1 \cdot p1$):
 -(-asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177),
 [!(asType<integer>($\$heap_funcstart_724,1 \cdot p1$) < 0]):
 asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177) ==
 asType<integer>(div(heapIs $\$heap_funcstart_724,1$, $\$heap_funcstart_724,1 \cdot p1$,
 177).rem)
 → [from term 8.0, literal $a < -\$heap_funcstart_724,1 \cdot p1$ is false whenever $-2 < (0$
 + literal a)]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$
 → [simplify]
 [15.7.2] true
 [15.8] ([false]: -(-asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177),
 [!(asType<integer>($\$heap_funcstart_724,1 \cdot p1$) < 0]):
 asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177) ==
 asType<integer>(div(heapIs $\$heap_funcstart_724,1$, $\$heap_funcstart_724,1 \cdot p1$,
 177).rem)
 → [simplify]
 [15.11] ([false]: -(-asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177), [!(0
 < - $\$heap_funcstart_724,1 \cdot p1$): asType<integer>($\$heap_funcstart_724,1 \cdot p1$) %
 177) == asType<integer>(div(heapIs $\$heap_funcstart_724,1$,
 $\$heap_funcstart_724,1 \cdot p1$, 177).rem)
 → [from term 8.0, literal $a < -\$heap_funcstart_724,1 \cdot p1$ is false whenever $-2 < (0$
 + literal a)]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$
 → [simplify]
 [15.11.2] true
 [15.12] ([false]: -(-asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177),
 [!false]: asType<integer>($\$heap_funcstart_724,1 \cdot p1$) % 177) ==
 asType<integer>(div(heapIs $\$heap_funcstart_724,1$, $\$heap_funcstart_724,1 \cdot p1$,
 177).rem)
 → [simplify]
 [15.17] $0 == (-div(heapIs $\$heap_funcstart_724,1$, $\$heap_funcstart_724,1 \cdot p1$,
 177).rem + ($\$heap_funcstart_724,1 \cdot p1$ % 177))$
 → [remainder is less than divisor]

Proof of rule precondition:

[15.17.0] $(177 + -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p1}, 177).\text{rem}) \leq 0$

\rightarrow [simplify]

[15.17.11] $176 < \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p1}, 177).\text{rem}$

\rightarrow [from term 1.28, *literal* $a < \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p1}, 177).\text{rem}$ is true whenever $(-1 + \text{literal}) < 191$]

Proof of rule precondition:

[15.17.11.0] $(-1 + 176) < 191$

\rightarrow [simplify]

[15.17.11.2] **true**

[15.17.12] **true**

[15.18] **false**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq \text{div1.quot}$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

```

$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==

```

```

asType<integer>(div2.quot))
div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))
(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <

`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [const static or extern object]
[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(\$heap_init.M1))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [const static or extern object]
[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [simplify]

[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
→ [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$
→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$
[Work on sub-term 4 of conjunction in term 5.40]

[8.0] $0 < \$heap_funcstart_724,1.p1$
[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p1), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$
→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$
→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_init.a1))$
→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$
→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$
[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] (**asType**<**integer**>(\$heap_funcstart_724,1.p1) /
asType<**integer**>(177)) == **asType**<**integer**>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)
→ [simplify]

[14.2] (\$heap_funcstart_724,1.p1 / 177) == **asType**<**integer**>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] ([**asType**<**integer**>(\$heap_funcstart_724,1.p1) < 0]:
-(**asType**<**integer**>(\$heap_funcstart_724,1.p1) / 177), []:
asType<**integer**>(\$heap_funcstart_724,1.p1) / 177 ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] ([**asType**<**integer**>(\$heap_funcstart_724,1.p1) < 0]:
-(**asType**<**integer**>(\$heap_funcstart_724,1.p1) / 177),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p1) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p1) / 177 ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)
→ [simplify]

[14.7] ([0 < -\$heap_funcstart_724,1.p1]:
-(**asType**<**integer**>(\$heap_funcstart_724,1.p1) / 177),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p1) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p1) / 177 ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)
→ [from term 8.0, literal a < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0
+ literal a)]

Proof of rule precondition:

[14.7.0] -2 < (0 + 0)

→ [simplify]

[14.7.2] **true**

[14.8] ([**false**]: -(**asType**<**integer**>(\$heap_funcstart_724,1.p1) / 177),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p1) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p1) / 177 ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)
→ [simplify]

[14.11] ([**false**]: -(**asType**<**integer**>(\$heap_funcstart_724,1.p1) / 177), [!(0 <

$-\$heap_funcstart_724,1.p1)]$: **asType<integer>**(\$heap_funcstart_724,1.p1) / 177)
 $==$ **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot)
 \rightarrow [from term 8.0, literal $a < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0$
 $+ literal a)$]
Proof of rule precondition:
[14.11.0] $-2 < (0 + 0)$
 \rightarrow [simplify]
[14.11.2] **true**
[14.12] ([false]: $-(\text{asType<integer>}(\$heap_funcstart_724,1.p1) / 177)$,
[!false]: **asType<integer>**(\$heap_funcstart_724,1.p1) / 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)
 \rightarrow [simplify]
[14.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot} + (\$heap_funcstart_724,1.p1 / 177))$
[Assume known post-assertion, class invariant or type constraint for term
14.17]
[20.0] **minof(int)** \leq div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot
 \rightarrow [simplify]
[20.3] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot}$
[Take goal term]
[1.0] **minof(short int)** \leq div1.quot
 \rightarrow [simplify]
[1.1] $-32768 \leq \text{div1.quot}$
 \rightarrow [from term 11.6, div1 is equal to div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]
[1.2] $-32768 \leq \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot}$
 \rightarrow [simplify]
[1.4] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{quot}$
 \rightarrow [from term 20.3, literal $a < \text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{quot}$ is true whenever $(-1 + literal a) < -32769]$

Proof of rule precondition:

[1.4.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.4.2] **true**

[1.5] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)

Condition defined at:

To prove: $\text{div1.quot} \leq \text{maxof}(\text{short int})$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\text{\$heap}_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\text{\$heap}_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\text{\$heap}_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\text{\$heap}_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\text{\$heap}_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \text{\$heap}_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$

$\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.p1),$

$\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.a1))$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.p1)) /$

$\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.a1))) ==$

```

asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <

$\neg \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$
 $[\text{Work on sub-term 4 of conjunction in term 5.40}]$
 $[8.0] 0 < \text{\$heap_funcstart_724,1.p1}$
 $[\text{Take given term}]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.p1}), \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{simplify}]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_init.a1}))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$
 $[\text{Assume known post-assertion, class invariant or type constraint for term 11.6}]$
 $[14.0] (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) / \text{asType<integer>}(177)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[14.2] (\text{\$heap_funcstart_724,1.p1} / 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 $\rightarrow [\text{expand definition of operator './' in class 'int' at built in declaration}]$
 $[14.3] ([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) < 0]: -(\neg \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) / 177), []: \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) / 177) ==$

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] ([**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]:

−(**asType<integer>**(\$heap_funcstart_724,1.p1) / 177),

[!(**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]):

asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)

→ [simplify]

[14.7] ([0 < −\$heap_funcstart_724,1.p1]:

−(**asType<integer>**(\$heap_funcstart_724,1.p1) / 177),

[!(**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]):

asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)

→ [from term 8.0, literal a < −\$heap_funcstart_724,1.p1 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[14.7.0] -2 < (0 + 0)

→ [simplify]

[14.7.2] **true**

[14.8] ([**false**]: −(**asType<integer>**(\$heap_funcstart_724,1.p1) / 177),

[!(**asType<integer>**(\$heap_funcstart_724,1.p1) < 0]):

asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)

→ [simplify]

[14.11] ([**false**]: −(**asType<integer>**(\$heap_funcstart_724,1.p1) / 177), [!(0 <

−\$heap_funcstart_724,1.p1)]: **asType<integer>**(\$heap_funcstart_724,1.p1) / 177)

== **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1,

\$heap_funcstart_724,1.p1, 177).quot)

→ [from term 8.0, literal a < −\$heap_funcstart_724,1.p1 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[14.11.0] -2 < (0 + 0)

→ [simplify]

[14.11.2] **true**

[14.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177),$
 [!false]: $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot})$
 → [simplify]
 [14.17] $0 == (-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot} + (\text{\$heap_funcstart_724,1.p1} / 177))$
 [Assume known post-assertion, class invariant or type constraint for term
 14.17]
 [21.0] $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot} \leq$
 $\text{maxof}(\text{int})$
 → [simplify]
 [21.9] $-32768 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot}$
 [Take goal term]
 [1.0] $\text{div1.quot} \leq \text{maxof}(\text{short int})$
 → [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177)]$
 [1.1] $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot} \leq$
 $\text{maxof}(\text{short int})$
 → [simplify]
 [1.10] $-32768 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot}$
 → [from term 21.9, literal $a < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot}$ is true whenever $(-1 + \text{literal } a) < -32768]$
Proof of rule precondition:
 [1.10.0] $(-32768 + -1) < -32768$
 → [simplify]
 [1.10.2] **true**
 [1.11] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{asType}\langle\text{short int}\rangle(\text{div1.quot})$

Given:

```
$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```



```

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))
(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
```

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
 $[\text{Work on sub-term 4 of conjunction in term 5.40}]$
 $[8.0] 0 < \$heap_funcstart_724,1.p1$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p1}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a1}))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a1}))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\$ \text{heap_init.a1}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) /$
 $\text{asType<integer>}(177)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [simplify]

[14.2] $(\$ \text{heap_funcstart_724,1.p1} / 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177),$
 $[(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0]):$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot})$

→ [simplify]

[14.7] $([0 < -\$ \text{heap_funcstart_724,1.p1}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177),$

$[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 $\rightarrow [from \text{ term } 8.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p1 \text{ is false whenever } -2 < (0$
 $+ \text{ literal } a)]$

Proof of rule precondition:

$[14.7.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[14.7.2] \text{ true}$

$[14.8] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 $\rightarrow [simplify]$
 $[14.11] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177), [!(0 <$
 $-\$heap_{funcstart_724,1}.p1)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot})$

$\rightarrow [from \text{ term } 8.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p1 \text{ is false whenever } -2 < (0$
 $+ \text{ literal } a)]$

Proof of rule precondition:

$[14.11.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[14.11.2] \text{ true}$

$[14.12] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 $\rightarrow [simplify]$
 $[14.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot} + (\$heap_{funcstart_724,1}.p1 / 177))$
 $[Assume \text{ known post-assertion, class invariant or type constraint for term } 14.17]$

$[20.0] \text{ minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot}$
 $\rightarrow [simplify]$

[20.3] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq \text{asType} < \text{short int} > (\text{div1.quot})$

\rightarrow [simplify]

[1.1] $-32768 \leq \text{asType} < \text{short int} > (\text{div1.quot})$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[1.2] $-32768 \leq \text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

\rightarrow [simplify]

[1.5] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

\rightarrow [from term 20.3, $\text{literal} < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$ is true whenever $(-1 + \text{literal}) < -32769$]

Proof of rule precondition:

[1.5.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.5.2] **true**

[1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)

Condition defined at:

To prove: $\text{asType} < \text{short int} > (\text{div1.quot}) \leq \text{maxof}(\text{int})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType} < \text{short int} > ((\text{int})30269)$

$\$ \text{heap}_{init}.\text{r1} == \text{asType} < \text{short int} > ((\text{int})171)$

$\$ \text{heap}_{init}.\text{a1} == \text{asType} < \text{short int} > ((\text{int})177)$

$\$ \text{heap}_{init}.\text{b1} == \text{asType} < \text{short int} > ((\text{int})2)$

$\$ \text{heap}_{init}.\text{M2} == \text{asType} < \text{short int} > ((\text{int})30307)$

$\$ \text{heap}_{init}.\text{r2} == \text{asType} < \text{short int} > ((\text{int})172)$

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]


```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(**asType<short int>**((**int**)30307)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(**asType<short
int>**((**int**)30323)))
→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)
[Work on sub-term 4 of conjunction in term 5.40]

[8.0] 0 < \$heap_funcstart_724,1.p1
[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))
→ [simplify]

[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))
→ [const static or extern object]

[11.2] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) /$
 $\text{asType<integer>}(177)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [simplify]

[14.2] $(\$ \text{heap_funcstart_724,1.p1} / 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177),$
 $[\text{!(asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot})$

→ [simplify]

[14.7] $([0 < -\$ \text{heap_funcstart_724,1.p1}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177),$
 $[\text{!(asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot})$

→ [from term 8.0, $\text{literal}a < -\$ \text{heap_funcstart_724,1.p1}$ is false whenever $-2 < (0 + \text{literal}a)$]

Proof of rule precondition:

[14.7.0] $-2 < (0 + 0)$

→ [simplify]

[14.7.2] **true**

[14.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / 177)$,
 $[\neg(\text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) < 0)]$:
 $\text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 \rightarrow [simplify]
[14.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / 177)$, $[\neg(0 <$
 $\neg \$heap_{funcstart_724,1}.p1)]$: $\text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / 177)$
 $== \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot})$
 \rightarrow [from term 8.0, literal $a < \neg \$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[14.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.11.2] **true**

[14.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / 177)$,
 $[\neg \text{false}]$: $\text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$

\rightarrow [simplify]

[14.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot} + (\$heap_{funcstart_724,1}.p1 / 177))$

[Assume known post-assertion, class invariant or type constraint for term
14.17]

[21.0] $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} \leq$
maxof(int)

\rightarrow [simplify]

[21.9] $-32768 < \neg \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot}$

[Take goal term]

[1.0] $\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot}) \leq \text{maxof(int)}$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177)$]

[1.1] $\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) \leq \text{maxof(int)}$

\rightarrow [simplify]

[1.11] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).$ quot

\rightarrow [from term 21.9, $\text{literal} < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).$ quot is true whenever $(-1 + \text{literal}) < -32768$]

Proof of rule precondition:

[1.11.0] $(-32768 + -1) < -32768$

\rightarrow [simplify]

[1.11.2] **true**

[1.12] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,35)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap_funcstart_724,1} \cdot b1$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$\text{heap_funcstart_724,1})$

```

div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

```

[Take goal term]
[1.0] minof(int) ≤ $heap_funcstart_724,1.b1
→ [simplify]
[1.1] -32768 ≤ $heap_funcstart_724,1.b1
→ [const static or extern object]
[1.2] -32768 ≤ $heap_init.b1
→ [expand definition of constant 'b1' at prang.c (17,20)]
[1.3] -32768 ≤ asType<short int>((int)2)
→ [simplify]
[1.6] true

```

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,35)

Condition defined at:

To prove: \$heap_funcstart_724,1.b1 ≤ maxof(int)

Given:

```

$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)

```

```

$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

```



```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take goal term]

[1.0] \$heap_funcstart_724,1.b1 ≤ **maxof(int)**

→ [const static or extern object]

[1.1] \$heap_init.b1 ≤ **maxof(int)**

→ [expand definition of constant 'b1' at prang.c (17,20)]

[1.2] asType<short int>((int)2) ≤ **maxof(int)**

→ [simplify]

[1.6] true

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,38)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) / \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) == \text{asType}\langle\text{integer}\rangle(\text{div1.quot})$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \% \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem})$

```

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

```

```

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>(asType<short
int>((int)30323)))

```

\rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] $0 < \$heap_funcstart_724,1.p1$
[Take given term]
[11.0] $div1 == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}<\text{int}>(\$heap_funcstart_724,1.p1), \text{asType}<\text{int}>(\$heap_funcstart_724,1.a1))$
 \rightarrow [simplify]
[11.1] $div1 == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}<\text{int}>(\$heap_funcstart_724,1.a1))$
 \rightarrow [const static or extern object]
[11.2] $div1 == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}<\text{int}>(\$heap_init.a1))$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] $div1 == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})177)))$
 \rightarrow [simplify]
[11.6] $div1 == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$
[Take goal term]
[1.0] $\text{minof}(\text{int}) \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div1.quot})) * \text{asType}<\text{int}>(\$heap_funcstart_724,1.b1))$
 \rightarrow [simplify]
[1.1] $-32768 \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div1.quot})) * \text{asType}<\text{int}>(\$heap_funcstart_724,1.b1))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$]
[1.2] $-32768 \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)) * \text{asType}<\text{int}>(\$heap_funcstart_724,1.b1))$
 \rightarrow [simplify]
[1.4] $-32768 \leq (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot * \text{asType}<\text{int}>(\$heap_funcstart_724,1.b1))$

→ [const static or extern object]

[1.5] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}<\text{int}>(\$ \text{heap_init.b1}))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[1.6] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})2)))$

→ [simplify]

[1.11] $-32769 < (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [literal comparison of product]

[1.12] $([2 < 0]: (-32769 / -2) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [0 < 2]: (-32769 / 2) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [0 == 2]: -32769 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.13] $([2 < 0]: (-32769 / -2) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [(0 < 2) \wedge !(2 < 0)]: (-32769 / 2) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [(0 == 2) \wedge !(0 < 2) \wedge !(2 < 0)]: -32769 < 0)$

→ [simplify]

[1.21] $-16385 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

→ [negate goal and search for contradiction]

[1.22] $!(-16385 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [simplify]

[1.24] $16384 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] $(\text{asType}<\text{integer}>(\$ \text{heap_funcstart_724,1.p1}) / \text{asType}<\text{integer}>(177)) == \text{asType}<\text{integer}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [simplify]

[14.2] $(\$ \text{heap_funcstart_724,1.p1} / 177) == \text{asType}<\text{integer}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] $([\text{asType}<\text{integer}>(\$ \text{heap_funcstart_724,1.p1}) < 0]: -(\text{asType}<\text{integer}>(\$ \text{heap_funcstart_724,1.p1}) / 177), []:$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ($[\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 \rightarrow [simplify]
[14.7] ($[0 < \neg\$heap_{funcstart_724,1}.p1]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 \rightarrow [from term 8.0, $\text{literal}_a < \neg\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]
Proof of rule precondition:
[14.7.0] $-2 < (0 + 0)$
 \rightarrow [simplify]
[14.7.2] **true**
[14.8] ($[\text{false}]: \neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 \rightarrow [simplify]
[14.11] ($[\text{false}]: \neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177), [\neg(0 <$
 $\neg\$heap_{funcstart_724,1}.p1)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot})$
 \rightarrow [from term 8.0, $\text{literal}_a < \neg\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]
Proof of rule precondition:
[14.11.0] $-2 < (0 + 0)$
 \rightarrow [simplify]

[14.11.2] **true**

[14.12] ([**false**]: $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177)$,
[!**false**]: $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot})$

→ [simplify]

[14.17] $0 == (-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot} + (\text{\$heap_funcstart_724,1.p1} / 177))$

[Create new term from terms 1.24, 14.17 using rule: transitivity 15]

[67.0] $(0 + 16384) < -(\text{\$heap_funcstart_724,1.p1} / 177)$

→ [simplify]

[67.7] $2899968 < -\text{\$heap_funcstart_724,1.p1}$

→ [from term 8.0, literal $a < -\text{\$heap_funcstart_724,1.p1}$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[67.7.0] $-2 < (0 + 2899968)$

→ [simplify]

[67.7.2] **true**

[67.8] **false**

Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,38)

Condition defined at:

To prove: $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\text{\$heap_funcstart_724,1.b1})) \leq \text{maxof}(\text{int})$

Given:

$\text{\$heap_init.LIMIT} == (\text{int})80$

$\text{\$heap_init.M1} == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\text{\$heap_init.r1} == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\text{\$heap_init.a1} == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\text{\$heap_init.b1} == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\text{\$heap_init.M2} == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\text{\$heap_init.r2} == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\text{\$heap_init.a2} == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(\$heap_funcstart_724,1.M1))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(\$heap_init.M1))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(**asType<short int>**((**int**)30307)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(**asType<short
int>**((**int**)30323)))
→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)
[Work on sub-term 3 of conjunction in term 5.40]

[7.0] -30269 < -\$heap_funcstart_724,1.p1
[Work on sub-term 4 of conjunction in term 5.40]

[8.0] 0 < \$heap_funcstart_724,1.p1
[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))
→ [simplify]

[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\$ \text{heap_init.a1}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$

[Take goal term]

[1.0] $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})) \leq \text{maxof(int)}$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[1.1] $(\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})) \leq \text{maxof(int)}$

→ [simplify]

[1.3] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})) \leq \text{maxof(int)}$

→ [const static or extern object]

[1.4] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType<int>}(\$ \text{heap_init.b1})) \leq \text{maxof(int)}$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[1.5] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType<int>}(\text{asType<short int>}((\text{int})2))) \leq \text{maxof(int)}$

→ [simplify]

[1.18] $-32768 < (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [literal comparison of product]

[1.19] $([-2 < 0]: (-32768 / 2) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [0 < -2]: (-32768 / -2) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [-2 == 0]: -32768 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.20] $([-2 < 0]: (-32768 / 2) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [(0 < -2) \wedge !(-2 < 0)]: (-32768 / -2) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [(-2 == 0) \wedge !(-2 < 0) \wedge !(0 < -2)]: -32768 < 0)$

\rightarrow [simplify]
 [1.24] $-16384 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot}$
 \rightarrow [negate goal and search for contradiction]
 [1.25] $!(-16384 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [simplify]
 [1.28] $16383 < \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot}$
 [Assume known post-assertion, class invariant or type constraint for term 11.6]
 [14.0] $(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / \text{asType}\langle\text{integer}\rangle(177)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [simplify]
 [14.2] $(\text{\$heap_funcstart_724,1.p1} / 177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [expand definition of operator './' in class 'int' at built in declaration]
 [14.3] $([\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177), []:$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [14.4] $([\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177),$
 $!([\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [simplify]
 [14.7] $([0 < -\text{\$heap_funcstart_724,1.p1}]:$
 $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177),$
 $!([\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) / 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [from term 8.0, $\text{literal} < -\text{\$heap_funcstart_724,1.p1}$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[14.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.7.2] **true**

[14.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) / 177)$,
[!($\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) < 0$)]:
 $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$

\rightarrow [simplify]

[14.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) / 177)$, [!($0 <$
 $\neg \$heap_{funcstart_724,1}.p1$)]: $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) / 177)$
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot})$

\rightarrow [from term 8.0, $\text{literal}a < \neg \$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}a)$]

Proof of rule precondition:

[14.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.11.2] **true**

[14.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) / 177)$,
[false]: $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$

\rightarrow [simplify]

[14.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot} + (\$heap_{funcstart_724,1}.p1 / 177))$

[Create new term from terms 1.28, 14.17 using rule: transitivity 16]

[67.0] $(0 + 16383) < (\$heap_{funcstart_724,1}.p1 / 177)$

\rightarrow [simplify]

[67.8] $2899967 < \$heap_{funcstart_724,1}.p1$

\rightarrow [from term 7.0, $\text{literal}a < \$heap_{funcstart_724,1}.p1$ is false whenever $-2 <$
 $(-30269 + \text{literal}a)$]

Proof of rule precondition:

[67.8.0] $-2 < (-30269 + 2899967)$

\rightarrow [simplify]

[67.8.2] true

[67.9] false

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,33)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1)))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) /$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div1.quot})$

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <

```

```

asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <

$-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$
 $[Work\ on\ sub-term\ 3\ of\ conjunction\ in\ term\ 5.40]$
 $[7.0] -30269 < -\$heap_funcstart_724,1.p1$
 $[Work\ on\ sub-term\ 4\ of\ conjunction\ in\ term\ 5.40]$
 $[8.0] 0 < \$heap_funcstart_724,1.p1$
 $[Take\ given\ term]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p1), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$
 $\rightarrow [\text{simplify}]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_init.a1))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$
 $[Take\ goal\ term]$
 $[1.0] \text{minof}(\text{short int}) \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1)))$
 $\rightarrow [\text{simplify}]$
 $[1.1] -32768 \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1)))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_funcstart_724,1,$

$\$heap_{funcstart_724,1} \cdot p1, 177]$
 $[1.2] -32768 \leq ((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{simplify}]$
 $[1.4] -32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{const static or extern object}]$
 $[1.5] -32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{init} \cdot r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$
 $[1.6] -32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{simplify}]$
 $[1.9] -32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)]$
 $[1.10] -32768 \leq ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{simplify}]$
 $[1.12] -32768 \leq ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot b1)))$
 $\rightarrow [\text{const static or extern object}]$
 $[1.13] -32768 \leq ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{init} \cdot b1)))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$

[1.14] $-32768 \leq ((171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}) - (\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot} * \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{asType}\langle \mathbf{short} \ \mathbf{int} \rangle((\mathbf{int})2))))$

→ [simplify]

[1.21] $-32769 < ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}))$

→ [negate goal and search for contradiction]

[1.22] $\neg(-32769 < ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem})))$

→ [simplify]

[1.27] $32768 < ((2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot}) + (-171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}))$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] $(\mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) / \mathbf{asType}\langle \mathbf{integer} \rangle(177)) == \mathbf{asType}\langle \mathbf{integer} \rangle(\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot})$

→ [simplify]

[14.2] $(\$heap_funcstart_724,1.p1 / 177) == \mathbf{asType}\langle \mathbf{integer} \rangle(\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] $([\mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) < 0]: \neg(\neg \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) / 177), []: \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) / 177) == \mathbf{asType}\langle \mathbf{integer} \rangle(\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] $([\mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) < 0]: \neg(\neg \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) / 177), [!(\mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) < 0]): \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) / 177) == \mathbf{asType}\langle \mathbf{integer} \rangle(\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot})$

→ [simplify]

[14.7] $([0 < -\$heap_funcstart_724,1.p1]: \neg(\neg \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) / 177), [!(\mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.p1) < 0]):$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$
 \rightarrow [from term 8.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[14.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.7.2] **true**

[14.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$

\rightarrow [simplify]

[14.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177), [\neg(0 <$
 $-\$heap_{funcstart_724,1}.p1)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot})$

\rightarrow [from term 8.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[14.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.11.2] **true**

[14.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177),$
 $[\neg\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) / 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot})$

\rightarrow [simplify]

[14.17] $0 == (\neg\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot} + (\$heap_{funcstart_724,1}.p1 / 177))$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[15.0] $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \%$
 $\text{asType}\langle\text{integer}\rangle(177)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})$

\rightarrow [simplify]

[15.2] $(\$heap_{funcstart_724,1}.p1 \% 177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})$

→ [expand definition of operator ‘.’ in class ‘int’ at built in declaration]

[15.3] $([\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0]:$
 $-(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177), []:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] $([\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0]:$
 $-(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$

→ [simplify]

[15.7] $([0 < -\$heap_{funcstart_724,1}.p1]:$
 $-(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$

→ [from term 8.0, $\text{literal}a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0 + \text{literal}a)$]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$

→ [simplify]

[15.7.2] **true**

[15.8] $([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$

→ [simplify]

[15.11] $([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177), [(0$
 $< -\$heap_{funcstart_724,1}.p1)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \%$
 $177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})$

→ [from term 8.0, $\text{literal}a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$

+ *literal*)]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$

→ [simplify]

[15.11.2] **true**

[15.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) \% 177)$,
[!false]: $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p1}) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem})$)

→ [simplify]

[15.17] $0 == (-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem} + (\text{\$heap_funcstart_724,1.p1} \% 177))$

[Copy term 1.27]

[77.0] $32768 < ((-171 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot}))$

→ [from term 15.17, $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{rem}$ is equal to $\text{\$heap_funcstart_724,1.p1} \% 177]$

[77.1] $32768 < ((-171 * (\text{\$heap_funcstart_724,1.p1} \% 177)) + (2 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot}))$

[Create new term from term 14.17 using rule: condition for equality of division]

[81.0] $((177 * (0 + -(-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot}))) < (1 + \text{\$heap_funcstart_724,1.p1})) \wedge$
 $(\text{\$heap_funcstart_724,1.p1} < (177 * (0 + 1 + -(-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot}))))$

→ [simplify]

[81.15] $(-1 < ((-177 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot}) + \text{\$heap_funcstart_724,1.p1})) \wedge (-177 < (-\text{\$heap_funcstart_724,1.p1} +$
 $(177 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})))$

[Work on sub-term 2 of conjunction in term 81.15]

[82.0] $-1 < ((-177 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot}) + \text{\$heap_funcstart_724,1.p1})$

[Create new term from terms 82.0, 7.0 using rule: transitivity 2]

[117.0] $(-30269 + -1 + 1) < (-177 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$

→ [simplify]

[117.1] $-30269 < (-177 * \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$

$\$heap_funcstart_724,1 \cdot p1, 177).quot)$
 \rightarrow [literal comparison of product]
[117.2] $([-177 < 0]: (-30269 / 177) < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot, [0 < -177]: (-30269 / -177) < div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot, [-177 == 0]: -30269 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[117.3] $([-177 < 0]: (-30269 / 177) < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot, [(0 < -177) \wedge !(-177 < 0)]: (-30269 / -177) < div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot, [(-177 == 0) \wedge !(-177 < 0) \wedge !(0 < -177)]: -30269 < 0)$
 \rightarrow [simplify]
[117.7] $-172 < -div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot$
[Create new term from terms 117.7, 77.1 using rule: transitivity 5]
[119.0] $32768 < ((-171 * (\$heap_funcstart_724,1 \cdot p1 \% 177)) + (2 * -(-172 + 1)))$
 \rightarrow [simplify]
[119.5] $32426 < (-171 * (\$heap_funcstart_724,1 \cdot p1 \% 177))$
 \rightarrow [literal comparison of product]
[119.6] $([-171 < 0]: (32426 / 171) < -(\$heap_funcstart_724,1 \cdot p1 \% 177), [0 < -171]: (32426 / -171) < (\$heap_funcstart_724,1 \cdot p1 \% 177), [-171 == 0]: 32426 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[119.7] $([-171 < 0]: (32426 / 171) < -(\$heap_funcstart_724,1 \cdot p1 \% 177), [(0 < -171) \wedge !(-171 < 0)]: (32426 / -171) < (\$heap_funcstart_724,1 \cdot p1 \% 177), [(-171 == 0) \wedge !(-171 < 0) \wedge !(0 < -171)]: 32426 < 0)$
 \rightarrow [simplify]
[119.12] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,33)

Condition defined at:

To prove: $((asType<int>(asType<short int>(div1.rem)) * asType<int>(\$heap_funcstart_724,1.r1)) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_funcstart_724,1.b1))) \leq \mathbf{maxof}(\mathbf{short int})$

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)
$heap_init.r3 == asType<short int>((int)170)
$heap_init.a3 == asType<short int>((int)178)
$heap_init.b3 == asType<short int>((int)63)
$heap_init.p1 == asType<short int>((int)1)
$heap_init.p2 == asType<short int>((int)2)
$heap_init.p3 == asType<short int>((int)3)
invariant1(heapIs $heap_funcstart_724,1)
div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p3),
asType<int>($heapfuncstart_724,1.a3))
(asType<integer>(asType<int>($heapfuncstart_724,1.p3)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a3))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p3)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a3))) ==
asType<integer>(div3.rem)
(asType<integer>($heapfuncstart_724,1.p3) <
asType<integer>($heapfuncstart_724,1.a3)) =>
(asType<integer>($heapfuncstart_724,1.p3) ==
asType<integer>(div3.rem))
(asType<integer>($heapfuncstart_724,1.a3) ≤
asType<integer>($heapfuncstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heapfuncstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
```

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
 $[\text{Work on sub-term 4 of conjunction in term 5.40}]$
 $[8.0] 0 < \$heap_funcstart_724,1.p1$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p1}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a1}))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a1}))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\$ \text{heap_init.a1}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$

[Take goal term]

[1.0] $((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))) \leq \text{maxof}(\text{short int})$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[1.1] $((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem)) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))) \leq \text{maxof}(\text{short int})$

→ [const static or extern object]

[1.4] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem * \text{asType<int>}(\$ \text{heap_init.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))) \leq \text{maxof}(\text{short int})$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[1.5] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem * \text{asType<int>}(\$ \text{heap_init.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))) \leq \text{maxof}(\text{short int})$

$$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) -$$

$$(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot}))) *$$

$$\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))) \leq \text{maxof}(\text{short int})$$

→ [simplify]

$$[1.8] ((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} * 171)$$

$$- (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot}))) *$$

$$\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))) \leq \text{maxof}(\text{short int})$$

→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)]

$$[1.9] ((171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})$$

$$- (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$$

$$\$heap_funcstart_724,1.p1, 177).\text{quot}))) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1)))$$

$$\leq \text{maxof}(\text{short int})$$

→ [simplify]

$$[1.11] ((171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))) \leq \text{maxof}(\text{short int})$$

→ [const static or extern object]

$$[1.12] ((171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_init.b1))) \leq \text{maxof}(\text{short int})$$

→ [expand definition of constant 'b1' at prang.c (17,20)]

$$[1.13] ((171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})2)))) \leq \text{maxof}(\text{short}$$

$$\text{int})$$

→ [simplify]

$$[1.32] -32768 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1,$$

$$\$heap_funcstart_724,1.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1,$$

$$\$heap_funcstart_724,1.p1, 177).\text{quot}))$$

→ [negate goal and search for contradiction]

$$[1.33] !(-32768 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1,$$

$$\$heap_funcstart_724,1.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1,$$

$$\$heap_funcstart_724,1.p1, 177).\text{quot})))$$

→ [simplify]

$$[1.38] 32767 < ((171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{rem}) + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$$

$$177).\text{quot}))$$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[14.0] (**asType**<integer>(\$heap_funcstart_724,1.p1) /
asType<integer>(177)) == **asType**<integer>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)

→ [simplify]

[14.2] (\$heap_funcstart_724,1.p1 / 177) == **asType**<integer>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)

→ [expand definition of operator './' in class 'int' at built in declaration]

[14.3] ([**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]:
-(**asType**<integer>(\$heap_funcstart_724,1.p1) / 177), []:
asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[14.4] ([**asType**<integer>(\$heap_funcstart_724,1.p1) < 0]:
-(**asType**<integer>(\$heap_funcstart_724,1.p1) / 177),
[!(**asType**<integer>(\$heap_funcstart_724,1.p1) < 0)]:
asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)

→ [simplify]

[14.7] ([0 < -\$heap_funcstart_724,1.p1]:
-(**asType**<integer>(\$heap_funcstart_724,1.p1) / 177),
[!(**asType**<integer>(\$heap_funcstart_724,1.p1) < 0)]:
asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)

→ [from term 8.0, literal a < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0
+ literal a)]

Proof of rule precondition:

[14.7.0] -2 < (0 + 0)

→ [simplify]

[14.7.2] **true**

[14.8] ([**false**]: -(**asType**<integer>(\$heap_funcstart_724,1.p1) / 177),
[!(**asType**<integer>(\$heap_funcstart_724,1.p1) < 0)]:
asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).quot)

→ [simplify]

[14.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) / 177)$, [!(0 < $\neg \text{\$heap_funcstart_724,1.p1}$)]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) / 177$)
 $\text{== asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 \rightarrow [from term 8.0, $\text{literal} < -\text{\$heap_funcstart_724,1.p1}$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[14.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.11.2] **true**

[14.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) / 177)$,
[false]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) / 177$) ==
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$

\rightarrow [simplify]

[14.17] $0 \text{ == } (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{quot} + (\text{\$heap_funcstart_724,1.p1} / 177))$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[15.0] ($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) \% \text{asType}\langle \text{integer} \rangle(177)$) $\text{== asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$

\rightarrow [simplify]

[15.2] $(\text{\$heap_funcstart_724,1.p1} \% 177) \text{ == asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$

\rightarrow [expand definition of operator $\%'$ in class 'int' at built in declaration]

[15.3] ([$\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) < 0$):
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) \% 177)$, []:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) \% 177$) ==
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] ([$\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) < 0$):
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) \% 177)$,
[!($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) < 0$)]:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p1}) \% 177$) ==
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177).\text{rem})$

\rightarrow [simplify]

[15.7] $([0 < -\$heap_funcstart_724,1.p1]:$
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177),$
 $[!(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$
 \rightarrow [from term 8.0, $\text{literal}a < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0$
 $+ \text{literal}a)$]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[15.7.2] **true**

[15.8] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177),$
 $[!(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$

\rightarrow [simplify]

[15.11] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177), [!(0$
 $< -\$heap_funcstart_724,1.p1)]: \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \%$
 $177) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{rem})$

\rightarrow [from term 8.0, $\text{literal}a < -\$heap_funcstart_724,1.p1$ is false whenever $-2 < (0$
 $+ \text{literal}a)$]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[15.11.2] **true**

[15.12] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177),$
 $[\text{false}]: \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p1) \% 177) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem})$

\rightarrow [simplify]

[15.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).\text{rem} + (\$heap_funcstart_724,1.p1 \% 177))$

[Assume known post-assertion, class invariant or type constraint for term
14.17]

[20.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$

177).quot
 → [simplify]
 [20.3] -32769 < div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).quot
 [Take given term]
 [24.0] (asType<integer>(\$heap_funcstart_724,1.p1) <
 asType<integer>(\$heap_funcstart_724,1.a1)) =>
 (asType<integer>(\$heap_funcstart_724,1.p1) ==
 asType<integer>(div1.rem))
 → [simplify]
 [24.1] (\$heap_funcstart_724,1.p1 < asType<integer>(\$heap_funcstart_724,1.a1))
 => (asType<integer>(\$heap_funcstart_724,1.p1) ==
 asType<integer>(div1.rem))
 → [const static or extern object]
 [24.2] (\$heap_funcstart_724,1.p1 < asType<integer>(\$heap_init.a1)) =>
 (asType<integer>(\$heap_funcstart_724,1.p1) ==
 asType<integer>(div1.rem))
 → [expand definition of constant 'a1' at prang.c (16,20)]
 [24.3] (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short
 int>((int)177))) => (asType<integer>(\$heap_funcstart_724,1.p1) ==
 asType<integer>(div1.rem))
 → [simplify]
 [24.10] (-177 < -\$heap_funcstart_724,1.p1) => (\$heap_funcstart_724,1.p1 ==
 asType<integer>(div1.rem))
 → [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177)]
 [24.11] (-177 < -\$heap_funcstart_724,1.p1) => (\$heap_funcstart_724,1.p1 ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).rem))
 → [simplify]
 [24.17] (0 == (-\$heap_funcstart_724,1.p1 + div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).rem)) ∨ (176 < \$heap_funcstart_724,1.p1)
 [Branch on disjunction or conditional in term 24.17]
 [59.0] (0 == (-\$heap_funcstart_724,1.p1 + div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).rem)) ∨ (176 < \$heap_funcstart_724,1.p1) ∨ !(0 ==
 (-\$heap_funcstart_724,1.p1 + div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).rem))
 [Copy term 1.38]

[60.0] $(32767 < ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}))) \vee (176 < \$heap_funcstart_724,1.p1) \vee !(0 == (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))$

→ [from term 59.0, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}$ is equal to $\$heap_funcstart_724,1.p1$]

[60.1] $(32767 < ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \$heap_funcstart_724,1.p1))) \vee \dots$

[Copy term 15.17]

[61.0] $(0 == (-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem} + (\$heap_funcstart_724,1.p1 \% 177))) \vee (176 < \$heap_funcstart_724,1.p1) \vee !(0 == (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))$

→ [from term 59.0, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}$ is equal to $\$heap_funcstart_724,1.p1$]

[61.1] $(0 == (-\$heap_funcstart_724,1.p1 + (\$heap_funcstart_724,1.p1 \% 177))) \vee \dots$

[Create new term from terms 1.38, 20.3 using rule: transitivity 11r]

[69.0] $(1 + 32767 + (-32769 * 2)) < (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})$

→ [simplify]

[69.2] $-32770 < (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem})$

→ [literal comparison of product]

[69.3] $([171 < 0]: (-32770 / -171) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}, [0 < 171]: (-32770 / 171) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}, [0 == 171]: -32770 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[69.4] $([171 < 0]: (-32770 / -171) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}, [(0 < 171) \wedge !(171 < 0)]: (-32770 / 171) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}, [(0 == 171) \wedge !(0 < 171) \wedge !(171 < 0)]: -32770 < 0)$

→ [simplify]

[69.12] $-192 < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).\text{rem}$

[Assume known post-assertion, class invariant or type constraint for term 61.1]

[70.0] $(\$heap_funcstart_724,1.p1 < 177) \vee (176 < \$heap_funcstart_724,1.p1) \vee !(0 == (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))$

$\$heap_{funcstart_724,1} \cdot p1, 177).rem))$
 $\rightarrow [simplify]$
 $[70.3] (-177 < -\$heap_{funcstart_724,1} \cdot p1) \vee \dots$
 $[Copy\ term\ 1.38]$
 $[72.0] 32767 < ((-2 * \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))$
 $\rightarrow [from\ term\ 15.17, \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem\ is\ equal\ to\ \$heap_{funcstart_724,1} \cdot p1 \% 177]$
 $[72.1] 32767 < ((-2 * \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * (\$heap_{funcstart_724,1} \cdot p1 \% 177)))$
 $[Copy\ term\ 60.1]$
 $[73.0] (32767 < ((-2 * \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \$heap_{funcstart_724,1} \cdot p1))) \vee (176 < \$heap_{funcstart_724,1} \cdot p1) \vee !(0 == (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))$
 $\rightarrow [from\ term\ 14.17, \text{div}(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot\ is\ equal\ to\ \$heap_{funcstart_724,1} \cdot p1 / 177]$
 $[73.1] (32767 < ((-2 * (\$heap_{funcstart_724,1} \cdot p1 / 177)) + (171 * \$heap_{funcstart_724,1} \cdot p1))) \vee \dots$
 $\rightarrow [division\ by\ larger\ divisor]$
Proof of rule precondition 1:
 $[73.1.0.0] literald < -\$heap_{funcstart_724,1} \cdot p1$
 $\rightarrow [unify\ with\ term\ 70.3]$
 $[73.1.0.1] \mathbf{true}$
Proof of rule precondition 2:
 $[73.1.1.0] literalc < \$heap_{funcstart_724,1} \cdot p1$
 $\rightarrow [unify\ with\ term\ 8.0]$
 $[73.1.1.1] \mathbf{true}$
Proof of rule precondition 3:
 $[73.1.2.0] -177 \leq 177$
 $\rightarrow [simplify]$
 $[73.1.2.2] \mathbf{true}$
Proof of rule precondition 4:
 $[73.1.3.0] -2 < 0$

\rightarrow [simplify]
 [73.1.3.1] **true**
 [73.2] $(32767 < ((-2 * \$heap_{funcstart_724,1}.p1) + (171 * \$heap_{funcstart_724,1}.p1))) \vee \dots$
 \rightarrow [simplify]
 [73.4] $(32767 < (169 * \$heap_{funcstart_724,1}.p1)) \vee \dots$
 \rightarrow [literal comparison of product]
 [73.5] $([169 < 0]: (32767 / -169) < -\$heap_{funcstart_724,1}.p1, [0 < 169]: (32767 / 169) < \$heap_{funcstart_724,1}.p1, [0 == 169]: 32767 < 0) \vee \dots$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [73.6] $([169 < 0]: (32767 / -169) < -\$heap_{funcstart_724,1}.p1, [(0 < 169) \wedge !(169 < 0)]: (32767 / 169) < \$heap_{funcstart_724,1}.p1, [(0 == 169) \wedge !(0 < 169) \wedge !(169 < 0)]: 32767 < 0) \vee \dots$
 \rightarrow [simplify]
 [73.13] $(\mathbf{true} \wedge (193 < \$heap_{funcstart_724,1}.p1)) \vee \dots$
 \rightarrow [from term 70.3, $literal_a < \$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (-177 + literal_a)$]
Proof of rule precondition:
 [73.13.0] $-2 < (-177 + 193)$
 \rightarrow [simplify]
 [73.13.2] **true**
 [73.14] $(\mathbf{true} \wedge \mathbf{false}) \vee \dots$
 \rightarrow [simplify]
 [73.15] **false** $\vee \dots$
 [Remove 'false' term 73.15 and fetch new term from containing clause]
 [74.0] $176 < \$heap_{funcstart_724,1}.p1$
 [Remove 'false' term 73.15 and fetch new term from containing clause]
 [75.0] $!(0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
 [Create new term from term 14.17 using rule: condition for equality of division]
 [79.0] $((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})))) < (1 + \$heap_{funcstart_724,1}.p1)) \wedge (\$heap_{funcstart_724,1}.p1 < (177 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))))$
 \rightarrow [simplify]

[79.15] $(-1 < ((-177 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot) + \$heap_{funcstart_724,1} \cdot p1)) \wedge (-177 < (-\$heap_{funcstart_724,1} \cdot p1 + (177 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot)))$
 \rightarrow [separate conjunction and work on first sub-term]

[79.16] $-177 < (-\$heap_{funcstart_724,1} \cdot p1 + (177 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot))$
[Create new term from term 75.0 using rule: not-equal implies greater-than or less-than]

[81.0] $(0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem)) \vee ((-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem) < 0)$
 \rightarrow [simplify]

[81.5] $(0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem)) \vee (0 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + \$heap_{funcstart_724,1} \cdot p1))$
[Branch on disjunction or conditional in term 81.5]

[82.0] $(0 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + \$heap_{funcstart_724,1} \cdot p1)) \vee (0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + \$heap_{funcstart_724,1} \cdot p1))$
[Create new term from terms 82.0, 79.16 using rule: transitivity 1]

[83.0] $((-177 + 0 + 1) < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + (177 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot))) \vee (0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + \$heap_{funcstart_724,1} \cdot p1))$
 \rightarrow [simplify]

[83.1] $(-176 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + (177 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot))) \vee \dots$
[Create new term from terms 83.1, 69.12 using rule: transitivity 2]

[85.0] $((-192 + -176 + 1) < (177 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot)) \vee (0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem + \$heap_{funcstart_724,1} \cdot p1))$
 \rightarrow [simplify]

[85.1] $(-367 < (177 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).quot)) \vee \dots$

→ [literal comparison of product]

[85.2] $([177 < 0]: (-367 / -177) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).quot, [0 < 177]: (-367 / 177) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).quot, [0 == 177]: -367 < 0) \vee \dots$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[85.3] $([177 < 0]: (-367 / -177) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).quot, [(0 < 177) \wedge !(177 < 0)]: (-367 / 177) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).quot, [(0 == 177) \wedge !(0 < 177) \wedge !(177 < 0)]: -367 < 0) \vee \dots$

→ [simplify]

[85.11] $(-3 < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).quot) \vee \dots$

[Create new term from terms 85.11, 72.1 using rule: transitivity 11]

[90.0] $((1 + 32767 + (-3 * 2)) < (171 * (\$heap_funcstart_724,1.p1 \% 177))) \vee (0 < (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).rem + \$heap_funcstart_724,1.p1))$

→ [simplify]

[90.2] $(32762 < (171 * (\$heap_funcstart_724,1.p1 \% 177))) \vee \dots$

→ [literal comparison of product]

[90.3] $([171 < 0]: (32762 / -171) < -(\$heap_funcstart_724,1.p1 \% 177), [0 < 171]: (32762 / 171) < (\$heap_funcstart_724,1.p1 \% 177), [0 == 171]: 32762 < 0) \vee \dots$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[90.4] $([171 < 0]: (32762 / -171) < -(\$heap_funcstart_724,1.p1 \% 177), [(0 < 171) \wedge !(171 < 0)]: (32762 / 171) < (\$heap_funcstart_724,1.p1 \% 177), [(0 == 171) \wedge !(0 < 171) \wedge !(171 < 0)]: 32762 < 0) \vee \dots$

→ [simplify]

[90.13] **false** $\vee \dots$

[Remove 'false' term 90.13 and fetch new term from containing clause]

[91.0] $0 < (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).rem)$

[Create new term from terms 91.0, 74.0 using rule: transitivity 2]

[93.0] $(0 + 1 + 176) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p1, 177).rem$

→ [simplify]

[93.1] $177 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}$

[Create new term from terms 93.1, 15.17 using rule: transitivity 16]

[94.0] $(0 + 177) < (\$ \text{heap_funcstart_724,1.p1} \% 177)$

→ [simplify]

[94.2] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (62,31)

To prove: $\text{asType}\langle\text{integer}\rangle(\$ \text{heap}_{724,1;745,8}.\text{p1}) < \text{asType}\langle\text{integer}\rangle(\$ \text{heap}_{724,1;745,8}.\text{M1})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\$ \text{heap}_{init}.\text{r1} == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\$ \text{heap}_{init}.\text{a1} == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\$ \text{heap}_{init}.\text{b1} == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$ \text{heap}_{init}.\text{M2} == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\$ \text{heap}_{init}.\text{r2} == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\$ \text{heap}_{init}.\text{a2} == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\$ \text{heap}_{init}.\text{b2} == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\$ \text{heap}_{init}.\text{M3} == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\$ \text{heap}_{init}.\text{r3} == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\$ \text{heap}_{init}.\text{a3} == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\$ \text{heap}_{init}.\text{b3} == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\$ \text{heap}_{init}.\text{p1} == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\$ \text{heap}_{init}.\text{p2} == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$ \text{heap}_{init}.\text{p3} == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$\text{heap_funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.p1}),$

$\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a1}))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.p1})) /$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a1}))) ==$

```

asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] ((((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.3] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.4] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <

```

asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&

```

$(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.M3))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[5.31] ((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \ \&\& (\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\$heap_{init}.M3))$
 $\rightarrow [expand\ definition\ of\ constant\ 'M3'\ at\ prang.c\ (24,20)]$
 $[5.32] ((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \ \&\& (\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30323)))$
 $\rightarrow [simplify]$
 $[5.40] (-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
 $[Work\ on\ sub-term\ 4\ of\ conjunction\ in\ term\ 5.40]$
 $[8.0] 0 < \$heap_{funcstart_724,1}.p1$
 $[Take\ given\ term]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.p1), \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.a1))$
 $\rightarrow [simplify]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.a1))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \text{asType}\langle \text{int} \rangle(\$heap_{init}.a1))$
 $\rightarrow [expand\ definition\ of\ constant\ 'a1'\ at\ prang.c\ (16,20)]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})177)))$
 $\rightarrow [simplify]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
 $[Assume\ known\ post-assertion,\ class\ invariant\ or\ type\ constraint\ for\ term\ 11.6]$
 $[14.0] (\text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.p1) / \text{asType}\langle \text{integer} \rangle(177)) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot)$
 $\rightarrow [simplify]$
 $[14.2] (\$heap_{funcstart_724,1} \cdot p1 / 177) == \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot)$
 $\rightarrow [expand \text{ definition of operator '.'/ in class 'int' at built in declaration}]$
 $[14.3] ([\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) < 0]:$
 $\quad -(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177), []:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $\quad 177).quot)$
 $\rightarrow [explicitly \text{ assert falsehood of skipped guards in subsequent guards}]$
 $[14.4] ([\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) < 0]:$
 $\quad -(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177),$
 $\quad [!(\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) < 0]):$
 $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $\quad 177).quot)$
 $\rightarrow [simplify]$
 $[14.7] ([0 < -\$heap_{funcstart_724,1} \cdot p1]:$
 $\quad -(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177),$
 $\quad [!(\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) < 0]):$
 $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $\quad 177).quot)$
 $\rightarrow [from \text{ term } 8.0, \text{ literal } a < -\$heap_{funcstart_724,1} \cdot p1 \text{ is false whenever } -2 < (0$
 $\quad + \text{ literal } a)]$

Proof of rule precondition:

$[14.7.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[14.7.2] \text{ true}$

$[14.8] ([\text{false}]: -(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177),$
 $\quad [!(\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) < 0]):$
 $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$
 $\quad 177).quot)$
 $\rightarrow [simplify]$
 $[14.11] ([\text{false}]: -(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177), [!(0 <$
 $\quad -\$heap_{funcstart_724,1} \cdot p1)]: \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p1) / 177)$
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_funcstart_724,1 \cdot p1, 177).quot)$

\rightarrow [from term 8.0, $literal_a < -\$heap_funcstart_724,1 \cdot p1$ is false whenever $-2 < (0 + literal_a)$]

Proof of rule precondition:

[14.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[14.11.2] **true**

[14.12] ([**false**]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) / 177),$

[**!false**]: $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) / 177) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot)$

\rightarrow [simplify]

[14.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot + (\$heap_funcstart_724,1 \cdot p1 / 177))$

[Assume known post-assertion, class invariant or type constraint for term 11.6]

[15.0] $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) \%$

$\text{asType}\langle\text{integer}\rangle(177)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$

$\$heap_funcstart_724,1 \cdot p1, 177).rem)$

\rightarrow [simplify]

[15.2] $(\$heap_funcstart_724,1 \cdot p1 \% 177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$

$\$heap_funcstart_724,1 \cdot p1, 177).rem)$

\rightarrow [expand definition of operator ‘.’ in class ‘int’ at built in declaration]

[15.3] ([**asType** $\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) < 0$]:

$-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) \% 177), []:$

$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) \% 177) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)$

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[15.4] ([**asType** $\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) < 0$]:

$-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) \% 177),$

[**!asType** $\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) < 0$]:

$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) \% 177) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)$

\rightarrow [simplify]

[15.7] ($[0 < -\$heap_funcstart_724,1 \cdot p1]$:

$-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) \% 177),$

[**!asType** $\langle\text{integer}\rangle(\$heap_funcstart_724,1 \cdot p1) < 0$]:

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 \rightarrow [from term 8.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[15.7.2] **true**

[15.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 \rightarrow [simplify]

[15.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177), [(0$
 $< -\$heap_{funcstart_724,1}.p1)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \%$
 $177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})$

\rightarrow [from term 8.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[15.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[15.11.2] **true**

[15.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 \rightarrow [simplify]

[15.17] $0 == (\neg\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem} + (\$heap_{funcstart_724,1}.p1 \% 177))$

[Assume known post-assertion, class invariant or type constraint for term 14.17]

[20.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{quot}$

\rightarrow [simplify]

[20.3] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

[Take given term]

[24.0] $(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) < \text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.a1})) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$

\rightarrow [simplify]

[24.1] $(\$ \text{heap_funcstart_724,1.p1} < \text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.a1})) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$

\rightarrow [const static or extern object]

[24.2] $(\$ \text{heap_funcstart_724,1.p1} < \text{asType}\langle\text{integer}\rangle(\$ \text{heap_init.a1})) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$

\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]

[24.3] $(\$ \text{heap_funcstart_724,1.p1} < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177))) \Rightarrow (\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$

\rightarrow [simplify]

[24.10] $(-177 < -\$ \text{heap_funcstart_724,1.p1}) \Rightarrow (\$ \text{heap_funcstart_724,1.p1} == \text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[24.11] $(-177 < -\$ \text{heap_funcstart_724,1.p1}) \Rightarrow (\$ \text{heap_funcstart_724,1.p1} == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

\rightarrow [simplify]

[24.17] $(0 == (-\$ \text{heap_funcstart_724,1.p1} + \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) \vee (176 < \$ \text{heap_funcstart_724,1.p1})$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

$$\text{int} > ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.r1})) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [simplify]

$$[59.3] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.r1})) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [const static or extern object]

$$[59.4] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType} < \text{int} > (\$ \text{heap_init.r1})) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [expand definition of constant 'r1' at prang.c (15,20)]

$$[59.5] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int})171))) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [simplify]

$$[59.8] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)]

$$[59.9] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [simplify]

$$[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$$

→ [const static or extern object]

$$[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$$

– (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot *
asType<int>(\$heap_init.b1))))
 → [expand definition of constant 'b1' at prang.c (17,20)]
 [59.13] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) – (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot * **asType<int>**(**asType<short int>**((int)2)))))
 → [simplify]
 [59.19] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))
 [Take goal term]
 [1.0] **asType<integer>**(\$heap724,1;745,8.p1) < **asType<integer>**(\$heap724,1;745,8.M1)
 → [from term 59.19, \$heap724,1;745,8 is equal to
 \$heap_funcstart_724,1.**replace**(p1 → (-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]
 [1.1] **asType<integer>**(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).p1) < **asType<integer>**(\$heap724,1;745,8.M1)
 → [simplify]
 [1.3] ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) < **asType<integer>**(\$heap724,1;745,8.M1)
 → [from term 59.19, \$heap724,1;745,8 is equal to
 \$heap_funcstart_724,1.**replace**(p1 → (-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]
 [1.4] ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) < **asType<integer>**(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).M1)
 → [const member of object with modified fields]
 [1.5] ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) < **asType<integer>**(\$heap_funcstart_724,1.M1)

→ [const static or extern object]

[1.6] $((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) < \text{asType}<\text{integer}>(\$ \text{heap_init.M1})$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.7] $((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) < \text{asType}<\text{integer}>(\text{asType}<\text{short int}>((\text{int})30269))$

→ [simplify]

[1.17] $-30269 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))$

→ [negate goal and search for contradiction]

[1.18] $!(-30269 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})))$

→ [simplify]

[1.23] $30268 < ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))$

[Branch on disjunction or conditional in term 24.17]

[62.0] $(0 == (-\$ \text{heap_funcstart_724,1.p1} + \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) \vee (176 < \$ \text{heap_funcstart_724,1.p1}) \vee !(0 == (-\$ \text{heap_funcstart_724,1.p1} + \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

[Copy term 1.23]

[64.0] $(30268 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \vee (176 < \$ \text{heap_funcstart_724,1.p1}) \vee !(0 == (-\$ \text{heap_funcstart_724,1.p1} + \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

→ [from term 62.0, $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}$ is equal to $\$ \text{heap_funcstart_724,1.p1}$]

[64.1] $(30268 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \$ \text{heap_funcstart_724,1.p1}))) \vee \dots$

[Copy term 15.17]

[65.0] $(0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} + (\$ \text{heap_funcstart_724,1.p1} \% 177))) \vee (176 < \$ \text{heap_funcstart_724,1.p1})$

$\vee !(0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$
 \rightarrow [from term 62.0, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}$ is equal to $\$heap_{funcstart_724,1}.p1$]
[65.1] $(0 == (-\$heap_{funcstart_724,1}.p1 + (\$heap_{funcstart_724,1}.p1 \% 177))) \vee \dots$
[Create new term from terms 1.23, 20.3 using rule: transitivity 11r]
[73.0] $(1 + 30268 + (-32769 * 2)) < (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})$
 \rightarrow [simplify]
[73.2] $-35269 < (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})$
 \rightarrow [literal comparison of product]
[73.3] $([171 < 0]: (-35269 / -171) < -\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}, [0 < 171]: (-35269 / 171) < \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}, [0 == 171]: -35269 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[73.4] $([171 < 0]: (-35269 / -171) < -\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}, [(0 < 171) \wedge !(171 < 0)]: (-35269 / 171) < \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}, [(0 == 171) \wedge !(0 < 171) \wedge !(171 < 0)]: -35269 < 0)$
 \rightarrow [simplify]
[73.12] $-207 < \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}$
[Assume known post-assertion, class invariant or type constraint for term 65.1]
[74.0] $(\$heap_{funcstart_724,1}.p1 < 177) \vee (176 < \$heap_{funcstart_724,1}.p1) \vee !(0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$
 \rightarrow [simplify]
[74.3] $(-177 < -\$heap_{funcstart_724,1}.p1) \vee \dots$
[Copy term 1.23]
[76.0] $30268 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$
 \rightarrow [from term 15.17, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}$ is equal to $\$heap_{funcstart_724,1}.p1 \% 177$]
[76.1] $30268 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * (\$heap_{funcstart_724,1}.p1 \% 177)))$

[Copy term 64.1]

[77.0] $(30268 < ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \$heap_{funcstart_724,1} \cdot p1))) \vee (176 < \$heap_{funcstart_724,1} \cdot p1) \vee !(0 == (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

→ [from term 14.17, $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot$ is equal to $\$heap_{funcstart_724,1} \cdot p1 / 177$]

[77.1] $(30268 < ((-2 * (\$heap_{funcstart_724,1} \cdot p1 / 177)) + (171 * \$heap_{funcstart_724,1} \cdot p1))) \vee \dots$

→ [division by larger divisor]

Proof of rule precondition 1:

[77.1.0.0] $\text{literal}d < -\$heap_{funcstart_724,1} \cdot p1$

→ [unify with term 74.3]

[77.1.0.1] **true**

Proof of rule precondition 2:

[77.1.1.0] $\text{literal}c < \$heap_{funcstart_724,1} \cdot p1$

→ [unify with term 8.0]

[77.1.1.1] **true**

Proof of rule precondition 3:

[77.1.2.0] $-177 \leq 177$

→ [simplify]

[77.1.2.2] **true**

Proof of rule precondition 4:

[77.1.3.0] $-2 < 0$

→ [simplify]

[77.1.3.1] **true**

[77.2] $(30268 < ((-2 * \$heap_{funcstart_724,1} \cdot p1) + (171 * \$heap_{funcstart_724,1} \cdot p1))) \vee \dots$

→ [simplify]

[77.4] $(30268 < (169 * \$heap_{funcstart_724,1} \cdot p1)) \vee \dots$

→ [literal comparison of product]

[77.5] $([169 < 0]: (30268 / -169) < -\$heap_{funcstart_724,1} \cdot p1, [0 < 169]: (30268 / 169) < \$heap_{funcstart_724,1} \cdot p1, [0 == 169]: 30268 < 0) \vee \dots$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[77.6] $[(169 < 0): (30268 / -169) < -\$heap_{funcstart_724,1}.p1, [(0 < 169) \wedge !(169 < 0)]: (30268 / 169) < \$heap_{funcstart_724,1}.p1, [(0 == 169) \wedge !(0 < 169) \wedge !(169 < 0)]: 30268 < 0) \vee \dots$

\rightarrow [simplify]

[77.13] $(\mathbf{true} \wedge (179 < \$heap_{funcstart_724,1}.p1)) \vee \dots$

\rightarrow [from term 74.3, *literal* $a < \$heap_{funcstart_724,1}.p1$ is false whenever $-2 < (-177 + \text{literal})$]

Proof of rule precondition:

[77.13.0] $-2 < (-177 + 179)$

\rightarrow [simplify]

[77.13.2] **true**

[77.14] $(\mathbf{true} \wedge \mathbf{false}) \vee \dots$

\rightarrow [simplify]

[77.15] **false** $\vee \dots$

[Remove 'false' term 77.15 and fetch new term from containing clause]

[78.0] $176 < \$heap_{funcstart_724,1}.p1$

[Remove 'false' term 77.15 and fetch new term from containing clause]

[79.0] $!(0 == (-\$heap_{funcstart_724,1}.p1 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$

[Create new term from term 14.17 using rule: condition for equality of division]

[83.0] $((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) < (1 + \$heap_{funcstart_724,1}.p1)) \wedge (\$heap_{funcstart_724,1}.p1 < (177 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))))$

\rightarrow [simplify]

[83.15] $(-1 < ((-177 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + \$heap_{funcstart_724,1}.p1)) \wedge (-177 < (-\$heap_{funcstart_724,1}.p1 + (177 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})))$

\rightarrow [separate conjunction and work on first sub-term]

[83.16] $-177 < (-\$heap_{funcstart_724,1}.p1 + (177 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))$

[Create new term from term 79.0 using rule: not-equal implies greater-than or less-than]

[85.0] $(0 < (-\$heap_{funcstart_724,1}.p1 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) \vee ((-\$heap_{funcstart_724,1}.p1 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) < 0)$

→ [simplify]

[85.5] $(0 < (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) \vee (0 < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + \$heap_funcstart_724,1.p1))$

[Branch on disjunction or conditional in term 85.5]

[86.0] $(0 < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + \$heap_funcstart_724,1.p1)) \vee (0 < (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + \$heap_funcstart_724,1.p1))$

[Create new term from terms 86.0, 83.16 using rule: transitivity 1]

[89.0] $((-177 + 0 + 1) < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + (177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))) \vee (0 < (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + \$heap_funcstart_724,1.p1))$

→ [simplify]

[89.1] $(-176 < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + (177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))) \vee \dots$

[Create new term from terms 89.1, 73.12 using rule: transitivity 2]

[91.0] $((-207 + -176 + 1) < (177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)) \vee (0 < (-\$heap_funcstart_724,1.p1 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem + \$heap_funcstart_724,1.p1))$

→ [simplify]

[91.1] $(-382 < (177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)) \vee \dots$

→ [literal comparison of product]

[91.2] $([177 < 0]: (-382 / -177) < -\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot, [0 < 177]: (-382 / 177) < \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot, [0 == 177]: -382 < 0) \vee \dots$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[91.3] $([177 < 0]: (-382 / -177) < -\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot, [(0 < 177) \wedge !(177 < 0)]: (-382 / 177) < \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot, [(0 ==$

$177) \wedge !(0 < 177) \wedge !(177 < 0)] : -382 < 0) \vee \dots$
 \rightarrow [simplify]
 [91.11] $(-3 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p1, 177).quot) \vee \dots$
 [Create new term from terms 91.11, 76.1 using rule: transitivity 11]
 [93.0] $((1 + 30268 + (-3 * 2)) < (171 * (\$heap_{funcstart_724,1} \cdot p1 \% 177))) \vee (0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)) \vee !(0 < (-\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem + \$heap_{funcstart_724,1} \cdot p1))$
 \rightarrow [simplify]
 [93.2] $(30263 < (171 * (\$heap_{funcstart_724,1} \cdot p1 \% 177))) \vee \dots$
 \rightarrow [literal comparison of product]
 [93.3] $([171 < 0] : (30263 / -171) < -(\$heap_{funcstart_724,1} \cdot p1 \% 177), [0 < 171] : (30263 / 171) < (\$heap_{funcstart_724,1} \cdot p1 \% 177), [0 == 171] : 30263 < 0) \vee \dots$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [93.4] $([171 < 0] : (30263 / -171) < -(\$heap_{funcstart_724,1} \cdot p1 \% 177), [(0 < 171) \wedge !(171 < 0)] : (30263 / 171) < (\$heap_{funcstart_724,1} \cdot p1 \% 177), [(0 == 171) \wedge !(0 < 171) \wedge !(171 < 0)] : 30263 < 0) \vee \dots$
 \rightarrow [simplify]
 [93.13] **false** $\vee \dots$
 [Remove 'false' term 93.13 and fetch new term from containing clause]
 [94.0] $0 < (-\$heap_{funcstart_724,1} \cdot p1 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)$
 [Create new term from terms 94.0, 78.0 using rule: transitivity 2]
 [96.0] $(0 + 1 + 176) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem$
 \rightarrow [simplify]
 [96.1] $177 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem$
 [Create new term from terms 96.1, 15.17 using rule: transitivity 16]
 [97.0] $(0 + 177) < (\$heap_{funcstart_724,1} \cdot p1 \% 177)$
 \rightarrow [simplify]
 [97.2] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (62,12)

To prove: $\neg \text{asType}\langle \text{integer const} \rangle (\$heap_{724,1;745,8}.M1) < \text{asType}\langle \text{integer} \rangle (\$heap_{724,1;745,8}.p1)$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

```

```

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *

```

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) && (asType<integer>(\$heap_{funcstart_724,1}.p1) < asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p2))) && (asType<integer>(\$heap_{funcstart_724,1}.p2) < asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p3))) && (asType<integer>(\$heap_{funcstart_724,1}.p3) < asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 < asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p2))) && (asType<integer>(\$heap_{funcstart_724,1}.p2) < asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p3))) && (asType<integer>(\$heap_{funcstart_724,1}.p3) < asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 < asType<integer>(\$heap_{init}.M1))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p2))) && (asType<integer>(\$heap_{funcstart_724,1}.p2) < asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p3))) && (asType<integer>(\$heap_{funcstart_724,1}.p3) < asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p2))) && (asType<integer>(\$heap_{funcstart_724,1}.p2) < asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 < asType<integer>(\$heap_{funcstart_724,1}.p3))) && (asType<integer>(\$heap_{funcstart_724,1}.p3) <

`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [simplify]
[5.16] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [const static or extern object]
[5.17] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3)))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3)))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323))))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$

$\neg \text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$
[Work on sub-term 3 of conjunction in term 5.40]
 $[7.0] -30269 < -\text{\$heap_funcstart_724,1.p1}$
[Work on sub-term 4 of conjunction in term 5.40]
 $[8.0] 0 < \text{\$heap_funcstart_724,1.p1}$
[Take given term]
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p1}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{simplify}]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{\$heap_init.a1}))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$
[Assume known post-assertion, class invariant or type constraint for term 11.6]
 $[14.0] (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) /$
 $\text{asType<integer>}(177)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[14.2] (\text{\$heap_funcstart_724,1.p1} / 177) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{quot})$
 $\rightarrow [\text{expand definition of operator './' in class 'int' at built in declaration}]$
 $[14.3] ([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) < 0]:$
 $\neg(\neg \text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) / 177), []:$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p1}) / 177) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $177).\text{quot})$
 $\rightarrow [\text{explicitly assert falsehood of skipped guards in subsequent guards}]$

[14.4] ([asType<integer>(\$heap_funcstart_724,1.p1) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p1) / 177),
 [!(asType<integer>(\$heap_funcstart_724,1.p1) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).quot)
 → [simplify]
 [14.7] ([0 < -\$heap_funcstart_724,1.p1]:
 -(-asType<integer>(\$heap_funcstart_724,1.p1) / 177),
 [!(asType<integer>(\$heap_funcstart_724,1.p1) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).quot)
 → [from term 8.0, literal a < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0
 + literal a)]

Proof of rule precondition:

[14.7.0] -2 < (0 + 0)

→ [simplify]

[14.7.2] true

[14.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p1) / 177),
 [!(asType<integer>(\$heap_funcstart_724,1.p1) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).quot)

→ [simplify]

[14.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p1) / 177), [!(0 <
 -\$heap_funcstart_724,1.p1)]: asType<integer>(\$heap_funcstart_724,1.p1) / 177)
 == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).quot)

→ [from term 8.0, literal a < -\$heap_funcstart_724,1.p1 is false whenever -2 < (0
 + literal a)]

Proof of rule precondition:

[14.11.0] -2 < (0 + 0)

→ [simplify]

[14.11.2] true

[14.12] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p1) / 177),
 [!false]: asType<integer>(\$heap_funcstart_724,1.p1) / 177) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
 177).quot)

\rightarrow [simplify]
 [14.17] $0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} + (\text{heap_funcstart_724,1.p1} / 177))$
 [Assume known post-assertion, class invariant or type constraint for term 11.6]
 [15.0] $(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% \text{asType}\langle\text{integer}\rangle(177)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow [simplify]
 [15.2] $(\$ \text{heap_funcstart_724,1.p1} \% 177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow [expand definition of operator '.*' in class 'int' at built in declaration]
 [15.3] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177), []:$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [15.4] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow [simplify]
 [15.7] $([0 < -\$ \text{heap_funcstart_724,1.p1}]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 \rightarrow [from term 8.0, literal $a < -\$ \text{heap_funcstart_724,1.p1}$ is false whenever $-2 < (0 + \text{literal } a)$]

Proof of rule precondition:

[15.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[15.7.2] **true**

[15.8] $([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) \% 177),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p1}) < 0]):$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[15.11] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177), [!(0$
 $< -\$heap_{funcstart_724,1}.p1]): \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \%$
 $177) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})$
 $\rightarrow [\text{from term 8.0, literal } a < -\$heap_{funcstart_724,1}.p1 \text{ is false whenever } -2 < (0$
 $+ \text{literal})]$

Proof of rule precondition:

$[15.11.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[15.11.2] \text{true}$

$[15.12] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) \% 177) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem})$

$\rightarrow [\text{simplify}]$

$[15.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem} + (\$heap_{funcstart_724,1}.p1 \% 177))$

$[\text{Take given term}]$

$[59.0] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{from term 11.6, div1 is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177)]$

$[59.1] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

$[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

→ [const static or extern object]

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take goal term]

[1.0] $-\text{asType}<\text{integer const}>(\$heap_{724,1;745,8}.M1) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1)$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$]

[1.1] $-\text{asType}<\text{integer const}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).M1) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1)$

\rightarrow [const member of object with modified fields]

[1.2] $-\text{asType}<\text{integer const}>(\$heap_{funcstart_724,1}.M1) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1)$

\rightarrow [const static or extern object]

[1.3] $-\text{asType}<\text{integer const}>(\$heap_{init}.M1) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1)$

\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]

[1.4] $-\text{asType}<\text{integer const}>(\text{asType}<\text{short int}>((\text{int})30269)) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1)$

\rightarrow [simplify]

[1.8] $-30269 < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1)$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$]

[1.9] $-30269 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).p1)$

\rightarrow [simplify]

[1.11] $-30269 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

\rightarrow [negate goal and search for contradiction]

[1.12] $!(-30269 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_funcstart_724,1 \cdot p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)))$
 \rightarrow [simplify]
[1.17] $30268 < ((2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot) + (-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)))$
[Copy term 1.17]
[79.0] $30268 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot)))$
 \rightarrow [from term 15.17, $\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem$ is equal to $\$heap_funcstart_724,1 \cdot p1 \% 177$]
[79.1] $30268 < ((-171 * (\$heap_funcstart_724,1 \cdot p1 \% 177)) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot)))$
[Create new term from term 14.17 using rule: condition for equality of division]
[83.0] $((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot))) < (1 + \$heap_funcstart_724,1 \cdot p1)) \wedge (\$heap_funcstart_724,1 \cdot p1 < (177 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot))))$
 \rightarrow [simplify]
[83.15] $(-1 < ((-177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot) + \$heap_funcstart_724,1 \cdot p1)) \wedge (-177 < (-\$heap_funcstart_724,1 \cdot p1 + (177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot))))$
[Work on sub-term 2 of conjunction in term 83.15]
[84.0] $-1 < ((-177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot) + \$heap_funcstart_724,1 \cdot p1)$
[Create new term from terms 84.0, 7.0 using rule: transitivity 2]
[118.0] $(-30269 + -1 + 1) < (-177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot)$
 \rightarrow [simplify]
[118.1] $-30269 < (-177 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot)$
 \rightarrow [literal comparison of product]
[118.2] $([-177 < 0]: (-30269 / 177) < -\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot, [0 < -177]: (-30269 / -177) < \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot, [-177 == 0]: -30269 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[118.3] $[-177 < 0]: (-30269 / 177) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [(0 < -177) \wedge !(-177 < 0)]: (-30269 / -177) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}, [(-177 == 0) \wedge !(-177 < 0) \wedge !(0 < -177)]: -30269 < 0$

\rightarrow [simplify]

[118.7] $-172 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}$

[Create new term from terms 118.7, 79.1 using rule: transitivity 5]

[121.0] $30268 < ((-171 * (\text{heap_funcstart_724,1.p1 \% 177})) + (2 * -(-172 + 1)))$

\rightarrow [simplify]

[121.5] $29926 < (-171 * (\text{heap_funcstart_724,1.p1 \% 177}))$

\rightarrow [literal comparison of product]

[121.6] $[-171 < 0]: (29926 / 171) < -(\text{heap_funcstart_724,1.p1 \% 177}), [0 < -171]: (29926 / -171) < (\text{heap_funcstart_724,1.p1 \% 177}), [-171 == 0]: 29926 < 0$

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[121.7] $[-171 < 0]: (29926 / 171) < -(\text{heap_funcstart_724,1.p1 \% 177}), [(0 < -171) \wedge !(-171 < 0)]: (29926 / -171) < (\text{heap_funcstart_724,1.p1 \% 177}), [(-171 == 0) \wedge !(-171 < 0) \wedge !(0 < -171)]: 29926 < 0$

\rightarrow [simplify]

[121.12] **false**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq \text{div2.rem}$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```



```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
```

$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.17] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323))))$
 \rightarrow [simplify]
[5.40] $((-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3))$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_funcstart_724,1.p2$
[Take given term]

[27.0] `div2 == div(heapIs $heap_funcstart_724,1,`
`asType<int>($heap_funcstart_724,1.p2),`
`asType<int>($heap_funcstart_724,1.a2))`
→ [simplify]

[27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>($heap_funcstart_724,1.a2))`
→ [const static or extern object]

[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>($heap_init.a2))`
→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>(asType<short int>((int)176)))`
→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
[Assume known post-assertion, class invariant or type constraint for term 27.6]

[31.0] `(asType<integer>($heap_funcstart_724,1.p2) %`
`asType<integer>(176)) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)`
→ [simplify]

[31.2] `($heap_funcstart_724,1.p2 % 176) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)`
→ [expand definition of operator '%' in class 'int' at built in declaration]

[31.3] `([asType<integer>($heap_funcstart_724,1.p2) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176), []:`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`176).rem)`
→ [explicitly assert falsehood of skipped guards in subsequent guards]

[31.4] `([asType<integer>($heap_funcstart_724,1.p2) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176),`
`!([asType<integer>($heap_funcstart_724,1.p2) < 0]):`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`176).rem)`
→ [simplify]

[31.7] `([0 < -$heap_funcstart_724,1.p2]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176),`
`!([asType<integer>($heap_funcstart_724,1.p2) < 0]):`

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [from term 9.0, $\text{literal} < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.7.2] **true**

[31.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]

[31.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176), [(0$
 $< -\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \%$
 $176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})$

\rightarrow [from term 9.0, $\text{literal} < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.11.2] **true**

[31.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[!false]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]

[31.17] $0 == (\neg\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem} + (\$heap_{funcstart_724,1}.p2 \% 176))$

[Assume known post-assertion, class invariant or type constraint for term 31.17]

[38.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem}$

\rightarrow [simplify]

[38.3] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}$

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq \text{div2.rem}$

\rightarrow [simplify]

[1.1] $-32768 \leq \text{div2.rem}$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.2] $-32768 \leq \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}$

\rightarrow [simplify]

[1.4] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}$

\rightarrow [from term 38.3, $\text{literal} < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32769$]

Proof of rule precondition:

[1.4.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.4.2] **true**

[1.5] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)

Condition defined at:

To prove: $\text{div2.rem} \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]


```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
```

$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.17] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323))))$
 \rightarrow [simplify]
[5.40] $((-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3))$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_funcstart_724,1.p2$
[Take given term]

[27.0] `div2 == div(heapIs $heap_funcstart_724,1,`
`asType<int>($heap_funcstart_724,1.p2),`
`asType<int>($heap_funcstart_724,1.a2))`
→ [simplify]

[27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>($heap_funcstart_724,1.a2))`
→ [const static or extern object]

[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>($heap_init.a2))`
→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>(asType<short int>((int)176)))`
→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
[Assume known post-assertion, class invariant or type constraint for term 27.6]

[31.0] `(asType<integer>($heap_funcstart_724,1.p2) %`
`asType<integer>(176)) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)`
→ [simplify]

[31.2] `($heap_funcstart_724,1.p2 % 176) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)`
→ [expand definition of operator '%' in class 'int' at built in declaration]

[31.3] `([asType<integer>($heap_funcstart_724,1.p2) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176), []:`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`176).rem)`
→ [explicitly assert falsehood of skipped guards in subsequent guards]

[31.4] `([asType<integer>($heap_funcstart_724,1.p2) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176),`
`!([asType<integer>($heap_funcstart_724,1.p2) < 0]):`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`176).rem)`
→ [simplify]

[31.7] `([0 < -$heap_funcstart_724,1.p2]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176),`
`!([asType<integer>($heap_funcstart_724,1.p2) < 0]):`

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.7.2] **true**

[31.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]

[31.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176), [(0$
 $< -\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \%$
 $176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})$

\rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.11.2] **true**

[31.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]

[31.17] $0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem} + (\$heap_{funcstart_724,1}.p2 \% 176))$

[Assume known post-assertion, class invariant or type constraint for term 31.17]

[39.0] $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} \leq$
 $\text{maxof}(\text{int})$

\rightarrow [simplify]

[39.9] $-32768 < -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p2}, 176).\text{rem}$

[Take goal term]

[1.0] $\text{div2}.\text{rem} \leq \text{maxof}(\text{short int})$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p2}, 176)$]

[1.1] $\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p2}, 176).\text{rem} \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.10] $-32768 < -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p2}, 176).\text{rem}$

\rightarrow [from term 39.9, $\text{literal} < -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p2}, 176).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32768$]

Proof of rule precondition:

[1.10.0] $(-32768 + -1) < -32768$

\rightarrow [simplify]

[1.10.2] **true**

[1.11] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{asType}<\text{short int}>(\text{div2}.\text{rem})$

Given:

$\$heap_{init}.\text{LIMIT} == (\text{int})80$

$\$heap_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==

```

```

asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

Proof:

[Take given term]
[5.0] invariant1(heapIs $heap_funcstart_724,1)
→ [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&

```

```

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```


→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<**integer**>(\$heap_init.M2)))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<**integer**>(**asType**<**short int**>((**int**)30307)))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(**asType**<**short**
int>((**int**)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)

[Work on sub-term 5 of conjunction in term 5.40]

[9.0] 0 < \$heap_funcstart_724,1.p2

[Take given term]

[27.0] div2 == div(**heapIs** \$heap_funcstart_724,1,

```

asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))
→ [simplify]
[27.1] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))
→ [const static or extern object]
[27.2] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_init.a2))
→ [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))
→ [simplify]
[27.6] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>($heap_funcstart_724,1.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)
→ [simplify]
[31.2] ($heap_funcstart_724,1.p2 % 176) == asType<integer>(div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)
→ [expand definition of operator '%' in class 'int' at built in declaration]
[31.3] ([asType<integer>($heap_funcstart_724,1.p2) < 0]:
-(asType<integer>($heap_funcstart_724,1.p2) % 176), []:
asType<integer>($heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>($heap_funcstart_724,1.p2) < 0]:
-(asType<integer>($heap_funcstart_724,1.p2) % 176),
[!(asType<integer>($heap_funcstart_724,1.p2) < 0)]:
asType<integer>($heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).rem)
→ [simplify]
[31.7] ([0 < -$heap_funcstart_724,1.p2]:
-(asType<integer>($heap_funcstart_724,1.p2) % 176),
[!(asType<integer>($heap_funcstart_724,1.p2) < 0)]:
asType<integer>($heap_funcstart_724,1.p2) % 176) ==

```

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [from term 9.0, literal $a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + literal)$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

→ [simplify]

[31.7.2] **true**

[31.8] ([false]: $-(\text{asType<integer>}(\$heap_funcstart_724,1.p2) \% 176)$,
[!(**asType<integer>**($\$heap_funcstart_724,1.p2$) < 0)]:
asType<integer>($\$heap_funcstart_724,1.p2$) \% 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [simplify]

[31.11] ([false]: $-(\text{asType<integer>}(\$heap_funcstart_724,1.p2) \% 176)$, [!($0 < -\$heap_funcstart_724,1.p2$)]: **asType<integer>**($\$heap_funcstart_724,1.p2$) \% 176) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [from term 9.0, literal $a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + literal)$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

→ [simplify]

[31.11.2] **true**

[31.12] ([false]: $-(\text{asType<integer>}(\$heap_funcstart_724,1.p2) \% 176)$,
[!false]: **asType<integer>**($\$heap_funcstart_724,1.p2$) \% 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [simplify]

[31.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem + (\$heap_funcstart_724,1.p2 \% 176))$

[Assume known post-assertion, class invariant or type constraint for term 31.17]

[38.0] **minof(int)** ≤ div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem

→ [simplify]

[38.3] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$

176).rem
 [Take goal term]
 [1.0] **minof**(int) ≤ **asType**<short int>(div2.rem)
 → [simplify]
 [1.1] -32768 ≤ **asType**<short int>(div2.rem)
 → [from term 27.6, div2 is equal to div(**heapIs** \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p2, 176)]
 [1.2] -32768 ≤ **asType**<short int>(div(**heapIs** \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p2, 176).rem)
 → [simplify]
 [1.5] -32769 < div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem
 → [from term 38.3, literal < div(**heapIs** \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p2, 176).rem is true whenever (-1 + literal) < -32769]
Proof of rule precondition:
 [1.5.0] (-32769 + -1) < -32769
 → [simplify]
 [1.5.2] **true**
 [1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)

Condition defined at:

To prove: **asType**<short int>(div2.rem) ≤ **maxof**(int)

Given:

\$heap_init.LIMIT == (int)80
 \$heap_init.M1 == **asType**<short int>((int)30269)
 \$heap_init.r1 == **asType**<short int>((int)171)
 \$heap_init.a1 == **asType**<short int>((int)177)
 \$heap_init.b1 == **asType**<short int>((int)2)
 \$heap_init.M2 == **asType**<short int>((int)30307)
 \$heap_init.r2 == **asType**<short int>((int)172)
 \$heap_init.a2 == **asType**<short int>((int)176)

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
```

$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.17] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $(((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323))))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_funcstart_724,1.p2$
[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{simplify}]$

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{const static or extern object}]$

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$
 $\rightarrow [\text{expand definition of constant 'a2' at prang.c (21,20)}]$

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 $\rightarrow [\text{simplify}]$

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 $[\text{Assume known post-assertion, class invariant or type constraint for term 27.6}]$

[31.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) \%$
 $\text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}, 176).\text{rem})$
 $\rightarrow [\text{simplify}]$

[31.2] $(\$ \text{heap_funcstart_724,1.p2} \% 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}, 176).\text{rem})$
 $\rightarrow [\text{expand definition of operator '}' in class 'int' at built in declaration}]$

[31.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $\neg(\neg \text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) \% 176), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{rem})$
 $\rightarrow [\text{explicitly assert falsehood of skipped guards in subsequent guards}]$

[31.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $\neg(\neg \text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) \% 176),$
 $[\neg(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{rem})$
 $\rightarrow [\text{simplify}]$

[31.7] $([0 < -\$ \text{heap_funcstart_724,1.p2}]:$
 $\neg(\neg \text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) \% 176),$
 $[\neg(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0)]:$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.7.2] **true**

[31.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]

[31.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176), [(0$
 $< -\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \%$
 $176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})$

\rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.11.2] **true**

[31.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[!false]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]

[31.17] $0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem} + (\$heap_{funcstart_724,1}.p2 \% 176))$

[Assume known post-assertion, class invariant or type constraint for term 31.17]

[39.0] $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} \leq$
 $\text{maxof}(\text{int})$

\rightarrow [simplify]

[39.9] $-32768 < -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}} \cdot p2, 176) \cdot \text{rem}$

[Take goal term]

[1.0] **asType**<short int>(div2.rem) \leq **maxof**(int)

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}} \cdot p2, 176)$]

[1.1] **asType**<short int>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} · p2, 176).rem) \leq **maxof**(int)

\rightarrow [simplify]

[1.11] $-32768 < -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}} \cdot p2, 176) \cdot \text{rem}$

\rightarrow [from term 39.9, literal $a < -\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}} \cdot p2, 176) \cdot \text{rem}$ is true whenever $(-1 + \text{literal } a) < -32768$]

Proof of rule precondition:

[1.11.0] $(-32768 + -1) < -32768$

\rightarrow [simplify]

[1.11.2] **true**

[1.12] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,10)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap}_{724,1;745,8} \cdot r2$

Given:

$\$heap_{init} \cdot \text{LIMIT} == (\text{int})80$

$\$heap_{init} \cdot \text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init} \cdot r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init} \cdot a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init} \cdot b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init} \cdot \text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init} \cdot r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init} \cdot a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init} \cdot b2 == \text{asType}<\text{short int}>((\text{int})35)$

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==

```

```

asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a1}))$
 $\rightarrow [\text{const static or extern object}]$

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\$ \text{heap_init.a1}))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177)))$
 $\rightarrow [\text{simplify}]$

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$
 $[\text{Take given term}]$

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)]$

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{simplify}]$

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{const static or extern object}]$

[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_init.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$

[59.5] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\text{asType<short int>}((\text{int})171))) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [from term 11.6, *div1* is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\$heap_{init} \cdot b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int}2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq \$heap_{724,1;745,8} \cdot r2$

→ [simplify]

[1.1] $-32768 \leq \$heap_{724,1;745,8} \cdot r2$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[1.2] $-32768 \leq \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2$
 \rightarrow [const member of object with modified fields]
[1.3] $-32768 \leq \$heap_{funcstart_724,1} \cdot r2$
 \rightarrow [const static or extern object]
[1.4] $-32768 \leq \$heap_{init} \cdot r2$
 \rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[1.5] $-32768 \leq \text{asType}<\text{short int}>((\text{int})172)$
 \rightarrow [simplify]
[1.8] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,10)

Condition defined at:

To prove: $\$heap_{724,1;745,8} \cdot r2 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$


```

$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p3),

```

```

asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,

$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$
 $[\text{Take given term}]$
 $[59.0] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)]$
 $[59.1] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 $\rightarrow [\text{simplify}]$
 $[59.3] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.4] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_init}.\text{r1})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$
 $[59.5] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 $\rightarrow [\text{simplify}]$
 $[59.8] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)]$
 $[59.9] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

$\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})) *$
 $\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{simplify}]$
 $[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\$ \text{heap_init.b1}))))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$
 $[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int} 2))))))$
 $\rightarrow [\text{simplify}]$
 $[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$
 $[Take goal term]$
 $[1.0] \$\text{heap}_{724,1;745,8.r2} \leq \text{maxof}(\text{int})$
 $\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to}$
 $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})))$
 $[1.1] \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \leq \text{maxof}(\text{int})$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[1.2] \$\text{heap_funcstart_724,1.r2} \leq \text{maxof}(\text{int})$
 $\rightarrow [\text{const static or extern object}]$
 $[1.3] \$\text{heap_init.r2} \leq \text{maxof}(\text{int})$
 $\rightarrow [\text{expand definition of constant 'r2' at prang.c (20,20)}]$
 $[1.4] \text{asType} < \text{short int} > ((\text{int} 172) \leq \text{maxof}(\text{int})$

→ [simplify]

[1.8] true

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,13)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) /$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div1.quot})$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \%$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$

```

asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==

```

```

asType<integer>(div3.rem))
(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1..replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] ((((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <

```

asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&

```


$(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.M3))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[5.31] ((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \ \&\&$
 $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\$heap_{init}.M3))$
 $\rightarrow [expand\ definition\ of\ constant\ 'M3'\ at\ prang.c\ (24,20)]$
 $[5.32] ((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \ \&\&$
 $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30323)))$
 $\rightarrow [simplify]$
 $[5.40] (-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
 $[Work\ on\ sub-term\ 5\ of\ conjunction\ in\ term\ 5.40]$
 $[9.0] 0 < \$heap_{funcstart_724,1}.p2$
 $[Take\ given\ term]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.a1))$
 $\rightarrow [simplify]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.a1))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle(\$heap_{init}.a1))$
 $\rightarrow [expand\ definition\ of\ constant\ 'a1'\ at\ prang.c\ (16,20)]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})177)))$
 $\rightarrow [simplify]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
 $[Take\ given\ term]$
 $[27.0] \text{div2} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.p2),$

`asType<int>($heap_funcstart_724,1.a2))`
 → [simplify]
 [27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>($heap_funcstart_724,1.a2))`
 → [const static or extern object]
 [27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>($heap_init.a2))`
 → [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`asType<int>(asType<short int>((int)176)))`
 → [simplify]
 [27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
 [Assume known post-assertion, class invariant or type constraint for term 27.6]
 [31.0] `(asType<integer>($heap_funcstart_724,1.p2) %`
`asType<integer>(176)) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)`
 → [simplify]
 [31.2] `($heap_funcstart_724,1.p2 % 176) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem)`
 → [expand definition of operator '%' in class 'int' at built in declaration]
 [31.3] `([asType<integer>($heap_funcstart_724,1.p2) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176), []:`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`176).rem)`
 → [explicitly assert falsehood of skipped guards in subsequent guards]
 [31.4] `([asType<integer>($heap_funcstart_724,1.p2) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176),`
`[!(asType<integer>($heap_funcstart_724,1.p2) < 0]):`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`
`176).rem)`
 → [simplify]
 [31.7] `([0 < -$heap_funcstart_724,1.p2]:`
`-(asType<integer>($heap_funcstart_724,1.p2) % 176),`
`[!(asType<integer>($heap_funcstart_724,1.p2) < 0]):`
`asType<integer>($heap_funcstart_724,1.p2) % 176) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,`

176).rem)

→ [from term 9.0, $\text{literal}_a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

→ [simplify]

[31.7.2] **true**

[31.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) \% 176),$
[!($\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) < 0$):
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) \% 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$

→ [simplify]

[31.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) \% 176),$ [!(0
 $< -\$heap_funcstart_724,1.p2$): $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) \%$
 $176) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{rem})$

→ [from term 9.0, $\text{literal}_a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

→ [simplify]

[31.11.2] **true**

[31.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) \% 176),$
[!false]: $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p2) \% 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$

→ [simplify]

[31.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem} + (\$heap_funcstart_724,1.p2 \% 176))$

[Take given term]

[59.0] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short}$
 $\text{int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_funcstart_724,1.b1))))$

→ [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177)$]

[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [simplify]

[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [const static or extern object]

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle (\$heap_{init} \cdot r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})171))) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [from term 11.6, div1 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot))) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

$\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType}<\text{int}>(\$ \text{heap_init.b1}))))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

$[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int}2))))))$
 \rightarrow [simplify]

$[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$
 [Take goal term]

$[1.0] \text{minof}(\text{int}) \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.\text{rem})) *$
 $\text{asType}<\text{int}>(\$ \text{heap}_{724,1;745,8}.\text{r2}))$
 \rightarrow [simplify]

$[1.1] -32768 \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.\text{rem})) *$
 $\text{asType}<\text{int}>(\$ \text{heap}_{724,1;745,8}.\text{r2}))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p2}, 176)]$

$[1.2] -32768 \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p2}, 176).\text{rem})) *$
 $\text{asType}<\text{int}>(\$ \text{heap}_{724,1;745,8}.\text{r2}))$
 \rightarrow [simplify]

$[1.4] -32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{rem} * \text{asType}<\text{int}>(\$ \text{heap}_{724,1;745,8}.\text{r2}))$
 \rightarrow [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to
 $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem}))]$

$[1.5] -32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{rem} * \text{asType}<\text{int}>(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))).\text{r2}))$
 \rightarrow [const member of object with modified fields]

$[1.6] -32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{rem} * \text{asType}<\text{int}>(\$ \text{heap_funcstart_724,1}.\text{r2}))$
 \rightarrow [const static or extern object]

[1.7] $-32768 \leq (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{init}.r2))$
 \rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

[1.8] $-32768 \leq (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{asType}\langle \mathbf{short} \ \mathbf{int} \rangle((\mathbf{int})172)))$
 \rightarrow [simplify]

[1.13] $-32769 < (172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem})$
 \rightarrow [literal comparison of product]

[1.14] $([172 < 0]: (-32769 / -172) < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem}, [0 < 172]: (-32769 / 172) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem}, [0 == 172]: -32769 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[1.15] $([172 < 0]: (-32769 / -172) < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem}, [(0 < 172) \wedge !(172 < 0)]: (-32769 / 172) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem}, [(0 == 172) \wedge !(0 < 172) \wedge !(172 < 0)]: -32769 < 0)$
 \rightarrow [simplify]

[1.23] $-191 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem}$
 \rightarrow [negate goal and search for contradiction]

[1.24] $!(-191 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem})$
 \rightarrow [simplify]

[1.26] $190 < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).\text{rem}$
[Create new term from terms 1.26, 31.17 using rule: transitivity 15]

[77.0] $(0 + 190) < -(\$heap_{funcstart_724,1}.p2 \% 176)$
 \rightarrow [simplify]

[77.2] **false**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,13)

Condition defined at:

To prove: $(\mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{asType}\langle \mathbf{short} \ \mathbf{int} \rangle(\text{div}2.\text{rem})) * \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;745,8}.r2)) \leq \mathbf{maxof}(\mathbf{int})$

Given:

```
$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p3),
asType<int>($heapfuncstart_724,1.a3))
(asType<integer>(asType<int>($heapfuncstart_724,1.p3)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a3))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p3)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a3))) ==
asType<integer>(div3.rem)
(asType<integer>($heapfuncstart_724,1.p3) <
asType<integer>($heapfuncstart_724,1.a3)) =>
(asType<integer>($heapfuncstart_724,1.p3) ==
asType<integer>(div3.rem))
(asType<integer>($heapfuncstart_724,1.a3) ≤
asType<integer>($heapfuncstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))
$heap724,1;745,8 == $heapfuncstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heapfuncstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heapfuncstart_724,1.b1))))

```



```

–asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[5.1] (((((0 < asType<integer>($heapfuncstart_724,1.p1)) &&
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.M1))) && (0 <
asType<integer>($heapfuncstart_724,1.p2))) &&
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.M2))) && (0 <
asType<integer>($heapfuncstart_724,1.p3))) &&
(asType<integer>($heapfuncstart_724,1.p3) <
asType<integer>($heapfuncstart_724,1.M3))

```

→ [simplify]

```

[5.3] (((((0 < $heapfuncstart_724,1.p1) && ($heapfuncstart_724,1.p1 <
asType<integer>($heapfuncstart_724,1.M1))) && (0 <
asType<integer>($heapfuncstart_724,1.p2))) &&
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.M2))) && (0 <
asType<integer>($heapfuncstart_724,1.p3))) &&
(asType<integer>($heapfuncstart_724,1.p3) <
asType<integer>($heapfuncstart_724,1.M3))

```

→ [const static or extern object]

```

[5.4] (((((0 < $heapfuncstart_724,1.p1) && ($heapfuncstart_724,1.p1 <
asType<integer>($heapinit.M1))) && (0 <
asType<integer>($heapfuncstart_724,1.p2))) &&
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.M2))) && (0 <
asType<integer>($heapfuncstart_724,1.p3))) &&
(asType<integer>($heapfuncstart_724,1.p3) <
asType<integer>($heapfuncstart_724,1.M3))

```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```

[5.5] (((((0 < $heapfuncstart_724,1.p1) && ($heapfuncstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heapfuncstart_724,1.p2))) &&

```

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$

`int>((int)30323)))`
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_funcstart_724,1.p2$
[Take given term]
[11.0] `div1 == div(heapIs $heap_funcstart_724,1, asType<int>($heap_funcstart_724,1.p1), asType<int>($heap_funcstart_724,1.a1))`
 \rightarrow [simplify]
[11.1] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>($heap_funcstart_724,1.a1))`
 \rightarrow [const static or extern object]
[11.2] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>($heap_init.a1))`
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>(asType<short int>((int)177)))`
 \rightarrow [simplify]
[11.6] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)`
[Take given term]
[27.0] `div2 == div(heapIs $heap_funcstart_724,1, asType<int>($heap_funcstart_724,1.p2), asType<int>($heap_funcstart_724,1.a2))`
 \rightarrow [simplify]
[27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, asType<int>($heap_funcstart_724,1.a2))`
 \rightarrow [const static or extern object]
[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, asType<int>($heap_init.a2))`
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, asType<int>(asType<short int>((int)176)))`

\rightarrow [simplify]
 [27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Take given term]
 [59.0] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]
 [59.1] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 \rightarrow [simplify]
 [59.3] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 \rightarrow [const static or extern object]
 [59.4] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 \rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
 [59.5] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 \rightarrow [simplify]
 [59.8] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]
 [59.9] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

$$- (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$$

$$\rightarrow [\text{simplify}]$$

$$[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$$

$$\rightarrow [\text{const static or extern object}]$$

$$[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.b1}))))$$

$$\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$$

$$[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))))$$

$$\rightarrow [\text{simplify}]$$

$$[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))))$$

$$[\text{Take goal term}]$$

$$[1.0] (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8.r2})) \leq \text{maxof}(\text{int})$$

$$\rightarrow [\text{from term 27.6, div2 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)]$$

$$[1.1] (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8.r2})) \leq \text{maxof}(\text{int})$$

$$\rightarrow [\text{simplify}]$$

$$[1.3] (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8.r2})) \leq \text{maxof}(\text{int})$$

$$\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to } \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))]$$

$$[1.4] (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \leq \text{maxof}(\text{int})$$

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) .r2)) \leq \text{maxof}(\text{int})$
→ [const member of object with modified fields]
[1.5] $(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem * \text{asType}<\text{int}>(\$heap_funcstart_724,1.r2)) \leq \text{maxof}(\text{int})$
→ [const static or extern object]
[1.6] $(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem * \text{asType}<\text{int}>(\$heap_init.r2)) \leq \text{maxof}(\text{int})$
→ [expand definition of constant 'r2' at prang.c (20,20)]
[1.7] $(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})172))) \leq \text{maxof}(\text{int})$
→ [simplify]
[1.20] $-32768 < (-172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)$
→ [literal comparison of product]
[1.21] $([-172 < 0]: (-32768 / 172) < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem, [0 < -172]: (-32768 / -172) < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem, [-172 == 0]: -32768 < 0)$
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.22] $([-172 < 0]: (-32768 / 172) < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem, [(0 < -172) \wedge !(-172 < 0)]: (-32768 / -172) < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem, [(-172 == 0) \wedge !(-172 < 0) \wedge !(0 < -172)]: -32768 < 0)$
→ [simplify]
[1.26] $-191 < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem$
→ [negate goal and search for contradiction]
[1.27] $!(-191 < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)$
→ [simplify]
[1.30] $190 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem$
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] $(\text{asType}<\text{integer}>(\$heap_funcstart_724,1.p2) \% \text{asType}<\text{integer}>(176)) == \text{asType}<\text{integer}>(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)$
→ [simplify]

[31.2] (\$heap_funcstart_724,1.p2 % 176) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [expand definition of operator '.*' in class 'int' at built in declaration]

[31.3] ([**asType<integer>**(\$heap_funcstart_724,1.p2) < 0]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p2) % 176), []:
asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[31.4] ([**asType<integer>**(\$heap_funcstart_724,1.p2) < 0]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p2) % 176),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p2) < 0]):
asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [simplify]

[31.7] ([0 < -\$heap_funcstart_724,1.p2]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p2) % 176),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p2) < 0]):
asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [from term 9.0, literal a < -\$heap_funcstart_724,1.p2 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[31.7.0] -2 < (0 + 0)

→ [simplify]

[31.7.2] **true**

[31.8] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p2) % 176),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p2) < 0]):
asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [simplify]

[31.11] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p2) % 176), [!(0
 < -\$heap_funcstart_724,1.p2)]: **asType<integer>**(\$heap_funcstart_724,1.p2) %
 176) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p2, 176).rem)

→ [from term 9.0, literal a < -\$heap_funcstart_724,1.p2 is false whenever -2 < (0

+ *literal*)]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

→ [simplify]

[31.11.2] **true**

[31.12] ([**false**]: $-(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
[!**false**]: $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$)

→ [simplify]

[31.17] $0 == (-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem} + (\text{\$heap_funcstart_724,1.p2} \% 176))$

→ [remainder is less than divisor]

Proof of rule precondition:

[31.17.0] $(176 + -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem}) \leq 0$

→ [simplify]

[31.17.11] $175 < \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem}$

→ [from term 1.30, $\text{literal} < \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem}$ is true whenever $(-1 + \text{literal}) < 190$]

Proof of rule precondition:

[31.17.11.0] $(-1 + 175) < 190$

→ [simplify]

[31.17.11.2] **true**

[31.17.12] **true**

[31.18] **false**

Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq \text{div2.quot}$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$


```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),

```

```

asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

```

!(0 == asType<integer>(\$heap_{724,1;745,8}.p1))

asType<integer>(\$heap_{724,1;745,8}.p1) <

asType<integer>(\$heap_{724,1;745,8}.M1)

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 5 of conjunction in term 5.40]

[9.0] $0 < \$heap_funcstart_724,1.p2$

[Take given term]

[27.0] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \mathbf{asType}<\mathbf{int}>(\$heap_funcstart_724,1.p2), \mathbf{asType}<\mathbf{int}>(\$heap_funcstart_724,1.a2))$

→ [simplify]

[27.1] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \mathbf{asType}<\mathbf{int}>(\$heap_funcstart_724,1.a2))$

→ [const static or extern object]

[27.2] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \mathbf{asType}<\mathbf{int}>(\$heap_{init}.a2))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})176)))$

→ [simplify]

[27.6] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] $(\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / \mathbf{asType}<\mathbf{integer}>(176)) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$

→ [simplify]

[30.2] $(\$heap_funcstart_724,1.p2 / 176) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$

→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] $([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) < 0]: \neg(\neg \mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / 176), []: \mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / 176) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] $([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) < 0]: \neg(\neg \mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / 176),$

$[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.7] ([0 < -\$heap_{funcstart_724,1}.p2]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{from term 9.0, literal } a < -\$heap_{funcstart_724,1}.p2 \text{ is false whenever } -2 < (0$
 $+ \text{literal})]$

Proof of rule precondition:

$[30.7.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[30.7.2] \text{ true}$

$[30.8] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.11] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176), [!(0 <$
 $-\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot})$
 $\rightarrow [\text{from term 9.0, literal } a < -\$heap_{funcstart_724,1}.p2 \text{ is false whenever } -2 < (0$
 $+ \text{literal})]$

Proof of rule precondition:

$[30.11.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[30.11.2] \text{ true}$

$[30.12] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$

[30.17] $0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} + (\$ \text{heap_funcstart_724,1.p2} / 176))$

[Assume known post-assertion, class invariant or type constraint for term 30.17]

[36.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

→ [simplify]

[36.3] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq \text{div2.quot}$

→ [simplify]

[1.1] $-32768 \leq \text{div2.quot}$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.2] $-32768 \leq \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

→ [simplify]

[1.4] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

→ [from term 36.3, $\text{literal} < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$ is true whenever $(-1 + \text{literal}) < -32769$]

Proof of rule precondition:

[1.4.0] $(-32769 + -1) < -32769$

→ [simplify]

[1.4.2] **true**

[1.5] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)

Condition defined at:

To prove: $\text{div2.quot} \leq \text{maxof}(\text{short int})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),

```



```

asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

```

!(0 == asType<integer>(\$heap_{724,1;745,8}.p1))

asType<integer>(\$heap_{724,1;745,8}.p1) <

asType<integer>(\$heap_{724,1;745,8}.M1)

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 5 of conjunction in term 5.40]

[9.0] $0 < \$heap_funcstart_724,1.p2$

[Take given term]

[27.0] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \mathbf{asType}<\mathbf{int}>(\$heap_funcstart_724,1.p2), \mathbf{asType}<\mathbf{int}>(\$heap_funcstart_724,1.a2))$

→ [simplify]

[27.1] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \mathbf{asType}<\mathbf{int}>(\$heap_funcstart_724,1.a2))$

→ [const static or extern object]

[27.2] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \mathbf{asType}<\mathbf{int}>(\$heap_{init}.a2))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})176)))$

→ [simplify]

[27.6] $div2 == div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] $(\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / \mathbf{asType}<\mathbf{integer}>(176)) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$

→ [simplify]

[30.2] $(\$heap_funcstart_724,1.p2 / 176) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$

→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] $([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) < 0]: \neg(\neg \mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / 176), []: \mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / 176) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] $([\mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) < 0]: \neg(\neg \mathbf{asType}<\mathbf{integer}>(\$heap_funcstart_724,1.p2) / 176),$

$[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.7] ([0 < -\$heap_{funcstart_724,1}.p2]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{from term 9.0, literal } a < -\$heap_{funcstart_724,1}.p2 \text{ is false whenever } -2 < (0$
 $+ \text{literal } a)]$

Proof of rule precondition:

$[30.7.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[30.7.2] \text{ true}$

$[30.8] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.11] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176), [!(0 <$
 $-\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot})$
 $\rightarrow [\text{from term 9.0, literal } a < -\$heap_{funcstart_724,1}.p2 \text{ is false whenever } -2 < (0$
 $+ \text{literal } a)]$

Proof of rule precondition:

$[30.11.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[30.11.2] \text{ true}$

$[30.12] ([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$

[30.17] $0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} + (\$ \text{heap_funcstart_724,1.p2} / 176))$

[Assume known post-assertion, class invariant or type constraint for term 30.17]

[37.0] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} \leq \text{maxof}(\text{int})$

\rightarrow [simplify]

[37.9] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

[Take goal term]

[1.0] $\text{div2.quot} \leq \text{maxof}(\text{short int})$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.1] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.10] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

\rightarrow [from term 37.9, $\text{literal} < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$ is true whenever $(-1 + \text{literal}) < -32768$]

Proof of rule precondition:

[1.10.0] $(-32768 + -1) < -32768$

\rightarrow [simplify]

[1.10.2] **true**

[1.11] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{asType}(\text{short int})(\text{div2.quot})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType}(\text{short int})((\text{int})30269)$

$\$ \text{heap}_{init}.\text{r1} == \text{asType}(\text{short int})((\text{int})171)$

```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==

```

```

asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```


Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(asType<short int>((int)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)

[Work on sub-term 5 of conjunction in term 5.40]

[9.0] $0 < \text{\$heap_funcstart_724,1.p2}$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176)$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) /$
 $\text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [simplify]

[30.2] $(\text{\$heap_funcstart_724,1.p2} / 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] $([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176), []:$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] $([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176),$
 $![\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) < 0]):$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$

\rightarrow [simplify]
 [30.7] $([0 < -\$heap_funcstart_724,1 \cdot p2]:$
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176),$
 $[(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot})$
 \rightarrow [from term 9.0, literal $a < -\$heap_funcstart_724,1 \cdot p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[30.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.7.2] **true**

[30.8] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176),$
 $[(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.11] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176), [!(0 <$
 $-\$heap_funcstart_724,1 \cdot p2)]: \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176)$
 $== \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1 \cdot p2, 176).\text{quot})$

\rightarrow [from term 9.0, literal $a < -\$heap_funcstart_724,1 \cdot p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[30.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.11.2] **true**

[30.12] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176),$
 $[\text{false}]: \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot} + (\$heap_funcstart_724,1 \cdot p2 / 176))$

[Assume known post-assertion, class invariant or type constraint for term
 30.17]

[36.0] **minof(int)** ≤ div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot

→ [simplify]

[36.3] -32769 < div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot

[Take goal term]

[1.0] **minof(int)** ≤ **asType**<**short int**>(div2.quot)

→ [simplify]

[1.1] -32768 ≤ **asType**<**short int**>(div2.quot)

→ [from term 27.6, div2 is equal to div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)]

[1.2] -32768 ≤ **asType**<**short int**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)

→ [simplify]

[1.5] -32769 < div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot

→ [from term 36.3, literal < div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot is true whenever (-1 + literal) < -32769]

Proof of rule precondition:

[1.5.0] (-32769 + -1) < -32769

→ [simplify]

[1.5.2] **true**

[1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)

Condition defined at:

To prove: **asType**<**short int**>(div2.quot) ≤ **maxof(int)**

Given:

\$heap_init.LIMIT == (**int**)80

\$heap_init.M1 == **asType**<**short int**>((**int**)30269)

\$heap_init.r1 == **asType**<**short int**>((**int**)171)

\$heap_init.a1 == **asType**<**short int**>((**int**)177)

\$heap_init.b1 == **asType**<**short int**>((**int**)2)

```

$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)

invariant1(heapIs $heapfuncstart_724,1)

div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧

$(0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M2})) \ \&\& \ (0 < \text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] \ ((((-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{\$heap_init.M2})) \ \&\& \ (0 < \text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3})))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] \ ((((-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30307)))) \ \&\& \ (0 < \text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3})))$
 $\rightarrow [\text{simplify}]$
 $[5.30] \ (((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] \ (((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] \ (((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323))))$
 $\rightarrow [\text{simplify}]$
 $[5.40] \ (-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$

[Work on sub-term 5 of conjunction in term 5.40]

[9.0] $0 < \text{\$heap_funcstart_724,1.p2}$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176)$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) /$
 $\text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [simplify]

[30.2] $(\text{\$heap_funcstart_724,1.p2} / 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] $([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176), []:$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] $([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176),$
 $!([\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) < 0]):$
 $\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$

\rightarrow [simplify]
 [30.7] $([0 < -\$heap_funcstart_724,1 \cdot p2]:$
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176),$
 $[(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot})$
 \rightarrow [from term 9.0, literal $a < -\$heap_funcstart_724,1 \cdot p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[30.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.7.2] **true**

[30.8] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176),$
 $[(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.11] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176), [!(0 <$
 $-\$heap_funcstart_724,1 \cdot p2)]: \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176)$
 $== \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1 \cdot p2, 176).\text{quot})$

\rightarrow [from term 9.0, literal $a < -\$heap_funcstart_724,1 \cdot p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[30.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.11.2] **true**

[30.12] $([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176),$
 $[\text{false}]: \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1 \cdot p2) / 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2,$
 $176).\text{quot} + (\$heap_funcstart_724,1 \cdot p2 / 176))$

[Assume known post-assertion, class invariant or type constraint for term
 30.17]

[37.0] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} \leq \text{maxof}(\text{int})$

→ [simplify]

[37.9] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

[Take goal term]

[1.0] $\text{asType}<\text{short int}>(\text{div2}.\text{quot}) \leq \text{maxof}(\text{int})$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.1] $\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) \leq \text{maxof}(\text{int})$

→ [simplify]

[1.11] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$

→ [from term 37.9, $\text{literal} < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$ is true whenever $(-1 + \text{literal}) < -32768$]

Proof of rule precondition:

[1.11.0] $(-32768 + -1) < -32768$

→ [simplify]

[1.11.2] **true**

[1.12] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,35)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap}_{724,1;745,8}.\text{b2}$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),

$\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.a1)$
 $\rightarrow [\text{simplify}]$
 $[11.1] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.a1))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle (\$heap_{init}.a1))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
 $[\text{Take given term}]$
 $[59.0] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.rem)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div1}.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177)]$
 $[59.1] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.r1)) -$
 $(\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div1}.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.4] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle (\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div1}.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$
 $[59.5] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})171))) -$

$(\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1.quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.8] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1.quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$
 $[59.9] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.11] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.12] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle (\$heap_{init}.b1))))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$
 $[59.13] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int}2))))))$
 $\rightarrow [\text{simplify}]$
 $[59.19] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
 $[\text{Take goal term}]$
 $[1.0] \text{minof}(\text{int}) \leq \$heap_{724,1;745,8}.b2$
 $\rightarrow [\text{simplify}]$
 $[1.1] -32768 \leq \$heap_{724,1;745,8}.b2$
 $\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to}]$

$\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))$

$[1.2] -32768 \leq \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))).\text{b2}$

$\rightarrow [\text{const member of object with modified fields}]$

$[1.3] -32768 \leq \$heap_funcstart_724,1.\text{b2}$

$\rightarrow [\text{const static or extern object}]$

$[1.4] -32768 \leq \$heap_init.\text{b2}$

$\rightarrow [\text{expand definition of constant 'b2' at prang.c (22,20)}]$

$[1.5] -32768 \leq \text{asType}<\text{short int}>((\text{int})35)$

$\rightarrow [\text{simplify}]$

$[1.8] \text{true}$

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,35)

Condition defined at:

To prove: $\$heap_{724,1;745,8}.\text{b2} \leq \text{maxof}(\text{int})$

Given:

$\$heap_init.\text{LIMIT} == (\text{int})80$

$\$heap_init.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_init.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_init.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_init.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_init.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_init.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_init.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_init.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_init.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_init.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_init.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_init.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$

```

$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==

```

```

asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.-replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

Proof:

[Take given term]

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,

```

$\text{asType}\langle \text{int} \rangle (\$heap_{init}.a1)$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})177)))$
 \rightarrow [simplify]
[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
[Take given term]
[59.0] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{rem})) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1)))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177)$]
[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.r1)) -$
 $(\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1)))$
 \rightarrow [simplify]
[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1)))$
 \rightarrow [const static or extern object]
[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1)))$
 \rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} *$
 $\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})171))) -$
 $(\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1)))$
 \rightarrow [simplify]
[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171)$
 $- (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1}.b1)))$

→ [from term 11.6, *div1* is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.9] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem}) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot})) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))))$

→ [simplify]

[59.11] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot} * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))))$

→ [const static or extern object]

[59.12] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot} * \text{asType} < \text{int} > (\$ \text{heap}_{\text{init}.b1}))))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot} * \text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int})2))))))$

→ [simplify]

[59.19] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem}))))$

[Take goal term]

[1.0] $\$ \text{heap}_{724,1;745,8}.b2 \leq \text{maxof}(\text{int})$

→ [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem})))$]

[1.1] $\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177). \text{rem}))))).b2 \leq \text{maxof}(\text{int})$

→ [const member of object with modified fields]

[1.2] $\$ \text{heap_funcstart_724,1}.b2 \leq \text{maxof}(\text{int})$

→ [const static or extern object]

[1.3] $\$heap_{init}.b2 \leq \text{maxof}(\text{int})$
 \rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[1.4] $\text{asType}<\text{short int}>((\text{int})35) \leq \text{maxof}(\text{int})$
 \rightarrow [simplify]
[1.8] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,38)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1)) /$

```

asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==

```

```

asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap_724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap_724,1;745,8.M1) <
asType<integer>($heap_724,1;745,8.p1)

!(0 == asType<integer>($heap_724,1;745,8.p1))

asType<integer>($heap_724,1;745,8.p1) <
asType<integer>($heap_724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <

`asType<integer>($heap_funcstart_724,1.M3))`
 \rightarrow [const static or extern object]
[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(\$heap_init.M1))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 < asType<integer>(asType<short int>((int)30269)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p2))) && (asType<integer>(\$heap_funcstart_724,1.p2) < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_funcstart_724,1.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [const static or extern object]
[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))
 \rightarrow [simplify]

[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle \mathbf{integer} \rangle(\mathbf{asType}\langle \mathbf{short int} \rangle((\mathbf{int})30323)))$
 \rightarrow [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$
[Work on sub-term 5 of conjunction in term 5.40]

[9.0] $0 < \$heap_funcstart_724,1.p2$
[Take given term]

[11.0] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_funcstart_724,1.p1), \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_funcstart_724,1.a1))$
 \rightarrow [simplify]

[11.1] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_funcstart_724,1.a1))$
 \rightarrow [const static or extern object]

[11.2] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_init.a1))$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{asType}\langle \mathbf{short int} \rangle((\mathbf{int})177)))$
 \rightarrow [simplify]

[11.6] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$
[Take given term]

$[27.0]$ $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{simplify}]$

$[27.1]$ $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{const static or extern object}]$

$[27.2]$ $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$
 $\rightarrow [\text{expand definition of constant 'a2' at prang.c (21,20)}]$

$[27.3]$ $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 $\rightarrow [\text{simplify}]$

$[27.6]$ $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 $[\text{Assume known post-assertion, class invariant or type constraint for term 27.6}]$

$[30.0]$ $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) /$
 $\text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 $\rightarrow [\text{simplify}]$

$[30.2]$ $(\$ \text{heap_funcstart_724,1.p2} / 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 $\rightarrow [\text{expand definition of operator './' in class 'int' at built in declaration}]$

$[30.3]$ $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $\neg(\neg \text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 $\rightarrow [\text{explicitly assert falsehood of skipped guards in subsequent guards}]$

$[30.4]$ $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $\neg(\neg \text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176),$
 $[\neg(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$

$[30.7]$ $([0 < -\$ \text{heap_funcstart_724,1.p2}]:$
 $\neg(\neg \text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176),$
 $[\neg(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0)]:$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 \rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[30.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.7.2] **true**

[30.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176), [(0 <$
 $-\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot})$

\rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[30.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.11.2] **true**

[30.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[!false]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.17] $0 == (\neg\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot} + (\$heap_{funcstart_724,1}.p2 / 176))$

[Take given term]

[59.0] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{rem})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p1, 177)]$

[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{const static or extern object}]$

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{const static or extern object}]$

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))$

\rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))$

\rightarrow [simplify]

[1.1] $-32768 \leq (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[1.2] $-32768 \leq (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))$

\rightarrow [simplify]

[1.4] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[1.5] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot b2))$

\rightarrow [const member of object with modified fields]

[1.6] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b2))$

\rightarrow [const static or extern object]
 [1.7] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}<\text{int}>(\$ \text{heap_init.b2}))$
 \rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
 [1.8] $-32768 \leq (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})35)))$
 \rightarrow [simplify]
 [1.13] $-32769 < (35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 \rightarrow [literal comparison of product]
 [1.14] $([35 < 0]: (-32769 / -35) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}, [0 < 35]: (-32769 / 35) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}, [0 == 35]: -32769 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [1.15] $([35 < 0]: (-32769 / -35) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}, [(0 < 35) \wedge !(35 < 0)]: (-32769 / 35) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}, [(0 == 35) \wedge !(0 < 35) \wedge !(35 < 0)]: -32769 < 0)$
 \rightarrow [simplify]
 [1.23] $-937 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$
 \rightarrow [negate goal and search for contradiction]
 [1.24] $!(-937 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 \rightarrow [simplify]
 [1.26] $936 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}$
 [Create new term from terms 1.26, 30.17 using rule: transitivity 15]
 [75.0] $(0 + 936) < -(\$ \text{heap_funcstart_724,1.p2} / 176)$
 \rightarrow [simplify]
 [75.7] $164736 < -\$ \text{heap_funcstart_724,1.p2}$
 \rightarrow [from term 9.0, literal $a < -\$ \text{heap_funcstart_724,1.p2}$ is false whenever $-2 < (0 + \text{literal } a)$]
Proof of rule precondition:
 [75.7.0] $-2 < (0 + 164736)$
 \rightarrow [simplify]

[75.7.2] true

[75.8] false

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,38)

Condition defined at:

To prove: (asType<int>(asType<short int>(div2.quot)) *
asType<int>(\$heap_{724,1;745,8}.b2)) ≤ maxof(int)

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

\$heap_{init}.p3 == asType<short int>((int)3)

invariant1(heapIs \$heap_{funcstart_724,1})

div1 == div(heapIs \$heap_{funcstart_724,1},

asType<int>(\$heap_{funcstart_724,1}.p1),

asType<int>(\$heap_{funcstart_724,1}.a1))

(asType<integer>(asType<int>(\$heap_{funcstart_724,1}.p1)) /
asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>(\$heap_{funcstart_724,1}.p1)) %
asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a1))) ==


```

asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==

```

```

asType<integer>(div3.rem))
(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1..replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] ((((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <

```

asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&

```

$(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [const static or extern object]
[5.31] $((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \&\& (\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\$heap_{init}.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \&\& (\$heap_{funcstart_724,1}.p3 < \text{asType}\langle \text{integer} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
[Work on sub-term 2 of conjunction in term 5.40]
[6.0] $-30307 < -\$heap_{funcstart_724,1}.p2$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_{funcstart_724,1}.p2$
[Take given term]
[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.p1), \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.a1))$
 \rightarrow [simplify]
[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.a1))$
 \rightarrow [const static or extern object]
[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \text{asType}\langle \text{int} \rangle(\$heap_{init}.a1))$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})177)))$
 \rightarrow [simplify]
[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 → [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 → [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$
 → [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 → [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) /$
 $\text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 → [simplify]

[30.2] $(\$ \text{heap_funcstart_724,1.p2} / 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 → [expand definition of operator './' in class 'int' at built in declaration]

[30.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 → [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176),$
 $[(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 → [simplify]

[30.7] $([0 < -\$ \text{heap_funcstart_724,1.p2}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176),$
 $[(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0)]:$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 \rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[30.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.7.2] **true**

[30.8] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.11] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176), [(0 <$
 $-\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot})$

\rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[30.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[30.11.2] **true**

[30.12] ([false]: $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[!false]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$

\rightarrow [simplify]

[30.17] $0 == (\neg\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot} + (\$heap_{funcstart_724,1}.p2 / 176))$

[Take given term]

[59.0] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{rem})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p1, 177)]$

[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{const static or extern object}]$

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{simplify}]$

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [\text{const static or extern object}]$

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}<\text{int}>(\$heap_{init}.b1))))$

\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int}2))))))$

\rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take goal term]

[1.0] $(\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}2.\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2)) \leq \text{maxof}(\text{int})$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]

[1.1] $(\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2)) \leq \text{maxof}(\text{int})$

\rightarrow [simplify]

[1.3] $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2)) \leq \text{maxof}(\text{int})$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$]

[1.4] $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).b2)) \leq \text{maxof}(\text{int})$

\rightarrow [const member of object with modified fields]

[1.5] $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.b2)) \leq \text{maxof}(\text{int})$

\rightarrow [const static or extern object]

[1.6] $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}<\text{int}>(\$heap_{init}.b2)) \leq \text{maxof}(\text{int})$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[1.7] $(\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot * \mathbf{asType}\langle\mathbf{int}\rangle(\mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})35))) \leq \mathbf{maxof}(\mathbf{int})$

→ [simplify]

[1.20] $-32768 < (-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot)$

→ [literal comparison of product]

[1.21] $([-35 < 0]: (-32768 / 35) < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot, [0 < -35]: (-32768 / -35) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot, [-35 == 0]: -32768 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.22] $([-35 < 0]: (-32768 / 35) < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot, [(0 < -35) \wedge !(-35 < 0)]: (-32768 / -35) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot, [(-35 == 0) \wedge !(-35 < 0) \wedge !(0 < -35)]: -32768 < 0)$

→ [simplify]

[1.26] $-937 < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot$

→ [negate goal and search for contradiction]

[1.27] $!(-937 < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot)$

→ [simplify]

[1.30] $936 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).quot$

[Create new term from terms 1.30, 30.17 using rule: transitivity 16]

[75.0] $(0 + 936) < (\$heap_{funcstart_724,1}.p2 / 176)$

→ [simplify]

[75.8] $164911 < \$heap_{funcstart_724,1}.p2$

→ [from term 6.0, literal $a < \$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (-30307 + \text{literal}a)$]

Proof of rule precondition:

[75.8.0] $-2 < (-30307 + 164911)$

→ [simplify]

[75.8.2] **true**

[75.9] **false**

Proof of verification condition: Type constraint satisfied in implicit

conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,33)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) /$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div1.quot})$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \%$

$\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$

$\text{asType}\langle\text{integer}\rangle(\text{div1.rem})$

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) <$

```

asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤

```

```

asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap_724,1;745,8 == $heap_funcstart_724,1..replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap_724,1;745,8.M1) <
asType<integer>($heap_724,1;745,8.p1)

!(0 == asType<integer>($heap_724,1;745,8.p1))

asType<integer>($heap_724,1;745,8.p1) <
asType<integer>($heap_724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <

```

$\neg \text{\$heap_funcstart_724,1.p1} \wedge (0 < \text{\$heap_funcstart_724,1.p1} \wedge (0 < \text{\$heap_funcstart_724,1.p2} \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \&\& (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1} \wedge (0 < \text{\$heap_funcstart_724,1.p2} \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \&\& (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323))))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1} \wedge (0 < \text{\$heap_funcstart_724,1.p2} \wedge (0 < \text{\$heap_funcstart_724,1.p3}))$
[Work on sub-term 2 of conjunction in term 5.40]
[6.0] $-30307 < -\text{\$heap_funcstart_724,1.p2}$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \text{\$heap_funcstart_724,1.p2}$
[Take given term]
[11.0] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.p1}), \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 \rightarrow [simplify]
[11.1] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$
 \rightarrow [const static or extern object]
[11.2] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{\$heap_init.a1}))$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, \text{asType<int>}(\text{asType<short int>}((\text{int})177)))$
 \rightarrow [simplify]
[11.6] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$
[Take given term]
[27.0] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.p2}), \text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[30.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / \text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [simplify]

[30.2] $(\$ \text{heap_funcstart_724,1.p2} / 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176),$
 $![\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [simplify]

[30.7] $([0 < -\$ \text{heap_funcstart_724,1.p2}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176),$
 $![\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [from term 9.0, $\text{literal}_a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[30.7.0] $-2 < (0 + 0)$

→ [simplify]

[30.7.2] **true**

[30.8] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) / 176)$,
[!($\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) < 0$)]:
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{quot})$

→ [simplify]

[30.11] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) / 176)$, [!($0 < -\$heap_funcstart_724,1.p2$)]: $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) / 176)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{quot})$

→ [from term 9.0, $\text{literal}_a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[30.11.0] $-2 < (0 + 0)$

→ [simplify]

[30.11.2] **true**

[30.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) / 176)$,
[false]: $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{quot})$

→ [simplify]

[30.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{quot} + (\$heap_funcstart_724,1.p2 / 176))$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[31.0] $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% \text{asType}\langle\text{integer}\rangle(176)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{rem})$

→ [simplify]

[31.2] $(\$heap_funcstart_724,1.p2 \% 176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{rem})$

→ [expand definition of operator '.%' in class 'int' at built in declaration]

[31.3] ([asType<integer>(\$heap_funcstart_724,1.p2) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p2) % 176), []:
 asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[31.4] ([asType<integer>(\$heap_funcstart_724,1.p2) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p2) % 176),
 [!(asType<integer>(\$heap_funcstart_724,1.p2) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [simplify]

[31.7] ([0 < -\$heap_funcstart_724,1.p2]:
 -(-asType<integer>(\$heap_funcstart_724,1.p2) % 176),
 [!(asType<integer>(\$heap_funcstart_724,1.p2) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [from term 9.0, literal a < -\$heap_funcstart_724,1.p2 is false whenever -2 < (0
 + literal a)]

Proof of rule precondition:

[31.7.0] -2 < (0 + 0)

→ [simplify]

[31.7.2] true

[31.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p2) % 176),
 [!(asType<integer>(\$heap_funcstart_724,1.p2) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).rem)

→ [simplify]

[31.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p2) % 176), [!(0
 < -\$heap_funcstart_724,1.p2)]: asType<integer>(\$heap_funcstart_724,1.p2) %
 176) == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p2, 176).rem)

→ [from term 9.0, literal a < -\$heap_funcstart_724,1.p2 is false whenever -2 < (0
 + literal a)]

Proof of rule precondition:

[31.11.0] -2 < (0 + 0)

\rightarrow [simplify]
 [31.11.2] true
 [31.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176)$,
 [!false]: $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]
 [31.17] $0 == (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem} + (\$heap_funcstart_724,1.p2 \% 176))$
 [Take given term]
 [59.0] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{rem})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177)$]
 [59.1] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$
 \rightarrow [simplify]
 [59.3] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} *$
 $\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$
 \rightarrow [const static or extern object]
 [59.4] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} *$
 $\text{asType}\langle\text{int}\rangle(\$heap_init.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$
 \rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
 [59.5] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} *$
 $\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$
 \rightarrow [simplify]
 [59.8] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$

$\text{int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) \\
- (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot})) * \\
\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1})))) \\
\rightarrow [\text{from term 11.6, div1 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p1}, 177)] \\
[59.9] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short} \\
\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) \\
- (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \\
\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1})))) \\
\rightarrow [\text{simplify}] \\
[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short} \\
\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) \\
- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \\
\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1})))) \\
\rightarrow [\text{const static or extern object}] \\
[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short} \\
\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) \\
- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \\
\text{asType} < \text{int} > (\$ \text{heap}_{\text{init}.b1})))) \\
\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}] \\
[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short} \\
\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) \\
- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \\
\text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int}2)))))) \\
\rightarrow [\text{simplify}] \\
[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \\
[\text{Take goal term}] \\
[1.0] \text{minof}(\text{short int}) \leq ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div2.rem})) * \\
\text{asType} < \text{int} > (\$ \text{heap}_{724,1;745,8.r2})) - (\text{asType} < \text{int} > (\text{asType} < \text{short} \\
\text{int} > (\text{div2.quot})) * \text{asType} < \text{int} > (\$ \text{heap}_{724,1;745,8.b2}))) \\
\rightarrow [\text{simplify}] \\
[1.1] -32768 \leq ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div2.rem})) * \\
\text{asType} < \text{int} > (\$ \text{heap}_{724,1;745,8.r2})) - (\text{asType} < \text{int} > (\text{asType} < \text{short} \\
\text{int} > (\text{div2.quot})) * \text{asType} < \text{int} > (\$ \text{heap}_{724,1;745,8.b2}))) \\
\rightarrow [\text{from term 27.6, div2 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176)]$

[1.2] $-32768 \leq ((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [simplify]

[1.4] $-32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).\text{rem})))]$

[1.5] $-32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).\text{rem})))).\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [const member of object with modified fields]

[1.6] $-32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [const static or extern object]

[1.7] $-32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{\text{init}}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[1.8] $-32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [simplify]

[1.11] $-32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).\text{rem} * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2})))$

→ [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176)]$

[1.12] $-32768 \leq ((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1}.p2, 176).rem) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))$
 \rightarrow [simplify]
[1.14] $-32768 \leq ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]$
[1.15] $-32768 \leq ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))))).b2)))$
 \rightarrow [const member of object with modified fields]
[1.16] $-32768 \leq ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b2)))$
 \rightarrow [const static or extern object]
[1.17] $-32768 \leq ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{init}.b2)))$
 \rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[1.18] $-32768 \leq ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})35))))$
 \rightarrow [simplify]
[1.25] $-32769 < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))$
 \rightarrow [negate goal and search for contradiction]
[1.26] $!(-32769 < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))))$
 \rightarrow [simplify]
[1.31] $32768 < ((35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (-172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$

176).rem))

[Copy term 1.31]

[86.0] $32768 < ((-172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).rem) + (35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot))$

→ [from term 31.17, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).rem$ is equal to $\$heap_funcstart_724,1.p2 \% 176$]

[86.1] $32768 < ((-172 * (\$heap_funcstart_724,1.p2 \% 176)) + (35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot))$

[Create new term from term 30.17 using rule: condition for equality of division]

[113.0] $((176 * (0 + -(-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot))) < (1 + \$heap_funcstart_724,1.p2)) \wedge (\$heap_funcstart_724,1.p2 < (176 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot))))$

→ [simplify]

[113.15] $(-1 < ((-176 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot) + \$heap_funcstart_724,1.p2)) \wedge (-176 < (-\$heap_funcstart_724,1.p2 + (176 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot)))$

[Work on sub-term 2 of conjunction in term 113.15]

[114.0] $-1 < ((-176 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot) + \$heap_funcstart_724,1.p2)$

[Create new term from terms 114.0, 6.0 using rule: transitivity 2]

[152.0] $(-30307 + -1 + 1) < (-176 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot)$

→ [simplify]

[152.1] $-30307 < (-176 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot)$

→ [literal comparison of product]

[152.2] $([-176 < 0]: (-30307 / 176) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot, [0 < -176]: (-30307 / -176) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot, [-176 == 0]: -30307 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[152.3] $([-176 < 0]: (-30307 / 176) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot, [(0 < -176) \wedge !(-176 < 0)]: (-30307 / -176) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).quot, [(-176 == 0) \wedge !(-176 < 0) \wedge !(0 < -176)]: -30307 < 0)$

→ [simplify]

[152.7] $-173 < -\text{div}(\text{heapIs } \$\text{heap}_{funcstart_724,1}, \$\text{heap}_{funcstart_724,1} \cdot p2, 176).$ quot

[Create new term from terms 152.7, 86.1 using rule: transitivity 5]

[159.0] $32768 < ((-172 * (\$heap_{funcstart_724,1} \cdot p2 \% 176)) + (35 * -(-173 + 1)))$

→ [simplify]

[159.5] $26748 < (-172 * (\$heap_{funcstart_724,1} \cdot p2 \% 176))$

→ [literal comparison of product]

[159.6] $([-172 < 0]: (26748 / 172) < -(\$heap_{funcstart_724,1} \cdot p2 \% 176), [0 < -172]: (26748 / -172) < (\$heap_{funcstart_724,1} \cdot p2 \% 176), [-172 == 0]: 26748 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[159.7] $([-172 < 0]: (26748 / 172) < -(\$heap_{funcstart_724,1} \cdot p2 \% 176), [(0 < -172) \wedge !(-172 < 0)]: (26748 / -172) < (\$heap_{funcstart_724,1} \cdot p2 \% 176), [(-172 == 0) \wedge !(-172 < 0) \wedge !(0 < -172)]: 26748 < 0)$

→ [simplify]

[159.12] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (63,33)

Condition defined at:

To prove: $((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{rem}))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.\text{LIMIT} == (\text{int})80$

$\$heap_{init}.\text{M1} == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$

$\$heap_{init}.\text{r1} == \text{asType}\langle \text{short int} \rangle((\text{int})171)$

$\$heap_{init}.\text{a1} == \text{asType}\langle \text{short int} \rangle((\text{int})177)$

$\$heap_{init}.\text{b1} == \text{asType}\langle \text{short int} \rangle((\text{int})2)$

$\$heap_{init}.\text{M2} == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$

$\$heap_{init}.\text{r2} == \text{asType}\langle \text{short int} \rangle((\text{int})172)$

$\$heap_{init}.\text{a2} == \text{asType}\langle \text{short int} \rangle((\text{int})176)$

$\$heap_{init}.\text{b2} == \text{asType}\langle \text{short int} \rangle((\text{int})35)$

$\$heap_{init}.\text{M3} == \text{asType}\langle \text{short int} \rangle((\text{int})30323)$

```

$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

```



```

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] ((((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <

```

asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

```

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_724,1.p3))) && (asType<integer>(\$heap_funcstart_724,1.p3) < asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) && (\$heap_funcstart_724,1.p3 < asType<integer>(asType<short int>((int)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)

[Work on sub-term 5 of conjunction in term 5.40]

[9.0] 0 < \$heap_funcstart_724,1.p2

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1, asType<int>(\$heap_funcstart_724,1.p1), asType<int>(\$heap_funcstart_724,1.a1))

\rightarrow [simplify]
 [11.1] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a1}))$
 \rightarrow [const static or extern object]
 [11.2] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\$ \text{heap_init.a1}))$
 \rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
 [11.3] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$
 \rightarrow [simplify]
 [11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$
 [Take given term]
 [27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow [simplify]
 [27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow [const static or extern object]
 [27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 \rightarrow [simplify]
 [27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Assume known post-assertion, class invariant or type constraint for term 27.6]
 [30.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) /$
 $\text{asType<integer>}(176)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 \rightarrow [simplify]
 [30.2] $(\$ \text{heap_funcstart_724,1.p2} / 176) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{heap_funcstart_724,1.p2}, 176).\text{quot})$
 \rightarrow [expand definition of operator './' in class 'int' at built in declaration]
 [30.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p2}) / 176), []:]$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ($[\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 \rightarrow [simplify]
[30.7] ($[0 < \neg\$heap_{funcstart_724,1}.p2]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 \rightarrow [from term 9.0, $\text{literal}a < \neg\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}a)$]
Proof of rule precondition:
[30.7.0] $-2 < (0 + 0)$
 \rightarrow [simplify]
[30.7.2] **true**
[30.8] ($[\text{false}]: \neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot})$
 \rightarrow [simplify]
[30.11] ($[\text{false}]: \neg(\neg\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176), [\neg(0 <$
 $\neg\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) / 176)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot})$
 \rightarrow [from term 9.0, $\text{literal}a < \neg\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}a)$]
Proof of rule precondition:
[30.11.0] $-2 < (0 + 0)$
 \rightarrow [simplify]

[30.11.2] **true**

[30.12] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) / 176)$),
[!**false**]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) / 176 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$

→ [simplify]

[30.17] $0 == (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot} + (\text{\$heap_funcstart_724,1.p2} / 176))$

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[31.0] ($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \%$
 $\text{asType}\langle \text{integer} \rangle(176)) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem})$

→ [simplify]

[31.2] $(\text{\$heap_funcstart_724,1.p2} \% 176) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem})$

→ [expand definition of operator ‘.’ in class ‘int’ at built in declaration]

[31.3] ([$\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) < 0$):
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$, []:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[31.4] ([$\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) < 0$):
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
[! $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) < 0$):
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$

→ [simplify]

[31.7] ([$0 < -\text{\$heap_funcstart_724,1.p2}$):
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
[! $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) < 0$):
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$

→ [from term 9.0, $\text{literal} < -\text{\$heap_funcstart_724,1.p2}$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]
 [31.7.2] **true**
 [31.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
 [!($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) < 0$):
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$
 \rightarrow [simplify]
 [31.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$, [!(0
 $< -\text{\$heap_funcstart_724,1.p2}$): $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \%$
 $176) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p2}, 176).\text{rem})$
 \rightarrow [from term 9.0, literal $a < -\text{\$heap_funcstart_724,1.p2}$ is false whenever $-2 < (0$
 $+ \text{literal})$]
Proof of rule precondition:
 [31.11.0] $-2 < (0 + 0)$
 \rightarrow [simplify]
 [31.11.2] **true**
 [31.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176)$,
 [false]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) \% 176) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem})$
 \rightarrow [simplify]
 [31.17] $0 == (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{rem} + (\text{\$heap_funcstart_724,1.p2} \% 176))$
 [Take given term]
 [40.0] ($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) <$
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.a2})) ==>$
 $(\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div2}.\text{rem}))$
 \rightarrow [simplify]
 [40.1] ($\text{\$heap_funcstart_724,1.p2} < \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.a2}))$
 $=> (\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div2}.\text{rem}))$
 \rightarrow [const static or extern object]
 [40.2] ($\text{\$heap_funcstart_724,1.p2} < \text{asType}\langle \text{integer} \rangle(\text{\$heap_init.a2})) ==>$
 $(\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p2}) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div2}.\text{rem}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[40.3] (\$heap_funcstart_724,1.p2 < **asType**<integer>(**asType**<short int>((int)176))) => (**asType**<integer>(\$heap_funcstart_724,1.p2) == **asType**<integer>(div2.rem))

→ [simplify]

[40.10] (-176 < -\$heap_funcstart_724,1.p2) => (\$heap_funcstart_724,1.p2 == **asType**<integer>(div2.rem))

→ [from term 27.6, div2 is equal to div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)]

[40.11] (-176 < -\$heap_funcstart_724,1.p2) => (\$heap_funcstart_724,1.p2 == **asType**<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))

→ [simplify]

[40.17] (0 == (-\$heap_funcstart_724,1.p2 + div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) ∨ (175 < \$heap_funcstart_724,1.p2)

[Take given term]

[59.0] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((**asType**<int>(**asType**<short int>(div1.rem)) * **asType**<int>(\$heap_funcstart_724,1.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [from term 11.6, div1 is equal to div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)]

[59.1] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) * **asType**<int>(\$heap_funcstart_724,1.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [simplify]

[59.3] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem * **asType**<int>(\$heap_funcstart_724,1.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [const static or extern object]

[59.4] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem * **asType**<int>(\$heap_init.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$
 \rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$
[Take goal term]

[1.0] $((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))) \leq \text{maxof}(\text{short int})$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.1] $((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$]

[1.4] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})).\text{r2}))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [const member of object with modified fields]

[1.5] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [const static or extern object]

[1.6] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{\text{init}}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[1.7] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})172))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.10] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * 172) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[1.11] $((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.13] $((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$]

[1.14] $((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [const member of object with modified fields]

[1.15] $((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [const static or extern object]

[1.16] $((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{\text{init}}.\text{b2}))) \leq \text{maxof}(\text{short int})$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[1.17] $((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})35)))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.36] $-32768 < ((-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}))$

→ [negate goal and search for contradiction]

[1.37] $!(-32768 < ((-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})))$

→ [simplify]

[1.42] $32767 < ((172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}) + (-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{quot}))$

[Branch on disjunction or conditional in term 40.17]

[69.0] $(0 == (-\$heap_funcstart_724,1.p2 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem})) \vee (175 < \$heap_funcstart_724,1.p2) \vee !(0 == (-\$heap_funcstart_724,1.p2 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}))$

[Copy term 1.42]

[70.0] $(32767 < ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}))) \vee (175 < \$heap_funcstart_724,1.p2) \vee !(0 == (-\$heap_funcstart_724,1.p2 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}))$

→ [from term 69.0, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}$ is equal to $\$heap_funcstart_724,1.p2$]

[70.1] $(32767 < ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \$heap_funcstart_724,1.p2))) \vee \dots$

[Copy term 31.17]

[71.0] $(0 == (-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem} + (\$heap_funcstart_724,1.p2 \% 176))) \vee (175 < \$heap_funcstart_724,1.p2) \vee !(0 == (-\$heap_funcstart_724,1.p2 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}))$

→ [from term 69.0, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}$ is equal to $\$heap_funcstart_724,1.p2$]

[71.1] $(0 == (-\$heap_funcstart_724,1.p2 + (\$heap_funcstart_724,1.p2 \% 176))) \vee \dots$

[Assume known post-assertion, class invariant or type constraint for term 71.1]

[78.0] $(\$heap_funcstart_724,1.p2 < 176) \vee (175 < \$heap_funcstart_724,1.p2) \vee !(0 == (-\$heap_funcstart_724,1.p2 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}))$

→ [simplify]

[78.3] $(-176 < -\$heap_funcstart_724,1.p2) \vee \dots$

[Copy term 1.42]

[80.0] $32767 < ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2, 176).\text{rem}))$

→ [from term 31.17, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p2,$

$176).rem$ is equal to $\$heap_{funcstart_724,1}.p2 \% 176]$
 $[80.1] \ 32767 < ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, \ 176).quot) + (172 * (\$heap_{funcstart_724,1}.p2 \% 176)))$
 $[Copy \ term \ 70.1]$
 $[81.0] \ (32767 < ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, \ 176).quot) + (172 * \$heap_{funcstart_724,1}.p2))) \vee (175 < \$heap_{funcstart_724,1}.p2) \vee !(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, \ 176).rem)))$
 $\rightarrow [from \ term \ 30.17, \ \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, \ 176).quot \text{ is equal to } \$heap_{funcstart_724,1}.p2 / 176]$
 $[81.1] \ (32767 < ((-35 * (\$heap_{funcstart_724,1}.p2 / 176)) + (172 * \$heap_{funcstart_724,1}.p2))) \vee \dots$
 $\rightarrow [division \ by \ larger \ divisor]$
Proof of rule precondition 1:
 $[81.1.0.0] \ literald < -\$heap_{funcstart_724,1}.p2$
 $\rightarrow [unify \ with \ term \ 78.3]$
 $[81.1.0.1] \ \mathbf{true}$
Proof of rule precondition 2:
 $[81.1.1.0] \ literalc < \$heap_{funcstart_724,1}.p2$
 $\rightarrow [unify \ with \ term \ 9.0]$
 $[81.1.1.1] \ \mathbf{true}$
Proof of rule precondition 3:
 $[81.1.2.0] \ -176 \leq 176$
 $\rightarrow [simplify]$
 $[81.1.2.2] \ \mathbf{true}$
Proof of rule precondition 4:
 $[81.1.3.0] \ -2 < 0$
 $\rightarrow [simplify]$
 $[81.1.3.1] \ \mathbf{true}$
 $[81.2] \ (32767 < ((-35 * \$heap_{funcstart_724,1}.p2) + (172 * \$heap_{funcstart_724,1}.p2))) \vee \dots$
 $\rightarrow [simplify]$
 $[81.4] \ (32767 < (137 * \$heap_{funcstart_724,1}.p2)) \vee \dots$
 $\rightarrow [literal \ comparison \ of \ product]$

[81.5] $([137 < 0]: (32767 / -137) < -\$heap_{funcstart_724,1}.p2, [0 < 137]: (32767 / 137) < \$heap_{funcstart_724,1}.p2, [0 == 137]: 32767 < 0) \vee \dots$

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[81.6] $([137 < 0]: (32767 / -137) < -\$heap_{funcstart_724,1}.p2, [(0 < 137) \wedge !(137 < 0)]: (32767 / 137) < \$heap_{funcstart_724,1}.p2, [(0 == 137) \wedge !(0 < 137) \wedge !(137 < 0)]: 32767 < 0) \vee \dots$

\rightarrow [simplify]

[81.13] $(\mathbf{true} \wedge (239 < \$heap_{funcstart_724,1}.p2)) \vee \dots$

\rightarrow [from term 78.3, $literal_a < \$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (-176 + literal_a)$]

Proof of rule precondition:

[81.13.0] $-2 < (-176 + 239)$

\rightarrow [simplify]

[81.13.2] **true**

[81.14] $(\mathbf{true} \wedge \mathbf{false}) \vee \dots$

\rightarrow [simplify]

[81.15] **false** $\vee \dots$

[Remove 'false' term 81.15 and fetch new term from containing clause]

[82.0] $175 < \$heap_{funcstart_724,1}.p2$

[Create new term from term 30.17 using rule: condition for equality of division]

[114.0] $((176 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}))) < (1 + \$heap_{funcstart_724,1}.p2)) \wedge (\$heap_{funcstart_724,1}.p2 < (176 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}))))$

\rightarrow [simplify]

[114.15] $(-1 < ((-176 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + \$heap_{funcstart_724,1}.p2)) \wedge (-176 < (-\$heap_{funcstart_724,1}.p2 + (176 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})))$

\rightarrow [separate conjunction and work on first sub-term]

[114.16] $-176 < (-\$heap_{funcstart_724,1}.p2 + (176 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}))$

[Create new term from terms 114.16, 82.0 using rule: transitivity 2]

[148.0] $(-176 + 1 + 175) < (176 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})$

\rightarrow [simplify]

[148.1] $0 < (176 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$

176).quot)
 → [product is positive]
 [148.2] $((0 < 176) \wedge (0 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1} \cdot p2, 176).quot)) \vee ((176 < 0) \wedge (\text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot < 0))$
 → [simplify]
 [148.7] $0 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot$
 [Create new term from terms 148.7, 80.1 using rule: transitivity 11]
 [151.0] $(1 + 32767 + (0 * 35)) < (172 * (\$heap_{funcstart_724,1} \cdot p2 \% 176))$
 → [simplify]
 [151.2] $32768 < (172 * (\$heap_{funcstart_724,1} \cdot p2 \% 176))$
 → [literal comparison of product]
 [151.3] $([172 < 0]: (32768 / -172) < -(\$heap_{funcstart_724,1} \cdot p2 \% 176), [0 <$
 $172]: (32768 / 172) < (\$heap_{funcstart_724,1} \cdot p2 \% 176), [0 == 172]: 32768 < 0)$
 → [explicitly assert falsehood of skipped guards in subsequent guards]
 [151.4] $([172 < 0]: (32768 / -172) < -(\$heap_{funcstart_724,1} \cdot p2 \% 176), [(0 <$
 $172) \wedge !(172 < 0)]: (32768 / 172) < (\$heap_{funcstart_724,1} \cdot p2 \% 176), [(0 ==$
 $172) \wedge !(0 < 172) \wedge !(172 < 0)]: 32768 < 0)$
 → [simplify]
 [151.13] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (64,31)

To prove: $\mathbf{asType<integer>}(\$heap_{724,1;747,8} \cdot p2) <$
 $\mathbf{asType<integer>}(\$heap_{724,1;747,8} \cdot M2)$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType<short int>}((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType<short int>}((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType<short int>}((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType<short int>}((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType<short int>}((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType<short int>}((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType<short int>}((\mathbf{int})176)$

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```



```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

```

!(0 == asType<integer>(\$heap_{724,1;747,8}.p2))

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<**integer**>(\$heap_funcstart_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<**integer**>(\$heap_init.M2))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<**integer**>(**asType**<**short int**>((**int**)30307)))) && (0 <
asType<**integer**>(\$heap_funcstart_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcstart_724,1.p3) <
asType<**integer**>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType**<**integer**>(**asType**<**short int**>((**int**)30323)))

→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <

$\$heap_{funcstart_724,1.p1}) \wedge (0 < \$heap_{funcstart_724,1.p2}) \wedge (0 < \$heap_{funcstart_724,1.p3})$
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] $0 < \$heap_{funcstart_724,1.p2}$
[Take given term]
[11.0] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1.p1}),$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1.a1}))$
 \rightarrow *[simplify]*
[11.1] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1},$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1.a1}))$
 \rightarrow *[const static or extern object]*
[11.2] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1},$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{init.a1}))$
 \rightarrow *[expand definition of constant 'a1' at prang.c (16,20)]*
[11.3] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1},$
 $\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})177)))$
 \rightarrow *[simplify]*
[11.6] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177)$
[Take given term]
[27.0] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1.p2}),$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1.a2}))$
 \rightarrow *[simplify]*
[27.1] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2},$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1.a2}))$
 \rightarrow *[const static or extern object]*
[27.2] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2},$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{init.a2}))$
 \rightarrow *[expand definition of constant 'a2' at prang.c (21,20)]*
[27.3] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2},$
 $\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})176)))$
 \rightarrow *[simplify]*
[27.6] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176)$
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] $(\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1.p2}) /$

$\text{asType}\langle\text{integer}\rangle(176)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs}$
 $\text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.2] (\text{\$heap_funcstart_724,1.p2} / 176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs}$
 $\text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$
 $\rightarrow [\text{expand definition of operator '.'/ in class 'int' at built in declaration}]$
 $[30.3] ([\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) < 0]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176), []:$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 $\rightarrow [\text{explicitly assert falsehood of skipped guards in subsequent guards}]$
 $[30.4] ([\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) < 0]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.7] ([0 < -\text{\$heap_funcstart_724,1.p2}]:$
 $\neg(\neg\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 $\rightarrow [\text{from term 9.0, literal } a < -\text{\$heap_funcstart_724,1.p2} \text{ is false whenever } -2 < (0$
 $+ \text{literal})]$
Proof of rule precondition:
 $[30.7.0] -2 < (0 + 0)$
 $\rightarrow [\text{simplify}]$
 $[30.7.2] \text{true}$
 $[30.8] ([\text{false}]: \neg(\neg\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176),$
 $[\neg(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $176).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[30.11] ([\text{false}]: \neg(\neg\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176), [\neg(0 <$
 $-\text{\$heap_funcstart_724,1.p2})]: \text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p2}) / 176)$

== **asType**<integer>(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot)
→ [from term 9.0, literal a < - \$heap_funcstart_724,1.p2 is false whenever -2 < (0
+ literal a)]

Proof of rule precondition:

[30.11.0] -2 < (0 + 0)

→ [simplify]

[30.11.2] **true**

[30.12] ([**false**]: -(**asType**<integer>(\$heap_funcstart_724,1.p2) / 176),
[**false**]: **asType**<integer>(\$heap_funcstart_724,1.p2) / 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).quot)

→ [simplify]

[30.17] 0 == (-div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).quot + (\$heap_funcstart_724,1.p2 / 176))

[Assume known post-assertion, class invariant or type constraint for term 27.6]

[31.0] (**asType**<integer>(\$heap_funcstart_724,1.p2) %
asType<integer>(176)) == **asType**<integer>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [simplify]

[31.2] (\$heap_funcstart_724,1.p2 % 176) == **asType**<integer>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)

→ [expand definition of operator '%' in class 'int' at built in declaration]

[31.3] ([**asType**<integer>(\$heap_funcstart_724,1.p2) < 0]:
-(**asType**<integer>(\$heap_funcstart_724,1.p2) % 176), []:
asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[31.4] ([**asType**<integer>(\$heap_funcstart_724,1.p2) < 0]:
-(**asType**<integer>(\$heap_funcstart_724,1.p2) % 176),
[!(**asType**<integer>(\$heap_funcstart_724,1.p2) < 0)]:
asType<integer>(\$heap_funcstart_724,1.p2) % 176) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).rem)

→ [simplify]

[31.7] ([0 < - \$heap_funcstart_724,1.p2]:
-(**asType**<integer>(\$heap_funcstart_724,1.p2) % 176),

$[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[31.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.7.2] **true**

$[31.8] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]
 $[31.11] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176), [!(0$
 $< -\$heap_{funcstart_724,1}.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \%$
 $176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})$

\rightarrow [from term 9.0, $\text{literal}_a < -\$heap_{funcstart_724,1}.p2$ is false whenever $-2 < (0$
 $+ \text{literal}_a)$]

Proof of rule precondition:

[31.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[31.11.2] **true**

$[31.12] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]
 $[31.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem} + (\$heap_{funcstart_724,1}.p2 \% 176))$
[Take given term]
 $[40.0] (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.a2)) ==>$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}2.\text{rem}))$

\rightarrow [simplify]
 [40.1] ($\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{\$heap_funcstart_724,1.a2})$)
 $\Rightarrow (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) ==$
 $\text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [const static or extern object]
 [40.2] ($\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{\$heap_init.a2})$) \Rightarrow
 $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) ==$
 $\text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
 [40.3] ($\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{asType<short$
 $\text{int>}((\text{int}176)))$) $\Rightarrow (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p2}) ==$
 $\text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [simplify]
 [40.10] ($-176 < -\text{\$heap_funcstart_724,1.p2}$) $\Rightarrow (\text{\$heap_funcstart_724,1.p2} ==$
 $\text{asType<integer>}(\text{div2.rem}))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1,}$
 $\text{\$heap_funcstart_724,1.p2, 176})]$
 [40.11] ($-176 < -\text{\$heap_funcstart_724,1.p2}$) $\Rightarrow (\text{\$heap_funcstart_724,1.p2} ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1, } \text{\$heap_funcstart_724,1.p2,}$
 $176).\text{rem}))$
 \rightarrow [simplify]
 [40.17] ($0 == (-\text{\$heap_funcstart_724,1.p2} + \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1,}$
 $\text{\$heap_funcstart_724,1.p2, 176).\text{rem}))} \vee (175 < \text{\$heap_funcstart_724,1.p2})$)
 [Take given term]
 [59.0] $\text{\$heap}_{724,1;745,8} == \text{\$heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) *$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short}$
 $\text{int>}(\text{div1.quot})) * \text{asType<int>}(\text{\$heap_funcstart_724,1.b1})))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1,}$
 $\text{\$heap_funcstart_724,1.p1, 177})]$
 [59.1] $\text{\$heap}_{724,1;745,8} == \text{\$heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1,}$
 $\text{\$heap_funcstart_724,1.p1, 177).\text{rem}))} * \text{asType<int>}(\text{\$heap_funcstart_724,1.r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) *$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.b1})))$
 \rightarrow [simplify]
 [59.3] $\text{\$heap}_{724,1;745,8} == \text{\$heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1, } \text{\$heap_funcstart_724,1.p1, 177).\text{rem} *$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 → [const static or extern object]
 [59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 → [expand definition of constant 'r1' at prang.c (15,20)]
 [59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 → [simplify]
 [59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 → [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$]
 [59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 → [simplify]
 [59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 → [const static or extern object]
 [59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.b1))))$
 → [expand definition of constant 'b1' at prang.c (17,20)]
 [59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})2))))$

→ [simplify]

[59.19] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))))

[Take given term]

[63.0] \$heap_{724,1;747,8} == \$heap_{724,1;745,8}.replace(p2 → asType<short int>((asType<int>(asType<short int>(div2.rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

→ [from term 59.19, \$heap_{724,1;745,8} is equal to

\$heap_{funcstart_724,1}.replace(p1 → (-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]

[63.1] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 → ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 → asType<short int>((asType<int>(asType<short int>(div2.rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

→ [from term 27.6, div2 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]

[63.2] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 → ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 → asType<short int>((asType<int>(asType<short int>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

→ [simplify]

[63.4] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 → ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

→ [from term 59.19, \$heap_{724,1;745,8} is equal to

\$heap_{funcstart_724,1}.replace(p1 → (-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},

$\$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot))) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot))) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{init}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot))) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})172))) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot))) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * 172) -$

$(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [simplify]
[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$]
[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).b2))))$
 \rightarrow [const member of object with modified fields]
[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b2))))$
 \rightarrow [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) * \text{asType}\langle\text{int}\rangle(\$heap_{init}.b2))))$

\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})35))))))$

\rightarrow [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))))$

[Take goal term]

[1.0] $\text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.p2) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.M2)$

\rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))$

[1.1] $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).p2) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.M2)$

\rightarrow [simplify]

[1.3] $((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$

176).rem)) < **asType<integer>**(&heap724,1;747,8.M2)
 → [from term 63.24, &heap724,1;747,8 is equal to
 &heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** &heapfuncstart_724,1,
 &heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** &heapfuncstart_724,1,
 &heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → (-35 * div(**heapIs**
 &heapfuncstart_724,1, &heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
 &heapfuncstart_724,1, &heapfuncstart_724,1.p2, 176).rem)))]
 [1.4] ((-35 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2, 176).quot)
 + (172 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2, 176).rem)) <
asType<integer>(&heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs**
 &heapfuncstart_724,1, &heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
 &heapfuncstart_724,1, &heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35
 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2, 176).quot) + (172 *
 div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2, 176).rem))).M2)
 → [const member of object with modified fields]
 [1.6] ((-35 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).quot) + (172 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).rem)) < **asType<integer>**(&heapfuncstart_724,1.M2)
 → [const static or extern object]
 [1.7] ((-35 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).quot) + (172 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).rem)) < **asType<integer>**(&heapinit.M2)
 → [expand definition of constant 'M2' at prang.c (19,20)]
 [1.8] ((-35 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).quot) + (172 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).rem)) < **asType<integer>**(**asType<short int>**((int)30307))
 → [simplify]
 [1.18] -30307 < ((-172 * div(**heapIs** &heapfuncstart_724,1,
 &heapfuncstart_724,1.p2, 176).rem) + (35 * div(**heapIs** &heapfuncstart_724,1,
 &heapfuncstart_724,1.p2, 176).quot))
 → [negate goal and search for contradiction]
 [1.19] !(-30307 < ((-172 * div(**heapIs** &heapfuncstart_724,1,
 &heapfuncstart_724,1.p2, 176).rem) + (35 * div(**heapIs** &heapfuncstart_724,1,
 &heapfuncstart_724,1.p2, 176).quot)))
 → [simplify]
 [1.24] 30306 < ((172 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).rem) + (-35 * div(**heapIs** &heapfuncstart_724,1, &heapfuncstart_724,1.p2,
 176).quot))
 [Branch on disjunction or conditional in term 40.17]

[73.0] $(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) \vee (175 < \$heap_{funcstart_724,1}.p2) \vee !(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$

[Copy term 1.24]

[76.0] $(30306 < ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))) \vee (175 < \$heap_{funcstart_724,1}.p2) \vee !(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$

\rightarrow [from term 73.0, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}$ is equal to $\$heap_{funcstart_724,1}.p2$]

[76.1] $(30306 < ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \$heap_{funcstart_724,1}.p2))) \vee \dots$

[Copy term 31.17]

[77.0] $(0 == (-\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} + (\$heap_{funcstart_724,1}.p2 \% 176))) \vee (175 < \$heap_{funcstart_724,1}.p2) \vee !(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$

\rightarrow [from term 73.0, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}$ is equal to $\$heap_{funcstart_724,1}.p2$]

[77.1] $(0 == (-\$heap_{funcstart_724,1}.p2 + (\$heap_{funcstart_724,1}.p2 \% 176))) \vee \dots$

[Assume known post-assertion, class invariant or type constraint for term 77.1]

[84.0] $(\$heap_{funcstart_724,1}.p2 < 176) \vee (175 < \$heap_{funcstart_724,1}.p2) \vee !(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$

\rightarrow [simplify]

[84.3] $(-176 < -\$heap_{funcstart_724,1}.p2) \vee \dots$

[Copy term 1.24]

[86.0] $30306 < ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$

\rightarrow [from term 31.17, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}$ is equal to $\$heap_{funcstart_724,1}.p2 \% 176$]

[86.1] $30306 < ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * (\$heap_{funcstart_724,1}.p2 \% 176)))$

[Copy term 76.1]

[87.0] $(30306 < ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \$heap_{funcstart_724,1}.p2))) \vee (175 < \$heap_{funcstart_724,1}.p2) \vee !(0 == (-\$heap_{funcstart_724,1}.p2 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$

\rightarrow [from term 30.17, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}$ is equal to $\$heap_{funcstart_724,1}.p2 / 176$]

[87.1] $(30306 < ((-35 * (\$heap_{funcstart_724,1}.p2 / 176)) + (172 * \$heap_{funcstart_724,1}.p2))) \vee \dots$

\rightarrow [division by larger divisor]

Proof of rule precondition 1:

[87.1.0.0] $\text{literal}d < -\$heap_{funcstart_724,1}.p2$

\rightarrow [unify with term 84.3]

[87.1.0.1] **true**

Proof of rule precondition 2:

[87.1.1.0] $\text{literal}c < \$heap_{funcstart_724,1}.p2$

\rightarrow [unify with term 9.0]

[87.1.1.1] **true**

Proof of rule precondition 3:

[87.1.2.0] $--176 \leq 176$

\rightarrow [simplify]

[87.1.2.2] **true**

Proof of rule precondition 4:

[87.1.3.0] $-2 < 0$

\rightarrow [simplify]

[87.1.3.1] **true**

[87.2] $(30306 < ((-35 * \$heap_{funcstart_724,1}.p2) + (172 * \$heap_{funcstart_724,1}.p2))) \vee \dots$

\rightarrow [simplify]

[87.4] $(30306 < (137 * \$heap_{funcstart_724,1}.p2)) \vee \dots$

\rightarrow [literal comparison of product]

[87.5] $([137 < 0]: (30306 / -137) < -\$heap_{funcstart_724,1}.p2, [0 < 137]: (30306 / 137) < \$heap_{funcstart_724,1}.p2, [0 == 137]: 30306 < 0) \vee \dots$

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[87.6] $([137 < 0]: (30306 / -137) < -\$heap_{funcstart_724,1}.p2, [(0 < 137) \wedge !(137 < 0)]: (30306 / 137) < \$heap_{funcstart_724,1}.p2, [(0 == 137) \wedge !(0 < 137) \wedge !(137 < 0)]: 30306 < 0) \vee \dots$

→ [simplify]

[87.13] (**true** \wedge ($221 < \text{\$heap_funcstart_724,1.p2}$)) \vee ...

→ [from term 84.3, *literal* $< \text{\$heap_funcstart_724,1.p2}$ is false whenever $-2 < (-176 + \text{literal})$]

Proof of rule precondition:

[87.13.0] $-2 < (-176 + 221)$

→ [simplify]

[87.13.2] **true**

[87.14] (**true** \wedge **false**) \vee ...

→ [simplify]

[87.15] **false** \vee ...

[Remove 'false' term 87.15 and fetch new term from containing clause]

[88.0] $175 < \text{\$heap_funcstart_724,1.p2}$

[Create new term from term 30.17 using rule: condition for equality of division]

[120.0] $((176 * (0 + -(-\text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot}))) < (1 + \text{\$heap_funcstart_724,1.p2})) \wedge (\text{\$heap_funcstart_724,1.p2} < (176 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot}))))$

→ [simplify]

[120.15] $(-1 < ((-176 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot}) + \text{\$heap_funcstart_724,1.p2})) \wedge (-176 < (-\text{\$heap_funcstart_724,1.p2} + (176 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot})))$

→ [separate conjunction and work on first sub-term]

[120.16] $-176 < (-\text{\$heap_funcstart_724,1.p2} + (176 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot}))$

[Create new term from terms 120.16, 88.0 using rule: transitivity 2]

[155.0] $(-176 + 1 + 175) < (176 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [simplify]

[155.1] $0 < (176 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot})$

→ [product is positive]

[155.2] $((0 < 176) \wedge (0 < \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot})) \vee ((176 < 0) \wedge (\text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176).\text{quot} < 0))$

→ [simplify]

[155.7] $0 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).$ quot
[Create new term from terms 155.7, 86.1 using rule: transitivity 11]
[160.0] $(1 + 30306 + (0 * 35)) < (172 * (\text{heap_funcstart_724,1.p2} \% 176))$
→ [simplify]
[160.2] $30307 < (172 * (\text{heap_funcstart_724,1.p2} \% 176))$
→ [literal comparison of product]
[160.3] $[(172 < 0): (30307 / -172) < -(\text{heap_funcstart_724,1.p2} \% 176), [0 < 172]: (30307 / 172) < (\text{heap_funcstart_724,1.p2} \% 176), [0 == 172]: 30307 < 0]$
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[160.4] $[(172 < 0): (30307 / -172) < -(\text{heap_funcstart_724,1.p2} \% 176), [(0 < 172) \wedge !(172 < 0)]: (30307 / 172) < (\text{heap_funcstart_724,1.p2} \% 176), [(0 == 172) \wedge !(0 < 172) \wedge !(172 < 0)]: 30307 < 0]$
→ [simplify]
[160.13] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (64,12)

To prove: $\text{asType}<\text{integer const}>(\$ \text{heap}_{724,1;747,8}.\text{M2}) < \text{asType}<\text{integer}>(\$ \text{heap}_{724,1;747,8}.\text{p2})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$
 $\$ \text{heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$ \text{heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$
 $\$ \text{heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$
 $\$ \text{heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$
 $\$ \text{heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$ \text{heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$
 $\$ \text{heap}_{init}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$
 $\$ \text{heap}_{init}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$
 $\$ \text{heap}_{init}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$ \text{heap}_{init}.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$
 $\$ \text{heap}_{init}.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$
 $\$ \text{heap}_{init}.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$
 $\$ \text{heap}_{init}.\text{p1} == \text{asType}<\text{short int}>((\text{int})1)$

```

$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

```

```

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

Proof:

[Take given term]

[5.0] invariant1(heapIs $heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&

```

```

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧

```

$(0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{\$heap_init.M2})) \ \&\& \ (0 < \text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \ \&\& \ (\text{\$heap_funcstart_724,1.p2} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30307)))) \ \&\& \ (0 < \text{asType<integer>}(\text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3})))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_funcstart_724,1.M3}))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\& \ (\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323))))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$
 $[\text{Work on sub-term 2 of conjunction in term 5.40}]$
 $[6.0] -30307 < -\text{\$heap_funcstart_724,1.p2}$
 $[\text{Work on sub-term 5 of conjunction in term 5.40}]$
 $[9.0] 0 < \text{\$heap_funcstart_724,1.p2}$
 $[\text{Take given term}]$
 $[11.0] \text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$

asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))
→ [simplify]
[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))
→ [const static or extern object]
[11.2] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))
→ [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(**asType<short int>**((**int**)177)))
→ [simplify]
[11.6] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)
[Take given term]
[27.0] div2 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p2),
asType<int>(\$heap_funcstart_724,1.a2))
→ [simplify]
[27.1] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_funcstart_724,1.a2))
→ [const static or extern object]
[27.2] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_init.a2))
→ [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(**asType<short int>**((**int**)176)))
→ [simplify]
[27.6] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (**asType<integer>**(\$heap_funcstart_724,1.p2) /
asType<integer>(176)) == **asType<integer>**(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)
→ [simplify]
[30.2] (\$heap_funcstart_724,1.p2 / 176) == **asType<integer>**(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]

[30.3] ([asType<integer>(\$heap_funcstart_724,1.p2) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p2) / 176), []:
 asType<integer>(\$heap_funcstart_724,1.p2) / 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).quot)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[30.4] ([asType<integer>(\$heap_funcstart_724,1.p2) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p2) / 176),
 [!(asType<integer>(\$heap_funcstart_724,1.p2) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p2) / 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).quot)

→ [simplify]

[30.7] ([0 < -\$heap_funcstart_724,1.p2]:
 -(-asType<integer>(\$heap_funcstart_724,1.p2) / 176),
 [!(asType<integer>(\$heap_funcstart_724,1.p2) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p2) / 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).quot)

→ [from term 9.0, literal < -\$heap_funcstart_724,1.p2 is false whenever -2 < (0
 + literal)]

Proof of rule precondition:

[30.7.0] -2 < (0 + 0)

→ [simplify]

[30.7.2] true

[30.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p2) / 176),
 [!(asType<integer>(\$heap_funcstart_724,1.p2) < 0)]:
 asType<integer>(\$heap_funcstart_724,1.p2) / 176) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
 176).quot)

→ [simplify]

[30.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p2) / 176), [!(0 <
 -\$heap_funcstart_724,1.p2)]: asType<integer>(\$heap_funcstart_724,1.p2) / 176)
 == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p2, 176).quot)

→ [from term 9.0, literal < -\$heap_funcstart_724,1.p2 is false whenever -2 < (0
 + literal)]

Proof of rule precondition:

[30.11.0] -2 < (0 + 0)

\rightarrow [simplify]
 [30.11.2] **true**
 [30.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) / 176)$,
 [!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) / 176$) ==
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{quot})$
 \rightarrow [simplify]
 [30.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{quot} + (\$heap_funcstart_724,1.p2 / 176))$
 [Assume known post-assertion, class invariant or type constraint for term 27.6]
 [31.0] ($\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \%$
 $\text{asType}\langle \text{integer} \rangle (176)) == \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{rem})$
 \rightarrow [simplify]
 [31.2] $(\$heap_funcstart_724,1.p2 \% 176) == \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{rem})$
 \rightarrow [expand definition of operator '.*' in class 'int' at built in declaration]
 [31.3] ([$\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) < 0$]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \% 176)$, []:
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \% 176$) ==
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [31.4] ([$\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) < 0$]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \% 176)$,
 [!($\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) < 0$)]:
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \% 176$) ==
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$
 \rightarrow [simplify]
 [31.7] ($[0 < -\$heap_funcstart_724,1.p2]$:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \% 176)$,
 [!($\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) < 0$)]:
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p2) \% 176$) ==
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$
 \rightarrow [from term 9.0, literal $a < -\$heap_funcstart_724,1.p2$ is false whenever $-2 < (0$
 $+ \text{literal})$]

Proof of rule precondition:

$[31.7.0] -2 < (0 + 0)$
 $\rightarrow [simplify]$
 $[31.7.2] \text{ true}$
 $[31.8] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$
 $\rightarrow [simplify]$
 $[31.11] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176), [(0$
 $< -\$heap_funcstart_724,1.p2)]: \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \%$
 $176) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).\text{rem})$
 $\rightarrow [from \text{ term } 9.0, \text{ literal } a < -\$heap_funcstart_724,1.p2 \text{ is false whenever } -2 < (0$
 $+ \text{ literal } a)]$
Proof of rule precondition:
 $[31.11.0] -2 < (0 + 0)$
 $\rightarrow [simplify]$
 $[31.11.2] \text{ true}$
 $[31.12] ([\text{false}]: -(-\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) \% 176) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem})$
 $\rightarrow [simplify]$
 $[31.17] 0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).\text{rem} + (\$heap_funcstart_724,1.p2 \% 176))$
 $[Take \text{ given term}]$
 $[59.0] \$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{rem})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$
 $\rightarrow [from \text{ term } 11.6, \text{ div1 is equal to } \text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177)]$
 $[59.1] \$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$

→ [simplify]

[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(\$heap_{funcstart_724,1}.r1)) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [const static or extern object]

[59.4] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(\$heap_{init}.r1)) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(asType<short int>((int)171))) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [simplify]

[59.8] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * 171) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [from term 11.6, div1 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]

[59.9] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (asType<int>(asType<short int>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [simplify]

[59.11] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [const static or extern object]

[59.12] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * asType<int>(\$heap_{init}.b1))))

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int}2))))))$

\rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

$\text{int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$
[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))) . \text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType} < \text{int} > (\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))) . r2)) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [const member of object with modified fields]
[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))) . \text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType} < \text{int} > (\$heap_{funcstart_724,1}.r2)) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [const static or extern object]
[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))) . \text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType} < \text{int} > (\$heap_{init}.r2)) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))) . \text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int})172))) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [simplify]

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.b2))))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[63.17]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short\ int}>((172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{init}.b2))))$
 $\rightarrow [expand\ definition\ of\ constant\ 'b2'\ at\ prang.c\ (22,20)]$
 $[63.18]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short\ int}>((172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})35))))$
 $\rightarrow [simplify]$
 $[63.24]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow ((-35 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))$
 $[Take\ goal\ term]$
 $[1.0]\ -\mathbf{asType}<\mathbf{integer\ const}>(\$heap_{724,1;747,8}.M2) <$
 $\mathbf{asType}<\mathbf{integer}>(\$heap_{724,1;747,8}.p2)$
 $\rightarrow [from\ term\ 63.24,\ \$heap_{724,1;747,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\mathbf{replace}(p2 \rightarrow (-35 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))]$
 $[1.1]\ -\mathbf{asType}<\mathbf{integer\ const}>(\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow ((-35 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))).M2) <$

$\text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.p2)$
 \rightarrow [const member of object with modified fields]
[1.3] $\neg \text{asType}\langle\text{integer const}\rangle(\$heap_{funcstart_724,1}.M2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.p2)$
 \rightarrow [const static or extern object]
[1.4] $\neg \text{asType}\langle\text{integer const}\rangle(\$heap_{init}.M2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.p2)$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.5] $\neg \text{asType}\langle\text{integer const}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.p2)$
 \rightarrow [simplify]
[1.9] $\neg 30307 < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;747,8}.p2)$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))]$
[1.10] $\neg 30307 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})).p2)$
 \rightarrow [simplify]
[1.12] $\neg 30307 < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem}))$
 \rightarrow [negate goal and search for contradiction]
[1.13] $\neg (\neg 30307 < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})))$
 \rightarrow [simplify]
[1.18] $30306 < ((35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{quot}) + (-172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).\text{rem}))$
[Copy term 1.18]
[90.0] $30306 < ((-172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_funcstart_724,1.p2, 176).rem) + (35 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot))$
 \rightarrow [from term 31.17, $\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem$ is equal to $\$heap_funcstart_724,1.p2 \% 176$]
[90.1] $30306 < ((-172 * (\$heap_funcstart_724,1.p2 \% 176)) + (35 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot))$
[Create new term from term 30.17 using rule: condition for equality of division]
[117.0] $((176 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot))) < (1 + \$heap_funcstart_724,1.p2)) \wedge (\$heap_funcstart_724,1.p2 < (176 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot))))$
 \rightarrow [simplify]
[117.15] $(-1 < ((-176 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + \$heap_funcstart_724,1.p2)) \wedge (-176 < (-\$heap_funcstart_724,1.p2 + (176 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)))$
[Work on sub-term 2 of conjunction in term 117.15]
[118.0] $-1 < ((-176 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + \$heap_funcstart_724,1.p2)$
[Create new term from terms 118.0, 6.0 using rule: transitivity 2]
[157.0] $(-30307 + -1 + 1) < (-176 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$
 \rightarrow [simplify]
[157.1] $-30307 < (-176 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)$
 \rightarrow [literal comparison of product]
[157.2] $([-176 < 0]: (-30307 / 176) < -\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot, [0 < -176]: (-30307 / -176) < \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot, [-176 == 0]: -30307 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[157.3] $([-176 < 0]: (-30307 / 176) < -\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot, [(0 < -176) \wedge !(-176 < 0)]: (-30307 / -176) < \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot, [(-176 == 0) \wedge !(-176 < 0) \wedge !(0 < -176)]: -30307 < 0)$
 \rightarrow [simplify]
[157.7] $-173 < -\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot$
[Create new term from terms 157.7, 90.1 using rule: transitivity 5]

[164.0] $30306 < ((-172 * (\$heap_funcstart_724,1.p2 \% 176)) + (35 * -(-173 + 1)))$
 \rightarrow [simplify]
[164.5] $24286 < (-172 * (\$heap_funcstart_724,1.p2 \% 176))$
 \rightarrow [literal comparison of product]
[164.6] $([-172 < 0]: (24286 / 172) < -(\$heap_funcstart_724,1.p2 \% 176), [0 < -172]: (24286 / -172) < (\$heap_funcstart_724,1.p2 \% 176), [-172 == 0]: 24286 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[164.7] $([-172 < 0]: (24286 / 172) < -(\$heap_funcstart_724,1.p2 \% 176), [(0 < -172) \wedge !(-172 < 0)]: (24286 / -172) < (\$heap_funcstart_724,1.p2 \% 176), [(-172 == 0) \wedge !(-172 < 0) \wedge !(0 < -172)]: 24286 < 0)$
 \rightarrow [simplify]
[164.12] **false**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq \text{div3.rem}$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

```

$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

```

```

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
```

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
 $[\text{Work on sub-term 6 of conjunction in term 5.40}]$
 $[10.0] 0 < \$heap_funcstart_724,1.p3$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \%$
 $\text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}, 178).\text{rem})$

→ [simplify]

[47.2] $(\$ \text{heap_funcstart_724,1.p3} \% 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}, 178).\text{rem})$

→ [expand definition of operator '% ' in class 'int' at built in declaration]

[47.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \% 178), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $[(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [simplify]

[47.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \% 178),$

$[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem})$
 $\rightarrow [from \text{ term } 10.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p3 \text{ is false whenever } -2 <$
 $(0 + \text{ literal } a)]$

Proof of rule precondition:

$[47.7.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[47.7.2] \text{ true}$

$[47.8] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \% 178),$
 $[(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem})$
 $\rightarrow [simplify]$
 $[47.11] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \% 178), [(0$
 $< -\$heap_{funcstart_724,1}.p3)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \%$
 $178) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem})$

$\rightarrow [from \text{ term } 10.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p3 \text{ is false whenever } -2 <$
 $(0 + \text{ literal } a)]$

Proof of rule precondition:

$[47.11.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[47.11.2] \text{ true}$

$[47.12] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \% 178),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem})$
 $\rightarrow [simplify]$
 $[47.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem} + (\$heap_{funcstart_724,1}.p3 \% 178))$
 $[Assume \text{ known post-assertion, class invariant or type constraint for term } 47.17]$

$[54.0] \text{ minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem}$
 $\rightarrow [simplify]$

[54.3] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq \text{div3.rem}$

\rightarrow [simplify]

[1.1] $-32768 \leq \text{div3.rem}$

\rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$]

[1.2] $-32768 \leq \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$

\rightarrow [simplify]

[1.4] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$

\rightarrow [from term 54.3, $\text{literal} < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32769$]

Proof of rule precondition:

[1.4.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.4.2] **true**

[1.5] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)

Condition defined at:

To prove: $\text{div3.rem} \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <

```

```

asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

```

[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [const static or extern object]

```

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>(asType<short
int>((int)30323)))

```

\rightarrow [simplify]
 [5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
 [Work on sub-term 6 of conjunction in term 5.40]
 [10.0] $0 < \$heap_{funcstart_724,1}.p3$
 [Take given term]
 [43.0] $div3 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.p3), \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a3))$
 \rightarrow [simplify]
 [43.1] $div3 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a3))$
 \rightarrow [const static or extern object]
 [43.2] $div3 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, \mathbf{asType}<\mathbf{int}>(\$heap_{init}.a3))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] $div3 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})178)))$
 \rightarrow [simplify]
 [43.6] $div3 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)$
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [47.0] $(\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}.p3) \% \mathbf{asType}<\mathbf{integer}>(178)) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)$
 \rightarrow [simplify]
 [47.2] $(\$heap_{funcstart_724,1}.p3 \% 178) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)$
 \rightarrow [expand definition of operator '.*' in class 'int' at built in declaration]
 [47.3] $([\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}.p3) < 0]: \neg(\neg \mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}.p3) \% 178), []: \mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}.p3) \% 178) == \mathbf{asType}<\mathbf{integer}>(div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [47.4] $([\mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}.p3) < 0]:$

$\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[47.7] ([0 < -\$heap_funcstart_724,1.p3]:$
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
 $\rightarrow [\text{from term } 10.0, \text{literal } a < -\$heap_funcstart_724,1.p3 \text{ is false whenever } -2 <$
 $(0 + \text{literal } a)]$

Proof of rule precondition:

$[47.7.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[47.7.2] \text{ true}$

$[47.8] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
 $\rightarrow [\text{simplify}]$
 $[47.11] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178), [\neg(0$
 $< -\$heap_funcstart_724,1.p3)]: \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \%$
 $178) == \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})$
 $\rightarrow [\text{from term } 10.0, \text{literal } a < -\$heap_funcstart_724,1.p3 \text{ is false whenever } -2 <$
 $(0 + \text{literal } a)]$

Proof of rule precondition:

$[47.11.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[47.11.2] \text{ true}$

$[47.12] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$

\rightarrow [simplify]
 [47.17] $0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} + (\$ \text{heap_funcstart_724,1.p3} \% 178))$
 [Assume known post-assertion, class invariant or type constraint for term 47.17]
 [55.0] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} \leq \text{maxof}(\text{int})$
 \rightarrow [simplify]
 [55.9] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$
 [Take goal term]
 [1.0] $\text{div3}.\text{rem} \leq \text{maxof}(\text{short int})$
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$]
 [1.1] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} \leq \text{maxof}(\text{short int})$
 \rightarrow [simplify]
 [1.10] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$
 \rightarrow [from term 55.9, $\text{literal} < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32768$]
Proof of rule precondition:
 [1.10.0] $(-32768 + -1) < -32768$
 \rightarrow [simplify]
 [1.10.2] **true**
 [1.11] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{asType}(\text{short int})(\text{div3}.\text{rem})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType}(\text{short int})((\text{int})30269)$


```

$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

```

```

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] $(((((0 < \$heap_{funcstart_724,1}.p1) \&\& (\$heap_{funcstart_724,1}.p1 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30269)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [simplify]
[5.16] $((((-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge$
 $(0 < \$heap_{funcstart_724,1}.p2)) \&\& (\$heap_{funcstart_724,1}.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [const static or extern object]
[5.17] $((((-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge$
 $(0 < \$heap_{funcstart_724,1}.p2)) \&\& (\$heap_{funcstart_724,1}.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{init}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge$
 $(0 < \$heap_{funcstart_724,1}.p2)) \&\& (\$heap_{funcstart_724,1}.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 <$
 $-\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 <$
 $\$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \&\&$
 $(\$heap_{funcstart_724,1}.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.M3))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 <$
 $-\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 <$
 $\$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)) \&\&$

$(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{\$heap_init.M3}))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType<integer>}(\text{asType<short int>}((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})$
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] $0 < \text{\$heap_funcstart_724,1.p3}$
[Take given term]
[43.0] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{asType<int>}(\text{\$heap_funcstart_724,1.p3}), \text{asType<int>}(\text{\$heap_funcstart_724,1.a3}))$
 \rightarrow [simplify]
[43.1] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, \text{asType<int>}(\text{\$heap_funcstart_724,1.a3}))$
 \rightarrow [const static or extern object]
[43.2] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, \text{asType<int>}(\text{\$heap_init.a3}))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$
 \rightarrow [simplify]
[43.6] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178)$
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] $(\text{asType<integer>}(\text{\$heap_funcstart_724,1.p3}) \% \text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [simplify]
[47.2] $(\text{\$heap_funcstart_724,1.p3} \% 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [expand definition of operator '.%' in class 'int' at built in declaration]

[47.3] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178), []:
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [simplify]

[47.7] ([0 < -\$heap_funcstart_724,1.p3]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[47.7.0] -2 < (0 + 0)

→ [simplify]

[47.7.2] true

[47.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [simplify]

[47.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178), [!(0
 < -\$heap_funcstart_724,1.p3): asType<integer>(\$heap_funcstart_724,1.p3) %
 178) == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p3, 178).rem)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[47.11.0] -2 < (0 + 0)

\rightarrow [simplify]
 [47.11.2] **true**
 [47.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178)$,
 [!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
 \rightarrow [simplify]
 [47.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem} + (\$heap_funcstart_724,1.p3 \% 178))$
 [Assume known post-assertion, class invariant or type constraint for term
 47.17]
 [54.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem}$
 \rightarrow [simplify]
 [54.3] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem}$
 [Take goal term]
 [1.0] $\text{minof}(\text{int}) \leq \text{asType}\langle \text{short int} \rangle (\text{div3}.\text{rem})$
 \rightarrow [simplify]
 [1.1] $-32768 \leq \text{asType}\langle \text{short int} \rangle (\text{div3}.\text{rem})$
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178)$]
 [1.2] $-32768 \leq \text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})$
 \rightarrow [simplify]
 [1.5] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem}$
 \rightarrow [from term 54.3, literal $a < \text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem}$ is true whenever $(-1 + \text{literal } a) < -32769$]
Proof of rule precondition:
 [1.5.0] $(-32769 + -1) < -32769$
 \rightarrow [simplify]
 [1.5.2] **true**
 [1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit

conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)

Condition defined at:

To prove: $\text{asType}\langle\text{short int}\rangle(\text{div3.rem}) \leq \text{maxof}(\text{int})$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$

$\text{\$heap}_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$

$\text{\$heap}_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$

$\text{\$heap}_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

$\text{\$heap}_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$

$\text{\$heap}_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$

$\text{\$heap}_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$

$\text{\$heap}_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$

$\text{\$heap}_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$

$\text{\$heap}_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$

$\text{invariant1}(\text{heapIs } \text{\$heap}_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$

$\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.p1),$

$\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.a1))$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.p1)) /$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1.quot})$

$(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.p1)) \%$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1.rem})$

$(\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.p1) <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.a1)) =>$
 $(\text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.p1) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1.rem}))$


```

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==

```

```

asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] ((((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}<\text{integer}>(\$heap_funcstart_724,1.M3))$

→ [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}<\text{integer}>(\$heap_init.M3))$

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}<\text{integer}>(\text{asType}<\text{short int}>((\text{int})30323)))$

→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \$heap_funcstart_724,1.p3$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}<\text{int}>(\$heap_funcstart_724,1.p3), \text{asType}<\text{int}>(\$heap_funcstart_724,1.a3))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, \text{asType}<\text{int}>(\$heap_funcstart_724,1.a3))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, \text{asType}<\text{int}>(\$heap_init.a3))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] (**asType**<**integer**>(\$heap_funcstart_724,1.p3) %
asType<**integer**>(178)) == **asType**<**integer**>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)

→ [simplify]

[47.2] (\$heap_funcstart_724,1.p3 % 178) == **asType**<**integer**>(div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)

→ [expand definition of operator '.%' in class 'int' at built in declaration]

[47.3] ([**asType**<**integer**>(\$heap_funcstart_724,1.p3) < 0]:
–(–**asType**<**integer**>(\$heap_funcstart_724,1.p3) % 178), []:
asType<**integer**>(\$heap_funcstart_724,1.p3) % 178) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] ([**asType**<**integer**>(\$heap_funcstart_724,1.p3) < 0]:
–(–**asType**<**integer**>(\$heap_funcstart_724,1.p3) % 178),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p3) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p3) % 178) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [simplify]

[47.7] ([0 < –\$heap_funcstart_724,1.p3]:
–(–**asType**<**integer**>(\$heap_funcstart_724,1.p3) % 178),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p3) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p3) % 178) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [from term 10.0, literal a < –\$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literal a)]

Proof of rule precondition:

[47.7.0] -2 < (0 + 0)

→ [simplify]

[47.7.2] **true**

[47.8] ([**false**]: –(–**asType**<**integer**>(\$heap_funcstart_724,1.p3) % 178),
[!(**asType**<**integer**>(\$heap_funcstart_724,1.p3) < 0)]:
asType<**integer**>(\$heap_funcstart_724,1.p3) % 178) ==
asType<**integer**>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [simplify]

[47.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3} \% 178))$, [!($0 < -\text{\$heap_funcstart_724,1.p3}$)]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3} \% 178) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$)
 \rightarrow [from term 10.0, *literal* $0 < -\text{\$heap_funcstart_724,1.p3}$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[47.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[47.11.2] **true**

[47.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3} \% 178))$, [!false]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3} \% 178) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$)

\rightarrow [simplify]

[47.17] $0 == (-\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem} + (\text{\$heap_funcstart_724,1.p3} \% 178))$

[Assume known post-assertion, class invariant or type constraint for term 47.17]

[55.0] $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem} \leq \text{maxof}(\text{int})$

\rightarrow [simplify]

[55.9] $-32768 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem}$

[Take goal term]

[1.0] $\text{asType}\langle \text{short int} \rangle(\text{div3}.\text{rem}) \leq \text{maxof}(\text{int})$

\rightarrow [from term 43.6, *div3* is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178)$]

[1.1] $\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem}) \leq \text{maxof}(\text{int})$

\rightarrow [simplify]

[1.11] $-32768 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem}$

\rightarrow [from term 55.9, *literal* $0 < -\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{rem}$ is true whenever $(-1 + \text{literal}) < -32768$]

Proof of rule precondition:

[1.11.0] $(-32768 + -1) < -32768$

$\rightarrow [simplify]$
 $[1.11.2] \text{ true}$
 $[1.12] \text{ true}$

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,10)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap}_{724,1;747,8}.\text{r3}$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$
 $\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$
 $\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$
 $\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$
 $\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$
 $\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$
 $\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$
 $\text{\$heap}_{init}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$
 $\text{\$heap}_{init}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$
 $\text{\$heap}_{init}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$
 $\text{\$heap}_{init}.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$
 $\text{\$heap}_{init}.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$
 $\text{\$heap}_{init}.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$
 $\text{\$heap}_{init}.\text{p1} == \text{asType}<\text{short int}>((\text{int})1)$
 $\text{\$heap}_{init}.\text{p2} == \text{asType}<\text{short int}>((\text{int})2)$
 $\text{\$heap}_{init}.\text{p3} == \text{asType}<\text{short int}>((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$\text{heap}_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$\text{heap}_{funcstart_724,1},$
 $\text{asType}<\text{int}>(\$ \text{heap}_{funcstart_724,1}.\text{p1}),$
 $\text{asType}<\text{int}>(\$ \text{heap}_{funcstart_724,1}.\text{a1}))$
 $(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$ \text{heap}_{funcstart_724,1}.\text{p1})) /$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$ \text{heap}_{funcstart_724,1}.\text{a1}))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{quot})$
 $(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$ \text{heap}_{funcstart_724,1}.\text{p1})) \%$

```

asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>

```



```

(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

```

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

```

→ [simplify]

```

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

```

→ [const static or extern object]

```

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))

```

→ [expand definition of constant 'a1' at prang.c (16,20)]

```

[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,

```

$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$
[Take given term]
[27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{simplify}]$
[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{const static or extern object}]$
[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType}\langle\text{int}\rangle(\$ \text{heap_init.a2}))$
 $\rightarrow [\text{expand definition of constant 'a2' at prang.c (21,20)}]$
[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})176)))$
 $\rightarrow [\text{simplify}]$
[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
[Take given term]
[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) *$
 $\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177)]$
[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{simplify}]$
[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{const static or extern object}]$
[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$

$\text{int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType} < \text{int} > (\$ \text{heap_init.r1})) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot})) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 \rightarrow [expand definition of constant 'r1' at prang.c (15,20)]

$[59.5] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int})171))) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot})) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 \rightarrow [simplify]

$[59.8] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div1.quot})) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

$[59.9] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 \rightarrow [simplify]

$[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 \rightarrow [const static or extern object]

$[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType} < \text{int} > (\$ \text{heap_init.b1}))))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

$[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int})2))))$
 \rightarrow [simplify]

$[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))))$

[63.0] \$heap_{724,1;747,8} == \\$heap_{724,1;745,8}.replace(p1 \rightarrow asType<short int>((asType<int>(asType<short int>(div2.rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

\(\rightarrow\) [from term 59.19, \$heap_{724,1;745,8}\$ is equal to
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]$

[63.1] \$heap_{724,1;747,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short int>((asType<int>(asType<short int>(div2.rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

\(\rightarrow\) [from term 27.6, div2 is equal to div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]

[63.2] \$heap_{724,1;747,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short int>((asType<int>(asType<short int>(div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

\(\rightarrow\) [simplify]

[63.4] \$heap_{724,1;747,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short int>(((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

\(\rightarrow\) [from term 59.19, \$heap_{724,1;745,8}\$ is equal to
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]$

[63.5] \$heap_{724,1;747,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short int>(((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
asType<int>(\$heap_{funcstart_724,1}.**replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))**.r2**)) -
asType<int>(**asType<short int>**(div2.quot)) *
asType<int>(\$heap_{724,1;745,8}.b2))))
→ [const member of object with modified fields]

[63.6] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem)))**.replace**(p2 → **asType<short int>**((div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *
asType<int>(\$heap_{funcstart_724,1}.r2)) - (**asType<int>**(**asType<short**
int>(div2.quot)) * **asType<int>**(\$heap_{724,1;745,8}.b2))))
→ [const static or extern object]

[63.7] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem)))**.replace**(p2 → **asType<short int>**((div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *
asType<int>(\$heap_{init}.r2)) - (**asType<int>**(**asType<short**
int>(div2.quot)) * **asType<int>**(\$heap_{724,1;745,8}.b2))))
→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem)))**.replace**(p2 → **asType<short int>**((div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *
asType<int>(**asType<short int>**((**int**)172))) -
(**asType<int>**(**asType<short int>**(div2.quot)) *
asType<int>(\$heap_{724,1;745,8}.b2))))
→ [simplify]

[63.11] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem)))**.replace**(p2 → **asType<short int>**((div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * 172) -
(**asType<int>**(**asType<short int>**(div2.quot)) *
asType<int>(\$heap_{724,1;745,8}.b2))))
→ [from term 27.6, div2 is equal to div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176)]

```
[63.12] $heap_{724,1;747,8} == $heap_{funcstart\_724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1}.p2, 176).quot)) * asType<int>($heap_{724,1;745,8}.b2))))
→ [simplify]
```

→ [from term 59.19, $\$heap_{724.1;745.8}$ is equal to

```
[63.15] $heap_{724,1;747,8} == $heap_{funcstart\_724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem))) .replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).quot *
asType<int>($heap_{funcstart\_724,1}.replace(p1 → ((-2 * div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem))).b2))))
```

```
[63.16] $heap_{724,1;747,8} == $heap_{funcstart\_724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).quot *
asType<int>($heap_{funcstart\_724,1}.b2))))
```

```
[63.17] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
```

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}<\text{int}>(\$heap_{init}.b2))))$
 \rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})35))))))$
 \rightarrow [simplify]
[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))))$
[Take goal term]
[1.0] $\text{minof}(\text{int}) \leq \$heap_{724,1;747,8}.r3$
 \rightarrow [simplify]
[1.1] $-32768 \leq \$heap_{724,1;747,8}.r3$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))))$
[1.2] $-32768 \leq \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))))).r3$
 \rightarrow [const member of object with modified fields]
[1.4] $-32768 \leq \$heap_{funcstart_724,1}.r3$
 \rightarrow [const static or extern object]
[1.5] $-32768 \leq \$heap_{init}.r3$
 \rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[1.6] $-32768 \leq \text{asType}<\text{short int}>((\text{int})170)$

→ [simplify]
 [1.9] true

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,10)

Condition defined at:

To prove: \$heap_{724,1;747,8}.r3 ≤ maxof(int)

Given:

\$heap_{init}.LIMIT == (int)80
 \$heap_{init}.M1 == asType<short int>((int)30269)
 \$heap_{init}.r1 == asType<short int>((int)171)
 \$heap_{init}.a1 == asType<short int>((int)177)
 \$heap_{init}.b1 == asType<short int>((int)2)
 \$heap_{init}.M2 == asType<short int>((int)30307)
 \$heap_{init}.r2 == asType<short int>((int)172)
 \$heap_{init}.a2 == asType<short int>((int)176)
 \$heap_{init}.b2 == asType<short int>((int)35)
 \$heap_{init}.M3 == asType<short int>((int)30323)
 \$heap_{init}.r3 == asType<short int>((int)170)
 \$heap_{init}.a3 == asType<short int>((int)178)
 \$heap_{init}.b3 == asType<short int>((int)63)
 \$heap_{init}.p1 == asType<short int>((int)1)
 \$heap_{init}.p2 == asType<short int>((int)2)
 \$heap_{init}.p3 == asType<short int>((int)3)
 invariant1(heapIs \$heap_{funcstart_724,1})
 div1 == div(heapIs \$heap_{funcstart_724,1},
 asType<int>(\$heap_{funcstart_724,1}.p1),
 asType<int>(\$heap_{funcstart_724,1}.a1))
 (asType<integer>(asType<int>(\$heap_{funcstart_724,1}.p1)) /
 asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a1))) ==
 asType<integer>(div1.quot)
 (asType<integer>(asType<int>(\$heap_{funcstart_724,1}.p1)) %
 asType<integer>(asType<int>(\$heap_{funcstart_724,1}.a1))) ==
 asType<integer>(div1.rem)


```

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

```

```

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$
[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow *[simplify]*

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow *[const static or extern object]*

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$
 \rightarrow *[expand definition of constant 'a2' at prang.c (21,20)]*

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 \rightarrow *[simplify]*

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$
 \rightarrow *[from term 11.6, div1 is equal to div(heapIs heap_funcstart_724,1, heap_funcstart_724,1.p1, 177)]*

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$
 \rightarrow *[simplify]*

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$
 \rightarrow *[const static or extern object]*

[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_init.r1}) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [from term 11.6, div1 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle \text{short$

$$\text{int} > ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div2}.\text{rem})) * \\ \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r2})) - (\text{asType} < \text{int} > (\text{asType} < \text{short} \\ \text{int} > (\text{div2}.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b2}))))$$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\ \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\ \$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$

$$[63.1] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short} \\ \text{int} > ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div2}.\text{rem})) * \\ \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r2})) - (\text{asType} < \text{int} > (\text{asType} < \text{short} \\ \text{int} > (\text{div2}.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b2}))))$$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\ \$heap_{funcstart_724,1}.p2, 176)]$

$$[63.2] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short} \\ \text{int} > ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\ \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r2})) - \\ (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div2}.\text{quot})) * \\ \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b2}))))$$

\rightarrow [simplify]

$$[63.4] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \\ \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r2})) - (\text{asType} < \text{int} > (\text{asType} < \text{short} \\ \text{int} > (\text{div2}.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b2}))))$$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\ \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\ \$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$

$$[63.5] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \\ \text{asType} < \text{int} > (\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \\$$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) .r2)) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) .replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(\$heap_{funcstart_724,1}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) .replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(\$heap_{init}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) .replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(asType<short int>((int)172))) -$
 $(asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) .replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * 172) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, div2 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]

[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → **asType**<short int>((172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) - (div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) * **asType**<int>(**asType**<short int>((int)35))))))

→ [simplify]

[63.24] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))))

[Take goal term]

[1.0] \$heap724,1;747,8.r3 ≤ **maxof**(int)

→ [from term 63.24, \$heap724,1;747,8 is equal to
\$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → (-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem)))]

[1.1] \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).r3 ≤ **maxof**(int)

→ [const member of object with modified fields]

[1.3] \$heapfuncstart_724,1.r3 ≤ **maxof**(int)

→ [const static or extern object]

[1.4] \$heapinit.r3 ≤ **maxof**(int)

→ [expand definition of constant 'r3' at prang.c (25,20)]

[1.5] **asType**<short int>((int)170) ≤ **maxof**(int)

→ [simplify]

[1.9] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,13)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.r3))$

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)
$heap_init.r3 == asType<short int>((int)170)
$heap_init.a3 == asType<short int>((int)178)
$heap_init.b3 == asType<short int>((int)63)
$heap_init.p1 == asType<short int>((int)1)
$heap_init.p2 == asType<short int>((int)2)
$heap_init.p3 == asType<short int>((int)3)
invariant1(heapIs $heap_funcstart_724,1)
div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
```

```

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==

```

```

asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] ((((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] ((((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&

```

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_funcstart_724,1.M3))$

→ [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle \mathbf{integer} \rangle(\$heap_init.M3))$

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle \mathbf{integer} \rangle(\mathbf{asType}\langle \mathbf{short} \mathbf{int} \rangle((\mathbf{int})30323)))$

→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \$heap_funcstart_724,1.p3$

[Take given term]

[11.0] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_funcstart_724,1.p1), \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_funcstart_724,1.a1))$

→ [simplify]

[11.1] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_funcstart_724,1.a1))$

→ [const static or extern object]

[11.2] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_init.a1))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{asType}\langle \mathbf{short} \mathbf{int} \rangle((\mathbf{int})177)))$

→ [simplify]

[11.6] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) \%$
 $\text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p3}, 178).\text{rem})$

→ [simplify]

[47.2] $(\$ \text{heap_funcstart_724,1.p3} \% 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p3}, 178).\text{rem})$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)$
 \rightarrow [expand definition of operator `'.%'` in class `'int'` at built in declaration]
[47.3] (`[asType<integer>($heap_{funcstart_724,1}.p3) < 0]:`
`-(-asType<integer>($heap_{funcstart_724,1}.p3) % 178), []:`
`asType<integer>($heap_{funcstart_724,1}.p3) % 178) ==`
`asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p3,`
`178).rem)`
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] (`[asType<integer>($heap_{funcstart_724,1}.p3) < 0]:`
`-(-asType<integer>($heap_{funcstart_724,1}.p3) % 178),`
`[!(asType<integer>($heap_{funcstart_724,1}.p3) < 0)]:`
`asType<integer>($heap_{funcstart_724,1}.p3) % 178) ==`
`asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p3,`
`178).rem)`
 \rightarrow [simplify]
[47.7] (`[0 < - $heap_{funcstart_724,1}.p3]:`
`-(-asType<integer>($heap_{funcstart_724,1}.p3) % 178),`
`[!(asType<integer>($heap_{funcstart_724,1}.p3) < 0)]:`
`asType<integer>($heap_{funcstart_724,1}.p3) % 178) ==`
`asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p3,`
`178).rem)`
 \rightarrow [from term 10.0, `literal < - $heap_{funcstart_724,1}.p3` is false whenever `-2 < (0 + literal)`]
Proof of rule precondition:
[47.7.0] `-2 < (0 + 0)`
 \rightarrow [simplify]
[47.7.2] **true**
[47.8] (`[false]: -(-asType<integer>($heap_{funcstart_724,1}.p3) % 178),`
`[!(asType<integer>($heap_{funcstart_724,1}.p3) < 0)]:`
`asType<integer>($heap_{funcstart_724,1}.p3) % 178) ==`
`asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p3,`
`178).rem)`
 \rightarrow [simplify]
[47.11] (`[false]: -(-asType<integer>($heap_{funcstart_724,1}.p3) % 178), [!(0`
`< - $heap_{funcstart_724,1}.p3)]: asType<integer>($heap_{funcstart_724,1}.p3) %`
`178) == asType<integer>(div(heapIs $heap_{funcstart_724,1},`
`$heap_{funcstart_724,1}.p3, 178).rem)`
 \rightarrow [from term 10.0, `literal < - $heap_{funcstart_724,1}.p3` is false whenever `-2 < (0 + literal)`]

Proof of rule precondition:

[47.11.0] $-2 < (0 + 0)$

→ [simplify]

[47.11.2] **true**

[47.12] ([false]: $-(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) \% 178)$,
[!false]: $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$

→ [simplify]

[47.17] $0 == (-\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem} + (\$heap_funcstart_724,1.p3 \% 178))$

[Take given term]

[59.0] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177)$]

[59.1] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$

→ [simplify]

[59.3] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$

→ [const static or extern object]

[59.4] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_init.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) -$
 $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.b1))))$

→ [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}1.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\$heap_{funcstart_724,1} \cdot b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\$heap_{init} \cdot b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int}2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}2.rem)) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8} \cdot r2)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8} \cdot b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle(\text{div2}.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$]

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_funcstart_724,1.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [const static or extern object]

[63.7] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_init.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.11] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>(\$heap724,1;745,8.b2))))

→ [from term 27.6, div2 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176)]

[63.12] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.14] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot)) * asType<int>(\$heap724,1;745,8.b2))))

```
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem) - (div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot *
asType<int>($heap_724,1;745,8.b2))))))
```

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow (-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{quot}) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{rem}))]$

```
[63.15] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).quot *
asType<int>($heap_{funcstart-724,1}.replace(p1 → ((-2 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).rem))).b2))))
```

→ [const member of object with modified fields]

```
[63.16] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).quot *
asType<int>($heap_{funcstart-724,1}.b2))))
```

→ [const static or extern object]

```
[63.17] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).quot *
asType<int>($heap_{init}.b2))))
```

→ [expand definition of constant 'b2' at prang.c (22,20)]

```
[63.18] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p1, 177).\text{rem}))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle\mathbf{short\ int}\rangle((172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p2, 176).\text{rem}) - (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p2, 176).\text{quot} *
```

$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}35))))$
 $\rightarrow [\text{simplify}]$
 $[63.24] \text{\$heap}_{724,1;747,8} == \text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p2, 176).\text{rem}))))$
 $[\text{Take goal term}]$
 $[1.0] \text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;747,8}.\text{r3}))$
 $\rightarrow [\text{simplify}]$
 $[1.1] -32768 \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;747,8}.\text{r3}))$
 $\rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p3, 178)]$
 $[1.2] -32768 \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p3, 178).\text{rem})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;747,8}.\text{r3}))$
 $\rightarrow [\text{simplify}]$
 $[1.4] -32768 \leq (\text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p3, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;747,8}.\text{r3}))$
 $\rightarrow [\text{from term 63.24, } \text{\$heap}_{724,1;747,8} \text{ is equal to } \text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p2, 176).\text{rem}))))$
 $[1.5] -32768 \leq (\text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p3, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p2, 176).\text{rem})))).\text{r3}))$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[1.7] -32768 \leq (\text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p3, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{funcstart_724,1}.\text{r3}))$
 $\rightarrow [\text{const static or extern object}]$

[1.8] $-32768 \leq (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem * \mathbf{asType}<\mathbf{int}>(\$heap_{init}.r3))$
 \rightarrow [expand definition of constant 'r3' at prang.c (25,20)]

[1.9] $-32768 \leq (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem * \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short \ int}>((\mathbf{int})170)))$
 \rightarrow [simplify]

[1.14] $-32769 < (170 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem)$
 \rightarrow [literal comparison of product]

[1.15] $(([170 < 0]: (-32769 / -170) < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem, [0 < 170]: (-32769 / 170) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem, [0 == 170]: -32769 < 0))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[1.16] $(([170 < 0]: (-32769 / -170) < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem, [(0 < 170) \wedge !(170 < 0)]: (-32769 / 170) < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem, [(0 == 170) \wedge !(0 < 170) \wedge !(170 < 0)]: -32769 < 0))$
 \rightarrow [simplify]

[1.24] $-193 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem$
 \rightarrow [negate goal and search for contradiction]

[1.25] $!(-193 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem)$
 \rightarrow [simplify]

[1.27] $192 < -\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p3, 178).rem$
[Create new term from terms 1.27, 47.17 using rule: transitivity 15]

[87.0] $(0 + 192) < -(\$heap_{funcstart_724,1}.p3 \% 178)$
 \rightarrow [simplify]

[87.2] **false**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,13)

Condition defined at:

To prove: $(\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short \ int}>(\text{div}3.rem)) * \mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.r3)) \leq \mathbf{maxof}(\mathbf{int})$

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)
$heap_init.r3 == asType<short int>((int)170)
$heap_init.a3 == asType<short int>((int)178)
$heap_init.b3 == asType<short int>((int)63)
$heap_init.p1 == asType<short int>((int)1)
$heap_init.p2 == asType<short int>((int)2)
$heap_init.p3 == asType<short int>((int)3)
invariant1(heapIs $heap_funcstart_724,1)
div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p3),
asType<int>($heapfuncstart_724,1.a3))

(asType<integer>(asType<int>($heapfuncstart_724,1.p3)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p3)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heapfuncstart_724,1.p3) <
asType<integer>($heapfuncstart_724,1.a3)) =>
(asType<integer>($heapfuncstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heapfuncstart_724,1.a3) ≤
asType<integer>($heapfuncstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heapfuncstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heapfuncstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heapfuncstart_724,1.b1))))

```



```

–asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) – (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
–asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <

```

asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))

```

→ [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$

→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \$heap_funcstart_724,1.p3$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p1), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_init.a1))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p2), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a2))$

\rightarrow [simplify]
 [27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow [const static or extern object]
 [27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 \rightarrow [simplify]
 [27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Take given term]
 [43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}), \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$
 \rightarrow [simplify]
 [43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$
 \rightarrow [const static or extern object]
 [43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$
 \rightarrow [simplify]
 [43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
 [Take given term]
 [59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]
 [59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))$
 \rightarrow [simplify]
[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [const static or extern object]
[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [simplify]
[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$]
[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [simplify]
[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [const static or extern object]
[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] \$heap724,1;745,8 == \$heapfuncstart_724,1.**replace**(p1 → **asType**<**short int**>((171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) - (div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot * **asType**<**int**>(**asType**<**short int**>((int)2))))))

→ [simplify]

[59.19] \$heap724,1;745,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)))

[Take given term]

[63.0] \$heap724,1;747,8 == \$heap724,1;745,8.**replace**(p2 → **asType**<**short int**>((**asType**<**int**>(**asType**<**short int**>(div2.rem)) * **asType**<**int**>(\$heap724,1;745,8.r2)) - (**asType**<**int**>(**asType**<**short int**>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to

\$heapfuncstart_724,1.**replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)))]

[63.1] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**replace**(p2 → **asType**<**short int**>((**asType**<**int**>(**asType**<**short int**>(div2.rem)) * **asType**<**int**>(\$heap724,1;745,8.r2)) - (**asType**<**int**>(**asType**<**short int**>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

→ [from term 27.6, div2 is equal to div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176)]

[63.2] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**replace**(p2 → **asType**<**short int**>((**asType**<**int**>(**asType**<**short int**>(div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem)) * **asType**<**int**>(\$heap724,1;745,8.r2)) - (**asType**<**int**>(**asType**<**short int**>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.4] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**replace**(p2 → **asType**<**short int**>((div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) * **asType**<**int**>(\$heap724,1;745,8.r2)) - (**asType**<**int**>(**asType**<**short int**>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

$$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})172))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.b2))))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[63.17]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short\ int}>((172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{init}.b2))))$
 $\rightarrow [expand\ definition\ of\ constant\ 'b2'\ at\ prang.c\ (22,20)]$
 $[63.18]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short\ int}>((172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})35))))$
 $\rightarrow [simplify]$
 $[63.24]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow ((-35 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))$
 $[Take\ goal\ term]$
 $[1.0]\ (\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>(div3.rem)) *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.r3)) \leq \mathbf{maxof}(\mathbf{int})$
 $\rightarrow [from\ term\ 43.6,\ div3\ is\ equal\ to\ div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178)]$
 $[1.1]\ (\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>(div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem)) * \mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.r3)) \leq$
 $\mathbf{maxof}(\mathbf{int})$
 $\rightarrow [simplify]$
 $[1.3]\ (div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.r3)) \leq \mathbf{maxof}(\mathbf{int})$
 $\rightarrow [from\ term\ 63.24,\ \$heap_{724,1;747,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$

$\$heap_funcstart_724,1.p1, 177).rem)))$.replace($p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$)

[1.4] ($\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * \text{asType}<\text{int}>(\$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.r3)) $\leq \text{maxof}(\text{int})$)

→ [const member of object with modified fields]

[1.6] ($\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * \text{asType}<\text{int}>(\$heap_funcstart_724,1.r3)) \leq \text{maxof}(\text{int})$)

→ [const static or extern object]

[1.7] ($\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * \text{asType}<\text{int}>(\$heap_init.r3)) \leq \text{maxof}(\text{int})$)

→ [expand definition of constant 'r3' at prang.c (25,20)]

[1.8] ($\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})170))) \leq \text{maxof}(\text{int})$)

→ [simplify]

[1.21] $-32768 < (-170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)$

→ [literal comparison of product]

[1.22] ($[-170 < 0]: (-32768 / 170) < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem, [0 < -170]: (-32768 / -170) < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem, [-170 == 0]: -32768 < 0$)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.23] ($[-170 < 0]: (-32768 / 170) < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem, [(0 < -170) \wedge !(-170 < 0)]: (-32768 / -170) < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem, [(-170 == 0) \wedge !(-170 < 0) \wedge !(0 < -170)]: -32768 < 0$)

→ [simplify]

[1.27] $-193 < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem$

→ [negate goal and search for contradiction]

[1.28] $!(-193 < -\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)$

\rightarrow [simplify]
 [1.31] $192 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}$
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [47.0] $(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% \text{asType}\langle\text{integer}\rangle(178)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [simplify]
 [47.2] $(\$ \text{heap_funcstart_724,1.p3} \% 178) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [expand definition of operator '.*' in class 'int' at built in declaration]
 [47.3] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\neg \text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178), []:$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [47.4] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\neg \text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [simplify]
 [47.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\neg \text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})$
 \rightarrow [from term 10.0, literal $a < -\$ \text{heap_funcstart_724,1.p3}$ is false whenever $-2 < (0 + \text{literal } a)$]

Proof of rule precondition:

[47.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[47.7.2] **true**

[47.8] $([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178) ==$

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)

→ [simplify]

[47.11] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) \% 178)$, [$!(0 < -\$heap_funcstart_724,1.p3)$]: **asType<integer>**($\$heap_funcstart_724,1.p3 \% 178$) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)

→ [from term 10.0, literal $a < -\$heap_funcstart_724,1.p3$ is false whenever $-2 < (0 + literal)$]

Proof of rule precondition:

[47.11.0] $-2 < (0 + 0)$

→ [simplify]

[47.11.2] **true**

[47.12] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) \% 178)$, [**!false**]: **asType<integer>**($\$heap_funcstart_724,1.p3 \% 178$) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)

→ [simplify]

[47.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem + (\$heap_funcstart_724,1.p3 \% 178))$

→ [remainder is less than divisor]

Proof of rule precondition:

[47.17.0] $(178 + \neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) \leq 0$

→ [simplify]

[47.17.11] $177 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem$

→ [from term 1.31, literal $a < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem$ is true whenever $(-1 + literal) < 192$]

Proof of rule precondition:

[47.17.11.0] $(-1 + 177) < 192$

→ [simplify]

[47.17.11.2] **true**

[47.17.12] **true**

[47.18] **false**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq \text{div3.quot}$

Given:

```
$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
```

```

asType<integer>(div1.rem))
(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

```

```

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <

```

asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]

[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <

```


$\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [simplify]
[5.30] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 \rightarrow [const static or extern object]
[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] $0 < \$heap_funcstart_724,1.p3$
[Take given term]
[43.0] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p3), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a3))$
 \rightarrow [simplify]
[43.1] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a3))$
 \rightarrow [const static or extern object]
[43.2] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, \text{asType}\langle\text{int}\rangle(\$heap_init.a3))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] $\text{div3} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})178)))$
 \rightarrow [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
[Assume known post-assertion, class invariant or type constraint for term 43.6]

[46.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / \text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow *[simplify]*

[46.2] $(\$ \text{heap_funcstart_724,1.p3} / 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow *[expand definition of operator './' in class 'int' at built in declaration]*

[46.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow *[explicitly assert falsehood of skipped guards in subsequent guards]*

[46.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $[\text{!(asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow *[simplify]*

[46.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $[\text{!(asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow *[from term 10.0, literal $a < -\$ \text{heap_funcstart_724,1.p3}$ is false whenever $-2 < (0 + \text{literal } a)$]*

Proof of rule precondition:

[46.7.0] $-2 < (0 + 0)$

\rightarrow *[simplify]*

[46.7.2] **true**

[46.8] $([\text{false}]: -(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $[\text{!(asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

\rightarrow [simplify]
 [46.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178)$, [!(0 < $\neg \$heap_funcstart_724,1.p3$)]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178$)
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot})$
 \rightarrow [from term 10.0, literal $a < \neg \$heap_funcstart_724,1.p3$ is false whenever $-2 < (0 + \text{literal})$]
Proof of rule precondition:
 [46.11.0] $-2 < (0 + 0)$
 \rightarrow [simplify]
 [46.11.2] **true**
 [46.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178)$, [!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178$) $==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot})$
 \rightarrow [simplify]
 [46.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot} + (\$heap_funcstart_724,1.p3 / 178))$
 [Assume known post-assertion, class invariant or type constraint for term 46.17]
 [52.0] $\text{minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}$
 \rightarrow [simplify]
 [52.3] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}$
 [Take goal term]
 [1.0] $\text{minof}(\text{short int}) \leq \text{div3}.\text{quot}$
 \rightarrow [simplify]
 [1.1] $-32768 \leq \text{div3}.\text{quot}$
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)$]
 [1.2] $-32768 \leq \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}$
 \rightarrow [simplify]
 [1.4] $-32769 < \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}$

\rightarrow [from term 52.3, $\text{literal}_a < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$ is true whenever $(-1 + \text{literal}_a) < -32769$]

Proof of rule precondition:

[1.4.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.4.2] **true**

[1.5] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)

Condition defined at:

To prove: $\text{div3.quot} \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$\text{heap_funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\text{asType}<\text{int}>(\$heap_funcstart_724,1.p1),$

$\text{asType}<\text{int}>(\$heap_funcstart_724,1.a1))$

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(**heapIs** \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <

```

asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <

```

$\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.M3}))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] $((((-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge$
 $(0 < \text{\$heap_funcstart_724,1.p2})) \ \&\& (\text{\$heap_funcstart_724,1.p2} <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \ \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.M3}))$
 \rightarrow [simplify]
[5.30] $(((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType}\langle\text{integer}\rangle(\text{\$heap_funcstart_724,1.M3}))$
 \rightarrow [const static or extern object]
[5.31] $(((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType}\langle\text{integer}\rangle(\text{\$heap_init.M3}))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] $(((-30307 < -\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 <$
 $-\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p2}) \wedge (0 < \text{\$heap_funcstart_724,1.p3})) \ \&\&$
 $(\text{\$heap_funcstart_724,1.p3} < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 \rightarrow [simplify]
[5.40] $(-30323 < -\text{\$heap_funcstart_724,1.p3}) \wedge (-30307 <$
 $-\text{\$heap_funcstart_724,1.p2}) \wedge (-30269 < -\text{\$heap_funcstart_724,1.p1}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p1}) \wedge (0 < \text{\$heap_funcstart_724,1.p2}) \wedge (0 <$
 $\text{\$heap_funcstart_724,1.p3})$
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] $0 < \text{\$heap_funcstart_724,1.p3}$
[Take given term]
[43.0] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\text{\$heap_funcstart_724,1.p3}),$
 $\text{asType}\langle\text{int}\rangle(\text{\$heap_funcstart_724,1.a3}))$
 \rightarrow [simplify]
[43.1] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$

`asType<int>($heap_funcstart_724,1.a3))`
 → [const static or extern object]
 [43.2] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,`
`asType<int>($heap_init.a3))`
 → [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,`
`asType<int>(asType<short int>((int)178)))`
 → [simplify]
 [43.6] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178)`
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [46.0] `(asType<integer>($heap_funcstart_724,1.p3) /`
`asType<integer>(178)) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot)`
 → [simplify]
 [46.2] `($heap_funcstart_724,1.p3 / 178) == asType<integer>(div(heapIs`
`$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot)`
 → [expand definition of operator './' in class 'int' at built in declaration]
 [46.3] `([asType<integer>($heap_funcstart_724,1.p3) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p3) / 178), []:`
`asType<integer>($heap_funcstart_724,1.p3) / 178) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,`
`178).quot)`
 → [explicitly assert falsehood of skipped guards in subsequent guards]
 [46.4] `([asType<integer>($heap_funcstart_724,1.p3) < 0]:`
`-(asType<integer>($heap_funcstart_724,1.p3) / 178),`
`[!(asType<integer>($heap_funcstart_724,1.p3) < 0]):`
`asType<integer>($heap_funcstart_724,1.p3) / 178) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,`
`178).quot)`
 → [simplify]
 [46.7] `([0 < -$heap_funcstart_724,1.p3]:`
`-(asType<integer>($heap_funcstart_724,1.p3) / 178),`
`[!(asType<integer>($heap_funcstart_724,1.p3) < 0]):`
`asType<integer>($heap_funcstart_724,1.p3) / 178) ==`
`asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,`
`178).quot)`
 → [from term 10.0, literal `a < -$heap_funcstart_724,1.p3` is false whenever `-2 < (0 + literal)`]

Proof of rule precondition:

[46.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[46.7.2] **true**

[46.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) / 178)$,
 $[(\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) < 0)]$:
 $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).\text{quot})$

\rightarrow [simplify]

[46.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) / 178)$, $[(0 <$
 $\neg \$heap_{funcstart_724,1} \cdot p3)]$: $\text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) / 178)$
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1} \cdot p3, 178).\text{quot})$

\rightarrow [from term 10.0, literal $a < -\$heap_{funcstart_724,1} \cdot p3$ is false whenever $-2 <$
 $(0 + \text{literal})$]

Proof of rule precondition:

[46.11.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[46.11.2] **true**

[46.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) / 178)$,
 $[!false]: \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1} \cdot p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).\text{quot})$

\rightarrow [simplify]

[46.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).\text{quot} + (\$heap_{funcstart_724,1} \cdot p3 / 178))$

[Assume known post-assertion, class invariant or type constraint for term
 46.17]

[53.0] $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).\text{quot} \leq$
maxof(int)

\rightarrow [simplify]

[53.9] $-32768 < \neg \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3,$
 $178).\text{quot}$

[Take goal term]

[1.0] $\text{div3}.\text{quot} \leq \text{maxof}(\text{short int})$

\rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p3, 178]$

$[1.1] \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} \leq \mathbf{maxof}(\mathbf{short\ int})$

$\rightarrow [simplify]$

$[1.10] -32768 < -\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}$

$\rightarrow [from\ term\ 53.9, literal_a < -\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}\ is\ true\ whenever\ (-1 + literal_a) < -32768]$

Proof of rule precondition:

$[1.10.0] (-32768 + -1) < -32768$

$\rightarrow [simplify]$

$[1.10.2] \mathbf{true}$

$[1.11] \mathbf{true}$

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)

Condition defined at:

To prove: $\mathbf{minof}(\mathbf{int}) \leq \mathbf{asType}<\mathbf{short\ int}>(\mathbf{div3}.\text{quot})$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$

$\$heap_{init}.M1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})30269)$

$\$heap_{init}.r1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})171)$

$\$heap_{init}.a1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})177)$

$\$heap_{init}.b1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})2)$

$\$heap_{init}.M2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})30307)$

$\$heap_{init}.r2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})172)$

$\$heap_{init}.a2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})176)$

$\$heap_{init}.b2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})35)$

$\$heap_{init}.M3 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})30323)$

$\$heap_{init}.r3 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})170)$

$\$heap_{init}.a3 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})178)$

$\$heap_{init}.b3 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})63)$

$\$heap_{init}.p1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})1)$

```

$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

```

```

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap_724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap_724,1;745,8.M1) <
asType<integer>($heap_724,1;745,8.p1)

!(0 == asType<integer>($heap_724,1;745,8.p1))

asType<integer>($heap_724,1;745,8.p1) <
asType<integer>($heap_724,1;745,8.M1)

$heap_724,1;747,8 == $heap_724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap_724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap_724,1;745,8.b2))))

-asType<integer const>($heap_724,1;747,8.M2) <
asType<integer>($heap_724,1;747,8.p2)

!(0 == asType<integer>($heap_724,1;747,8.p2))

asType<integer>($heap_724,1;747,8.p2) <
asType<integer>($heap_724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```
[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
```

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$
 $[5.40] (-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
 $[\text{Work on sub-term 6 of conjunction in term 5.40}]$
 $[10.0] 0 < \$heap_funcstart_724,1.p3$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[46.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) /$
 $\text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [simplify]

[46.2] $(\$ \text{heap_funcstart_724,1.p3} / 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[46.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $[(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0)]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{quot})$

→ [simplify]

[46.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$

$[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot})$
 $\rightarrow [from \text{ term } 10.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p3 \text{ is false whenever } -2 <$
 $(0 + \text{ literal } a)]$

Proof of rule precondition:

$[46.7.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[46.7.2] \text{ true}$

$[46.8] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot})$
 $\rightarrow [simplify]$
 $[46.11] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178), [!(0 <$
 $-\$heap_{funcstart_724,1}.p3)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot})$

$\rightarrow [from \text{ term } 10.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p3 \text{ is false whenever } -2 <$
 $(0 + \text{ literal } a)]$

Proof of rule precondition:

$[46.11.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[46.11.2] \text{ true}$

$[46.12] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot})$
 $\rightarrow [simplify]$

$[46.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot} + (\$heap_{funcstart_724,1}.p3 / 178))$

$[Assume \text{ known post-assertion, class invariant or type constraint for term } 46.17]$

$[52.0] \text{ minof}(\text{int}) \leq \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot}$
 $\rightarrow [simplify]$

[52.3] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq \text{asType}<\text{short int}>(\text{div3.quot})$

\rightarrow [simplify]

[1.1] $-32768 \leq \text{asType}<\text{short int}>(\text{div3.quot})$

\rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$]

[1.2] $-32768 \leq \text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

\rightarrow [simplify]

[1.5] $-32769 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$

\rightarrow [from term 52.3, $\text{literal} < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$ is true whenever $(-1 + \text{literal}) < -32769$]

Proof of rule precondition:

[1.5.0] $(-32769 + -1) < -32769$

\rightarrow [simplify]

[1.5.2] **true**

[1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)

Condition defined at:

To prove: $\text{asType}<\text{short int}>(\text{div3.quot}) \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <

```

```

asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[5.1] (((((0 < asType<integer>($heap_funcstart_724,1.p1)) &&
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [simplify]

```

[5.3] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_funcstart_724,1.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [const static or extern object]

```

[5.4] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))

```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```

[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>(asType<short
int>((int)30323)))

```

\rightarrow [simplify]
 [5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$
 [Work on sub-term 6 of conjunction in term 5.40]
 [10.0] $0 < \$heap_{funcstart_724,1}.p3$
 [Take given term]
 [43.0] $div3 == div(heapIs \$heap_{funcstart_724,1}, asType<int>(\$heap_{funcstart_724,1}.p3), asType<int>(\$heap_{funcstart_724,1}.a3))$
 \rightarrow [simplify]
 [43.1] $div3 == div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, asType<int>(\$heap_{funcstart_724,1}.a3))$
 \rightarrow [const static or extern object]
 [43.2] $div3 == div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, asType<int>(\$heap_{init}.a3))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] $div3 == div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, asType<int>(asType<short int>((int)178)))$
 \rightarrow [simplify]
 [43.6] $div3 == div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)$
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [46.0] $(asType<integer>(\$heap_{funcstart_724,1}.p3) / asType<integer>(178)) == asType<integer>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot)$
 \rightarrow [simplify]
 [46.2] $(\$heap_{funcstart_724,1}.p3 / 178) == asType<integer>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot)$
 \rightarrow [expand definition of operator './' in class 'int' at built in declaration]
 [46.3] $([asType<integer>(\$heap_{funcstart_724,1}.p3) < 0]: -(-asType<integer>(\$heap_{funcstart_724,1}.p3) / 178), []: asType<integer>(\$heap_{funcstart_724,1}.p3) / 178) == asType<integer>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [46.4] $([asType<integer>(\$heap_{funcstart_724,1}.p3) < 0]:$

$\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[46.7] ([0 < -\$heap_funcstart_724,1.p3]:$
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
 $\rightarrow [\text{from term } 10.0, \text{literal } a < -\$heap_funcstart_724,1.p3 \text{ is false whenever } -2 <$
 $(0 + \text{literal } a)]$

Proof of rule precondition:

$[46.7.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[46.7.2] \text{ true}$

$[46.8] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) < 0)]:$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
 $\rightarrow [\text{simplify}]$
 $[46.11] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178), [\neg(0 <$
 $-\$heap_funcstart_724,1.p3)]: \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178)$
 $== \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{quot})$
 $\rightarrow [\text{from term } 10.0, \text{literal } a < -\$heap_funcstart_724,1.p3 \text{ is false whenever } -2 <$
 $(0 + \text{literal } a)]$

Proof of rule precondition:

$[46.11.0] -2 < (0 + 0)$

$\rightarrow [\text{simplify}]$

$[46.11.2] \text{ true}$

$[46.12] ([\text{false}]: \neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178),$
 $[\neg(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$

\rightarrow [simplify]
 [46.17] $0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} + (\$ \text{heap_funcstart_724,1.p3} / 178))$
 [Assume known post-assertion, class invariant or type constraint for term 46.17]
 [53.0] $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} \leq \text{maxof}(\text{int})$
 \rightarrow [simplify]
 [53.9] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$
 [Take goal term]
 [1.0] **asType<short int>**(div3.quot) \leq **maxof(int)**
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$]
 [1.1] **asType<short int>**($\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$) \leq **maxof(int)**
 \rightarrow [simplify]
 [1.11] $-32768 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$
 \rightarrow [from term 53.9, $\text{literal} < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$ is true whenever $(-1 + \text{literal}) < -32768$]
Proof of rule precondition:
 [1.11.0] $(-32768 + -1) < -32768$
 \rightarrow [simplify]
 [1.11.2] **true**
 [1.12] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,35)

Condition defined at:

To prove: **minof(int)** \leq $\$ \text{heap}_{724,1;747,8.b3}$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType<short int>}((\text{int})30269)$

```

$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

```

```

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

→ [simplify]

[11.6] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)

[Take given term]

[27.0] div2 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p2),
asType<int>(\$heap_funcstart_724,1.a2))

→ [simplify]

[27.1] div2 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_funcstart_724,1.a2))

→ [const static or extern object]

[27.2] div2 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_init.a2))

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) *$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short}$
 $\text{int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})))$

→ [const static or extern object]

[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_init.r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\text{asType<short int>}((\text{int})171))) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})))$

→ [simplify]

[59.8] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1})))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1}.p1, 177]$
 $[59.9] \ \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.11] \ \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.12] \ \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$
 $[59.13] \ \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$
 $\rightarrow [\text{simplify}]$
 $[59.19] \ \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))$
 $[Take \ given \ term]$
 $[63.0] \ \$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to}$
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))]$
 $[63.1] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

`int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))`
 \rightarrow [from term 27.6, `div2` is equal to `div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176)`]
`[63.2] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)) * asType<int>($heap724,1;745,8.r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap724,1;745,8.b2))))
 \rightarrow [simplify]
[63.4] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
 \rightarrow [from term 59.19, $heap724,1;745,8 is equal to
$heapfuncstart_724,1._replace(p1 \rightarrow (-2 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).rem)))]
[63.5] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem *
asType<int>($heapfuncstart_724,1._replace(p1 \rightarrow ((-2 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap724,1;745,8.b2))))
 \rightarrow [const member of object with modified fields]
[63.6] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem *
asType<int>($heapfuncstart_724,1.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
 \rightarrow [const static or extern object]`

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [simplify]

[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))$

[63.15] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) * \text{asType}<\text{int}>(\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).b2))))))$

→ [const member of object with modified fields]

[63.16] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) * \text{asType}<\text{int}>(\$heap_funcstart_724,1.b2))))))$

→ [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) * \text{asType}<\text{int}>(\$heap_{init}.b2))))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})35))))))$

→ [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1,$

$\$heap_{funcstart_724,1}.p2, 176).rem)))$
[Take goal term]
 $[1.0] \text{ minof}(\text{int}) \leq \$heap_{724,1;747,8}.b3$
 \rightarrow *[simplify]*
 $[1.1] -32768 \leq \$heap_{724,1;747,8}.b3$
 \rightarrow *[from term 63.24, $\$heap_{724,1;747,8}$ is equal to*
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))]$
 $[1.2] -32768 \leq \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))).b3$
 \rightarrow *[const member of object with modified fields]*
 $[1.4] -32768 \leq \$heap_{funcstart_724,1}.b3$
 \rightarrow *[const static or extern object]*
 $[1.5] -32768 \leq \$heap_{init}.b3$
 \rightarrow *[expand definition of constant 'b3' at prang.c (27,20)]*
 $[1.6] -32768 \leq \text{asType}<\text{short int}>((\text{int})63)$
 \rightarrow *[simplify]*
 $[1.9] \text{ true}$

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,35)

Condition defined at:

To prove: $\$heap_{724,1;747,8}.b3 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

```

$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *

```

```

asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

```

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

```

→ [simplify]

```

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

```

→ [const static or extern object]

```

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))

```

→ [expand definition of constant 'a1' at prang.c (16,20)]

```

[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

```

→ [simplify]

```

[11.6] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)

```

[Take given term]

```

[27.0] div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

```

→ [simplify]

```

[27.1] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))

```

→ [const static or extern object]

```

[27.2] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_init.a2))

```

→ [expand definition of constant 'a2' at prang.c (21,20)]

```

[27.3] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))

```

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [const static or extern object]

[59.4] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [simplify]

[59.8] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.9] $\$ \text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

$$- (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$$

$$\rightarrow [\text{simplify}]$$

$$[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))$$

$$\rightarrow [\text{const static or extern object}]$$

$$[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.b1}))))$$

$$\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$$

$$[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))))$$

$$\rightarrow [\text{simplify}]$$

$$[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))))$$

$$[\text{Take given term}]$$

$$[63.0] \$\text{heap}_{724,1;747,8} == \$\text{heap}_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$$

$$\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to } \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))]$$

$$[63.1] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$$

$$\rightarrow [\text{from term 27.6, div2 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)]$$

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$

$$177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

→ [expand definition of constant 'r2' at prang.c (20,20)]

$$[63.8] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

→ [simplify]

$$[63.11] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

→ [from term 27.6, div2 is equal to div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)]

$$[63.12] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

→ [simplify]

$$[63.14] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).quot) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

→ [from term 59.19, \$heap_{724,1;745,8} is equal to \$heap_funcstart_724,1.replace(p1 → (-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]

[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle \mathbf{short\ int} \rangle((172 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot b2))))))$

→ [const member of object with modified fields]

[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle \mathbf{short\ int} \rangle((172 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{funcstart_724,1} \cdot b2))))))$

→ [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle \mathbf{short\ int} \rangle((172 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{init} \cdot b2))))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle \mathbf{short\ int} \rangle((172 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})35))))))$

→ [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \mathbf{replace}(p2 \rightarrow ((-35 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))))$

[Take goal term]

[1.0] $\$heap_{724,1;747,8}.b3 \leq \mathbf{maxof(int)}$
→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{quot}) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{rem})))\mathbf{replace}(p2 \rightarrow (-35 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{quot}) + (172 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{rem}))]$
[1.1] $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{quot}) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{rem})))\mathbf{replace}(p2 \rightarrow ((-35 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{quot}) + (172 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{rem})))\mathbf{.b3} \leq \mathbf{maxof(int)}$
→ [const member of object with modified fields]
[1.3] $\$heap_{funcstart_724,1}.b3 \leq \mathbf{maxof(int)}$
→ [const static or extern object]
[1.4] $\$heap_{init}.b3 \leq \mathbf{maxof(int)}$
→ [expand definition of constant 'b3' at prang.c (27,20)]
[1.5] $\mathbf{asType<short int>}((\mathbf{int})63) \leq \mathbf{maxof(int)}$
→ [simplify]
[1.9] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,38)

Condition defined at:

To prove: $\mathbf{minof(int)} \leq (\mathbf{asType<int>}(\mathbf{asType<short int>}(\mathbf{div3.quot})) * \mathbf{asType<int>}(\$heap_{724,1;747,8}.b3))$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType<short int>}((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType<short int>}((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType<short int>}((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType<short int>}((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType<short int>}((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType<short int>}((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType<short int>}((\mathbf{int})176)$

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

```

!(0 == asType<integer>(\$heap_{724,1;747,8}.p2))

asType<integer>(\$heap_{724,1;747,8}.p2) <

asType<integer>(\$heap_{724,1;747,8}.M2)

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$
 $\rightarrow [\text{simplify}]$

[5.40] $(-30323 < -\$heap_{funcstart_724,1}.p3) \wedge (-30307 < -\$heap_{funcstart_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p1) \wedge (0 < \$heap_{funcstart_724,1}.p2) \wedge (0 < \$heap_{funcstart_724,1}.p3)$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \$heap_{funcstart_724,1}.p3$

[Take given term]

[11.0] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.p1), \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a1))$

→ [simplify]

[11.1] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a1))$

→ [const static or extern object]

[11.2] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \mathbf{asType}<\mathbf{int}>(\$heap_{init}.a1))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})177)))$

→ [simplify]

[11.6] $div1 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$

[Take given term]

[27.0] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.p2), \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a2))$

→ [simplify]

[27.1] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, \mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.a2))$

→ [const static or extern object]

[27.2] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, \mathbf{asType}<\mathbf{int}>(\$heap_{init}.a2))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, \mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})176)))$

→ [simplify]

[27.6] $div2 == div(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[46.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) /$
 $\text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [simplify]

[46.2] $(\$ \text{heap_funcstart_724,1.p3} / 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[46.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $!([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $178).\text{quot})$

→ [simplify]

[46.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$

$[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot})$
 $\rightarrow [from \text{ term } 10.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p3 \text{ is false whenever } -2 <$
 $(0 + \text{ literal } a)]$

Proof of rule precondition:

$[46.7.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[46.7.2] \text{ true}$

$[46.8] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178),$
 $[!(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) < 0)]:$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot})$
 $\rightarrow [simplify]$
 $[46.11] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178), [!(0 <$
 $-\$heap_{funcstart_724,1}.p3)]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178)$
 $== \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot})$

$\rightarrow [from \text{ term } 10.0, \text{ literal } a < -\$heap_{funcstart_724,1}.p3 \text{ is false whenever } -2 <$
 $(0 + \text{ literal } a)]$

Proof of rule precondition:

$[46.11.0] -2 < (0 + 0)$

$\rightarrow [simplify]$

$[46.11.2] \text{ true}$

$[46.12] ([\text{false}]: -(\neg \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178),$
 $[\text{false}]: \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p3) / 178) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot})$
 $\rightarrow [simplify]$
 $[46.17] 0 == (-\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{quot} + (\$heap_{funcstart_724,1}.p3 / 178))$
 $[Take \text{ given term}]$

$[59.0] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short}$
 $\text{int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{rem})) *$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short}$
 $\text{int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$

→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]

[59.1] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)) * asType<int>(\$heap_funcstart_724,1.r1)) -
(asType<int>(asType<short int>(div1.quot))) *
asType<int>(\$heap_funcstart_724,1.b1))))

→ [simplify]

[59.3] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(\$heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot))) * asType<int>(\$heap_funcstart_724,1.b1))))

→ [const static or extern object]

[59.4] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(\$heap_init.r1)) - (asType<int>(asType<short
int>(div1.quot))) * asType<int>(\$heap_funcstart_724,1.b1))))

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot))) *
asType<int>(\$heap_funcstart_724,1.b1))))

→ [simplify]

[59.8] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot))) *
asType<int>(\$heap_funcstart_724,1.b1))))

→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]

[59.9] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot))) *
asType<int>(\$heap_funcstart_724,1.b1))))

→ [simplify]

[59.11] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
int>((171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot *
asType<int>(\$heap_funcstart_724,1.b1))))

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)]$

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

→ [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

→ [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \\
\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})172))) - \\
(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \\
\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \\
\rightarrow [\text{simplify}]$

$[63.11] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * 172) - \\
(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \\
\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \\
\rightarrow [\text{from term 27.6, div2 is equal to div(heapIs } \$heap_{funcstart_724,1}, \\
\$heap_{funcstart_724,1}.p2, 176)]$

$[63.12] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - \\
(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\
\$heap_{funcstart_724,1}.p2, 176).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \\
\rightarrow [\text{simplify}]$

$[63.14] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \\
\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \\
\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to} \\
\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\
\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \\
\$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$

$[63.15] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \\
\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \\
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).b2))))$

→ [const member of object with modified fields]

```
[63.16] $heap724,1;747,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem) - (div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot *
asType<int>($heapfuncstart_724,1.b2))))
```

→ [const static or extern object]

```
[63.17] $heap724,1;747,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem) - (div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot *
asType<int>($heapinit.b2))))
```

→ [expand definition of constant 'b2' at prang.c (22,20)]

```
[63.18] $heap724,1;747,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem) - (div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot *
asType<int>(asType<short int>((int)35))))))
```

→ [simplify]

```
[63.24] $heap724,1;747,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem))))
```

[Take goal term]

```
[1.0] minof(int) ≤ (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))
```

→ [simplify]

```
[1.1] -32768 ≤ (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))
```

→ [from term 43.6, div3 is equal to div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p3, 178)]

```
[1.2] -32768 ≤ (asType<int>(asType<short int>(div(heapIs
```

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))$
 \rightarrow [simplify]
[1.4] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))]$
[1.5] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).b3))$
 \rightarrow [const member of object with modified fields]
[1.7] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.b3))$
 \rightarrow [const static or extern object]
[1.8] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\$heap_{init}.b3))$
 \rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[1.9] $-32768 \leq (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})63)))$
 \rightarrow [simplify]
[1.14] $-32769 < (63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot)$
 \rightarrow [literal comparison of product]
[1.15] $[(63 < 0): (-32769 / -63) < -\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot, [0 < 63]: (-32769 / 63) < \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot, [0 == 63]: -32769 < 0)$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[1.16] $[(63 < 0): (-32769 / -63) < -\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot, [(0 < 63) \wedge !(63 < 0)]: (-32769 / 63) < \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot, [(0 == 63) \wedge !(0 < 63) \wedge !(63 < 0)]: -32769 < 0)$

\rightarrow [simplify]
 [1.24] $-521 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p3, 178).\text{quot}$
 \rightarrow [negate goal and search for contradiction]
 [1.25] $\neg(-521 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p3, 178).\text{quot})$
 \rightarrow [simplify]
 [1.27] $520 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p3, 178).\text{quot}$
 [Create new term from terms 1.27, 46.17 using rule: transitivity 15]
 [85.0] $(0 + 520) < -(\$ \text{heap_funcstart_724,1} \cdot p3 / 178)$
 \rightarrow [simplify]
 [85.7] $92560 < -\$ \text{heap_funcstart_724,1} \cdot p3$
 \rightarrow [from term 10.0, literal $a < -\$ \text{heap_funcstart_724,1} \cdot p3$ is false whenever $-2 < (0 + \text{literal})$]
Proof of rule precondition:
 [85.7.0] $-2 < (0 + 92560)$
 \rightarrow [simplify]
 [85.7.2] **true**
 [85.8] **false**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,38)

Condition defined at:

To prove: $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div3}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;747,8}.b3)) \leq \text{maxof}(\text{int})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$
 $\$ \text{heap}_{init}.\text{M1} == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$
 $\$ \text{heap}_{init}.\text{r1} == \text{asType}\langle \text{short int} \rangle((\text{int})171)$
 $\$ \text{heap}_{init}.\text{a1} == \text{asType}\langle \text{short int} \rangle((\text{int})177)$
 $\$ \text{heap}_{init}.\text{b1} == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$ \text{heap}_{init}.\text{M2} == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$

```

$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

```

```

–asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_init.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge$
 $(0 < \$heap_funcstart_724,1.p2)) \&\& (\$heap_funcstart_724,1.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{simplify}]$
 $[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_funcstart_724,1.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$
 $\rightarrow [\text{expand definition of constant 'M3' at prang.c (24,20)}]$
 $[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short}$

int>((**int**)30323)))
 → [simplify]
 [5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)
 → [separate conjunction and work on first sub-term]
 [5.41] -30323 < -\$heap_funcstart_724,1.p3
 [Work on sub-term 6 of conjunction in term 5.40]
 [10.0] 0 < \$heap_funcstart_724,1.p3
 [Take given term]
 [11.0] div1 == div(**heapIs** \$heap_funcstart_724,1, **asType**<**int**>(\$heap_funcstart_724,1.p1), **asType**<**int**>(\$heap_funcstart_724,1.a1))
 → [simplify]
 [11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, **asType**<**int**>(\$heap_funcstart_724,1.a1))
 → [const static or extern object]
 [11.2] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, **asType**<**int**>(\$heap_init.a1))
 → [expand definition of constant 'a1' at prang.c (16,20)]
 [11.3] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, **asType**<**int**>(asType<**short int**>((**int**)177)))
 → [simplify]
 [11.6] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)
 [Take given term]
 [27.0] div2 == div(**heapIs** \$heap_funcstart_724,1, **asType**<**int**>(\$heap_funcstart_724,1.p2), **asType**<**int**>(\$heap_funcstart_724,1.a2))
 → [simplify]
 [27.1] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, **asType**<**int**>(\$heap_funcstart_724,1.a2))
 → [const static or extern object]
 [27.2] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, **asType**<**int**>(\$heap_init.a2))
 → [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))`
→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
[Take given term]

[43.0] `div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))`
→ [simplify]

[43.1] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_funcstart_724,1.a3))`
→ [const static or extern object]

[43.2] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_init.a3))`
→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>(asType<short int>((int)178)))`
→ [simplify]

[43.6] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178)`
[Assume known post-assertion, class invariant or type constraint for term 43.6]

[46.0] `(asType<integer>($heap_funcstart_724,1.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot)`
→ [simplify]

[46.2] `($heap_funcstart_724,1.p3 / 178) == asType<integer>(div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot)`
→ [expand definition of operator './' in class 'int' at built in declaration]

[46.3] `([asType<integer>($heap_funcstart_724,1.p3) < 0]:
-(asType<integer>($heap_funcstart_724,1.p3) / 178), []:
asType<integer>($heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
178).quot)`
→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] `([asType<integer>($heap_funcstart_724,1.p3) < 0]:
-(asType<integer>($heap_funcstart_724,1.p3) / 178),
[!(asType<integer>($heap_funcstart_724,1.p3) < 0]):
asType<integer>($heap_funcstart_724,1.p3) / 178) ==`

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [simplify]

[46.7] ([0 < -\$heap_funcstart_724,1.p3]:
-(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178),
[!(**asType<integer>**(\$heap_funcstart_724,1.p3) < 0]):
asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literal a)]

Proof of rule precondition:

[46.7.0] -2 < (0 + 0)

→ [simplify]

[46.7.2] **true**

[46.8] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178),
[!(**asType<integer>**(\$heap_funcstart_724,1.p3) < 0]):
asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [simplify]

[46.11] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178), [(0 <
-\$heap_funcstart_724,1.p3)]: **asType<integer>**(\$heap_funcstart_724,1.p3) / 178)
== **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).quot)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literal a)]

Proof of rule precondition:

[46.11.0] -2 < (0 + 0)

→ [simplify]

[46.11.2] **true**

[46.12] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178),
[**false**]: **asType<integer>**(\$heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [simplify]

[46.17] 0 == (-div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot + (\$heap_funcstart_724,1.p3 / 178))

[Take given term]

[59.0] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$]

[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [simplify]

[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [const static or extern object]

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$

177).rem))).**.replace**(p2 → **asType**<short
int>((**asType**<int>(**asType**<short int>(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))) * **asType**<int>(\$heap724,1;745,8.r2)) -
(**asType**<int>(**asType**<short int>(div2.quot))) *
asType<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.4] \$heap724,1;747,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → **asType**<short int>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap724,1;745,8.r2)) - (**asType**<int>(**asType**<short
int>(div2.quot)) * **asType**<int>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to
\$heap_funcstart_724,1.**.replace**(p1 → (-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))]

[63.5] \$heap724,1;747,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → **asType**<short int>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).r2)) -
(**asType**<int>(**asType**<short int>(div2.quot))) *
asType<int>(\$heap724,1;745,8.b2))))

→ [const member of object with modified fields]

[63.6] \$heap724,1;747,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → **asType**<short int>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_funcstart_724,1.r2)) - (**asType**<int>(**asType**<short
int>(div2.quot)) * **asType**<int>(\$heap724,1;745,8.b2))))

→ [const static or extern object]

[63.7] \$heap724,1;747,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → **asType**<short int>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_init.r2)) - (**asType**<int>(**asType**<short
int>(div2.quot)) * **asType**<int>(\$heap724,1;745,8.b2))))

$\text{int} > (\text{div} 2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int})172)))) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div} 2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [simplify]
[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * 172) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div} 2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [from term 27.6, $\text{div} 2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]$
[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [simplify]
[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))]$
[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).b2))))))$

→ [const member of object with modified fields]

$[63.16] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1} \cdot b2))))))$

→ [const static or extern object]

$[63.17] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init} \cdot b2))))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

$[63.18] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int}35))))))$

→ [simplify]

$[63.24] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))$

[Take goal term]

$[1.0] (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div3}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;747,8}.b3)) \leq \text{maxof}(\text{int})$

→ [from term 43.6, $\text{div}3$ is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$]

[1.1] $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap724,1;747,8.b3})) \leq \text{maxof}(\text{int})$

→ [simplify]

[1.3] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap724,1;747,8.b3})) \leq \text{maxof}(\text{int})$

→ [from term 63.24, $\$ \text{heap724,1;747,8}$ is equal to $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))$]

[1.4] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{b3})) \leq \text{maxof}(\text{int})$

→ [const member of object with modified fields]

[1.6] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b3})) \leq \text{maxof}(\text{int})$

→ [const static or extern object]

[1.7] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.b3})) \leq \text{maxof}(\text{int})$

→ [expand definition of constant 'b3' at prang.c (27,20)]

[1.8] $(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})63))) \leq \text{maxof}(\text{int})$

→ [simplify]

[1.21] $-32768 < (-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [literal comparison of product]

[1.22] $([-63 < 0]: (-32768 / 63) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [0 < -63]: (-32768 / -63) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [-63 == 0]: -32768 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.23] $([-63 < 0]: (-32768 / 63) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [(0 < -63) \wedge !(-63 < 0)]: (-32768 / -63) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [(-63 == 0) \wedge !(-63 < 0) \wedge !(0 < -63)]: -32768 < 0)$

→ [simplify]

[1.27] $-521 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$

→ [negate goal and search for contradiction]

[1.28] $!(-521 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [simplify]

[1.31] $520 < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$

[Create new term from terms 1.31, 46.17 using rule: transitivity 16]

[85.0] $(0 + 520) < (\text{heap_funcstart_724,1.p3} / 178)$

→ [simplify]

[85.8] $92737 < \$\text{heap_funcstart_724,1.p3}$

→ [from term 5.41, literal $a < \$\text{heap_funcstart_724,1.p3}$ is false whenever $-2 < (-30323 + \text{literal})$]

Proof of rule precondition:

[85.8.0] $-2 < (-30323 + 92737)$

→ [simplify]

[85.8.2] **true**

[85.9] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,33)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq ((\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.rem})) * \text{asType}<\text{int}>(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$ \text{heap}_{724,1;747,8}.\text{b3})))$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\$ \text{heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==

```



```

asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

```

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [expand definition of constant 'M2' at prang.c (19,20)]

```
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
```

→ [simplify]

```
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
```

→ [const static or extern object]

```
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_init.M3))
```

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$

→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

→ [separate conjunction and work on first sub-term]

[5.41] $-30323 < -\$heap_funcstart_724,1.p3$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \$heap_funcstart_724,1.p3$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p1), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_init.a1))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p2), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a2))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a2))$

→ [const static or extern object]

[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_init.a2))`
→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))`
→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
[Take given term]

[43.0] `div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))`
→ [simplify]

[43.1] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_funcstart_724,1.a3))`
→ [const static or extern object]

[43.2] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_init.a3))`
→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>(asType<short int>((int)178)))`
→ [simplify]

[43.6] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178)`
[Assume known post-assertion, class invariant or type constraint for term 43.6]

[46.0] `(asType<integer>($heap_funcstart_724,1.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot)`
→ [simplify]

[46.2] `($heap_funcstart_724,1.p3 / 178) == asType<integer>(div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot)`
→ [expand definition of operator './' in class 'int' at built in declaration]

[46.3] `([asType<integer>($heap_funcstart_724,1.p3) < 0]:
-(asType<integer>($heap_funcstart_724,1.p3) / 178), []:
asType<integer>($heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
178).quot)`
→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) / 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).quot)

→ [simplify]

[46.7] ([0 < -\$heap_funcstart_724,1.p3]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) / 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).quot)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[46.7.0] -2 < (0 + 0)

→ [simplify]

[46.7.2] true

[46.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) / 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).quot)

→ [simplify]

[46.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) / 178), [!(0 < -\$heap_funcstart_724,1.p3)]: asType<integer>(\$heap_funcstart_724,1.p3) / 178)
 == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p3, 178).quot)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[46.11.0] -2 < (0 + 0)

→ [simplify]

[46.11.2] true

[46.12] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) / 178),
 [!false]: asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).quot)

\rightarrow [simplify]
 [46.17] $0 == (-\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} + (\$ \text{heap_funcstart_724,1.p3} / 178))$
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [47.0] $(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% \text{asType}\langle\text{integer}\rangle(178)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$
 \rightarrow [simplify]
 [47.2] $(\$ \text{heap_funcstart_724,1.p3} \% 178) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$
 \rightarrow [expand definition of operator '.*' in class 'int' at built in declaration]
 [47.3] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178), []:$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [47.4] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$
 \rightarrow [simplify]
 [47.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]):$
 $\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$
 \rightarrow [from term 10.0, literal $a < -\$ \text{heap_funcstart_724,1.p3}$ is false whenever $-2 < (0 + \text{literal } a)$]

Proof of rule precondition:

[47.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]

[47.7.2] **true**

[47.8] $([\text{false}]: -(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) \% 178),$
 $!([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]):$

asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [simplify]

[47.11] ([false]: $\neg(\neg \text{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178)$, [!(0
< $\neg \$heap_funcstart_724,1.p3$): **asType<integer>**(\$heap_funcstart_724,1.p3) %
178) == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem)

→ [from term 10.0, literal a < $\neg \$heap_funcstart_724,1.p3$ is false whenever $-2 < (0 + literal a)$]

Proof of rule precondition:

[47.11.0] $-2 < (0 + 0)$

→ [simplify]

[47.11.2] **true**

[47.12] ([false]: $\neg(\neg \text{asType<integer>}(\$heap_funcstart_724,1.p3) \% 178)$,
[!false]: **asType<integer>**(\$heap_funcstart_724,1.p3) % 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem)

→ [simplify]

[47.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
178).rem + $(\$heap_funcstart_724,1.p3 \% 178))$

[Take given term]

[59.0] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short**
int>((**asType<int>**(**asType<short int>**(div1.rem)) *
asType<int>(\$heap_funcstart_724,1.r1)) - (**asType<int>**(**asType<short**
int>(div1.quot)) * **asType<int>**(\$heap_funcstart_724,1.b1))))

→ [from term 11.6, div1 is equal to div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]

[59.1] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short**
int>((**asType<int>**(**asType<short int>**(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)) * **asType<int>**(\$heap_funcstart_724,1.r1)) -
(**asType<int>**(**asType<short int>**(div1.quot)) *
asType<int>(\$heap_funcstart_724,1.b1))))

→ [simplify]

[59.3] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(\$heap_funcstart_724,1.r1)) - (**asType<int>**(**asType<short**
int>(div1.quot)) * **asType<int>**(\$heap_funcstart_724,1.b1))))

→ [const static or extern object]

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) *$

$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 \rightarrow [simplify]
[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).b2))))))$
 \rightarrow [const member of object with modified fields]
[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b2))))))$
 \rightarrow [const static or extern object]
[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b2))))))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.b2}))))$
 $\rightarrow [\text{expand definition of constant 'b2' at prang.c (22,20)}]$
 $[63.18] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})35))))))$
 $\rightarrow [\text{simplify}]$
 $[63.24] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))$
 $[Take \text{ goal term}]$
 $[1.0] \text{minof}(\text{short int}) \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))))$
 $\rightarrow [\text{simplify}]$
 $[1.1] -32768 \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))))$
 $\rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)]$
 $[1.2] -32768 \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))))$
 $\rightarrow [\text{simplify}]$
 $[1.4] -32768 \leq ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))))$

→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})))\text{.replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})))]$

[1.5] $-32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})))\text{.replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})))\text{.r3})) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))$

→ [const member of object with modified fields]

[1.7] $-32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))$

→ [const static or extern object]

[1.8] $-32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem} * \text{asType}<\text{int}>(\$heap_{init}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))$

→ [expand definition of constant 'r3' at prang.c (25,20)]

[1.9] $-32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})170))) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))$

→ [simplify]

[1.12] $-32768 \leq ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).\text{rem} * 170) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))$

→ [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178)]$

[1.13] $-32768 \leq ((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))$

→ [simplify]

[1.15] $-32768 \leq ((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_funcstart_724,1.p3, 178).rem) - (div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot * asType<int>(\$heap724,1;747,8.b3)))$
 → [from term 63.24, $\$heap724,1;747,8$ is equal to
 $\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))).\text{replace}(p2 \rightarrow (-35 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]$
 [1.16] $-32768 \leq ((170 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).rem) - (div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot * asType<int>(\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35$
 $* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).b3)))$
 → [const member of object with modified fields]
 [1.18] $-32768 \leq ((170 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).rem) - (div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot * asType<int>(\$heap_funcstart_724,1.b3)))$
 → [const static or extern object]
 [1.19] $-32768 \leq ((170 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).rem) - (div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot * asType<int>(\$heap_init.b3)))$
 → [expand definition of constant 'b3' at prang.c (27,20)]
 [1.20] $-32768 \leq ((170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem) - (div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).quot * asType<int>(asType<short int>((int)63))))$
 → [simplify]
 [1.27] $-32769 < ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem))$
 → [negate goal and search for contradiction]
 [1.28] $!(-32769 < ((-63 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).rem)))$
 → [simplify]
 [1.33] $32768 < ((63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).quot) + (-170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem))$

[Copy term 1.33]

[96.0] $32768 < ((-170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem) + (63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))$

→ [from term 47.17, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem$ is equal to $\$heap_funcstart_724,1.p3 \% 178$]

[96.1] $32768 < ((-170 * (\$heap_funcstart_724,1.p3 \% 178)) + (63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))$

[Create new term from term 46.17 using rule: condition for equality of division]

[147.0] $((178 * (0 + -(-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))) < (1 + \$heap_funcstart_724,1.p3)) \wedge (\$heap_funcstart_724,1.p3 < (178 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))))$

→ [simplify]

[147.15] $(-1 < ((-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + \$heap_funcstart_724,1.p3)) \wedge (-178 < (-\$heap_funcstart_724,1.p3 + (178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)))$

[Work on sub-term 2 of conjunction in term 147.15]

[148.0] $-1 < ((-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + \$heap_funcstart_724,1.p3)$

[Create new term from terms 148.0, 5.41 using rule: transitivity 2]

[204.0] $(-30323 + -1 + 1) < (-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)$

→ [simplify]

[204.1] $-30323 < (-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)$

→ [literal comparison of product]

[204.2] $([-178 < 0]: (-30323 / 178) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot, [0 < -178]: (-30323 / -178) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot, [-178 == 0]: -30323 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[204.3] $([-178 < 0]: (-30323 / 178) < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot, [(0 < -178) \wedge !(-178 < 0)]: (-30323 / -178) < \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot, [(-178 == 0) \wedge !(-178 < 0) \wedge !(0 < -178)]: -30323 < 0)$

→ [simplify]

[204.7] $-171 < -\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3,$

178).quot
[Create new term from terms 204.7, 96.1 using rule: transitivity 5]
[214.0] $32768 < ((-170 * (\$heap_{funcstart_724,1}.p3 \% 178)) + (63 * -(-171 + 1)))$
→ [simplify]
[214.5] $22058 < (-170 * (\$heap_{funcstart_724,1}.p3 \% 178))$
→ [literal comparison of product]
[214.6] $[-170 < 0]: (22058 / 170) < -(\$heap_{funcstart_724,1}.p3 \% 178), [0 < -170]: (22058 / -170) < (\$heap_{funcstart_724,1}.p3 \% 178), [-170 == 0]: 22058 < 0)$
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[214.7] $[-170 < 0]: (22058 / 170) < -(\$heap_{funcstart_724,1}.p3 \% 178), [(0 < -170) \wedge !(-170 < 0)]: (22058 / -170) < (\$heap_{funcstart_724,1}.p3 \% 178), [(-170 == 0) \wedge !(-170 < 0) \wedge !(0 < -170)]: 22058 < 0)$
→ [simplify]
[214.12] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (65,33)

Condition defined at:

To prove: $((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div3.rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div3.quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.b3))) \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle \text{short int} \rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle \text{short int} \rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle \text{short int} \rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle \text{short int} \rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle \text{short int} \rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle \text{short int} \rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle \text{short int} \rangle((\text{int})170)$

```

$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==

```

```

asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1..replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8..replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[5.5] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3)))

→ [simplify]

[5.16] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.17] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(\$heap_init.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[5.18] ((((-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧
(0 < \$heap_funcstart_724,1.p2)) && (\$heap_funcstart_724,1.p2 <
asType<integer>(**asType<short int>**((**int**)30307)))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(**asType<integer>**(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))
→ [simplify]

[5.30] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_funcstart_724,1.M3))
→ [const static or extern object]

[5.31] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(\$heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] ((-30307 < -\$heap_funcstart_724,1.p2) ∧ (-30269 <
-\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p2) ∧ (0 < \$heap_funcstart_724,1.p3)) &&
(\$heap_funcstart_724,1.p3 < **asType<integer>**(**asType<short
int>**((**int**)30323)))
→ [simplify]

[5.40] (-30323 < -\$heap_funcstart_724,1.p3) ∧ (-30307 <
-\$heap_funcstart_724,1.p2) ∧ (-30269 < -\$heap_funcstart_724,1.p1) ∧ (0 <
\$heap_funcstart_724,1.p1) ∧ (0 < \$heap_funcstart_724,1.p2) ∧ (0 <
\$heap_funcstart_724,1.p3)

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \text{\$heap_funcstart_724,1.p3}$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p1}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a1}))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{\$heap_init.a1}))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p1}, 177)$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a2}))$

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{\$heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p2}, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\text{\$heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[46.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / \text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [simplify]

[46.2] $(\$ \text{heap_funcstart_724,1.p3} / 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [expand definition of operator './' in class 'int' at built in declaration]

[46.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $![\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [simplify]

[46.7] $([0 < -\$ \text{heap_funcstart_724,1.p3}]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178),$
 $![\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]]:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$
 $\text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$

→ [from term 10.0, *literal* $a < -\$heap_funcstart_724,1.p3$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[46.7.0] $-2 < (0 + 0)$

→ [simplify]

[46.7.2] **true**

[46.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) / 178)$,
 $[\neg(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) < 0)]$:
 $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) / 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$

→ [simplify]

[46.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) / 178)$, $[\neg(0 < -\$heap_funcstart_724,1.p3)]$: $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) / 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{quot})$

→ [from term 10.0, *literal* $a < -\$heap_funcstart_724,1.p3$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[46.11.0] $-2 < (0 + 0)$

→ [simplify]

[46.11.2] **true**

[46.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) / 178)$,
 $[\text{false}]$: $\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) / 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$

→ [simplify]

[46.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot} + (\$heap_funcstart_724,1.p3 / 178))$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] $(\text{asType}\langle \text{integer} \rangle(\$heap_funcstart_724,1.p3) \% \text{asType}\langle \text{integer} \rangle(178)) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})$

→ [simplify]

[47.2] $(\$heap_funcstart_724,1.p3 \% 178) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})$

→ [expand definition of operator ' $\%$ ' in class 'int' at built in declaration]

[47.3] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178), []:
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [simplify]

[47.7] ([0 < -\$heap_funcstart_724,1.p3]:
 -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[47.7.0] -2 < (0 + 0)

→ [simplify]

[47.7.2] true

[47.8] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178),
 [!(asType<integer>(\$heap_funcstart_724,1.p3) < 0]):
 asType<integer>(\$heap_funcstart_724,1.p3) % 178) ==
 asType<integer>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
 178).rem)

→ [simplify]

[47.11] ([false]: -(-asType<integer>(\$heap_funcstart_724,1.p3) % 178), [!(0
 < -\$heap_funcstart_724,1.p3): asType<integer>(\$heap_funcstart_724,1.p3) %
 178) == asType<integer>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p3, 178).rem)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[47.11.0] -2 < (0 + 0)

\rightarrow [simplify]
 [47.11.2] **true**
 [47.12] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178)$,
 [**!false**]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178$) ==
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem})$
 \rightarrow [simplify]
 [47.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem} + (\$heap_funcstart_724,1.p3 \% 178))$
 [Take given term]
 [56.0] ($\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) <$
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.a3)$) ==>
 $(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div3}.\text{rem}))$
 \rightarrow [simplify]
 [56.1] $(\$heap_funcstart_724,1.p3 < \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.a3))$
 ==> $(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div3}.\text{rem}))$
 \rightarrow [const static or extern object]
 [56.2] $(\$heap_funcstart_724,1.p3 < \text{asType}\langle \text{integer} \rangle (\$heap_init.a3)) ==>$
 $(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div3}.\text{rem}))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
 [56.3] $(\$heap_funcstart_724,1.p3 < \text{asType}\langle \text{integer} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{int})178))) ==> (\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div3}.\text{rem}))$
 \rightarrow [simplify]
 [56.10] $(-178 < -\$heap_funcstart_724,1.p3) ==> (\$heap_funcstart_724,1.p3 ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div3}.\text{rem}))$
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178)$]
 [56.11] $(-178 < -\$heap_funcstart_724,1.p3) ==> (\$heap_funcstart_724,1.p3 ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem}))$
 \rightarrow [simplify]
 [56.17] $(0 == (\neg \$heap_funcstart_724,1.p3 + \text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})) \vee (177 < \$heap_funcstart_724,1.p3)$
 [Take given term]

[59.0] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177)$]

[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [simplify]

[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [const static or extern object]

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.\text{r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.\text{p1}, 177).\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{b1}))))$

\rightarrow [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

\rightarrow [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$

\rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))]$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]$

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) -$
 $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{simplify}]$
 $[63.4] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.5] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[63.6] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{const static or extern object}]$
 $[63.7] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{expand definition of constant 'r2' at prang.c (20,20)}]$

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot *$
asType<int>(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).b2))))
→ [const member of object with modified fields]

[63.16] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.**replace**(p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 \rightarrow \mathbf{asType<short\ int>}((172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot * \mathbf{asType<int>}(\$heap_funcstart_724,1.b2))))$
→ [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.**replace**(p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 \rightarrow \mathbf{asType<short\ int>}((172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot * \mathbf{asType<int>}(\$heap_init.b2))))$
→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.**replace**(p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 \rightarrow \mathbf{asType<short\ int>}((172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot * \mathbf{asType<int>}(\mathbf{asType<short\ int>}((\mathbf{int})35))))))$
→ [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_funcstart_724,1.**replace**(p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))))$
[Take goal term]

[1.0] $((\mathbf{asType<int>}(\mathbf{asType<short\ int>}(\mathbf{div3}.rem)) * \mathbf{asType<int>}(\$heap_{724,1;747,8}.r3)) - (\mathbf{asType<int>}(\mathbf{asType<short\ int>}(\mathbf{div3}.quot)) * \mathbf{asType<int>}(\$heap_{724,1;747,8}.b3))) \leq \mathbf{maxof(short\ int})$
→ [from term 43.6, div3 is equal to div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)]

[1.1] $((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [from term 63.24, $\$ \text{heap}_{724,1;747,8}$ is equal to $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))]$

[1.4] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [const member of object with modified fields]

[1.6] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [const static or extern object]

[1.7] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{\text{init}}.\text{r3})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [expand definition of constant 'r3' at prang.c (25,20)]

[1.8] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})170))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.11] $((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * 170) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))) \leq \text{maxof}(\text{short int})$

→ [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1}.p3, 178)]$

[1.12] $((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))) \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.14] $((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))) \leq \text{maxof}(\text{short int})$

\rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))]$

[1.15] $((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).b3))) \leq \text{maxof}(\text{short int})$

\rightarrow [const member of object with modified fields]

[1.17] $((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.b3))) \leq \text{maxof}(\text{short int})$

\rightarrow [const static or extern object]

[1.18] $((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}<\text{int}>(\$heap_{init}.b3))) \leq \text{maxof}(\text{short int})$

\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]

[1.19] $((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})63)))) \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.38] $-32768 < ((-170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) + (63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}))$

→ [negate goal and search for contradiction]

[1.39] $\neg(-32768 < ((-170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem) + (63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)))$

→ [simplify]

[1.44] $32767 < ((170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem) + (-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))$

[Branch on disjunction or conditional in term 56.17]

[81.0] $(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem)) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))$

[Copy term 1.44]

[82.0] $(32767 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))$

→ [from term 81.0, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem$ is equal to $\$heap_funcstart_724,1.p3$]

[82.1] $(32767 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + (170 * \$heap_funcstart_724,1.p3))) \vee \dots$

[Copy term 47.17]

[83.0] $(0 == (-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem + (\$heap_funcstart_724,1.p3 \% 178))) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))$

→ [from term 81.0, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem$ is equal to $\$heap_funcstart_724,1.p3$]

[83.1] $(0 == (-\$heap_funcstart_724,1.p3 + (\$heap_funcstart_724,1.p3 \% 178))) \vee \dots$

[Assume known post-assertion, class invariant or type constraint for term 83.1]

[88.0] $(\$heap_funcstart_724,1.p3 < 178) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))$

→ [simplify]

[88.3] $(-178 < -\$heap_funcstart_724,1.p3) \vee \dots$

[Copy term 1.44]

[90.0] $32767 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{rem}))$

→ [from term 47.17, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{rem}$ is equal to $\$heap_funcstart_724,1.p3 \% 178$]

[90.1] $32767 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * (\$heap_funcstart_724,1.p3 \% 178)))$

[Copy term 82.1]

[91.0] $(32767 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \$heap_funcstart_724,1.p3))) \vee (177 < \$heap_funcstart_724,1.p3) \vee !(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{rem}))$

→ [from term 46.17, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).\text{quot}$ is equal to $\$heap_funcstart_724,1.p3 / 178$]

[91.1] $(32767 < ((-63 * (\$heap_funcstart_724,1.p3 / 178)) + (170 * \$heap_funcstart_724,1.p3))) \vee \dots$

→ [division by larger divisor]

Proof of rule precondition 1:

[91.1.0.0] $\text{literal}d < -\$heap_funcstart_724,1.p3$

→ [unify with term 88.3]

[91.1.0.1] **true**

Proof of rule precondition 2:

[91.1.1.0] $\text{literal}c < \$heap_funcstart_724,1.p3$

→ [unify with term 10.0]

[91.1.1.1] **true**

Proof of rule precondition 3:

[91.1.2.0] $-178 \leq 178$

→ [simplify]

[91.1.2.2] **true**

Proof of rule precondition 4:

[91.1.3.0] $-2 < 0$

→ [simplify]

[91.1.3.1] **true**

[91.2] $(32767 < ((-63 * \$heap_funcstart_724,1.p3) + (170 * \$heap_funcstart_724,1.p3))) \vee \dots$

\rightarrow [simplify]
 [91.4] $(32767 < (107 * \text{\$heap_funcstart_724,1.p3})) \vee \dots$
 \rightarrow [literal comparison of product]
 [91.5] $([107 < 0]: (32767 / -107) < -\text{\$heap_funcstart_724,1.p3}, [0 < 107]: (32767 / 107) < \text{\$heap_funcstart_724,1.p3}, [0 == 107]: 32767 < 0) \vee \dots$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 [91.6] $([107 < 0]: (32767 / -107) < -\text{\$heap_funcstart_724,1.p3}, [(0 < 107) \wedge !(107 < 0)]: (32767 / 107) < \text{\$heap_funcstart_724,1.p3}, [(0 == 107) \wedge !(0 < 107) \wedge !(107 < 0)]: 32767 < 0) \vee \dots$
 \rightarrow [simplify]
 [91.13] $(\mathbf{true} \wedge (306 < \text{\$heap_funcstart_724,1.p3})) \vee \dots$
 \rightarrow [from term 88.3, $\text{literal}_a < \text{\$heap_funcstart_724,1.p3}$ is false whenever $-2 < (-178 + \text{literal}_a)$]
Proof of rule precondition:
 [91.13.0] $-2 < (-178 + 306)$
 \rightarrow [simplify]
 [91.13.2] **true**
 [91.14] $(\mathbf{true} \wedge \mathbf{false}) \vee \dots$
 \rightarrow [simplify]
 [91.15] **false** $\vee \dots$
 [Remove 'false' term 91.15 and fetch new term from containing clause]
 [92.0] $177 < \text{\$heap_funcstart_724,1.p3}$
 [Create new term from term 46.17 using rule: condition for equality of division]
 [147.0] $((178 * (0 + -(-\text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{quot}))) < (1 + \text{\$heap_funcstart_724,1.p3})) \wedge (\text{\$heap_funcstart_724,1.p3} < (178 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{quot}))))$
 \rightarrow [simplify]
 [147.15] $(-1 < ((-178 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{quot}) + \text{\$heap_funcstart_724,1.p3})) \wedge (-178 < (-\text{\$heap_funcstart_724,1.p3} + (178 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{quot}))))$
 \rightarrow [separate conjunction and work on first sub-term]
 [147.16] $-178 < (-\text{\$heap_funcstart_724,1.p3} + (178 * \text{div}(\mathbf{heapIs} \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3}, 178).\text{quot}))$
 [Create new term from terms 147.16, 92.0 using rule: transitivity 2]

[201.0] $(-178 + 1 + 177) < (178 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot)$
 → [simplify]
 [201.1] $0 < (178 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot)$
 → [product is positive]
 [201.2] $((0 < 178) \wedge (0 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot)) \vee ((178 < 0) \wedge (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot < 0))$
 → [simplify]
 [201.7] $0 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot$
 [Create new term from terms 201.7, 90.1 using rule: transitivity 11]
 [204.0] $(1 + 32767 + (0 * 63)) < (170 * (\$heap_{funcstart_724,1} \cdot p3 \% 178))$
 → [simplify]
 [204.2] $32768 < (170 * (\$heap_{funcstart_724,1} \cdot p3 \% 178))$
 → [literal comparison of product]
 [204.3] $([170 < 0]: (32768 / -170) < -(\$heap_{funcstart_724,1} \cdot p3 \% 178), [0 < 170]: (32768 / 170) < (\$heap_{funcstart_724,1} \cdot p3 \% 178), [0 == 170]: 32768 < 0)$
 → [explicitly assert falsehood of skipped guards in subsequent guards]
 [204.4] $([170 < 0]: (32768 / -170) < -(\$heap_{funcstart_724,1} \cdot p3 \% 178), [(0 < 170) \wedge !(170 < 0)]: (32768 / 170) < (\$heap_{funcstart_724,1} \cdot p3 \% 178), [(0 == 170) \wedge !(0 < 170) \wedge !(170 < 0)]: 32768 < 0)$
 → [simplify]
 [204.13] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (66,31)

To prove: $\mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{724,1;749,8} \cdot p3) < \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_{724,1;749,8} \cdot M3)$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$

$\$heap_{init}.M1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})30269)$

$\$heap_{init}.r1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})171)$

$\$heap_{init}.a1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})177)$

$\$heap_{init}.b1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})2)$

```

$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *

```

```

asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_{funcstart_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_{funcstart_724,1}.p1)) &&
(asType<integer>(\$heap_{funcstart_724,1}.p1) <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3))

→ [simplify]

[5.3] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{funcstart_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p2))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p2) <
asType<integer>(\$heap_{funcstart_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcstart_724,1}.p3))) &&
(asType<integer>(\$heap_{funcstart_724,1}.p3) <
asType<integer>(\$heap_{funcstart_724,1}.M3))

→ [const static or extern object]

[5.4] (((((0 < \$heap_{funcstart_724,1}.p1) && (\$heap_{funcstart_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <


```

asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))

```

→ [const static or extern object]

[5.31] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\$heap_init.M3))$

→ [expand definition of constant 'M3' at prang.c (24,20)]

[5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\& (\$heap_funcstart_724,1.p3 < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)))$

→ [simplify]

[5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)$

[Work on sub-term 6 of conjunction in term 5.40]

[10.0] $0 < \$heap_funcstart_724,1.p3$

[Take given term]

[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p1), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$

→ [simplify]

[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a1))$

→ [const static or extern object]

[11.2] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\$heap_init.a1))$

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$

→ [simplify]

[11.6] $\text{div1} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$heap_funcstart_724,1, \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.p2), \text{asType}\langle\text{int}\rangle(\$heap_funcstart_724,1.a2))$

\rightarrow [simplify]
 [27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a2}))$
 \rightarrow [const static or extern object]
 [27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.a2}))$
 \rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})176)))$
 \rightarrow [simplify]
 [27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Take given term]
 [43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.p3}), \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a3}))$
 \rightarrow [simplify]
 [43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.a3}))$
 \rightarrow [const static or extern object]
 [43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.a3}))$
 \rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})178)))$
 \rightarrow [simplify]
 [43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [46.0] $(\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) / \text{asType}\langle\text{integer}\rangle(178)) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow [simplify]
 [46.2] $(\$ \text{heap_funcstart_724,1.p3} / 178) == \text{asType}\langle\text{integer}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 \rightarrow [expand definition of operator './' in class 'int' at built in declaration]
 [46.3] $([\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) < 0]: -(-\text{asType}\langle\text{integer}\rangle(\$ \text{heap_funcstart_724,1.p3}) / 178), []:$

asType<integer>(\$heap_{funcstart_724,1}.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,
178).quot)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] ([**asType<integer>**(\$heap_{funcstart_724,1}.p3) < 0]:
–(**asType<integer>**(\$heap_{funcstart_724,1}.p3) / 178),
[!(**asType<integer>**(\$heap_{funcstart_724,1}.p3) < 0]):
asType<integer>(\$heap_{funcstart_724,1}.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,
178).quot)

→ [simplify]

[46.7] ([0 < –\$heap_{funcstart_724,1}.p3]:
–(**asType<integer>**(\$heap_{funcstart_724,1}.p3) / 178),
[!(**asType<integer>**(\$heap_{funcstart_724,1}.p3) < 0]):
asType<integer>(\$heap_{funcstart_724,1}.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,
178).quot)

→ [from term 10.0, literal_a < –\$heap_{funcstart_724,1}.p3 is false whenever -2 <
(0 + literal_a)]

Proof of rule precondition:

[46.7.0] -2 < (0 + 0)

→ [simplify]

[46.7.2] **true**

[46.8] ([**false**]: –(**asType<integer>**(\$heap_{funcstart_724,1}.p3) / 178),
[!(**asType<integer>**(\$heap_{funcstart_724,1}.p3) < 0]):
asType<integer>(\$heap_{funcstart_724,1}.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,
178).quot)

→ [simplify]

[46.11] ([**false**]: –(**asType<integer>**(\$heap_{funcstart_724,1}.p3) / 178), [!(0 <
–\$heap_{funcstart_724,1}.p3)]: **asType<integer>**(\$heap_{funcstart_724,1}.p3) / 178)
== **asType<integer>**(div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p3, 178).quot)

→ [from term 10.0, literal_a < –\$heap_{funcstart_724,1}.p3 is false whenever -2 <
(0 + literal_a)]

Proof of rule precondition:

[46.11.0] -2 < (0 + 0)

→ [simplify]

[46.11.2] **true**

[46.12] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) / 178)$),
[!**false**]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) / 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{quot})$

→ [simplify]

[46.17] $0 == (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{quot} + (\text{\$heap_funcstart_724,1.p3} / 178))$

[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] ($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \%$
 $\text{asType}\langle \text{integer} \rangle(178)) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$

→ [simplify]

[47.2] $(\text{\$heap_funcstart_724,1.p3} \% 178) == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$

→ [expand definition of operator ‘.’ in class ‘int’ at built in declaration]

[47.3] ([$\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) < 0$]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$, []:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] ([$\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) < 0$]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$,
[! $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) < 0$]:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [simplify]

[47.7] ([$0 < -\text{\$heap_funcstart_724,1.p3}$]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$,
[! $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) < 0$]:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [from term 10.0, $\text{literal} < -\text{\$heap_funcstart_724,1.p3}$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[47.7.0] $-2 < (0 + 0)$

\rightarrow [simplify]
 [47.7.2] **true**
 [47.8] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$,
 [!($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) < 0$):
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 178).rem)
 \rightarrow [simplify]
 [47.11] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$, [!(0
 $< -\text{\$heap_funcstart_724,1.p3}$): $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \%$
 178) == $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p3}, 178).rem)$
 \rightarrow [from term 10.0, literal $a < -\text{\$heap_funcstart_724,1.p3}$ is false whenever $-2 <$
 $(0 + \text{literal})$]
Proof of rule precondition:
 [47.11.0] $-2 < (0 + 0)$
 \rightarrow [simplify]
 [47.11.2] **true**
 [47.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$,
 [false]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 178).rem)
 \rightarrow [simplify]
 [47.17] $0 == (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 178).rem + $(\text{\$heap_funcstart_724,1.p3} \% 178))$
 [Take given term]
 [56.0] $(\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) <$
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.a3})) ==>$
 $(\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div3.rem}))$
 \rightarrow [simplify]
 [56.1] $(\text{\$heap_funcstart_724,1.p3} < \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.a3}))$
 $=> (\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div3.rem}))$
 \rightarrow [const static or extern object]
 [56.2] $(\text{\$heap_funcstart_724,1.p3} < \text{asType}\langle \text{integer} \rangle(\text{\$heap_init.a3})) ==>$
 $(\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div3.rem}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[56.3] (\$heap_funcstart_724,1.p3 < **asType**<integer>(**asType**<short int>((int)178))) => (**asType**<integer>(\$heap_funcstart_724,1.p3) == **asType**<integer>(div3.rem))

→ [simplify]

[56.10] (-178 < -\$heap_funcstart_724,1.p3) => (\$heap_funcstart_724,1.p3 == **asType**<integer>(div3.rem))

→ [from term 43.6, div3 is equal to div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)]

[56.11] (-178 < -\$heap_funcstart_724,1.p3) => (\$heap_funcstart_724,1.p3 == **asType**<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))

→ [simplify]

[56.17] (0 == (-\$heap_funcstart_724,1.p3 + div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)) ∨ (177 < \$heap_funcstart_724,1.p3)

[Take given term]

[59.0] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((**asType**<int>(**asType**<short int>(div1.rem)) * **asType**<int>(\$heap_funcstart_724,1.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [from term 11.6, div1 is equal to div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)]

[59.1] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((**asType**<int>(**asType**<short int>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) * **asType**<int>(\$heap_funcstart_724,1.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [simplify]

[59.3] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem * **asType**<int>(\$heap_funcstart_724,1.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [const static or extern object]

[59.4] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType**<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem * **asType**<int>(\$heap_init.r1)) - (**asType**<int>(**asType**<short int>(div1.quot)) * **asType**<int>(\$heap_funcstart_724,1.b1))))

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)]$

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$
 $\rightarrow [\text{simplify}]$

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$
 $\rightarrow [\text{Take given term}]$

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle$

$\text{int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$
[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > (\text{div}2.\text{rem})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r}2)) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176)]$
[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r}2)) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [simplify]
[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{r}2)) - (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}2.\text{quot})) * \text{asType} < \text{int} > (\$heap_{724,1;745,8}.\text{b}2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$
[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType} < \text{short int} > ((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}) * \text{asType} < \text{int} > (\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{r}2)) -$

$(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot}))) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))$
 \rightarrow [const member of object with modified fields]
[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [const static or extern object]
[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})172))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [simplify]
[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * 172) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) -$
 $(asType<int>(asType<short int>(div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [simplify]$
 $[63.14] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 59.19, \$heap_{724,1;745,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.15] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).b2))))$
 $\rightarrow [const\ member\ of\ object\ with\ modified\ fields]$
 $[63.16] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.b2))))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[63.17] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{init}.b2))))$
 $\rightarrow [expand\ definition\ of\ constant\ 'b2'\ at\ prang.c\ (22,20)]$

int>((**asType**<**int**>(**asType**<**short int**>(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem))) * **asType**<**int**>(\$heap724,1;747,8.r3)) -
(**asType**<**int**>(**asType**<**short int**>(div3.quot))) *
asType<**int**>(\$heap724,1;747,8.b3))))

→ [simplify]

[67.4] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap724,1;747,8.r3)) - (**asType**<**int**>(**asType**<**short**
int>(div3.quot))) * **asType**<**int**>(\$heap724,1;747,8.b3))))

→ [from term 63.24, \$heap724,1;747,8 is equal to

\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 → (-35 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]

[67.5] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 → ((-35
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).r3)) -
(**asType**<**int**>(**asType**<**short int**>(div3.quot))) *
asType<**int**>(\$heap724,1;747,8.b3))))

→ [const member of object with modified fields]

[67.7] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap_funcstart_724,1.r3)) - (**asType**<**int**>(**asType**<**short**

`int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [const static or extern object]
[67.8] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_init.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [simplify]
[67.12] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [from term 43.6, div3 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178)]
[67.13] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,`

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}<\text{int}>(\$heap_{init}.b3))))$

→ [expand definition of constant 'b3' at prang.c (27,20)]

$[67.20] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})63))))))$

→ [simplify]

$[67.26] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))))$

[Take goal term]

$[1.0] \text{asType}<\text{integer}>(\$heap_{724,1;749,8}.p3) < \text{asType}<\text{integer}>(\$heap_{724,1;749,8}.M3)$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))$

$[1.1] \text{asType}<\text{integer}>(\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_funcstart_724,1 \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)))$). $p3 < \text{asType}<\text{integer}>(\$heap_{724,1;749,8}.M3)$

→ [simplify]

$[1.3] ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)) < \text{asType}<\text{integer}>(\$heap_{724,1;749,8}.M3)$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_funcstart_724,1$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2, 176).rem)))$.**replace**($p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)))$])

$[1.4] ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)) < \text{asType}<\text{integer}>(\$heap_funcstart_724,1$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)))$). $M3)$

→ [const member of object with modified fields]

$[1.7] ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)) < \text{asType}<\text{integer}>(\$heap_funcstart_724,1.M3)$

→ [const static or extern object]

$[1.8] ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)) < \text{asType}<\text{integer}>(\$heap_{init}.M3)$

→ [expand definition of constant 'M3' at prang.c (24,20)]

$[1.9] ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1 \cdot p3, 178).rem)) < \text{asType}<\text{integer}>(\text{asType}<\text{short int}>((\text{int})30323))$

→ [simplify]

$[1.19] -30323 < ((-170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1,$

$\$heap_funcstart_724,1.p3, 178).rem) + (63 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot))$
 \rightarrow [negate goal and search for contradiction]
[1.20] $\neg(-30323 < ((-170 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) + (63 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot))))$
 \rightarrow [simplify]
[1.25] $30322 < ((170 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) + (-63 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot)))$
[Branch on disjunction or conditional in term 56.17]
[87.0] $(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
[Copy term 1.25]
[92.0] $(30322 < ((-63 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [from term 87.0, $\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem$ is equal to $\$heap_funcstart_724,1.p3$]
[92.1] $(30322 < ((-63 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \$heap_funcstart_724,1.p3)))) \vee \dots$
[Copy term 47.17]
[93.0] $(0 == (-\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem + (\$heap_funcstart_724,1.p3 \% 178))) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [from term 87.0, $\text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem$ is equal to $\$heap_funcstart_724,1.p3$]
[93.1] $(0 == (-\$heap_funcstart_724,1.p3 + (\$heap_funcstart_724,1.p3 \% 178))) \vee \dots$
[Assume known post-assertion, class invariant or type constraint for term 93.1]
[97.0] $(\$heap_funcstart_724,1.p3 < 178) \vee (177 < \$heap_funcstart_724,1.p3) \vee \neg(0 == (-\$heap_funcstart_724,1.p3 + \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))$
 \rightarrow [simplify]

[97.3] $(-178 < -\$heap_{funcstart_724,1}.p3) \vee \dots$

[Copy term 1.25]

[102.0] $30322 < ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))$

\rightarrow [from term 47.17, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}$ is equal to $\$heap_{funcstart_724,1}.p3 \% 178$]

[102.1] $30322 < ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * (\$heap_{funcstart_724,1}.p3 \% 178)))$

[Copy term 92.1]

[103.0] $(30322 < ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \$heap_{funcstart_724,1}.p3))) \vee (177 < \$heap_{funcstart_724,1}.p3) \vee !(0 == (-\$heap_{funcstart_724,1}.p3 + \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))$

\rightarrow [from term 46.17, $\text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}$ is equal to $\$heap_{funcstart_724,1}.p3 / 178$]

[103.1] $(30322 < ((-63 * (\$heap_{funcstart_724,1}.p3 / 178)) + (170 * \$heap_{funcstart_724,1}.p3))) \vee \dots$

\rightarrow [division by larger divisor]

Proof of rule precondition 1:

[103.1.0.0] $\text{literal}d < -\$heap_{funcstart_724,1}.p3$

\rightarrow [unify with term 97.3]

[103.1.0.1] **true**

Proof of rule precondition 2:

[103.1.1.0] $\text{literal}c < \$heap_{funcstart_724,1}.p3$

\rightarrow [unify with term 10.0]

[103.1.1.1] **true**

Proof of rule precondition 3:

[103.1.2.0] $-178 \leq 178$

\rightarrow [simplify]

[103.1.2.2] **true**

Proof of rule precondition 4:

[103.1.3.0] $-2 < 0$

\rightarrow [simplify]

[103.1.3.1] **true**

$[103.2] (30322 < ((-63 * \$heap_{funcstart_724,1}.p3) + (170 * \$heap_{funcstart_724,1}.p3))) \vee \dots$
 $\rightarrow [simplify]$
 $[103.4] (30322 < (107 * \$heap_{funcstart_724,1}.p3)) \vee \dots$
 $\rightarrow [literal\ comparison\ of\ product]$
 $[103.5] ([107 < 0]: (30322 / -107) < -\$heap_{funcstart_724,1}.p3, [0 < 107]: (30322 / 107) < \$heap_{funcstart_724,1}.p3, [0 == 107]: 30322 < 0) \vee \dots$
 $\rightarrow [explicitly\ assert\ falsehood\ of\ skipped\ guards\ in\ subsequent\ guards]$
 $[103.6] ([107 < 0]: (30322 / -107) < -\$heap_{funcstart_724,1}.p3, [(0 < 107) \wedge !(107 < 0)]: (30322 / 107) < \$heap_{funcstart_724,1}.p3, [(0 == 107) \wedge !(0 < 107) \wedge !(107 < 0)]: 30322 < 0) \vee \dots$
 $\rightarrow [simplify]$
 $[103.13] (\mathbf{true} \wedge (283 < \$heap_{funcstart_724,1}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 97.3, literal_a < \$heap_{funcstart_724,1}.p3\ is\ false\ whenever\ -2 < (-178 + literal_a)]$
Proof of rule precondition:
 $[103.13.0] -2 < (-178 + 283)$
 $\rightarrow [simplify]$
 $[103.13.2] \mathbf{true}$
 $[103.14] (\mathbf{true} \wedge \mathbf{false}) \vee \dots$
 $\rightarrow [simplify]$
 $[103.15] \mathbf{false} \vee \dots$
 $[Remove\ 'false'\ term\ 103.15\ and\ fetch\ new\ term\ from\ containing\ clause]$
 $[104.0] 177 < \$heap_{funcstart_724,1}.p3$
 $[Create\ new\ term\ from\ term\ 46.17\ using\ rule:\ condition\ for\ equality\ of\ division]$
 $[159.0] ((178 * (0 + -(-div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot))) < (1 + \$heap_{funcstart_724,1}.p3)) \wedge (\$heap_{funcstart_724,1}.p3 < (178 * (0 + 1 + -(-div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot))))$
 $\rightarrow [simplify]$
 $[159.15] (-1 < ((-178 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + \$heap_{funcstart_724,1}.p3)) \wedge (-178 < (-\$heap_{funcstart_724,1}.p3 + (178 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot)))$
 $\rightarrow [separate\ conjunction\ and\ work\ on\ first\ sub-term]$
 $[159.16] -178 < (-\$heap_{funcstart_724,1}.p3 + (178 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot))$

[Create new term from terms 159.16, 104.0 using rule: transitivity 2]
[213.0] $(-178 + 1 + 177) < (178 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p3, 178)).\text{quot}$
→ [simplify]
[213.1] $0 < (178 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p3, 178)).\text{quot}$
→ [product is positive]
[213.2] $((0 < 178) \wedge (0 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p3, 178)).\text{quot})) \vee ((178 < 0) \wedge (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p3, 178)).\text{quot} < 0))$
→ [simplify]
[213.7] $0 < \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1} \cdot p3, 178)).\text{quot}$
[Create new term from terms 213.7, 102.1 using rule: transitivity 11]
[217.0] $(1 + 30322 + (0 * 63)) < (170 * (\$heap_{funcstart_724,1} \cdot p3 \% 178))$
→ [simplify]
[217.2] $30323 < (170 * (\$heap_{funcstart_724,1} \cdot p3 \% 178))$
→ [literal comparison of product]
[217.3] $([170 < 0]: (30323 / -170) < -(\$heap_{funcstart_724,1} \cdot p3 \% 178), [0 < 170]: (30323 / 170) < (\$heap_{funcstart_724,1} \cdot p3 \% 178), [0 == 170]: 30323 < 0)$
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[217.4] $([170 < 0]: (30323 / -170) < -(\$heap_{funcstart_724,1} \cdot p3 \% 178), [(0 < 170) \wedge !(170 < 0)]: (30323 / 170) < (\$heap_{funcstart_724,1} \cdot p3 \% 178), [(0 == 170) \wedge !(0 < 170) \wedge !(170 < 0)]: 30323 < 0)$
→ [simplify]
[217.13] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (66,12)

To prove: $\text{asType}<\mathbf{integer\ const}>(\$heap_{724,1;749,8}.M3) < \text{asType}<\mathbf{integer}>(\$heap_{724,1;749,8}.p3)$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$

$\$heap_{init}.M1 == \text{asType}<\mathbf{short\ int}>((\mathbf{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\mathbf{short\ int}>((\mathbf{int})171)$

$\$heap_{init}.a1 == \text{asType}<\mathbf{short\ int}>((\mathbf{int})177)$

```

$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
- asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short

```

```

int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

```

Proof:

[Take given term]

[5.0] invariant1(heapIs \$heap_funcstart_724,1)

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[5.1] (((((0 < asType<integer>(\$heap_funcstart_724,1.p1)) &&
(asType<integer>(\$heap_funcstart_724,1.p1) <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))

→ [simplify]

[5.3] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_funcstart_724,1.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p3))) &&
(asType<integer>(\$heap_funcstart_724,1.p3) <
asType<integer>(\$heap_funcstart_724,1.M3))

→ [const static or extern object]

[5.4] (((((0 < \$heap_funcstart_724,1.p1) && (\$heap_funcstart_724,1.p1 <
asType<integer>(\$heap_init.M1))) && (0 <
asType<integer>(\$heap_funcstart_724,1.p2))) &&
(asType<integer>(\$heap_funcstart_724,1.p2) <
asType<integer>(\$heap_funcstart_724,1.M2))) && (0 <


```

asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_funcstart_724,1.p1) && ($heap_funcstart_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_724,1.p2))) &&
(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.16] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_funcstart_724,1.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.17] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧
(0 < $heap_funcstart_724,1.p2)) && ($heap_funcstart_724,1.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_724,1.p3))) &&
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.M3))
→ [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <
$heap_funcstart_724,1.p2) ∧ (0 < $heap_funcstart_724,1.p3)) &&
($heap_funcstart_724,1.p3 < asType<integer>($heap_funcstart_724,1.M3))
→ [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) ∧ (-30269 <
-$heap_funcstart_724,1.p1) ∧ (0 < $heap_funcstart_724,1.p1) ∧ (0 <

```

$\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle\mathbf{integer}\rangle(\$heap_init.M3))$
 → [expand definition of constant 'M3' at prang.c (24,20)]
 [5.32] $((-30307 < -\$heap_funcstart_724,1.p2) \wedge (-30269 <$
 $-\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p2) \wedge (0 < \$heap_funcstart_724,1.p3)) \&\&$
 $(\$heap_funcstart_724,1.p3 < \mathbf{asType}\langle\mathbf{integer}\rangle(\mathbf{asType}\langle\mathbf{short}$
 $\mathbf{int}\rangle((\mathbf{int})30323)))$
 → [simplify]
 [5.40] $(-30323 < -\$heap_funcstart_724,1.p3) \wedge (-30307 <$
 $-\$heap_funcstart_724,1.p2) \wedge (-30269 < -\$heap_funcstart_724,1.p1) \wedge (0 <$
 $\$heap_funcstart_724,1.p1) \wedge (0 < \$heap_funcstart_724,1.p2) \wedge (0 <$
 $\$heap_funcstart_724,1.p3)$
 → [separate conjunction and work on first sub-term]
 [5.41] $-30323 < -\$heap_funcstart_724,1.p3$
 [Work on sub-term 6 of conjunction in term 5.40]
 [10.0] $0 < \$heap_funcstart_724,1.p3$
 [Take given term]
 [11.0] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1,$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_funcstart_724,1.p1),$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_funcstart_724,1.a1))$
 → [simplify]
 [11.1] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_funcstart_724,1.a1))$
 → [const static or extern object]
 [11.2] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_init.a1))$
 → [expand definition of constant 'a1' at prang.c (16,20)]
 [11.3] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\mathbf{asType}\langle\mathbf{short} \mathbf{int}\rangle((\mathbf{int})177)))$
 → [simplify]
 [11.6] $\mathbf{div1} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)$
 [Take given term]
 [27.0] $\mathbf{div2} == \mathbf{div}(\mathbf{heapIs} \$heap_funcstart_724,1,$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_funcstart_724,1.p2),$
 $\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_funcstart_724,1.a2))$
 → [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 → [const static or extern object]
 [27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$
 → [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 → [simplify]
 [27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 [Take given term]
 [43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$
 → [simplify]
 [43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$
 → [const static or extern object]
 [43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_init.a3}))$
 → [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$
 → [simplify]
 [43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
 [Assume known post-assertion, class invariant or type constraint for term 43.6]
 [46.0] $(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) /$
 $\text{asType<integer>}(178)) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 → [simplify]
 [46.2] $(\$ \text{heap_funcstart_724,1.p3} / 178) == \text{asType<integer>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot})$
 → [expand definition of operator './' in class 'int' at built in declaration]
 [46.3] $([\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) < 0]:$
 $-(\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178), []:$
 $\text{asType<integer>}(\$ \text{heap_funcstart_724,1.p3}) / 178) ==$

asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[46.4] ([**asType<integer>**(\$heap_funcstart_724,1.p3) < 0]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p3) < 0]):
asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [simplify]

[46.7] ([0 < -\$heap_funcstart_724,1.p3]:
 -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p3) < 0]):
asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literal a)]

Proof of rule precondition:

[46.7.0] -2 < (0 + 0)

→ [simplify]

[46.7.2] **true**

[46.8] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178),
 [!(**asType<integer>**(\$heap_funcstart_724,1.p3) < 0]):
asType<integer>(\$heap_funcstart_724,1.p3) / 178) ==
asType<integer>(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).quot)

→ [simplify]

[46.11] ([**false**]: -(**asType<integer>**(\$heap_funcstart_724,1.p3) / 178), [!(0 <
-\$heap_funcstart_724,1.p3)]: **asType<integer>**(\$heap_funcstart_724,1.p3) / 178)
 == **asType<integer>**(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).quot)

→ [from term 10.0, literal a < -\$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literal a)]

Proof of rule precondition:

[46.11.0] -2 < (0 + 0)

→ [simplify]

[46.11.2] **true**

[46.12] ([false]: $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178)$,
[!false]: $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) / 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot})$
→ [simplify]

[46.17] $0 == (\neg \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{quot} + (\$heap_funcstart_724,1.p3 / 178))$
[Assume known post-assertion, class invariant or type constraint for term 43.6]

[47.0] $(\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \%$
 $\text{asType}\langle \text{integer} \rangle (178)) == \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})$
→ [simplify]

[47.2] $(\$heap_funcstart_724,1.p3 \% 178) == \text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).\text{rem})$
→ [expand definition of operator '.*' in class 'int' at built in declaration]

[47.3] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178)$, []:
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
→ [explicitly assert falsehood of skipped guards in subsequent guards]

[47.4] ([asType<integer>(\$heap_funcstart_724,1.p3) < 0]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178)$,
[!(asType<integer>(\$heap_funcstart_724,1.p3) < 0)]:
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
→ [simplify]

[47.7] ([0 < -\\$heap_funcstart_724,1.p3]:
 $\neg(\neg \text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178)$,
[!(asType<integer>(\$heap_funcstart_724,1.p3) < 0)]:
 $\text{asType}\langle \text{integer} \rangle (\$heap_funcstart_724,1.p3) \% 178) ==$
 $\text{asType}\langle \text{integer} \rangle (\text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).\text{rem})$
→ [from term 10.0, literal a < -\\$heap_funcstart_724,1.p3 is false whenever -2 < (0 + literal a)]

Proof of rule precondition:

[47.7.0] $-2 < (0 + 0)$

→ [simplify]

[47.7.2] **true**

[47.8] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$,
[!($\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) < 0$)]:
 $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [simplify]

[47.11] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$, [!(0
 $< -\text{\$heap_funcstart_724,1.p3}$)]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \%$
 $178 == \text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p3}, 178).\text{rem})$

→ [from term 10.0, *literal* $< -\text{\$heap_funcstart_724,1.p3}$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[47.11.0] $-2 < (0 + 0)$

→ [simplify]

[47.11.2] **true**

[47.12] ([**false**]: $\neg(\neg \text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178)$,
[**false**]: $\text{asType}\langle \text{integer} \rangle(\text{\$heap_funcstart_724,1.p3}) \% 178 ==$
 $\text{asType}\langle \text{integer} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{rem})$

→ [simplify]

[47.17] $0 == (\neg \text{div}(\text{heapIs } \text{\$heap_funcstart_724,1}, \text{\$heap_funcstart_724,1.p3},$
 $178).\text{rem} + (\text{\$heap_funcstart_724,1.p3} \% 178))$

[Take given term]

[59.0] $\text{\$heap}_{724,1;745,8} == \text{\$heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\text{\$heap_funcstart_724,1.r1}) -$
 $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\text{\$heap_funcstart_724,1.b1}))))$

→ [from term 11.6, *div1* is equal to $\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177)$]

[59.1] $\text{\$heap}_{724,1;745,8} == \text{\$heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \text{\$heap_funcstart_724,1},$
 $\text{\$heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\text{\$heap_funcstart_724,1.r1}) -$
 $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\text{\$heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.3] $\text{\$heap}_{724,1;745,8} == \text{\$heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType}\langle \text{short}$

`int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [const static or extern object]

[59.4] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>($heap_init.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [simplify]

[59.8] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]

[59.9] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [simplify]

[59.11] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_funcstart_724,1.b1))))`
→ [const static or extern object]

[59.12] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_init.b1))))`
→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_init.b1))))`

asType<int>(asType<short int>((int)2))))

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{rem})) * \text{asType<int>}(\$heap_{724,1;745,8}.r2)) - (\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{quot})) * \text{asType<int>}(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$]

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{rem})) * \text{asType<int>}(\$heap_{724,1;745,8}.r2)) - (\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{quot})) * \text{asType<int>}(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType<int>}(\$heap_{724,1;745,8}.r2)) - (\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{quot})) * \text{asType<int>}(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) * \text{asType<int>}(\$heap_{724,1;745,8}.r2)) - (\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{quot})) * \text{asType<int>}(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))). \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))).r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))). \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))). \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{init}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))). \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})172))) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))). \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>((\text{int})172))) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * 172) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 27.6,\ div2\ is\ equal\ to\ div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176)]$
 $[63.12]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) -$
 $(asType<int>(asType<short int>(div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [simplify]$
 $[63.14]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 59.19,\ \$heap_{724,1;745,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.15]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).b2))))$
 $\rightarrow [const\ member\ of\ object\ with\ modified\ fields]$
 $[63.16]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.b2))))$
 $\rightarrow [const\ static\ or\ extern\ object]$

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\texttt{replace}(p2 \rightarrow \texttt{asType}<\texttt{short int}>((172 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) * \texttt{asType}<\texttt{int}>(\$heap_{init}.b2))))$

\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\texttt{replace}(p2 \rightarrow \texttt{asType}<\texttt{short int}>((172 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) * \texttt{asType}<\texttt{int}>(\texttt{asType}<\texttt{short int}>((\texttt{int})35))))$

\rightarrow [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\texttt{replace}(p2 \rightarrow ((-35 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))))$

[Take given term]

[67.0] $\$heap_{724,1;749,8} == \$heap_{724,1;747,8}.\texttt{replace}(p3 \rightarrow \texttt{asType}<\texttt{short int}>((\texttt{asType}<\texttt{int}>(\texttt{asType}<\texttt{short int}>(\text{div3}.\text{rem})) * \texttt{asType}<\texttt{int}>(\$heap_{724,1;747,8}.r3)) - (\texttt{asType}<\texttt{int}>(\texttt{asType}<\texttt{short int}>(\text{div3}.\text{quot})) * \texttt{asType}<\texttt{int}>(\$heap_{724,1;747,8}.b3))))$

\rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to

$\$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\texttt{replace}(p2 \rightarrow (-35 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))$

[67.1] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\texttt{replace}(p2 \rightarrow ((-35 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\texttt{replace}(p3 \rightarrow \texttt{asType}<\texttt{short int}>((\texttt{asType}<\texttt{int}>(\texttt{asType}<\texttt{short int}>(\text{div3}.\text{rem})) * \texttt{asType}<\texttt{int}>(\$heap_{724,1;747,8}.r3)) - (\texttt{asType}<\texttt{int}>(\texttt{asType}<\texttt{short int}>(\text{div3}.\text{quot})) * \texttt{asType}<\texttt{int}>(\$heap_{724,1;747,8}.b3))))$

```
[67.2] $heap724,1;749,8 == $heap_funcstart_724,1..replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem))).replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem))).replace(p3 → asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p3, 178).rem)) * asType<int>($heap724,1;747,8.r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))
→ [simplifv]
```

```
[67.4] $heap_{724,1;749,8} == $heap_{funcstart\_724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1.p1}, 177).quot) + (171 *
div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1.p1},
177).rem))).replace(p2 → ((-35 * div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1.p2}, 176).rem))).replace(p3 → asType<short
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1.p3}, 178).rem *
asType<int>($heap_{724,1;747,8}.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap_{724,1;747,8}.b3))))
```

→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{quot}) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{rem}))).\mathbf{replace}(p2 \rightarrow (-35 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{quot}) + (172 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{rem}))]$

```
[67.5] $heap724,1;749,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem *
asType<int>($heapfuncstart_724,1._replace(p1 → ((-2 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).rem)))._replace(p2 → ((-35
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot) + (172 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))
```

→ [const member of object with modified fields]

[67.7] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}3.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [const static or extern object]

[67.8] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\$heap_{init}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}3.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})170))) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}3.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [simplify]

[67.12] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * 170) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}3.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178)$]

$\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((170$
 $* \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.b3))))$

→ [const static or extern object]

[67.19] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((170$
 $* \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $\text{asType}<\text{int}>(\$heap_{init}.b3))))$

→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((170$
 $* \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $\text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})63))))$

→ [simplify]

[67.26] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$

[Take goal term]

[1.0] $-\text{asType}<\text{integer const}>(\$heap_{724,1;749,8}.M3) <$
 $\text{asType}<\text{integer}>(\$heap_{724,1;749,8}.p3)$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs}$

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.**replace**($p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$)

[1.1] **asType**<integer const>($\$heap_funcstart_724,1$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$).**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$).M3) <

asType<integer>($\$heap_{724,1;749,8}.p3$)

→ [const member of object with modified fields]

[1.4] **asType**<integer const>($\$heap_funcstart_724,1.M3$) <

asType<integer>($\$heap_{724,1;749,8}.p3$)

→ [const static or extern object]

[1.5] **asType**<integer const>($\$heap_{init}.M3$) <

asType<integer>($\$heap_{724,1;749,8}.p3$)

→ [expand definition of constant 'M3' at prang.c (24,20)]

[1.6] **asType**<integer const>(**asType**<short int>((int)30323)) <

asType<integer>($\$heap_{724,1;749,8}.p3$)

→ [simplify]

[1.10] -30323 < **asType**<integer>($\$heap_{724,1;749,8}.p3$)

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_funcstart_724,1$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$).**replace**($p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$)

[1.11] -30323 < **asType**<integer>($\$heap_funcstart_724,1$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$).**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$).p3)

→ [simplify]

[1.13] $-30323 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))$

→ [negate goal and search for contradiction]

[1.14] $!(-30323 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem)))$

→ [simplify]

[1.19] $30322 < ((63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + (-170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem))$

[Copy term 1.19]

[100.0] $30322 < ((-170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem) + (63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))$

→ [from term 47.17, $\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).rem$ is equal to $\$heap_funcstart_724,1.p3 \% 178$]

[100.1] $30322 < ((-170 * (\$heap_funcstart_724,1.p3 \% 178)) + (63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))$

[Create new term from term 46.17 using rule: condition for equality of division]

[155.0] $((178 * (0 + -(-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))) < (1 + \$heap_funcstart_724,1.p3)) \wedge (\$heap_funcstart_724,1.p3 < (178 * (0 + 1 + -(-\text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot))))$

→ [simplify]

[155.15] $(-1 < ((-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + \$heap_funcstart_724,1.p3)) \wedge (-178 < (-\$heap_funcstart_724,1.p3 + (178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)))$

[Work on sub-term 2 of conjunction in term 155.15]

[156.0] $-1 < ((-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot) + \$heap_funcstart_724,1.p3)$

[Create new term from terms 156.0, 5.41 using rule: transitivity 2]

[214.0] $(-30323 + -1 + 1) < (-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)$

→ [simplify]

[214.1] $-30323 < (-178 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \ \$heap_funcstart_724,1.p3, 178).quot)$

→ [literal comparison of product]

[214.2] $([-178 < 0]: (-30323 / 178) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [0 < -178]: (-30323 / -178) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [-178 == 0]: -30323 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[214.3] $([-178 < 0]: (-30323 / 178) < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [(0 < -178) \wedge !(-178 < 0)]: (-30323 / -178) < \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}, [(-178 == 0) \wedge !(-178 < 0) \wedge !(0 < -178)]: -30323 < 0)$

→ [simplify]

[214.7] $-171 < -\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}$

[Create new term from terms 214.7, 100.1 using rule: transitivity 5]

[224.0] $30322 < ((-170 * (\text{heap_funcstart_724,1.p3 \% 178})) + (63 * -(-171 + 1)))$

→ [simplify]

[224.5] $19612 < (-170 * (\text{heap_funcstart_724,1.p3 \% 178}))$

→ [literal comparison of product]

[224.6] $([-170 < 0]: (19612 / 170) < -(\text{heap_funcstart_724,1.p3 \% 178}), [0 < -170]: (19612 / -170) < (\text{heap_funcstart_724,1.p3 \% 178}), [-170 == 0]: 19612 < 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[224.7] $([-170 < 0]: (19612 / 170) < -(\text{heap_funcstart_724,1.p3 \% 178}), [(0 < -170) \wedge !(-170 < 0)]: (19612 / -170) < (\text{heap_funcstart_724,1.p3 \% 178}), [(-170 == 0) \wedge !(-170 < 0) \wedge !(0 < -170)]: 19612 < 0)$

→ [simplify]

[224.12] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,27)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap}_{724,1;749,8}.\text{M1}$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==

```

```

asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

```

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<**int**>(\$heap_funcstart_724,1.p1),
asType<**int**>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(**asType**<**short int**>((**int**)177)))

→ [simplify]

[11.6] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)

[Take given term]

[27.0] div2 == div(**heapIs** \$heap_funcstart_724,1,
asType<**int**>(\$heap_funcstart_724,1.p2),

asType<int>(\$heap_funcstart_724,1.a2))
 → [simplify]
 [27.1] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_funcstart_724,1.a2))
 → [const static or extern object]
 [27.2] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_init.a2))
 → [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(**asType<short int>**((**int**)176)))
 → [simplify]
 [27.6] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)
 [Take given term]
 [43.0] div3 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p3),
asType<int>(\$heap_funcstart_724,1.a3))
 → [simplify]
 [43.1] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(\$heap_funcstart_724,1.a3))
 → [const static or extern object]
 [43.2] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(\$heap_init.a3))
 → [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(**asType<short int>**((**int**)178)))
 → [simplify]
 [43.6] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)
 [Take given term]
 [59.0] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((**asType<int>**(**asType<short int>**(div1.rem)) *
asType<int>(\$heap_funcstart_724,1.r1)) - (**asType<int>**(**asType<short int>**(div1.quot)) * **asType<int>**(\$heap_funcstart_724,1.b1))))
 → [from term 11.6, div1 is equal to div(**heapIs** \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177)]
 [59.1] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((**asType<int>**(**asType<short int>**(div(**heapIs** \$heap_funcstart_724,1,

$\$heap_{funcstart_724,1}.p1, 177).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) -$
 $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.4] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$
 $[59.5] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.8] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$
 $[59.9] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.11] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.12] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\text{asType}\langle\text{int}\rangle(\$heap_{init}.b1))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))))$
 \rightarrow [simplify]
[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
[Take given term]
[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$
[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]$
[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [simplify]
[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.5] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).r2)) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
→ [const member of object with modified fields]
 $[63.6] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{funcstart_724,1}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
→ [const static or extern object]
 $[63.7] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{init}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
→ [expand definition of constant 'r2' at prang.c (20,20)]
 $[63.8] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(asType<short int>((int)172))) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<short int>((div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem * 172) -
(**asType**<int>(**asType**<short int>(div2.quot)) *
asType<int>(\$heap724,1;745,8.b2))))

→ [from term 27.6, div2 is equal to div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p2, 176)]

[63.12] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<short int>((172 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) -
(**asType**<int>(**asType**<short int>(div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p2, 176).quot)) * **asType**<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.14] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<short int>((172 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) - (div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot *
asType<int>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to

\$heapfuncstart_724,1.**replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem)))]

[63.15] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<short int>((172 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) - (div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot *
asType<int>(\$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).b2))))

→ [const member of object with modified fields]

[63.16] \$heap724,1;747,8 == \$heapfuncstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,

$177).rem)))$.**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b2))))$)
 \rightarrow [const static or extern object]
 $[63.17] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b2))))$)
 \rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
 $[63.18] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})35))))$)
 \rightarrow [simplify]
 $[63.24] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$)
[Take given term]
 $[67.0] \$heap_{724,1;749,8} == \$heap_{724,1;747,8}.$ **replace**($p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}3).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}3).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.b3))))$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))$]
 $[67.1] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$

177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((**asType**<**int**>(asType<**short int**>(div3.rem)) *
asType<**int**>(\$heap724,1;747,8.r3)) - (asType<**int**>(asType<**short**
int>(div3.quot)) * asType<**int**>(\$heap724,1;747,8.b3))))))
→ [from term 43.6, div3 is equal to div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178)]

[67.2] \$heap724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((asType<**int**>(asType<**short int**>(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem)) * asType<**int**>(\$heap724,1;747,8.r3)) -
(asType<**int**>(asType<**short int**>(div3.quot)) *
asType<**int**>(\$heap724,1;747,8.b3))))))

→ [simplify]

[67.4] \$heap724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap724,1;747,8.r3)) - (asType<**int**>(asType<**short**
int>(div3.quot)) * asType<**int**>(\$heap724,1;747,8.b3))))))

→ [from term 63.24, \$heap724,1;747,8 is equal to
\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → (-35 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]

[67.5] \$heap724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.r3)) - $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [const member of object with modified fields]

[67.7] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [const static or extern object]

[67.8] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})170))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [simplify]

[67.12] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$

$\$heap_{funcstart_724,1.p2, 176}).rem))$).replace($p3 \rightarrow asType<short$
 $int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3, 178}).rem * 170)$
 $- (asType<int>(asType<short int>(div3.quot)) *$
 $asType<int>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [from\ term\ 43.6,\ div3\ is\ equal\ to\ div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p3, 178})]$
 $[67.13]\ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1, 177}).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1,$
 $177).rem)))$).replace($p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2, 176}).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2, 176}).rem)))$).replace($p3 \rightarrow asType<short int>((170$
 $* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3, 178}).rem) -$
 $(asType<int>(asType<short int>(div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p3, 178}).quot)) * asType<int>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [simplify]$
 $[67.15]\ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1, 177}).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1,$
 $177).rem)))$).replace($p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2, 176}).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2, 176}).rem)))$).replace($p3 \rightarrow asType<short int>((170$
 $* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3, 178}).rem) -$
 $(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3, 178}).quot *$
 $asType<int>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [from\ term\ 63.24,\ \$heap_{724,1;747,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1, 177}).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1, 177}).rem)))$).replace($p2 \rightarrow (-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2, 176}).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2, 176}).rem))]$
 $[67.16]\ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1, 177}).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1,$
 $177).rem)))$).replace($p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2, 176}).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2, 176}).rem)))$).replace($p3 \rightarrow asType<short int>((170$
 $* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3, 178}).rem) -$
 $(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3, 178}).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1, 177}).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1, 177}).rem)))$).replace($p2 \rightarrow ((-35$
 $* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2, 176}).quot) + (172 *$

div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))b3))))

→ [const member of object with modified fields]

[67.18] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_funcstart_724,1.b3))))))

→ [const static or extern object]

[67.19] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_init.b3))))))

→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63))))))

→ [simplify]

[67.26] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))

[Take goal term]

[1.0] **minof(int)** ≤ \$heap_{724,1;749,8}.M1

→ [simplify]

[1.1] -32768 ≤ \$heap_{724,1;749,8}.M1

→ [from term 67.26, \$heap_{724,1;749,8} is equal to

\$heap_{funcstart_724,1}.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).**_replace**(p3 → (-63 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))]

[1.2] -32768 ≤ \$heap_{funcstart_724,1}.**_replace**(p1 → ((-2 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).**_replace**(p2 → ((-35
* div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,
176).rem))).**_replace**(p3 → ((-63 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p3, 178).rem))).M1

→ [const member of object with modified fields]

[1.5] -32768 ≤ \$heap_{funcstart_724,1}.M1

→ [const static or extern object]

[1.6] -32768 ≤ \$heap_{init}.M1

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.7] -32768 ≤ **asType<short int>**((**int**)30269)

→ [simplify]

[1.10] **true**

Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,27)

Condition defined at:

To prove: \$heap_{724,1;749,8}.M1 ≤ **maxof(int)**

Given:

\$heap_{init}.LIMIT == (**int**)80

\$heap_{init}.M1 == **asType<short int>**((**int**)30269)

\$heap_{init}.r1 == **asType<short int>**((**int**)171)


```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==

```

```

asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

```

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(**heapIs** \$heap_funcstart_724,1,
asType<**int**>(\$heap_funcstart_724,1.p1),
asType<**int**>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<**int**>(**asType**<**short int**>((**int**)177)))

→ [simplify]

[11.6] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)

[Take given term]

[27.0] div2 == div(**heapIs** \$heap_funcstart_724,1,
asType<**int**>(\$heap_funcstart_724,1.p2),

asType<int>(\$heap_funcstart_724,1.a2))
 → [simplify]
 [27.1] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_funcstart_724,1.a2))
 → [const static or extern object]
 [27.2] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_init.a2))
 → [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(**asType<short int>**((**int**)176)))
 → [simplify]
 [27.6] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)
 [Take given term]
 [43.0] div3 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p3),
asType<int>(\$heap_funcstart_724,1.a3))
 → [simplify]
 [43.1] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(\$heap_funcstart_724,1.a3))
 → [const static or extern object]
 [43.2] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(\$heap_init.a3))
 → [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(**asType<short int>**((**int**)178)))
 → [simplify]
 [43.6] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)
 [Take given term]
 [59.0] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((**asType<int>**(**asType<short int>**(div1.rem)) *
asType<int>(\$heap_funcstart_724,1.r1)) - (**asType<int>**(**asType<short int>**(div1.quot)) * **asType<int>**(\$heap_funcstart_724,1.b1))))
 → [from term 11.6, div1 is equal to div(**heapIs** \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177)]
 [59.1] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((**asType<int>**(**asType<short int>**(div(**heapIs** \$heap_funcstart_724,1,

$\$heap_{funcstart_724,1}.p1, 177).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) -$
 $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.4] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r1)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$
 $[59.5] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.8] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div(heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$
 $[59.9] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{simplify}]$
 $[59.11] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.12] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$

$\text{asType}\langle\text{int}\rangle(\$heap_{init}.b1))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))))$
 \rightarrow [simplify]
[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
[Take given term]
[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$
[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]$
[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$
 \rightarrow [simplify]
[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 → [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$
 [63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).r2)) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 → [const member of object with modified fields]
 [63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{funcstart_724,1}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 → [const static or extern object]
 [63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{init}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 → [expand definition of constant 'r2' at prang.c (20,20)]
 [63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(asType<short int>((int)172))) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → **asType**<short int>((div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem * 172) - (**asType**<int>(**asType**<short int>(div2.quot)) * **asType**<int>(\$heap724,1;745,8.b2))))

→ [from term 27.6, div2 is equal to div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176)]

[63.12] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → **asType**<short int>((172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) - (**asType**<int>(**asType**<short int>(div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot)) * **asType**<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.14] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → **asType**<short int>((172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) - (div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot * **asType**<int>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to

\$heapfuncstart_724,1.**.replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)))]

[63.15] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → **asType**<short int>((172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem) - (div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot * **asType**<int>(\$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).b2))))

→ [const member of object with modified fields]

[63.16] \$heap724,1;747,8 == \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,

$$177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b2}))))))$$

→ [const static or extern object]

$$[63.17] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init.b2}))))))$$

→ [expand definition of constant 'b2' at prang.c (22,20)]

$$[63.18] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})35))))))$$

→ [simplify]

$$[63.24] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))$$

[Take given term]

$$[67.0] \$\text{heap}_{724,1;749,8} == \$\text{heap}_{724,1;747,8}.\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div3}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;747,8}.\text{r3})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div3}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;747,8}.\text{b3}))))$$

→ [from term 63.24, $\$ \text{heap}_{724,1;747,8}$ is equal to

$$\$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))$$

$$[67.1] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$$

177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((**asType**<**int**>(**asType**<**short int**>(div3.rem)) *
asType<**int**>(\$heap724,1;747,8.r3)) - (**asType**<**int**>(**asType**<**short**
int>(div3.quot)) * **asType**<**int**>(\$heap724,1;747,8.b3))))

→ [from term 43.6, div3 is equal to div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178)]

[67.2] \$heap724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((**asType**<**int**>(**asType**<**short int**>(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem)) * **asType**<**int**>(\$heap724,1;747,8.r3)) -
(**asType**<**int**>(**asType**<**short int**>(div3.quot)) *
asType<**int**>(\$heap724,1;747,8.b3))))

→ [simplify]

[67.4] \$heap724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap724,1;747,8.r3)) - (**asType**<**int**>(**asType**<**short**
int>(div3.quot)) * **asType**<**int**>(\$heap724,1;747,8.b3))))

→ [from term 63.24, \$heap724,1;747,8 is equal to

\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → (-35 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]

[67.5] \$heap724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short**
int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.r3)) - $(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [const member of object with modified fields]

[67.7] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [const static or extern object]

[67.8] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})170))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.quot)) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

\rightarrow [simplify]

[67.12] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$

div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))b3))))

→ [const member of object with modified fields]

[67.18] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_funcstart_724,1.b3))))))

→ [const static or extern object]

[67.19] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_init.b3))))))

→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63))))))

→ [simplify]

[67.26] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))

[Take goal term]

[1.0] $\$heap_{724,1;749,8}.M1 \leq \mathbf{maxof(int)}$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{quot}) + (171 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\mathbf{rem})))\mathbf{.replace}(p2 \rightarrow ((-35 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{quot}) + (172 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{rem})))\mathbf{.replace}(p3 \rightarrow (-63 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\mathbf{quot}) + (170 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\mathbf{rem})))]$

[1.1] $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\mathbf{quot}) + (171 * \mathbf{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\mathbf{rem})))\mathbf{.replace}(p2 \rightarrow ((-35$
 $* \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\mathbf{quot}) + (172 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2,$
 $176).\mathbf{rem})))\mathbf{.replace}(p3 \rightarrow ((-63 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\mathbf{quot}) + (170 * \mathbf{div}(\mathbf{heapIs} \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\mathbf{rem})))\mathbf{.M1} \leq \mathbf{maxof(int)}$

→ [const member of object with modified fields]

[1.4] $\$heap_{funcstart_724,1}.M1 \leq \mathbf{maxof(int)}$

→ [const static or extern object]

[1.5] $\$heap_{init}.M1 \leq \mathbf{maxof(int)}$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.6] $\mathbf{asType<short int>}((\mathbf{int})30269) \leq \mathbf{maxof(int)}$

→ [simplify]

[1.10] \mathbf{true}

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,17)

Condition defined at:

To prove: $\mathbf{minof(int)} \leq \$heap_{724,1;749,8}.p1$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$

$\$heap_{init}.M1 == \mathbf{asType<short int>}((\mathbf{int})30269)$

$\$heap_{init}.r1 == \mathbf{asType<short int>}((\mathbf{int})171)$

$\$heap_{init}.a1 == \mathbf{asType<short int>}((\mathbf{int})177)$

$\$heap_{init}.b1 == \mathbf{asType<short int>}((\mathbf{int})2)$

```

$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *

```



```

asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

→ [simplify]

[11.6] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)

[Take given term]

[27.0] div2 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p2),
asType<int>(\$heap_funcstart_724,1.a2))

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$
 $\rightarrow [\text{const static or extern object}]$

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$
 $\rightarrow [\text{expand definition of constant 'a2' at prang.c (21,20)}]$

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$
 $\rightarrow [\text{simplify}]$

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$
 $[\text{Take given term}]$

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}), \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$
 $\rightarrow [\text{simplify}]$

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$
 $\rightarrow [\text{const static or extern object}]$

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$
 $\rightarrow [\text{expand definition of constant 'a3' at prang.c (26,20)}]$

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$
 $\rightarrow [\text{simplify}]$

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
 $[\text{Take given term}]$

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)]$

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(\$heap_{funcstart_724,1}.r1)) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [const static or extern object]

[59.4] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(\$heap_{init}.r1)) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(asType<short int>((int)171))) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [simplify]

[59.8] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * 171) - (asType<int>(asType<short int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [from term 11.6, div1 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]

[59.9] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (asType<int>(asType<short int>(div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [simplify]

[59.11] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * asType<int>(\$heap_{funcstart_724,1}.b1))))

→ [const static or extern object]

[59.12] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 → asType<short int>((171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * asType<int>(\$heap_{init}.b1))))

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))))$

\rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[60.0] $-\text{asType}\langle\text{integer const}\rangle(\$heap_{724,1;745,8}.M1) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1)$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[60.1] $-\text{asType}\langle\text{integer const}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).M1) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1)$

\rightarrow [const member of object with modified fields]

[60.2] $-\text{asType}\langle\text{integer const}\rangle(\$heap_{funcstart_724,1}.M1) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1)$

\rightarrow [const static or extern object]

[60.3] $-\text{asType}\langle\text{integer const}\rangle(\$heap_{init}.M1) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1)$

\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]

[60.4] $-\text{asType}\langle\text{integer const}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}30269)) < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1)$

\rightarrow [simplify]

[60.8] $-30269 < \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1)$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[60.9] $-30269 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).p1)$

\rightarrow [simplify]

[60.11] $-30269 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$

[Take given term]

[63.0] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap}_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

\rightarrow [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]$

[63.1] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)]$

[63.2] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

\rightarrow [simplify]

[63.4] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

\rightarrow [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) *$

$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))))$
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 \rightarrow [simplify]
[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).b2))))))$
 \rightarrow [const member of object with modified fields]
[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b2))))))$
 \rightarrow [const static or extern object]
[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b2))))))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle\text{int}\rangle(\$heap_{init}.b2))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

$[63.18] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})35))))))$

→ [simplify]

$[63.24] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))$

[Take given term]

$[67.0] \$\text{heap}_{724,1;749,8} == \$\text{heap}_{724,1;747,8}._replace(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to

$\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))$

$[67.1] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))._replace(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$

→ [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$


```

div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_funcstart_724,1.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

```

→ [const static or extern object]

```

[67.8] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_init.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

```

→ [expand definition of constant 'r3' at prang.c (25,20)]

```

[67.9] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))

```

→ [simplify]

```

[67.12] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))

```

→ [from term 43.6, div3 is equal to div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)]

```

[67.13] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *

```


$\$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow asType<short\ int>((170$
 $* div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.b3))))$

$\rightarrow [const\ static\ or\ extern\ object]$

[67.19] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.replace($p2 \rightarrow ((-35 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow asType<short\ int>((170$
 $* div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $asType<int>(\$heap_{init}.b3))))$

$\rightarrow [expand\ definition\ of\ constant\ 'b3'\ at\ prang.c\ (27,20)]$

[67.20] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.replace($p2 \rightarrow ((-35 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow asType<short\ int>((170$
 $* div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $asType<int>(asType<short\ int>((int)63))))$

$\rightarrow [simplify]$

[67.26] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.replace($p2 \rightarrow ((-35 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$

$[Take\ goal\ term]$

[1.0] minof(int) $\leq \$heap_{724,1;749,8}.p1$

$\rightarrow [simplify]$

[1.1] $-32768 \leq \$heap_{724,1;749,8}.p1$

$\rightarrow [from\ term\ 67.26,\ \$heap_{724,1;749,8}\ is\ equal\ to$

$\$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * div(heapIs$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$)

[1.2] $-32768 \leq \$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$).replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$).p1

\rightarrow [simplify]

[1.7] $-32769 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$

\rightarrow [from term 60.11, literal $a < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$ is true whenever $(-1 + \text{literal}) < -30269$]

Proof of rule precondition:

[1.7.0] $(-32769 + -1) < -30269$

\rightarrow [simplify]

[1.7.2] **true**

[1.8] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,17)

Condition defined at:

To prove: $\$heap_{724,1;749,8}.p1 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

```

$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

```

```

–asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) – (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

–asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

```

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

```

→ [simplify]

```

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

```

→ [const static or extern object]

```

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))

```

→ [expand definition of constant 'a1' at prang.c (16,20)]

```

[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

```

→ [simplify]

```

[11.6] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)

```

[Take given term]

```

[27.0] div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

```

→ [simplify]

```

[27.1] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))

```


→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}), \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

`int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [const static or extern object]

[59.4] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>($heap_init.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [simplify]

[59.8] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]

[59.9] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [simplify]

[59.11] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_funcstart_724,1.b1))))`
→ [const static or extern object]

[59.12] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_init.b1))))`
→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_init.b1))))`

$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))$
 $\rightarrow [\text{simplify}]$
 $[59.19] \text{\$heap}_{724,1;745,8} == \text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem}))))$
 $[\text{Take given term}]$
 $[62.0] \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{724,1;745,8}.p1) < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{724,1;745,8}.M1)$
 $\rightarrow [\text{from term 59.19, } \text{\$heap}_{724,1;745,8} \text{ is equal to } \text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem}))))]$
 $[62.1] \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem}))))).p1) < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{724,1;745,8}.M1)$
 $\rightarrow [\text{simplify}]$
 $[62.3] ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{724,1;745,8}.M1)$
 $\rightarrow [\text{from term 59.19, } \text{\$heap}_{724,1;745,8} \text{ is equal to } \text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem}))))]$
 $[62.4] ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem}))))).M1)$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[62.5] ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{funcstart_724,1}.M1)$
 $\rightarrow [\text{const static or extern object}]$
 $[62.6] ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{init}.M1)$
 $\rightarrow [\text{expand definition of constant 'M1' at prang.c (14,20)}]$
 $[62.7] ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1}, \text{\$heap}_{funcstart_724,1}.p1,$

177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) < asType<integer>(asType<short int>((int)30269))

→ [simplify]

[62.17] -30269 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))

[Take given term]

[63.0] \$heap724,1;747,8 == \$heap724,1;745,8._replace(p2 → asType<short int>((asType<int>(asType<short int>(div2.rem)) * asType<int>(\$heap724,1;745,8.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to \$heap_funcstart_724,1._replace(p1 → (-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]

[63.1] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → asType<short int>((asType<int>(asType<short int>(div2.rem)) * asType<int>(\$heap724,1;745,8.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [from term 27.6, div2 is equal to div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)]

[63.2] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → asType<short int>((asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) * asType<int>(\$heap724,1;745,8.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.4] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → asType<short int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem * asType<int>(\$heap724,1;745,8.r2)) - (asType<int>(asType<short int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

→ [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

→ [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}<\text{int}>(\$heap_{init}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})172))) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$

$177).rem)))$.**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$)
 \rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]
[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$)
 \rightarrow [simplify]
[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$)
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$]
[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$). $b2))))$)
 \rightarrow [const member of object with modified fields]
[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b2))))$)

→ [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b2))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})35))))))$

→ [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))))$

[Take given term]

[67.0] $\$heap_{724,1;749,8} == \$heap_{724,1;747,8} \cdot \text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}3.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}3.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.b3))))$

→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)))]$

[67.1] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)))) \cdot \text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}3.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}3.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;747,8}.b3))))$

→ [const member of object with modified fields]

```
[67.7] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_funcstart_724,1.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
```

→ [const static or extern object]

```
[67.8] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_init.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
```

→ [expand definition of constant 'r3' at prang.c (25,20)]

```
[67.9] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))
```

→ [simplify]

```
[67.12] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))
```

→ [from term 43.6, div3 is equal to div(heapIs \$heap_funcstart_724,1,

$\$heap_{funcstart_724,1} \cdot p3, 178)]$

[67.13] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$
→ [simplify]

[67.15] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)))$

[67.16] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot b3))))$

→ [const member of object with modified fields]

[67.18] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1,$

177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short int**>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<**int**>(\$heap_funcstart_724,1.b3))))))

→ [const static or extern object]

[67.19] \$heap_724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short int**>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<**int**>(\$heap_init.b3))))))

→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] \$heap_724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<**short int**>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<**int**>(**asType**<**short int**>((**int**)63))))))

→ [simplify]

[67.26] \$heap_724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))

[Take goal term]

[1.0] \$heap_724,1;749,8.p1 ≤ **maxof**(**int**)

→ [from term 67.26, \$heap_724,1;749,8 is equal to

\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs**

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))]$

[1.1] $\$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$). $p1 \leq \text{maxof}(\text{int})$

\rightarrow [simplify]

[1.18] $-32768 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))$

\rightarrow [from term 62.17, literal $a < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))$ is true whenever $(-1 + \text{literal}) < -30269]$

Proof of rule precondition:

[1.18.0] $(-32768 + -1) < -30269$

\rightarrow [simplify]

[1.18.2] **true**

[1.19] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,11)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq$

$\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0)$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}\langle \text{short int} \rangle((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}\langle \text{short int} \rangle((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$

```

$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

```

```

–asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) – (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
–asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

```

[Take given term]
[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
→ [simplify]
[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))
→ [const static or extern object]
[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))
→ [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))
→ [simplify]
[11.6] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))
→ [simplify]
[27.1] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))

```

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}), \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div}(\$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))))$

`int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [const static or extern object]

[59.4] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>($heap_init.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [simplify]

[59.8] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]

[59.9] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot)) *
asType<int>($heap_funcstart_724,1.b1))))`
→ [simplify]

[59.11] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_funcstart_724,1.b1))))`
→ [const static or extern object]

[59.12] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_init.b1))))`
→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
- (div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot *
asType<int>($heap_init.b1))))`

$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int}2))))$
 $\rightarrow [\text{simplify}]$
 $[59.19] \text{\$heap}_{724,1;745,8} == \text{\$heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))))$
 $[\text{Take given term}]$
 $[61.0] !(0 == \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{724,1;745,8}.p1))$
 $\rightarrow [\text{from term 59.19, } \text{\$heap}_{724,1;745,8} \text{ is equal to } \text{\$heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))))]$
 $[61.1] !(0 == \text{asType}\langle\text{integer}\rangle(\text{\$heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))))).p1))$
 $\rightarrow [\text{simplify}]$
 $[61.3] !(0 == ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))))$
 $[\text{Take given term}]$
 $[63.0] \text{\$heap}_{724,1;747,8} == \text{\$heap}_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{from term 59.19, } \text{\$heap}_{724,1;745,8} \text{ is equal to } \text{\$heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))))]$
 $[63.1] \text{\$heap}_{724,1;747,8} == \text{\$heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{from term 27.6, } \text{div}2 \text{ is equal to } \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p2, 176)]$
 $[63.2] \text{\$heap}_{724,1;747,8} == \text{\$heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{\text{funcstart}_{724,1}}, \text{\$heap}_{\text{funcstart}_{724,1}}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{rem})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\text{\$heap}_{724,1;745,8}.b2))))$

int>((**asType**<**int**>(**asType**<**short int**>(div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))) * **asType**<**int**>(\$heap724,1;745,8.r2)) -
(**asType**<**int**>(**asType**<**short int**>(div2.quot)) *
asType<**int**>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.4] \$heap724,1;747,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<**short int**>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<**int**>(\$heap724,1;745,8.r2)) - (**asType**<**int**>(**asType**<**short**
int>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

→ [from term 59.19, \$heap724,1;745,8 is equal to
\$heap_funcstart_724,1.**replace**(p1 → (-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))]

[63.5] \$heap724,1;747,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<**short int**>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<**int**>(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).r2)) -
(**asType**<**int**>(**asType**<**short int**>(div2.quot)) *
asType<**int**>(\$heap724,1;745,8.b2))))

→ [const member of object with modified fields]

[63.6] \$heap724,1;747,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<**short int**>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<**int**>(\$heap_funcstart_724,1.r2)) - (**asType**<**int**>(**asType**<**short**
int>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

→ [const static or extern object]

[63.7] \$heap724,1;747,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → **asType**<**short int**>((div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<**int**>(\$heap_init.r2)) - (**asType**<**int**>(**asType**<**short**
int>(div2.quot)) * **asType**<**int**>(\$heap724,1;745,8.b2))))

→ [expand definition of constant 'r2' at prang.c (20,20)]

```
[63.8] $heap724,1;747,8 == $heap_funcstart_724,1..replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem *
asType<int>(asType<short int>((int)172)))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap724,1;745,8.b2))))
```

→ [simplify]

```
[63.11] $heap724,1;747,8 == $heap_funcstart_724,1..replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap724,1;745,8.b2))))
```

→ [from term 27.6, div2 is equal to div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176)]

```
[63.12] $heap724,1;747,8 == $heap_funcstart_724,1..replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot)) * asType<int>($heap724,1;745,8.b2))))
```

→ [simplify]

```
[63.14] $heap724,1;747,8 == $heap_funcstart_724,1..replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem) - (div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot *
asType<int>($heap724,1;745,8.b2))))
```

→ [from term 59.19, \$heap724,1;745,8 is equal to

```
$heap_funcstart_724,1..replace(p1 → (-2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem)))]
```

```
[63.15] $heap724,1;747,8 == $heap_funcstart_724,1..replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
```

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot *$
 $asType<int>(\$heap_funcstart_724,1.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).b2))))$

→ [const member of object with modified fields]

$[63.16] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot *$
 $asType<int>(\$heap_funcstart_724,1.b2))))$

→ [const static or extern object]

$[63.17] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot *$
 $asType<int>(\$heap_{init}.b2))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

$[63.18] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) - (div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot *$
 $asType<int>(asType<short int>((int)35))))$

→ [simplify]

$[63.24] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).rem))))$

[Take given term]

$[67.0] \$heap_{724,1;749,8} == \$heap_{724,1;747,8}.replace(p3 \rightarrow asType<short$
 $int>((asType<int>(asType<short int>(div3.rem)) *$
 $asType<int>(\$heap_{724,1;747,8}.r3)) - (asType<int>(asType<short$
 $int>(div3.quot)) * asType<int>(\$heap_{724,1;747,8}.b3))))$

[67.5] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [const member of object with modified fields]

[67.7] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [const static or extern object]

[67.8] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\$heap_{init}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))$

→ [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})170))) -$

$(\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot}))) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))$
 $\rightarrow [\text{simplify}]$
 $[67.12] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem} * 170) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3.quot}))) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)]$
 $[67.13] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}))) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{simplify}]$
 $[67.15] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 63.24, } \$heap_{724,1;747,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))]$
 $[67.16] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$


```

177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot *
asType<int>($heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem))).b3))))

```

→ [const member of object with modified fields]

```

[67.18] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot *
asType<int>($heap_funcstart_724,1.b3))))

```

→ [const static or extern object]

```

[67.19] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot *
asType<int>($heap_init.b3))))

```

→ [expand definition of constant 'b3' at prang.c (27,20)]

```

[67.20] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63)))))

```

→ [simplify]

```

[67.26] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *

```

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))))$

[Take goal term]

[1.0] $\text{minof}(\text{int}) \leq \text{static_cast}\langle \text{integer} \rangle (\text{asType}\langle \text{int} \rangle (\$ \text{heap}_{724,1;749,8} \cdot p1) < (\text{int})0)$

→ [simplify]

[1.1] $-32768 \leq \text{static_cast}\langle \text{integer} \rangle (\text{asType}\langle \text{int} \rangle (\$ \text{heap}_{724,1;749,8} \cdot p1) < (\text{int})0)$

→ [from term 67.26, $\$ \text{heap}_{724,1;749,8}$ is equal to

$\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))) \cdot \text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))))$

[1.2] $-32768 \leq$

$\text{static_cast}\langle \text{integer} \rangle (\text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))) \cdot p1) < (\text{int})0)$

→ [simplify]

[1.14] $-32768 \leq ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, []: 0)$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.15] $-32768 \leq ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [!(0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot})))]: 0)$

→ [simplify]

[1.20] $-32768 \leq ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [-1 < ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 0)$

→ [from term 61.3, $-1 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$ is true if and only if $0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$]

[1.21] $-32768 \leq ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 0)$

→ [simplify]

[1.23] $-32769 < ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 0)$

→ [move guard outside expression]

[1.24] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: -32769 < 1, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: -32769 < 0)$

→ [simplify]

[1.26] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: \text{true}, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: \text{true})$

→ [all guards have equal guarded terms]

[1.27] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,11)

Condition defined at:

To prove: $\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0) \leq \text{maxof}(\text{int})$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

```

```

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *

```

```

asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))`
→ [simplify]

[11.6] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)`
[Take given term]

[27.0] `div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))`
→ [simplify]

[27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))`
→ [const static or extern object]

[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_init.a2))`
→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))`
→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
[Take given term]

[43.0] `div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))`
→ [simplify]

[43.1] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_funcstart_724,1.a3))`
→ [const static or extern object]

[43.2] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_init.a3))`
→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>(asType<short int>((int)178)))`
→ [simplify]

[43.6] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178)`
[Take given term]

[59.0] `$heap_724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short`

`int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`
→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]
[59.1] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)) * asType<int>(\$heap_funcstart_724,1.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
asType<int>(\$heap_funcstart_724,1.b1))))
→ [simplify]
[59.3] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(\$heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>(\$heap_funcstart_724,1.b1))))
→ [const static or extern object]
[59.4] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(\$heap_init.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>(\$heap_funcstart_724,1.b1))))
→ [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType<int>(\$heap_funcstart_724,1.b1))))
→ [simplify]
[59.8] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType<int>(\$heap_funcstart_724,1.b1))))
→ [from term 11.6, div1 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177)]
[59.9] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short
int>((171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot)) *
asType<int>(\$heap_funcstart_724,1.b1))))
→ [simplify]
[59.11] \$heap724,1;745,8 == \$heap_funcstart_724,1._replace(p1 → asType<short

$\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{const static or extern object}]$

$[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\$ \text{heap_init.b1}))))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$

$[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int} 2))))))$
 $\rightarrow [\text{simplify}]$

$[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$
 $[\text{Take given term}]$

$[61.0] !(0 == \text{asType} < \text{integer} > (\$ \text{heap}_{724,1;745,8}.p1))$
 $\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to}$
 $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})))]$

$[61.1] !(0 == \text{asType} < \text{integer} > (\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))))).p1))$
 $\rightarrow [\text{simplify}]$

$[61.3] !(0 == ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{rem}))))$
 $[\text{Take given term}]$

$[63.0] \$\text{heap}_{724,1;747,8} == \$\text{heap}_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div2}.\text{rem})) *$
 $\text{asType} < \text{int} > (\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType} < \text{int} > (\text{asType} < \text{short}$
 $\text{int} > (\text{div2}.\text{quot})) * \text{asType} < \text{int} > (\$ \text{heap}_{724,1;745,8}.\text{b2}))))$
 $\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to}$
 $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})))]$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle(\text{div2}.rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [simplify]

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$]

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2}.quot))) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

\rightarrow [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_funcstart_724,1.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [const static or extern object]

[63.7] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(\$heap_init.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.11] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>(\$heap724,1;745,8.b2))))

→ [from term 27.6, div2 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176)]

[63.12] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot)) * asType<int>(\$heap724,1;745,8.b2))))

→ [simplify]

[63.14] \$heap724,1;747,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot)) * asType<int>(\$heap724,1;745,8.b2))))

```
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))..replace(p2 → asType<short int>((172 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem) - (div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot *
asType<int>($heap_724,1;745,8.b2))))))
```

```
[63.15] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).quot *
asType<int>($heap_{funcstart-724,1}.replace(p1 → ((-2 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).rem))).b2))))
```

```
[63.16] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).quot *
asType<int>($heap_{funcstart-724,1}.b2))))
```

```
[63.17] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.replace(p1 → ((-2 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1, 177).quot) + (171 *
div(heapIs $heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p1,
177).rem))).replace(p2 → asType<short int>((172 * div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).rem) - (div(heapIs
$heap_{funcstart-724,1}, $heap_{funcstart-724,1}.p2, 176).quot *
asType<int>($heap_{init}.b2))))
```

```
[63.18] $heap_{724,1;747,8} == $heap_{funcstart-724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p1, 177).\text{rem}))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle\mathbf{short\ int}\rangle((172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p2, 176).\text{rem}) - (\text{div}(\mathbf{heapIs} \ \$heap_{funcstart-724,1}, \ \$heap_{funcstart-724,1}p2, 176).\text{quot} *
```

$\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int}35))))$
 $\rightarrow [\text{simplify}]$
[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))))$
[Take given term]
[67.0] $\$heap_{724,1;749,8} == \$heap_{724,1;747,8}.\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}3.\text{rem})) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}3.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 63.24, } \$heap_{724,1;747,8} \text{ is equal to}$
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))]$
[67.1] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}3.\text{rem})) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}3.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 43.6, } \text{div}3 \text{ is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)]$
[67.2] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem})) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;747,8}.r3)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}3.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{simplify}]$

177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<short int>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) –
(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_724,1;747,8.b3))))))

→ [from term 63.24, \$heap_724,1;747,8 is equal to

\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → (-35 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]

[67.16] \$heap_724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<short int>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) –
(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).b3))))))

→ [const member of object with modified fields]

[67.18] \$heap_724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<short int>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) –
(div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_funcstart_724,1.b3))))))

→ [const static or extern object]

[67.19] \$heap_724,1;749,8 == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → **asType**<short int>((170
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) –

(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(\$heap_init.b3))))

→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) -
(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63)))))

→ [simplify]

[67.26] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))

[Take goal term]

[1.0] static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) < (int)0) ≤
maxof(int)

→ [from term 67.26, \$heap724,1;749,8 is equal to

\$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → (-63 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))]

[1.1] static_cast<integer>(asType<int>(\$heap_funcstart_724,1._replace(p1
→ ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) +
(171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).p1) < (int)0) ≤
maxof(int)

→ [simplify]

[1.13] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, []: 0) \leq \text{maxof}(\text{int})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.14] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [!(0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))): 0] \leq \text{maxof}(\text{int})$

→ [simplify]

[1.19] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [-1 < ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 0] \leq \text{maxof}(\text{int})$

→ [from term 61.3, $-1 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$ is true if and only if $0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$]

[1.20] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 0] \leq \text{maxof}(\text{int})$

→ [simplify]

[1.22] $(-1 + ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 1, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 0)) < 32767$

→ [move guard outside expression]

[1.23] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: -1 + 1, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: -1 + 0] < 32767$

→ [simplify]

[1.26] $0 < (32767 + -([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 0, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 0] < 32767$

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: -1))$
 \rightarrow [move guard outside expression]
[1.27] $0 < (32767 + ([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: -0, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: --1))$
 \rightarrow [simplify]
[1.29] $0 < (32767 + ([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 0, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 1))$
 \rightarrow [move guard outside expression]
[1.30] $0 < ([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 0 + 32767, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 1 + 32767)$
 \rightarrow [simplify]
[1.32] $0 < ([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 32767, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 32768)$
 \rightarrow [move guard outside expression]
[1.33] $([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 0 < 32767, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 < 32768)$
 \rightarrow [simplify]
[1.35] $([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: true, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: true)$
 \rightarrow [all guards have equal guarded terms]
[1.36] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,25)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.M1) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0)))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) /$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1}.quot)$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \%$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1}.rem)$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) <$

```

asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤

```

```

asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1..replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8..replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8..replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,

$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 $\rightarrow [\text{const static or extern object}]$
 $[11.2] \text{ div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{init}.a1))$
 $\rightarrow [\text{expand definition of constant 'a1' at prang.c (16,20)}]$
 $[11.3] \text{ div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})177)))$
 $\rightarrow [\text{simplify}]$
 $[11.6] \text{ div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$
 $[\text{Take given term}]$
 $[27.0] \text{ div2} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p2),$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a2))$
 $\rightarrow [\text{simplify}]$
 $[27.1] \text{ div2} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a2))$
 $\rightarrow [\text{const static or extern object}]$
 $[27.2] \text{ div2} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{init}.a2))$
 $\rightarrow [\text{expand definition of constant 'a2' at prang.c (21,20)}]$
 $[27.3] \text{ div2} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})176)))$
 $\rightarrow [\text{simplify}]$
 $[27.6] \text{ div2} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$
 $[\text{Take given term}]$
 $[43.0] \text{ div3} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p3),$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a3))$
 $\rightarrow [\text{simplify}]$
 $[43.1] \text{ div3} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a3))$
 $\rightarrow [\text{const static or extern object}]$
 $[43.2] \text{ div3} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $\text{asType}\langle\text{int}\rangle(\$heap_{init}.a3))$
 $\rightarrow [\text{expand definition of constant 'a3' at prang.c (26,20)}]$
 $[43.3] \text{ div3} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$

$\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})178)))$
 $\rightarrow [\text{simplify}]$
 $[43.6] \text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$
 $[\text{Take given term}]$
 $[59.0] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)]$
 $[59.1] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$
 $\rightarrow [\text{simplify}]$
 $[59.3] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r1}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.4] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_init.r1}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$
 $\rightarrow [\text{expand definition of constant 'r1' at prang.c (15,20)}]$
 $[59.5] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$
 $\rightarrow [\text{simplify}]$
 $[59.8] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$
 $\rightarrow [\text{from term 11.6, div1 is equal to div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)]$
 $[59.9] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div1.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b1}))))))$

$\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot})) *$
 $\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{simplify}]$
 $[59.11] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1.b1}))))$
 $\rightarrow [\text{const static or extern object}]$
 $[59.12] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\$ \text{heap_init.b1}))))$
 $\rightarrow [\text{expand definition of constant 'b1' at prang.c (17,20)}]$
 $[59.13] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$
 $- (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} *$
 $\text{asType} < \text{int} > (\text{asType} < \text{short int} > ((\text{int} 2))))))$
 $\rightarrow [\text{simplify}]$
 $[59.19] \$\text{heap}_{724,1;745,8} == \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$
 $[\text{Take given term}]$
 $[61.0] !(0 == \text{asType} < \text{integer} > (\$ \text{heap}_{724,1;745,8}.p1))$
 $\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to}$
 $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem})))$
 $[61.1] !(0 == \text{asType} < \text{integer} > (\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))).\text{p1}))$
 $\rightarrow [\text{simplify}]$
 $[61.3] !(0 == ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1},$
 $177).\text{rem}))))$
 $[\text{Take given term}]$
 $[63.0] \$\text{heap}_{724,1;747,8} == \$\text{heap}_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType} < \text{short}$
 $\text{int} > ((\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div} 2).\text{rem})) *$

$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, \$heap_{724,1;745,8} is equal to
\$heap_funcstart_724,1.**.replace**(p1 → (-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))]]]

[63.1] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem))) *
asType<int>\$(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>\$(\$heap_{724,1;745,8}.b2)))))

→ [from term 27.6, div2 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176)]]]

[63.2] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → asType<short
int>((asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))) * asType<int>\$(\$heap_{724,1;745,8}.r2)) -
(asType<int>(asType<short int>(div2.quot))) *
asType<int>\$(\$heap_{724,1;745,8}.b2)))))

→ [simplify]

[63.4] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → asType<short
int>((div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem) *
asType<int>\$(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>\$(\$heap_{724,1;745,8}.b2)))))

→ [from term 59.19, \$heap_{724,1;745,8} is equal to
\$heap_funcstart_724,1.**.replace**(p1 → (-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))]]]

[63.5] \$heap_{724,1;747,8} == \$heap_funcstart_724,1.**.replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**.replace**(p2 → asType<short
int>((div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem) *
asType<int>\$(\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) .r2)) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [const\ member\ of\ object\ with\ modified\ fields]$
 $[63.6] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{funcstart_724,1}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[63.7] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(\$heap_{init}.r2)) - (asType<int>(asType<short$
 $int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [expand\ definition\ of\ constant\ 'r2'\ at\ prang.c\ (20,20)]$
 $[63.8] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(asType<short int>((int)172))) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [simplify]$
 $[63.11] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * 172) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 27.6,\ div2\ is\ equal\ to\ div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176)]$
 $[63.12] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$

$177).rem)))$.**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$)
 \rightarrow [simplify]
[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$)
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$]
[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).b2))))
 \rightarrow [const member of object with modified fields]
[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b2))))$)
 \rightarrow [const static or extern object]
[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b2))))$)
 \rightarrow [expand definition of constant 'b2' at prang.c (22,20)]

int>((**asType**<**int**>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem))) * **asType**<**int**>(\$heap724,1;747,8.r3)) -
(asType<**int**>(asType<short int>(div3.quot))) *
asType<**int**>(\$heap724,1;747,8.b3))))

→ [simplify]

[67.4] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → **asType**<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap724,1;747,8.r3)) - (asType<**int**>(asType<short
int>(div3.quot))) * asType<**int**>(\$heap724,1;747,8.b3))))

→ [from term 63.24, \$heap724,1;747,8 is equal to

\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 → (-35 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]

[67.5] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → **asType**<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**replace**(p2 → ((-35
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).r3)) -
(asType<**int**>(asType<short int>(div3.quot))) *
asType<**int**>(\$heap724,1;747,8.b3))))

→ [const member of object with modified fields]

[67.7] \$heap724,1;749,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**replace**(p3 → **asType**<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<**int**>(\$heap_funcstart_724,1.r3)) - (asType<**int**>(asType<short

`int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [const static or extern object]
[67.8] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_init.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [simplify]
[67.12] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))`
 \rightarrow [from term 43.6, div3 is equal to div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178)]
[67.13] `$heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_funcstart_724,1,`

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}<\text{int}>(\$heap_{init}.b3))))$

\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]

$[67.20] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})63))))))$

\rightarrow [simplify]

$[67.26] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))))$

[Take goal term]

$[1.0] \text{minof}(\text{int}) \leq (\text{asType}<\text{int}>(\$heap_{724,1;749,8}.M1) * \text{asType}<\text{int}>(\text{static_cast}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{724,1;749,8}.p1) < (\text{int})0)))$

\rightarrow [simplify]

$[1.1] -32768 \leq (\text{asType}<\text{int}>(\$heap_{724,1;749,8}.M1) * \text{asType}<\text{int}>(\text{static_cast}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{724,1;749,8}.p1) < (\text{int})0)))$

\rightarrow [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))._replace(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))]$
 $[1.2] -32768 \leq (\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))).M1) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;749,8}.p1) < (\text{int})0))))$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[1.5] -32768 \leq (\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.M1) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;749,8}.p1) < (\text{int})0))))$
 $\rightarrow [\text{const static or extern object}]$
 $[1.6] -32768 \leq (\text{asType}\langle\text{int}\rangle(\$ \text{heap}_{init}.M1) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;749,8}.p1) < (\text{int})0))))$
 $\rightarrow [\text{expand definition of constant 'M1' at prang.c (14,20)}]$
 $[1.7] -32768 \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30269)) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;749,8}.p1) < (\text{int})0))))$
 $\rightarrow [\text{simplify}]$
 $[1.10] -32768 \leq (30269 * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;749,8}.p1) < (\text{int})0))))$
 $\rightarrow [\text{from term 67.26, } \$\text{heap}_{724,1;749,8} \text{ is equal to } \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))))]$
 $[1.11] -32768 \leq (30269 * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))]$

$\$heap_funcstart_724,1.p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$. $p1 < (\mathbf{int}0)))$
 \rightarrow [simplify]
 $[1.23] -32768 \leq (30269 * \mathbf{asType}<\mathbf{int}>([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 1, []: 0)))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
 $[1.24] -32768 \leq (30269 * \mathbf{asType}<\mathbf{int}>([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 1, [!(0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 0)))$
 \rightarrow [simplify]
 $[1.29] -32768 \leq (30269 * \mathbf{asType}<\mathbf{int}>([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 1, [-1 < ((171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (-2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 0)))$
 \rightarrow [from term 61.3, $-1 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$ is true if and only if $0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$]
 $[1.30] -32768 \leq (30269 * \mathbf{asType}<\mathbf{int}>([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 1, [0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0)))$
 \rightarrow [simplify]
 $[1.31] -32768 \leq (30269 * ([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 1, [0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0)))$
 \rightarrow [move guard outside expression]
 $[1.32] -32768 \leq ([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 1 * 30269, [0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 * 30269)$

→ [simplify]

[1.36] $-32769 < ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 30269, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 0)$

→ [move guard outside expression]

[1.37] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: -32769 < 30269, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: -32769 < 0)$

→ [simplify]

[1.39] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: \text{true}, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: \text{true})$

→ [all guards have equal guarded terms]

[1.40] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,25)

Condition defined at:

To prove: $(\text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;749,8}.\text{M1}) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;749,8}.\text{p1}) < (\text{int})0))) \leq \text{maxof}(\text{int})$

Given:

$\$ \text{heap}_{init}.\text{LIMIT} == (\text{int})80$

$\$ \text{heap}_{init}.\text{M1} == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$

$\$ \text{heap}_{init}.\text{r1} == \text{asType}\langle \text{short int} \rangle((\text{int})171)$

$\$ \text{heap}_{init}.\text{a1} == \text{asType}\langle \text{short int} \rangle((\text{int})177)$

$\$ \text{heap}_{init}.\text{b1} == \text{asType}\langle \text{short int} \rangle((\text{int})2)$

$\$ \text{heap}_{init}.\text{M2} == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$

$\$ \text{heap}_{init}.\text{r2} == \text{asType}\langle \text{short int} \rangle((\text{int})172)$

$\$ \text{heap}_{init}.\text{a2} == \text{asType}\langle \text{short int} \rangle((\text{int})176)$

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

```

```

!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

```

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

```

→ [simplify]

```

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

```

→ [const static or extern object]

```

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))

```

→ [expand definition of constant 'a1' at prang.c (16,20)]

```

[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

```

→ [simplify]

```

[11.6] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)

```

[Take given term]

```

[27.0] div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

```

→ [simplify]

```

[27.1] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))

```

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\$ \text{heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}), \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType<short int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

$$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

→ [const static or extern object]

[59.4]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

→ [simplify]

[59.8]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

→ [from term 11.6, div1 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]

[59.9]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

→ [simplify]

[59.11]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

→ [const static or extern object]

[59.12]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.b1))))$$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13]
$$\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})2))))$$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[61.0] $!(0 == \text{asType}\langle\text{integer}\rangle(\$heap_{724,1;745,8}.p1))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[61.1] $!(0 == \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).p1))$

→ [simplify]

[61.3] $!(0 == ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))$

[Take given term]

[63.0] $\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[63.1] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)$]

[63.2] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p2, 176).rem)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) -$
 $(\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{simplify}]$
 $[63.4] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]$
 $[63.5] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[63.6] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{const static or extern object}]$
 $[63.7] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.\text{quot})) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [\text{expand definition of constant 'r2' at prang.c (20,20)}]$

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.11] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 27.6, $\text{div}2$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)$]

[63.12] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [simplify]

[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
asType<int>(\$heap_{funcstart_724,1}.**replace**(p1 → ((-2 * div(**heapIs**
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.b2))))

→ [const member of object with modified fields]

[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**(p1 → ((-2 *
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.**replace**(p2 → **asType<short int>**((172 * div(**heapIs**
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
asType<int>(\$heap_{funcstart_724,1}.b2))))

→ [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**(p1 → ((-2 *
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.**replace**(p2 → **asType<short int>**((172 * div(**heapIs**
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
asType<int>(\$heap_{init}.b2))))

→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**(p1 → ((-2 *
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.**replace**(p2 → **asType<short int>**((172 * div(**heapIs**
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
asType<int>(**asType<short int>**((int)35))))

→ [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.$ **replace**(p1 → ((-2 *
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
div(**heapIs** $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.**replace**(p2 → ((-35 * div(**heapIs** $\$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}$ $\$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$

[Take given term]

[67.0] $\$heap_{724,1;749,8} == \$heap_{724,1;747,8}.$ **replace**(p3 → **asType<short**
int>((**asType<int>**(**asType<short int>**(div3.rem)) *
asType<int>(\$heap_{724,1;747,8}.r3)) - (**asType<int>**(**asType<short**
int>(div3.quot)) * **asType<int>**(\$heap_{724,1;747,8}.b3))))

→ [from term 63.24, $\$heap_{724,1;747,8}$ is equal to


```

div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap724,1;747,8.b3))))

```

→ [const member of object with modified fields]

```

[67.7] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_funcstart_724,1.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

```

→ [const static or extern object]

```

[67.8] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>($heap_init.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

```

→ [expand definition of constant 'r3' at prang.c (25,20)]

```

[67.9] $heap724,1;749,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → asType<short
int>((div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *

```

$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))$
 $\rightarrow [\text{simplify}]$
 $[67.12] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem} * 170) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)]$
 $[67.13] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{simplify}]$
 $[67.15] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 63.24, } \$heap_{724,1;747,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))]$
 $[67.16] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))

[Take goal term]

[1.0] (asType<int>(\$heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) ≤ maxof(int)

→ [from term 67.26, \$heap724,1;749,8 is equal to

\$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → (-63 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))]

[1.1] (asType<int>(\$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35
* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
176).rem)))._replace(p3 → ((-63 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem))).M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) ≤ maxof(int)

→ [const member of object with modified fields]

[1.4] (asType<int>(\$heap_funcstart_724,1.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) ≤ maxof(int)

→ [const static or extern object]

[1.5] (asType<int>(\$heap_init.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) ≤ maxof(int)

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.6] (asType<int>(asType<short int>((int)30269)) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) ≤ maxof(int)

→ [simplify]

[1.9] (30269 *
asType<int>(**static_cast<integer>**(**asType<int>**(\$heap_{724,1};749,8.p1) <
(int)0))) ≤ **maxof**(int)

→ [from term 67.26, \$heap_{724,1};749,8 is equal to
\$heap_{funcstart_724,1}.**replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem)))).**replace**(p2 → ((-35 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))).**replace**(p3 → (-63 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))]

[1.10] (30269 *
asType<int>(**static_cast<integer>**(**asType<int>**(\$heap_{funcstart_724,1}.**replace**(p1
→ ((-2 * div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) +
(171 * div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem)))).**replace**(p2 → ((-35 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176).rem)))).**replace**(p3 → ((-63 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))))).p1 < (int)0))) ≤
maxof(int)

→ [simplify]

[1.22] (30269 * **asType<int>**(([0 < ((-171 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot))]: 1, []: 0))) ≤ **maxof**(int)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.23] (30269 * **asType<int>**(([0 < ((-171 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot))]: 1, [!(0 < ((-171 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: 0))) ≤ **maxof**(int)

→ [simplify]

[1.28] (30269 * **asType<int>**(([0 < ((-171 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot))]: 1, [-1 < ((171 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (-2 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: 0))) ≤ **maxof**(int)

→ [from term 61.3, -1 < ((-2 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem)) is true if and only if 0 < ((-2 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(**heapIs**
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]

→ [simplify]

[1.42] $0 < (32767 + ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: -30268, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 1))$

→ [move guard outside expression]

[1.43] $0 < ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: -30268 + 32767, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 1 + 32767)$

→ [simplify]

[1.45] $0 < ([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 2499, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 32768)$

→ [move guard outside expression]

[1.46] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: 0 < 2499, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: 0 < 32768)$

→ [simplify]

[1.48] $([0 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))]: \text{true}, [0 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]: \text{true})$

→ [all guards have equal guarded terms]

[1.49] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,5)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$\text{heap}_{724,1;749,8.p1}$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,

```

```

asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <

```

```

asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

```

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

```

→ [simplify]

```

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

```

→ [const static or extern object]

```

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))

```

→ [expand definition of constant 'a1' at prang.c (16,20)]

```

[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

```

→ [simplify]

[11.6] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)`
[Take given term]

[27.0] `div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))`
→ [simplify]

[27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))`
→ [const static or extern object]

[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_init.a2))`
→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))`
→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`
[Take given term]

[43.0] `div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))`
→ [simplify]

[43.1] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_funcstart_724,1.a3))`
→ [const static or extern object]

[43.2] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>($heap_init.a3))`
→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
asType<int>(asType<short int>((int)178)))`
→ [simplify]

[43.6] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178)`
[Take given term]

[59.0] `$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))`

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1.quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1.quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [const static or extern object]

[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init.r1})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1.quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1.quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.8] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div1.quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.9] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))) * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [simplify]

[59.11] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1.b1}))))$

→ [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$

→ [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$

→ [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Take given term]

[60.0] $-\text{asType}\langle \text{integer const} \rangle(\$heap_{724,1;745,8}.M1) < \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1)$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[60.1] $-\text{asType}\langle \text{integer const} \rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).M1) < \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1)$

→ [const member of object with modified fields]

[60.2] $-\text{asType}\langle \text{integer const} \rangle(\$heap_{funcstart_724,1}.M1) < \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1)$

→ [const static or extern object]

[60.3] $-\text{asType}\langle \text{integer const} \rangle(\$heap_{init}.M1) < \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1)$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[60.4] $-\text{asType}\langle \text{integer const} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30269)) < \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1)$

→ [simplify]

[60.8] $-30269 < \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1)$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

$[60.9] -30269 < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot p1)$

$\rightarrow [\text{simplify}]$

$[60.11] -30269 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

$[Take \text{ given term}]$

$[63.0] \$heap_{724,1;747,8} == \$heap_{724,1;745,8} \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.rem)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

$\rightarrow [from \text{ term } 59.19, \$heap_{724,1;745,8} \text{ is equal to } \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))]$

$[63.1] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.rem)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

$\rightarrow [from \text{ term } 27.6, \text{div2} \text{ is equal to } \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176)]$

$[63.2] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.r2)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div2}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

$\rightarrow [\text{simplify}]$

$[63.4] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \cdot \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.r2)) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}<\text{int}>(\$heap_{724,1;745,8}.b2))))$

$$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))$$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))]$

$$\begin{aligned} [63.5] \quad & \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ & 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \\ & \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).r2)) - \\ & (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \\ & \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \end{aligned}$$

\rightarrow [const member of object with modified fields]

$$\begin{aligned} [63.6] \quad & \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ & 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \\ & \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \end{aligned}$$

\rightarrow [const static or extern object]

$$\begin{aligned} [63.7] \quad & \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ & 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \\ & \text{asType}\langle\text{int}\rangle(\$heap_{init}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \end{aligned}$$

\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

$$\begin{aligned} [63.8] \quad & \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ & 177).\text{rem}))).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * \\ & \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})172))) - \\ & (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}2.\text{quot})) * \\ & \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))) \end{aligned}$$

\rightarrow [simplify]

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}.b2))))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[63.17]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short\ int}>((172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{init}.b2))))$
 $\rightarrow [expand\ definition\ of\ constant\ 'b2'\ at\ prang.c\ (22,20)]$
 $[63.18]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short\ int}>((172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})35))))$
 $\rightarrow [simplify]$
 $[63.24]\ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow ((-35 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))$
 $[Take\ given\ term]$
 $[67.0]\ \$heap_{724,1;749,8} == \$heap_{724,1;747,8}.\mathbf{replace}(p3 \rightarrow \mathbf{asType}<\mathbf{short}$
 $\mathbf{int}>((\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short\ int}>(div3.rem)) *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.r3)) - (\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short}$
 $\mathbf{int}>(div3.quot)) * \mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [from\ term\ 63.24,\ \$heap_{724,1;747,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\mathbf{replace}(p2 \rightarrow (-35 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))]$
 $[67.1]\ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(\mathbf{heapIs}\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\mathbf{replace}(p2 \rightarrow ((-35 * div(\mathbf{heapIs}\ \$heap_{funcstart_724,1},$

* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) .r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>(\$heap724,1;747,8.b3))))

→ [const member of object with modified fields]

[67.7] \$heap724,1;749,8 == \$heap_funcstart_724,1. _replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))). _replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))). _replace(p3 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<int>(\$heap_funcstart_724,1.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>(\$heap724,1;747,8.b3))))

→ [const static or extern object]

[67.8] \$heap724,1;749,8 == \$heap_funcstart_724,1. _replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))). _replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))). _replace(p3 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<int>(\$heap_init.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>(\$heap724,1;747,8.b3))))

→ [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] \$heap724,1;749,8 == \$heap_funcstart_724,1. _replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))). _replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))). _replace(p3 → asType<short
int>((div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>(\$heap724,1;747,8.b3))))

→ [simplify]

[67.12] \$heap724,1;749,8 == \$heap_funcstart_724,1. _replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))). _replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))). _replace(p3 → asType<short

$\text{int} > ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * 170) \\
- (\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div3}.\text{quot}))) * \\
\text{asType} < \text{int} > (\$ \text{heap}_{724,1;747,8}.\text{b3})))) \\
\rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p3}, 178)] \\
[67.13] \$ \text{heap}_{724,1;749,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow \text{asType} < \text{short int} > ((170 \\
* \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\
(\text{asType} < \text{int} > (\text{asType} < \text{short int} > (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p3}, 178).\text{quot}))) * \text{asType} < \text{int} > (\$ \text{heap}_{724,1;747,8}.\text{b3})))) \\
\rightarrow [\text{simplify}] \\
[67.15] \$ \text{heap}_{724,1;749,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow \text{asType} < \text{short int} > ((170 \\
* \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\
(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \\
\text{asType} < \text{int} > (\$ \text{heap}_{724,1;747,8}.\text{b3})))) \\
\rightarrow [\text{from term 63.24, } \$ \text{heap}_{724,1;747,8} \text{ is equal to } \\
\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \\
\$ \text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \\
\$ \text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) \\
[67.16] \$ \text{heap}_{724,1;749,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\
177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\
\$ \text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow \text{asType} < \text{short int} > ((170 \\
* \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\
(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \\
\text{asType} < \text{int} > (\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \\
\$ \text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \\
\$ \text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 \\
* \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \\
\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{b3}))))$

→ [const member of object with modified fields]

```
[67.18] $heap724,1;749,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))..replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -
(div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot *
asType<int>($heapfuncstart_724,1.b3))))
```

→ [const static or extern object]

```
[67.19] $heap724,1;749,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))..replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -
(div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot *
asType<int>($heapinit.b3))))
```

→ [expand definition of constant 'b3' at prang.c (27,20)]

```
[67.20] $heap724,1;749,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))..replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -
(div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63))))))
```

→ [simplify]

```
[67.26] $heap724,1;749,8 == $heapfuncstart_724,1..replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))..replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))..replace(p3 → ((-63 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem))))
```

[Take goal term]

[1.0] **minof**(**int**) ≤ \$heap724,1;749,8.p1

→ [simplify]

[1.1] $-32768 \leq \$heap_{724,1;749,8}.p1$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem})))]$

[1.2] $-32768 \leq \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).p1$

→ [simplify]

[1.7] $-32769 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$

→ [from term 60.11, *literal* $< ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$ is true whenever $(-1 + \text{literal}) < -30269]$

Proof of rule precondition:

[1.7.0] $(-32769 + -1) < -30269$

→ [simplify]

[1.7.2] **true**

[1.8] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,5)

Condition defined at:

To prove: $\$heap_{724,1;749,8}.p1 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.\text{LIMIT} == (\text{int})80$

```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),

```

```

asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

```

```

!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

→ [simplify]

[11.6] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)

[Take given term]

[27.0] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p2}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$

→ [simplify]

[27.1] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a2}))$

→ [const static or extern object]

[27.2] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\$ \text{heap_init.a2}))$

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})176)))$

→ [simplify]

[27.6] $\text{div2} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1.a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\$ \text{heap_init.a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType<short int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1.rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.r1})) - (\text{asType<int>}(\text{asType<short int>}(\text{div1.quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1.b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1}.p1, 177)]$

[59.1] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)) * asType<int>(\$heap_{funcstart_724,1}.r1)) - (asType<int>(asType<short\ int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [simplify]$

[59.3] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(\$heap_{funcstart_724,1}.r1)) - (asType<int>(asType<short\ int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [const\ static\ or\ extern\ object]$

[59.4] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(\$heap_{init}.r1)) - (asType<int>(asType<short\ int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [expand\ definition\ of\ constant\ 'r1'\ at\ prang.c\ (15,20)]$

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * asType<int>(asType<short\ int>((int)171))) - (asType<int>(asType<short\ int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [simplify]$

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem * 171) - (asType<int>(asType<short\ int>(div1.quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [from\ term\ 11.6,\ div1\ is\ equal\ to\ div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)]$

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (asType<int>(asType<short\ int>(div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot)) * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [simplify]$

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow asType<short\ int>((171 * div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) - (div(heapIs\ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot * asType<int>(\$heap_{funcstart_724,1}.b1))))$

$\rightarrow [const\ static\ or\ extern\ object]$

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}<\text{int}>(\$heap_{init}.b1))))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot} * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})2))))))$
 \rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$
[Take given term]

[62.0] $\text{asType}<\text{integer}>(\$heap_{724,1;745,8}.p1) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.M1)$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$]

[62.1] $\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).p1) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.M1)$
 \rightarrow [simplify]

[62.3] $((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}<\text{integer}>(\$heap_{724,1;745,8}.M1)$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$]

[62.4] $((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).M1)$
 \rightarrow [const member of object with modified fields]

[62.5] $((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).M1)$

$177).rem)) < \text{asType}\langle \text{integer} \rangle (\$heap_{funcstart_724,1}.M1)$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[62.6] ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)) < \text{asType}\langle \text{integer} \rangle (\$heap_{init}.M1)$
 $\rightarrow [expand\ definition\ of\ constant\ 'M1'\ at\ prang.c\ (14,20)]$
 $[62.7] ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)) < \text{asType}\langle \text{integer} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})30269))$
 $\rightarrow [simplify]$
 $[62.17] -30269 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot))$
 $[Take\ given\ term]$
 $[63.0] \$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div2}.rem)) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 59.19, \$heap_{724,1;745,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.1] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div2}.rem)) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short}$
 $\text{int} \rangle (\text{div2}.quot)) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 27.6, \text{div2}\ is\ equal\ to\ \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176)]$
 $[63.2] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short}$
 $\text{int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)) * \text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8}.r2)) -$
 $(\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div2}.quot)) *$
 $\text{asType}\langle \text{int} \rangle (\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [simplify]$

[63.4] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[63.5] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [const member of object with modified fields]

[63.6] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [const static or extern object]

[63.7] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

[63.8] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$heap_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem *$
 $asType<int>(asType<short int>((int)172))) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [simplify]$
 $[63.11] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem * 172) -$
 $(asType<int>(asType<short int>(div2.quot)) *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 27.6,\ div2\ is\ equal\ to\ div(heapIs\ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176)]$
 $[63.12] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) -$
 $(asType<int>(asType<short int>(div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [simplify]$
 $[63.14] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{724,1;745,8}.b2))))$
 $\rightarrow [from\ term\ 59.19,\ \$heap_{724,1;745,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.15] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))).replace(p2 \rightarrow asType<short int>((172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
 $asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).b2))))$

→ [const member of object with modified fields]

```
[63.16] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem) - (div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot *
asType<int>($heapfuncstart_724,1.b2))))
```

→ [const static or extern object]

```
[63.17] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem) - (div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot *
asType<int>($heapinit.b2))))
```

→ [expand definition of constant 'b2' at prang.c (22,20)]

```
[63.18] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → asType<short int>((172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem) - (div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
```

→ [simplify]

```
[63.24] $heap724,1;747,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem))))
```

[Take given term]

```
[67.0] $heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
```

→ [from term 63.24, \$heap724,1;747,8 is equal to

```
$heapfuncstart_724,1._replace(p1 → ((-2 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).rem)))._replace(p2 → (-35 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs
```

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))]$
 [67.1] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.rem)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8.r3}) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8.b3}))))$
 \rightarrow [from term 43.6, div3 is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178)]$
 [67.2] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178).rem)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8.r3}) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8.b3}))))$
 \rightarrow [simplify]
 [67.4] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem))).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178).rem * \text{asType}<\text{int}>(\$heap_{724,1;747,8.r3}) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3}.quot)) * \text{asType}<\text{int}>(\$heap_{724,1;747,8.b3}))))$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).rem))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem)))]$
 [67.5] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p2, 176).rem)))$.replace(p3 \rightarrow asType<short
 int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem *
 asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs
 \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs
 \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) \rightarrow .replace(p2 \rightarrow ((-35
 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))) \rightarrow .r3)) -
 (asType<int>(asType<short int>(div3.quot)) *
 asType<int>(\$heap_{724,1;747,8}.b3))))

\rightarrow [const member of object with modified fields]

[67.7] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).rem))) \rightarrow .replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p2, 176).rem))) \rightarrow .replace(p3 \rightarrow asType<short
 int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem *
 asType<int>(\$heap_{funcstart_724,1}.r3)) - (asType<int>(asType<short
 int>(div3.quot)) * asType<int>(\$heap_{724,1;747,8}.b3))))

\rightarrow [const static or extern object]

[67.8] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).rem))) \rightarrow .replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p2, 176).rem))) \rightarrow .replace(p3 \rightarrow asType<short
 int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem *
 asType<int>(\$heap_{init}.r3)) - (asType<int>(asType<short
 int>(div3.quot)) * asType<int>(\$heap_{724,1;747,8}.b3))))

\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).rem))) \rightarrow .replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p2, 176).rem))) \rightarrow .replace(p3 \rightarrow asType<short
 int>((div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem *
 asType<int>(asType<short int>((int)170))) -
 (asType<int>(asType<short int>(div3.quot)) *
 asType<int>(\$heap_{724,1;747,8}.b3))))

\rightarrow [simplify]

[67.12] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 *

asType<int>(\$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).b3))))

→ [const member of object with modified fields]

[67.18] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → **asType<short int>**((170 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) - (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot * **asType<int>**(\$heap_funcstart_724,1.b3))))))

→ [const static or extern object]

[67.19] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → **asType<short int>**((170 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) - (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot * **asType<int>**(\$heap_init.b3))))))

→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → **asType<short int>**((170 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem) - (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot * **asType<int>**(**asType<short int>**((int)63))))))

→ [simplify]

[67.26] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$

[Take goal term]

[1.0] $\$heap_{724,1;749,8}.p1 \leq \mathbf{maxof(int)}$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow (-63 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))]$

[1.1] $\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).p1 \leq \mathbf{maxof(int)}$

→ [simplify]

[1.18] $-32768 < ((-171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))$

→ [from term 62.17, $literal_a < ((-171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))$ is true whenever $(-1 + literal_a) < -30269$

Proof of rule precondition:

[1.18.0] $(-32768 + -1) < -30269$

→ [simplify]

[1.18.2] **true**

[1.19] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,8)

Condition defined at:

To prove: $\mathbf{minof(short\ int)} \leq ((\mathbf{asType<int>}(\$heap_{724,1;749,8}.M1) * \mathbf{asType<int>}(\mathbf{static_cast<integer>}(\mathbf{asType<int>}(\$heap_{724,1;749,8}.p1) <$

```

(int)0))) + asType<int>($heap724,1;749,8.p1))
Given:
$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==

```

```

asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short

```

```

int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

[11.0] div1 == div(heapIs \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p1),
asType<int>(\$heap_funcstart_724,1.a1))

→ [simplify]

[11.1] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_funcstart_724,1.a1))

→ [const static or extern object]

[11.2] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
asType<int>(\$heap_init.a1))

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] div1 == div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,

asType<int>(asType<short int>((int)177)))
 → [simplify]
 [11.6] div1 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177)
 [Take given term]
 [27.0] div2 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p2),
asType<int>(\$heap_funcstart_724,1.a2))
 → [simplify]
 [27.1] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_funcstart_724,1.a2))
 → [const static or extern object]
 [27.2] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(\$heap_init.a2))
 → [expand definition of constant 'a2' at prang.c (21,20)]
 [27.3] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))
 → [simplify]
 [27.6] div2 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176)
 [Take given term]
 [43.0] div3 == div(**heapIs** \$heap_funcstart_724,1,
asType<int>(\$heap_funcstart_724,1.p3),
asType<int>(\$heap_funcstart_724,1.a3))
 → [simplify]
 [43.1] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(\$heap_funcstart_724,1.a3))
 → [const static or extern object]
 [43.2] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(\$heap_init.a3))
 → [expand definition of constant 'a3' at prang.c (26,20)]
 [43.3] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
asType<int>(asType<short int>((int)178)))
 → [simplify]
 [43.6] div3 == div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178)
 [Take given term]
 [59.0] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**_replace**(p1 → **asType<short int>((asType<int>(asType<short int>(div1.rem)) ***

$$\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$]

$$[59.1] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [simplify]

$$[59.3] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [const static or extern object]

$$[59.4] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\$heap_{init}.r1)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]

$$[59.5] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})171))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [simplify]

$$[59.8] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem} * 171) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}1.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177)$]

$$[59.9] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.b1))))$$

\rightarrow [simplify]

$$[59.11] \$heap_{724,1;745,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})$$

– (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot *
asType<int>(\$heap_funcstart_724,1.b1))))
 → [const static or extern object]
 [59.12] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) – (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot * **asType<int>**(\$heap_init.b1))))
 → [expand definition of constant 'b1' at prang.c (17,20)]
 [59.13] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → **asType<short int>**((171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) – (div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot * **asType<int>**(**asType<short int>**((int)2)))))
 → [simplify]
 [59.19] \$heap724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))
 [Take given term]
 [60.0] –**asType<integer const>**(\$heap724,1;745,8.M1) < **asType<integer>**(\$heap724,1;745,8.p1)
 → [from term 59.19, \$heap724,1;745,8 is equal to
 \$heap_funcstart_724,1.**replace**(p1 → (-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]
 [60.1] –**asType<integer const>**(\$heap_funcstart_724,1.**replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).M1) < **asType<integer>**(\$heap724,1;745,8.p1)
 → [const member of object with modified fields]
 [60.2] –**asType<integer const>**(\$heap_funcstart_724,1.M1) < **asType<integer>**(\$heap724,1;745,8.p1)
 → [const static or extern object]
 [60.3] –**asType<integer const>**(\$heap_init.M1) < **asType<integer>**(\$heap724,1;745,8.p1)
 → [expand definition of constant 'M1' at prang.c (14,20)]
 [60.4] –**asType<integer const>**(**asType<short int>**((int)30269)) < **asType<integer>**(\$heap724,1;745,8.p1)
 → [simplify]
 [60.8] -30269 < **asType<integer>**(\$heap724,1;745,8.p1)

→ [from term 59.19, \$heap_{724,1;745,8} is equal to
 \$heap_{funcstart_724,1}.replace(p1 → (-2 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p1, 177).rem)))]
 [60.9] -30269 < asType<integer>(\$heap_{funcstart_724,1}.replace(p1 → ((-2 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).p1)
 → [simplify]
 [60.11] -30269 < ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).rem))
 [Take given term]
 [61.0] !(0 == asType<integer>(\$heap_{724,1;745,8}.p1))
 → [from term 59.19, \$heap_{724,1;745,8} is equal to
 \$heap_{funcstart_724,1}.replace(p1 → (-2 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p1, 177).rem)))]
 [61.1] !(0 == asType<integer>(\$heap_{funcstart_724,1}.replace(p1 → ((-2 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).p1)
 → [simplify]
 [61.3] !(0 == ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).rem)))
 [Take given term]
 [63.0] \$heap_{724,1;747,8} == \$heap_{724,1;745,8}.replace(p2 → asType<short
 int>((asType<int>(asType<short int>(div2.rem)) *
 asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short
 int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))
 → [from term 59.19, \$heap_{724,1;745,8} is equal to
 \$heap_{funcstart_724,1}.replace(p1 → (-2 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},
 \$heap_{funcstart_724,1}.p1, 177).rem)))]
 [63.1] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 → ((-2 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
 div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
 177).rem))).replace(p2 → asType<short
 int>((asType<int>(asType<short int>(div2.rem)) *
 asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short
 int>(div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\$ \text{heap_init.r2})) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2.quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap724,1;745,8.b2}))))$
 $\rightarrow [\text{expand definition of constant 'r2' at prang.c (20,20)}]$
 $[63.8] \$\text{heap724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2.quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap724,1;745,8.b2}))))$
 $\rightarrow [\text{simplify}]$
 $[63.11] \$\text{heap724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * 172) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div2.quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap724,1;745,8.b2}))))$
 $\rightarrow [\text{from term 27.6, div2 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)]$
 $[63.12] \$\text{heap724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})) * \text{asType}\langle \text{int} \rangle(\$ \text{heap724,1;745,8.b2}))))$
 $\rightarrow [\text{simplify}]$
 $[63.14] \$\text{heap724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) * \text{asType}\langle \text{int} \rangle(\$ \text{heap724,1;745,8.b2}))))$
 $\rightarrow [\text{from term 59.19, } \$\text{heap724,1;745,8} \text{ is equal to } \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))]$

[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))), \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))), b2))))))$

\rightarrow [const member of object with modified fields]

[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))), \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}<\text{int}>(\$heap_{funcstart_724,1} \cdot b2))))))$

\rightarrow [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))), \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}<\text{int}>(\$heap_{init} \cdot b2))))))$

\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))), \text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})35))))))$

\rightarrow [simplify]

[63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))), \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))))$

[67.0] \$heap_{724,1;749,8} == \\$heap_{724,1;747,8}.replace(p3 \rightarrow asType<short int>((asType<int>(asType<short int>(div3.rem)) * asType<int>(\\$heap_{724,1;747,8}.r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8}.b3))))

\(\rightarrow\) [from term 63.24, \$heap_{724,1;747,8}\$ is equal to
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow (-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))]$

[67.1] \$heap_{724,1;749,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((asType<int>(asType<short int>(div3.rem)) * asType<int>(\\$heap_{724,1;747,8}.r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8}.b3))))

\(\rightarrow\) [from term 43.6, div3 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178)]

[67.2] \$heap_{724,1;749,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((asType<int>(asType<short int>(div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p3, 178).rem)) * asType<int>(\\$heap_{724,1;747,8}.r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8}.b3))))

\(\rightarrow\) [simplify]

[67.4] \$heap_{724,1;749,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1}.p3, 178).rem) * asType<int>(\\$heap_{724,1;747,8}.r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8}.b3))))

$$\begin{aligned} & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short} \\ & \text{int}>((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \\ & \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})170))) - \\ & (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \\ & \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{simplify}] \\ & [67.12] \$heap_{724,1;749,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short} \\ & \text{int}>((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * 170) \\ & - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \\ & \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p3}, 178)] \\ & [67.13] \$heap_{724,1;749,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 \\ & * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\ & (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{simplify}] \\ & [67.15] \$heap_{724,1;749,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 \\ & * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\ & (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \\ & \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{from term 63.24, } \$heap_{724,1;747,8} \text{ is equal to} \\ & \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow (-35 * \text{div}(\text{heapIs }
\end{aligned}$$


```

$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem)))

[67.16] $heap724,1;749,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -
(div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot *
asType<int>($heapfuncstart_724,1._replace(p1 → ((-2 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).rem)))._replace(p2 → ((-35
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot) + (172 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem))).b3))))
→ [const member of object with modified fields]

[67.18] $heap724,1;749,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -
(div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot *
asType<int>($heapfuncstart_724,1.b3))))
→ [const static or extern object]

[67.19] $heap724,1;749,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -
(div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot *
asType<int>($heapinit.b3))))
→ [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] $heap724,1;749,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → asType<short int>((170
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem) -

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(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63))))

→ [simplify]

[67.26] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))

[Take goal term]

[1.0] minof(short int) ≤ ((asType<int>(\$heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1))

→ [simplify]

[1.1] -32768 ≤ ((asType<int>(\$heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1))

→ [from term 67.26, \$heap724,1;749,8 is equal to

\$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → (-63 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))]

[1.2] -32768 ≤ ((asType<int>(\$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1))

→ [const member of object with modified fields]

[1.5] -32768 ≤ ((asType<int>(\$heap_funcstart_724,1.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1))

→ [const static or extern object]

[1.6] $-32768 \leq ((\text{asType}\langle\text{int}\rangle(\$heap_{init}.M1) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1))$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.7] $-32768 \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30269)) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1))$

→ [simplify]

[1.10] $-32768 \leq ((30269 * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1))$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem})))$

[1.11] $-32768 \leq ((30269 * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).p1) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1))$

→ [simplify]

[1.23] $-32768 \leq ((30269 * \text{asType}\langle\text{int}\rangle(((0 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) : 1, [] : 0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1))$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.24] $-32768 \leq ((30269 * \text{asType}\langle\text{int}\rangle(((0 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) : 1, [!(0 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) : 0])) +$

asType<int>(\$heap724,1;749,8.p1))

→ [simplify]

[1.29] -32768 ≤ ((30269 * **asType<int>**(([0 < ((-171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot))]: 1, [-1 < ((171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) + (-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot))]: 0))) + **asType<int>**(\$heap724,1;749,8.p1))

→ [from term 61.3, -1 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)) is true if and only if 0 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)))]

[1.30] -32768 ≤ ((30269 * **asType<int>**(([0 < ((-171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot))]: 1, [0 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))]: 0))) + **asType<int>**(\$heap724,1;749,8.p1))

→ [simplify]

[1.31] -32768 ≤ ((30269 * ([0 < ((-171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot))]: 1, [0 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))]: 0)) + **asType<int>**(\$heap724,1;749,8.p1))

→ [move guard outside expression]

[1.32] -32768 ≤ (([0 < ((-171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot))]: 1 * 30269, [0 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))]: 0 * 30269) + **asType<int>**(\$heap724,1;749,8.p1))

→ [simplify]

[1.34] -32768 ≤ ((([0 < ((-171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot))]: 30269, [0 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))]: 0) + **asType<int>**(\$heap724,1;749,8.p1))

→ [from term 67.26, \$heap724,1;749,8 is equal to

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))$

\rightarrow [move guard outside expression]

[1.45] $([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: -32769 < (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: -32769 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]$

\rightarrow [simplify]

[1.47] $([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: -63038 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: -32769 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]$

\rightarrow [from term 60.11, $\text{literal} < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))$ is true whenever $(-1 + \text{literal}) < -30269$]

Proof of rule precondition:

[1.47.0] $(-63038 + -1) < -30269$

\rightarrow [simplify]

[1.47.2] **true**

[1.48] $([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: \text{true}, [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: -32769 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]$

\rightarrow [from term 60.11, $\text{literal} < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))$ is true whenever $(-1 + \text{literal}) < -30269$]

$\$heap_{funcstart_724,1}.p1, 177).rem))$ is true whenever $(-1 + literal_a) < -30269]$

Proof of rule precondition:

[1.48.0] $(-32769 + -1) < -30269$

$\rightarrow [simplify]$

[1.48.2] **true**

[1.49] $([0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: \mathbf{true}, [0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))]: \mathbf{true})$

$\rightarrow [all\ guards\ have\ equal\ guarded\ terms]$

[1.50] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,8)

Condition defined at:

To prove: $((\mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;749,8}.M1) * \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{static_cast}\langle \mathbf{integer} \rangle(\mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;749,8}.p1) < (\mathbf{int})0))) + \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;749,8}.p1)) \leq \mathbf{maxof}(\mathbf{short\ int})$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$

$\$heap_{init}.M1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})30269)$

$\$heap_{init}.r1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})171)$

$\$heap_{init}.a1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})177)$

$\$heap_{init}.b1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})2)$

$\$heap_{init}.M2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})30307)$

$\$heap_{init}.r2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})172)$

$\$heap_{init}.a2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})176)$

$\$heap_{init}.b2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})35)$

$\$heap_{init}.M3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})30323)$

$\$heap_{init}.r3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})170)$

$\$heap_{init}.a3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})178)$

$\$heap_{init}.b3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})63)$

$\$heap_{init}.p1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})1)$

```

$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

```



```

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

```

```

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

Proof:

[Take given term]

```

[11.0] div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

```

→ [simplify]

```

[11.1] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_funcstart_724,1.a1))

```

→ [const static or extern object]

```

[11.2] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>($heap_init.a1))

```

→ [expand definition of constant 'a1' at prang.c (16,20)]

```

[11.3] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
asType<int>(asType<short int>((int)177)))

```

→ [simplify]

```

[11.6] div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)

```

[Take given term]

```

[27.0] div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

```

→ [simplify]

```

[27.1] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_funcstart_724,1.a2))

```

→ [const static or extern object]

```

[27.2] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>($heap_init.a2))

```

→ [expand definition of constant 'a2' at prang.c (21,20)]

```

[27.3] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
asType<int>(asType<short int>((int)176)))

```

→ [simplify]

```

[27.6] div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)

```

[Take given term]

[43.0] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{p3}),$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{a3}))$

→ [simplify]

[43.1] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p3},$
 $\text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{a3}))$

→ [const static or extern object]

[43.2] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p3},$
 $\text{asType<int>}(\$ \text{heap_init}.\text{a3}))$

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p3},$
 $\text{asType<int>}(\text{asType<short int>}((\text{int})178)))$

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p3}, 178)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType<short}$
 $\text{int>}((\text{asType<int>}(\text{asType<short int>}(\text{div1}.\text{rem})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1}.\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$
 $\$ \text{heap_funcstart_724,1}.\text{p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p1}, 177).\text{rem}) * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1}.\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1}.\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [const static or extern object]

[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(\text{p1} \rightarrow \text{asType<short}$
 $\text{int>}((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1}.\text{p1}, 177).\text{rem} * \text{asType<int>}(\$ \text{heap_init}.\text{r1})) -$
 $(\text{asType<int>}(\text{asType<short int>}(\text{div1}.\text{quot})) * \text{asType<int>}(\$ \text{heap_funcstart_724,1}.\text{b1}))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})171))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [simplify]

[59.8] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem * 171) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}1.quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [from term 11.6, $\text{div}1$ is equal to $\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177)$]

[59.9] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot)) * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [simplify]

[59.11] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b1))))$
 \rightarrow [const static or extern object]

[59.12] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b1))))$
 \rightarrow [expand definition of constant 'b1' at prang.c (17,20)]

[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})2))))))$
 \rightarrow [simplify]

[59.19] $\$heap_{724,1;745,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))))$
[Take given term]

[61.0] $!(0 == \text{asType}\langle \text{integer} \rangle(\$heap_{724,1;745,8}.p1))$
 \rightarrow [from term 59.19, $\$heap_{724,1;745,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

$[61.1] \text{ !(0 == asType<integer>}(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).p1))$

$\rightarrow [\text{simplify}]$

$[61.3] \text{ !(0 == ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))$

$\rightarrow [\text{Take given term}]$

$[62.0] \text{ asType<integer>}(\$heap_{724,1;745,8}.p1) < \text{asType<integer>}(\$heap_{724,1;745,8}.M1)$

$\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

$[62.1] \text{ asType<integer>}(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).p1) < \text{asType<integer>}(\$heap_{724,1;745,8}.M1)$

$\rightarrow [\text{simplify}]$

$[62.3] ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType<integer>}(\$heap_{724,1;745,8}.M1)$

$\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

$[62.4] ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType<integer>}(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))).M1)$

$\rightarrow [\text{const member of object with modified fields}]$

$[62.5] ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})) < \text{asType<integer>}(\$heap_{funcstart_724,1}.M1)$

$\rightarrow [\text{const static or extern object}]$

[62.6] $((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) < \text{asType}\langle\text{integer}\rangle(\$ \text{heap_init.M1})$

→ [expand definition of constant 'M1' at prang.c (14,20)]

[62.7] $((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) < \text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30269))$

→ [simplify]

[62.17] $-30269 < ((-171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}))$

[Take given term]

[63.0] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap}_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

→ [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to $\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))$]

[63.1] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

→ [from term 27.6, div2 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)$]

[63.2] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

→ [simplify]

[63.4] $\$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$

$$177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

\rightarrow [from term 59.19, $\$ \text{heap}_{724,1;745,8}$ is equal to
 $\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).rem)))$

$$[63.5] \$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

\rightarrow [const member of object with modified fields]

$$[63.6] \$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$ \text{heap_funcstart_724,1}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

\rightarrow [const static or extern object]

$$[63.7] \$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{init}.r2)) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) * \text{asType}\langle \text{int} \rangle(\$ \text{heap}_{724,1;745,8}.b2))))))$$

\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]

$$[63.8] \$ \text{heap}_{724,1;747,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{div}(\text{heapIs } \$ \text{heap_funcstart_724,1}, \$ \text{heap_funcstart_724,1} \cdot p2, 176).rem * \text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})172))) - (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle(\text{div}2.quot)) *$$

$\text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2)))))$
 $\rightarrow [\text{simplify}]$
 $[63.11] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem} * 172) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [\text{from term 27.6, div2 is equal to div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176)]$
 $[63.12] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [\text{simplify}]$
 $[63.14] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [\text{from term 59.19, } \$heap_{724,1;745,8} \text{ is equal to } \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))]$
 $[63.15] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).b2))))))$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[63.16] \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).b2)))))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.b2}))))$
 $\rightarrow [\text{const static or extern object}]$
 $[63.17] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{init}.b2))))$
 $\rightarrow [\text{expand definition of constant 'b2' at prang.c (22,20)}]$
 $[63.18] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})35))))))$
 $\rightarrow [\text{simplify}]$
 $[63.24] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))$
 $[\text{Take given term}]$
 $[67.0] \$\text{heap}_{724,1;749,8} == \$\text{heap}_{724,1;747,8}._replace(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{rem})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.r3)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div3}.\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;747,8}.b3))))$
 $\rightarrow [\text{from term 63.24, } \$\text{heap}_{724,1;747,8} \text{ is equal to } \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))]$
 $[67.1] \$\text{heap}_{724,1;749,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))))$

asType<int>(\$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\$heap724,1;747,8.b3))))

→ [const member of object with modified fields]

[67.7] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → asType<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * asType<int>(\$heap_funcstart_724,1.r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\$heap724,1;747,8.b3))))

→ [const static or extern object]

[67.8] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → asType<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * asType<int>(\$heap_init.r3)) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\$heap724,1;747,8.b3))))

→ [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → asType<short int>((div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem * asType<int>(asType<short int>((int)170))) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\$heap724,1;747,8.b3))))

→ [simplify]

[67.12] \$heap724,1;749,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,

$177).rem))))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))._replace(p3 \rightarrow \mathbf{asType}<\mathbf{short}$
 $\mathbf{int}>((\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem * 170)$
 $- (\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \ \mathbf{int}>(\text{div}3.quot)) *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [from \ term \ 43.6, \text{div}3 \ is \ equal \ to \ \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178)]$
 $[67.13] \ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}._replace(p1 \rightarrow ((-2 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))._replace(p3 \rightarrow \mathbf{asType}<\mathbf{short} \ \mathbf{int}>((170$
 $* \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(\mathbf{asType}<\mathbf{int}>(\mathbf{asType}<\mathbf{short} \ \mathbf{int}>(\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot)) * \mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [simplify]$
 $[67.15] \ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}._replace(p1 \rightarrow ((-2 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))._replace(p3 \rightarrow \mathbf{asType}<\mathbf{short} \ \mathbf{int}>((170$
 $* \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;747,8}.b3))))$
 $\rightarrow [from \ term \ 63.24, \ \$heap_{724,1;747,8} \ is \ equal \ to$
 $\$heap_{funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))))._replace(p2 \rightarrow (-35 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))]$
 $[67.16] \ \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}._replace(p1 \rightarrow ((-2 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem))))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))))._replace(p3 \rightarrow \mathbf{asType}<\mathbf{short} \ \mathbf{int}>((170$
 $* \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$
 $(\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot *$
 $\mathbf{asType}<\mathbf{int}>(\$heap_{funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs}$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.b3))))

\rightarrow [const member of object with modified fields]

[67.18] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.b3))))$

\rightarrow [const static or extern object]

[67.19] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\$heap_{init}.b3))))$

\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]

[67.20] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow \text{asType}<\text{short int}>((170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})63))))$

\rightarrow [simplify]

[67.26] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$

[Take goal term]

[1.0] ((asType<int>(\$heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1)) ≤ maxof(short int)

→ [from term 67.26, \$heap724,1;749,8 is equal to

\$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem))).**replace**(p2 → ((-35 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).**replace**(p3 → (-63 *
div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem))]

[1.1] ((asType<int>(\$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**replace**(p2 → ((-35
* div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 *
div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2,
176).rem))).**replace**(p3 → ((-63 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p3, 178).rem))).M1) *

asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1)) ≤ maxof(short int)

→ [const member of object with modified fields]

[1.4] ((asType<int>(\$heapfuncstart_724,1.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1)) ≤ maxof(short int)

→ [const static or extern object]

[1.5] ((asType<int>(\$heapinit.M1) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1)) ≤ maxof(short int)

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.6] ((asType<int>(asType<short int>((int)30269)) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1)) ≤ maxof(short int)

→ [simplify]

[1.9] ((30269 *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;749,8.p1) <
(int)0))) + asType<int>(\$heap724,1;749,8.p1)) ≤ maxof(short int)

→ [from term 67.26, \$heap724,1;749,8 is equal to

\$heapfuncstart_724,1.**replace**(p1 → ((-2 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heapfuncstart_724,1,

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$heap_funcstart_724,1.p1, 177).rem))).replace(p2 → ((-35 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem))).replace(p3 → (-63 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem)))

[1.10] ((30269 *
asType<int>(static.cast<integer>(asType<int>($heap_funcstart_724,1.replace(p1
→ ((-2 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) +
(171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem))).replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem))).replace(p3 → ((-63 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem))).p1 < (int)0))) +
asType<int>($heap724,1;749,8.p1)) ≤ maxof(short int)

→ [simplify]

[1.22] ((30269 * asType<int>((([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))]: 1, [0: 0])) +
asType<int>($heap724,1;749,8.p1)) ≤ maxof(short int)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.23] ((30269 * asType<int>((([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))]: 1, [!(0 < ((-171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot))]): 0])) +
asType<int>($heap724,1;749,8.p1)) ≤ maxof(short int)

→ [simplify]

[1.28] ((30269 * asType<int>((([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))]: 1, [-1 < ((171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem) + (-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot))]): 0])) +
asType<int>($heap724,1;749,8.p1)) ≤ maxof(short int)

→ [from term 61.3, -1 < ((-2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem)) is true if and only if 0 < ((-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)))]

[1.29] ((30269 * asType<int>((([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))]: 1, [0 < ((-2 * div(heapIs

```

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0))) +$
 $asType<int>(\$heap_{724,1;749,8}.p1)) \leq \maxof(short\ int)$
 $\rightarrow [simplify]$
 $[1.30] (([0 < ((-171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot))]: 1, [0 < ((-2 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0)) +$
 $asType<int>(\$heap_{724,1;749,8}.p1)) \leq \maxof(short\ int)$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.31] ((([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).quot))]: 1 * 30269, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))]: 0 * 30269) +$
 $asType<int>(\$heap_{724,1;749,8}.p1)) \leq \maxof(short\ int)$
 $\rightarrow [simplify]$
 $[1.33] ((([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).quot))]: 30269, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))]: 0) + asType<int>(\$heap_{724,1;749,8}.p1))$
 $\leq \maxof(short\ int)$
 $\rightarrow [from\ term\ 67.26, \$heap_{724,1;749,8}\ is\ equal\ to$
 $\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow (-63 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))]$
 $[1.34] ((([0 < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,$
 $177).quot))]: 30269, [0 < ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))]: 0) +$
 $asType<int>(\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 \rightarrow ((-35$
 $* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$

$176).rem)))$. **replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$. $p1)) \leq \text{maxof}(\text{short int})$

→ [simplify]

$[1.39] ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 30269, [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0)) \leq \text{maxof}(\text{short int})$

→ [move guard outside expression]

$[1.40] ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)) \leq \text{maxof}(\text{short int})$

→ [simplify]

$[1.43] (-1 + ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) < 32767$

→ [move guard outside expression]

$[1.44] ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: -1 + (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: -1 + ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) < 32767$

→ [simplify]

[illegible]

```
[1.49] 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))]: -(30268 + (-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)), [0 < ((-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem))]: -(-1 + (-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem))))
```

→ [simplify]

```
[.1.61] 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))]: -30268 + (-171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot), [0 < ((-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem))]: 1 + (-171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem) + (2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot)))
```

$$\rightarrow [\text{move guard outside expression}]$$

```
[1.62] 0 < ([0 < ((-171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot))] : 32767 + (-30268 + (-171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot)), [0 < ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem))] : 32767 +
(1 + (-171 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem)
+ (2 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot)))
```

$$\rightarrow [simplify]$$
$$[1.66] \ 0 < ([0 < ((-171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724, 1, \\ \$heap_funcstart_724, 1.\text{pl}, 177).\text{rem}) + (2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724, 1,$$

$\$heap_funcstart_724,1.p1, 177).quot))]: 2499 + (-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 32768 + (-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))$

→ [move guard outside expression]

$[1.67] ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 0 < (2499 + (-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 < (32768 + (-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)))$

→ [simplify]

$[1.69] ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: -2499 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 < (32768 + (-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)))$

→ [from guard, $\text{literal} < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))$ is true whenever $(-1 + \text{literal}) < 0$]

Proof of rule precondition:

[1.69.0] $(-2499 + -1) < 0$

→ [simplify]

[1.69.2] **true**

$[1.70] ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: \text{true}, [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 < (32768 + (-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)))$

→ [simplify]

[1.72] ([0 < ((-171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: **true**, [0 < ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: -32768 < ((-171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)))

→ [from term 62.17, literal < ((-171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)) is true whenever (-1 + literal) < -30269]

Proof of rule precondition:

[1.72.0] (-32768 + -1) < -30269

→ [simplify]

[1.72.2] **true**

[1.73] ([0 < ((-171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: **true**, [0 < ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: **true**)

→ [all guards have equal guarded terms]

[1.74] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,27)

Condition defined at:

To prove: minof(int) ≤ \$heap_{724,1;752,8}.M2

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

```

$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <

```

```

asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <

```

```

asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

```

Proof:

```

[Take goal term]
[1.0] minof(int) ≤ $heap724,1;752,8.M2
→ [simplify]
[1.1] -32768 ≤ $heap724,1;752,8.M2
→ [const static or extern object]
[1.2] -32768 ≤ $heapinit.M2
→ [expand definition of constant 'M2' at prang.c (19,20)]
[1.3] -32768 ≤ asType<short int>((int)30307)
→ [simplify]
[1.6] true

```

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,27)

Condition defined at:

To prove: \$heap724,1;752,8.M2 ≤ maxof(int)

Given:

\$heap_{init}.LIMIT == (int)80

```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),

```



```

asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

```

```

!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

```

Proof:

[Take goal term]

[1.0] \$heap724,1;752,8.M2 ≤ maxof(int)

→ [const static or extern object]

[1.1] \$heap_{init}.M2 ≤ maxof(int)

→ [expand definition of constant 'M2' at prang.c (19,20)]

[1.2] asType<short int>((int)30307) ≤ maxof(int)

→ [simplify]

[1.6] true

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,17)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{\$heap}_{724,1;752,8}.\text{p2}$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{init}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{init}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{init}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$

$\text{\$heap}_{init}.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$

$\text{\$heap}_{init}.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$

$\text{\$heap}_{init}.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$

$\text{\$heap}_{init}.\text{p1} == \text{asType}<\text{short int}>((\text{int})1)$

$\text{\$heap}_{init}.\text{p2} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{p3} == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \text{\$heap}_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$
 $\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{p1}),$
 $\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{a1}))$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{p1})) /$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{a1}))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{quot})$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{p1})) \%$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{a1}))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{rem})$

$(\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{p1}) <$
 $\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{a1})) ==>$
 $(\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{p1}) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{rem}))$

$(\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{a1}) \leq$

```

asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

```

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

```

Proof:

[Take goal term]

[1.0] **minof**(**int**) ≤ \$heap724,1;752,8.p2

→ [simplify]

[1.3] -32769 < \$heap724,1;752,8.p2

→ [negate goal and search for contradiction]

[1.4] !(-32769 < \$heap724,1;752,8.p2)

\rightarrow [simplify]
 [1.6] $32768 < -\$heap_{724,1;752,8}.p2$
 [Assume known post-assertion, class invariant or type constraint for term 1.6]
 [72.0] $\text{minof}(\text{short int}) \leq \$heap_{724,1;752,8}.p2$
 \rightarrow [simplify]
 [72.3] $-32769 < \$heap_{724,1;752,8}.p2$
 \rightarrow [from term 1.6, $\text{literal}_a < \$heap_{724,1;752,8}.p2$ is false whenever $-2 < (32768 + \text{literal}_a)$]

Proof of rule precondition:

[72.3.0] $-2 < (-32769 + 32768)$
 \rightarrow [simplify]
 [72.3.2] **true**
 [72.4] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,17)

Condition defined at:

To prove: $\$heap_{724,1;752,8}.p2 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

```

$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)

div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==

```

```

asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *

```



```

asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

```

Proof:

[Take goal term]

[1.0] \$heap724,1;752,8.p2 ≤ maxof(int)

→ [simplify]

[1.9] -32768 < -\$heap724,1;752,8.p2

→ [negate goal and search for contradiction]

[1.10] !(-32768 < -\$heap724,1;752,8.p2)

→ [simplify]

[1.13] 32767 < \$heap724,1;752,8.p2

[Assume known post-assertion, class invariant or type constraint for term 1.13]

[72.0] \$heap724,1;752,8.p2 ≤ maxof(short int)

→ [simplify]

[72.9] -32768 < -\$heap724,1;752,8.p2

→ [from term 1.13, literal a < -\$heap724,1;752,8.p2 is false whenever -2 < (32767 + literal a)]

Proof of rule precondition:

[72.9.0] -2 < (-32768 + 32767)

→ [simplify]

[72.9.2] true

[72.10] false

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,11)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq$

`static_cast<integer>(asType<int>($heap724,1;752,8.p2) < (int)0)`

Given:

`$heapinit.LIMIT == (int)80`

`$heapinit.M1 == asType<short int>((int)30269)`

`$heapinit.r1 == asType<short int>((int)171)`

`$heapinit.a1 == asType<short int>((int)177)`

`$heapinit.b1 == asType<short int>((int)2)`

`$heapinit.M2 == asType<short int>((int)30307)`

`$heapinit.r2 == asType<short int>((int)172)`

`$heapinit.a2 == asType<short int>((int)176)`

`$heapinit.b2 == asType<short int>((int)35)`

`$heapinit.M3 == asType<short int>((int)30323)`

`$heapinit.r3 == asType<short int>((int)170)`

`$heapinit.a3 == asType<short int>((int)178)`

`$heapinit.b3 == asType<short int>((int)63)`

`$heapinit.p1 == asType<short int>((int)1)`

`$heapinit.p2 == asType<short int>((int)2)`

`$heapinit.p3 == asType<short int>((int)3)`

`invariant1(heapIs $heapfuncstart_724,1)`

`div1 == div(heapIs $heapfuncstart_724,1,`

`asType<int>($heapfuncstart_724,1.p1),`

`asType<int>($heapfuncstart_724,1.a1))`

`(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /`

`asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==`

`asType<integer>(div1.quot)`

`(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %`

`asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==`

`asType<integer>(div1.rem)`

`(asType<integer>($heapfuncstart_724,1.p1) <`

`asType<integer>($heapfuncstart_724,1.a1)) =>`

`(asType<integer>($heapfuncstart_724,1.p1) ==`

`asType<integer>(div1.rem))`

`(asType<integer>($heapfuncstart_724,1.a1) ≤`

`asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==`

```

asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short

```

```

int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heapfuncstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heapfuncstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

```

Proof:

[Take goal term]

[1.0] minof(**int**) ≤ static.cast<**integer**>(**asType**<**int**>(\$heap_{724,1;752,8}.p2)
 < (**int**)0)

→ [simplify]

[1.6] -32768 ≤ ([0 < -\$heap_{724,1;752,8}.p2]: 1, []: 0)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.7] -32768 ≤ ([0 < -\$heap_{724,1;752,8}.p2]: 1, [!(0 < -\$heap_{724,1;752,8}.p2]): 0)

\rightarrow [simplify]
 [1.12] $-32769 < ([0 < -\$heap_{724,1;752,8}.p2]: 1, [-1 < \$heap_{724,1;752,8}.p2]: 0)$
 \rightarrow [move guard outside expression]
 [1.13] $([0 < -\$heap_{724,1;752,8}.p2]: -32769 < 1, [-1 < \$heap_{724,1;752,8}.p2]: -32769 < 0)$
 \rightarrow [simplify]
 [1.15] $([0 < -\$heap_{724,1;752,8}.p2]: \mathbf{true}, [-1 < \$heap_{724,1;752,8}.p2]: \mathbf{true})$
 \rightarrow [all guards have equal guarded terms]
 [1.16] \mathbf{true}

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,11)

Condition defined at:

To prove: $\mathbf{static_cast}\langle\mathbf{integer}\rangle(\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_{724,1;752,8}.p2) < (\mathbf{int})0) \leq \mathbf{maxof}(\mathbf{int})$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})176)$
 $\$heap_{init}.b2 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})35)$
 $\$heap_{init}.M3 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})30323)$
 $\$heap_{init}.r3 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})170)$
 $\$heap_{init}.a3 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})178)$
 $\$heap_{init}.b3 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})63)$
 $\$heap_{init}.p1 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})1)$
 $\$heap_{init}.p2 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})2)$
 $\$heap_{init}.p3 == \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})3)$

```

invariant1(heapIs $heap_funcstart_724,1)

div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

```

```

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

```

Proof:

[Take goal term]

[1.0] static_cast<integer>(asType<int>(\$heap724,1;752,8.p2) < (int)0) ≤
maxof(int)

→ [simplify]

[1.5] ([0 < -\$heap724,1;752,8.p2]: 1, []: 0) ≤ maxof(int)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.6] ([0 < -\$heap724,1;752,8.p2]: 1, [!(0 < -\$heap724,1;752,8.p2)]: 0) ≤
maxof(int)

→ [simplify]

[1.11] (-1 + ([0 < -\$heap724,1;752,8.p2]: 1, [-1 < \$heap724,1;752,8.p2]: 0)) <
32767

→ [move guard outside expression]

[1.12] ([0 < -\$heap724,1;752,8.p2]: -1 + 1, [-1 < \$heap724,1;752,8.p2]: -1 + 0) <
32767

→ [simplify]

[1.15] 0 < (32767 + -([0 < -\$heap724,1;752,8.p2]: 0, [-1 < \$heap724,1;752,8.p2]:
-1))

→ [move guard outside expression]

[1.16] 0 < (32767 + ([0 < -\$heap724,1;752,8.p2]: -0, [-1 < \$heap724,1;752,8.p2]:
--1))

→ [simplify]

[1.18] 0 < (32767 + ([0 < -\$heap724,1;752,8.p2]: 0, [-1 < \$heap724,1;752,8.p2]:
1))

→ [move guard outside expression]

[1.19] 0 < ([0 < -\$heap724,1;752,8.p2]: 0 + 32767, [-1 < \$heap724,1;752,8.p2]: 1
+ 32767)

→ [simplify]

[1.21] 0 < ([0 < -\$heap724,1;752,8.p2]: 32767, [-1 < \$heap724,1;752,8.p2]: 32768)

→ [move guard outside expression]

[1.22] ([0 < -\$heap_{724,1;752,8}.p2]: 0 < 32767, [-1 < \$heap_{724,1;752,8}.p2]: 0 < 32768)

→ [simplify]

[1.24] ([0 < -\$heap_{724,1;752,8}.p2]: **true**, [-1 < \$heap_{724,1;752,8}.p2]: **true**)

→ [all guards have equal guarded terms]

[1.25] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,25)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.M2) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0)))$

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

\$heap_{init}.p3 == asType<short int>((int)3)

invariant1(heapIs \$heap_{funcstart_724,1})

div1 == div(heapIs \$heap_{funcstart_724,1},

```

asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==

```

```

asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <

```

$\text{asType}\langle\text{integer}\rangle(\$heap_{724,1;749,8}.M3)$
 $\$heap_{724,1;752,8} == \$heap_{724,1;749,8}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.M1) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;749,8}.p1)))$

Proof:

[Take goal term]

$[1.0] \text{minof}(\text{int}) \leq (\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.M2) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0)))$

→ [simplify]

$[1.1] -32768 \leq (\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.M2) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0)))$

→ [const static or extern object]

$[1.2] -32768 \leq (\text{asType}\langle\text{int}\rangle(\$heap_{init}.M2) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0)))$

→ [expand definition of constant 'M2' at prang.c (19,20)]

$[1.3] -32768 \leq (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0)))$

→ [simplify]

$[1.11] -32768 \leq (30307 * \text{asType}\langle\text{int}\rangle([(0 < -\$heap_{724,1;752,8}.p2]: 1, []: 0)))$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

$[1.12] -32768 \leq (30307 * \text{asType}\langle\text{int}\rangle([(0 < -\$heap_{724,1;752,8}.p2]: 1, [(0 < -\$heap_{724,1;752,8}.p2)]: 0)))$

→ [simplify]

$[1.16] -32768 \leq (30307 * ([0 < -\$heap_{724,1;752,8}.p2]: 1, [-1 < \$heap_{724,1;752,8}.p2]: 0))$

→ [move guard outside expression]

$[1.17] -32768 \leq ([0 < -\$heap_{724,1;752,8}.p2]: 1 * 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0 * 30307)$

→ [simplify]

$[1.21] -32769 < ([0 < -\$heap_{724,1;752,8}.p2]: 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0)$

→ [move guard outside expression]

[1.22] $([0 < -\$heap_{724,1;752,8}.p2]: -32769 < 30307, [-1 < \$heap_{724,1;752,8}.p2]: -32769 < 0)$

→ [simplify]

[1.24] $([0 < -\$heap_{724,1;752,8}.p2]: \text{true}, [-1 < \$heap_{724,1;752,8}.p2]: \text{true})$

→ [all guards have equal guarded terms]

[1.25] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,25)

Condition defined at:

To prove: $(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;752,8}.M2) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0))) \leq \text{maxof}(\text{int}))$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle \text{short int} \rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle \text{short int} \rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle \text{short int} \rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle \text{short int} \rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle \text{short int} \rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle \text{short int} \rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle \text{short int} \rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle \text{short int} \rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle \text{short int} \rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle \text{short int} \rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle \text{short int} \rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.p1),$

```

asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

$\$heap_{724,1;752,8} == \$heap_{724,1;749,8} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.M1) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.p1) < (\text{int}0)))) + \text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.p1)))$

Proof:

[Take goal term]

$[1.0] (\text{asType}\langle \text{int} \rangle(\$heap_{724,1;752,8}.M2) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;752,8}.p2) < (\text{int}0)))) \leq \text{maxof}(\text{int})$

→ [const static or extern object]

$[1.1] (\text{asType}\langle \text{int} \rangle(\$heap_{init}.M2) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;752,8}.p2) < (\text{int}0)))) \leq \text{maxof}(\text{int})$

→ [expand definition of constant 'M2' at prang.c (19,20)]

$[1.2] (\text{asType}\langle \text{int} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int}30307)) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;752,8}.p2) < (\text{int}0)))) \leq \text{maxof}(\text{int})$

→ [simplify]

$[1.10] (30307 * \text{asType}\langle \text{int} \rangle([0 < -\$heap_{724,1;752,8}.p2]: 1, []: 0))) \leq \text{maxof}(\text{int})$

→ [explicitly assert falsehood of skipped guards in subsequent guards]

$[1.11] (30307 * \text{asType}\langle \text{int} \rangle([0 < -\$heap_{724,1;752,8}.p2]: 1, [!(0 < -\$heap_{724,1;752,8}.p2)]: 0))) \leq \text{maxof}(\text{int})$

→ [simplify]

$[1.15] (30307 * ([0 < -\$heap_{724,1;752,8}.p2]: 1, [-1 < \$heap_{724,1;752,8}.p2]: 0)) \leq \text{maxof}(\text{int})$

→ [move guard outside expression]

$[1.16] ([0 < -\$heap_{724,1;752,8}.p2]: 1 * 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0 * 30307) \leq \text{maxof}(\text{int})$

→ [simplify]

$[1.20] (-1 + ([0 < -\$heap_{724,1;752,8}.p2]: 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0)) < 32767$

→ [move guard outside expression]

$[1.21] ([0 < -\$heap_{724,1;752,8}.p2]: -1 + 30307, [-1 < \$heap_{724,1;752,8}.p2]: -1 + 0) < 32767$

→ [simplify]

$[1.24] 0 < (32767 + -([0 < -\$heap_{724,1;752,8}.p2]: 30306, [-1 <$

$\$heap_{724,1;752,8.p2}]: -1))$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.25]\ 0 < (32767 + ([0 < -\$heap_{724,1;752,8.p2}]: -30306, [-1 < \$heap_{724,1;752,8.p2}]: -1]))$
 $\rightarrow [simplify]$
 $[1.27]\ 0 < (32767 + ([0 < -\$heap_{724,1;752,8.p2}]: -30306, [-1 < \$heap_{724,1;752,8.p2}]: 1]))$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.28]\ 0 < ([0 < -\$heap_{724,1;752,8.p2}]: -30306 + 32767, [-1 < \$heap_{724,1;752,8.p2}]: 1 + 32767])$
 $\rightarrow [simplify]$
 $[1.30]\ 0 < ([0 < -\$heap_{724,1;752,8.p2}]: 2461, [-1 < \$heap_{724,1;752,8.p2}]: 32768])$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.31]\ ([0 < -\$heap_{724,1;752,8.p2}]: 0 < 2461, [-1 < \$heap_{724,1;752,8.p2}]: 0 < 32768])$
 $\rightarrow [simplify]$
 $[1.33]\ ([0 < -\$heap_{724,1;752,8.p2}]: \mathbf{true}, [-1 < \$heap_{724,1;752,8.p2}]: \mathbf{true}])$
 $\rightarrow [all\ guards\ have\ equal\ guarded\ terms]$
 $[1.34]\ \mathbf{true}$

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,5)

Condition defined at:

To prove: $\minof(int) \leq \$heap_{724,1;752,8.p2}$

Given:

$\$heap_{init}.LIMIT == (int)80$
 $\$heap_{init}.M1 == asType<short int>((int)30269)$
 $\$heap_{init}.r1 == asType<short int>((int)171)$
 $\$heap_{init}.a1 == asType<short int>((int)177)$
 $\$heap_{init}.b1 == asType<short int>((int)2)$
 $\$heap_{init}.M2 == asType<short int>((int)30307)$
 $\$heap_{init}.r2 == asType<short int>((int)172)$
 $\$heap_{init}.a2 == asType<short int>((int)176)$

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

```

```

!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0)))) + asType<int>($heap724,1;749,8.p1)))

```

Proof:

```

[Take goal term]
[1.0] minof(int) ≤ $heap724,1;752,8.p2
→ [simplify]
[1.3] -32769 < $heap724,1;752,8.p2
→ [negate goal and search for contradiction]
[1.4] !(-32769 < $heap724,1;752,8.p2)
→ [simplify]
[1.6] 32768 < -$heap724,1;752,8.p2
[Assume known post-assertion, class invariant or type constraint for term 1.6]
[72.0] minof(short int) ≤ $heap724,1;752,8.p2
→ [simplify]
[72.3] -32769 < $heap724,1;752,8.p2
→ [from term 1.6, literal < $heap724,1;752,8.p2 is false whenever -2 < (32768
+ literal)]

```

Proof of rule precondition:

```

[72.3.0] -2 < (-32769 + 32768)
→ [simplify]
[72.3.2] true

```

[72.4] false

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,5)

Condition defined at:

To prove: $\$heap_{724,1;752,8}.p2 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1),$

$\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1)) /$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.quot)$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1)) \%$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.rem)$

$(\text{asType}<\text{integer}>(\$heap_{funcstart_724,1}.p1) <$

```

asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤

```

```

asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

```

Proof:

[Take goal term]

[1.0] \$heap724,1;752,8.p2 ≤ maxof(int)

\rightarrow [simplify]
 [1.9] $-32768 < -\$heap_{724,1;752,8}.p2$
 \rightarrow [negate goal and search for contradiction]
 [1.10] $\neg(-32768 < -\$heap_{724,1;752,8}.p2)$
 \rightarrow [simplify]
 [1.13] $32767 < \$heap_{724,1;752,8}.p2$
 [Assume known post-assertion, class invariant or type constraint for term 1.13]
 [72.0] $\$heap_{724,1;752,8}.p2 \leq \mathbf{maxof}(\mathbf{short\ int})$
 \rightarrow [simplify]
 [72.9] $-32768 < -\$heap_{724,1;752,8}.p2$
 \rightarrow [from term 1.13, $literal_a < -\$heap_{724,1;752,8}.p2$ is false whenever $-2 < (32767 + literal_a)$]
Proof of rule precondition:
 [72.9.0] $-2 < (-32768 + 32767)$
 \rightarrow [simplify]
 [72.9.2] **true**
 [72.10] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,8)

Condition defined at:

To prove: $\mathbf{minof}(\mathbf{short\ int}) \leq ((\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;752,8}.M2) * \mathbf{asType}<\mathbf{int}>(\mathbf{static_cast}<\mathbf{integer}>(\mathbf{asType}<\mathbf{int}>(\$heap_{724,1;752,8}.p2) < (\mathbf{int})0))) + \mathbf{asType}<\mathbf{int}>(\$heap_{724,1;752,8}.p2))$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType}<\mathbf{short\ int}>((\mathbf{int})176)$


```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

```

```

!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0)))) + asType<int>($heap724,1;749,8.p1)))

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ ((asType<int>(\$heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;752,8.p2) <
(int)0)))) + asType<int>(\$heap724,1;752,8.p2))

→ [simplify]

[1.1] -32768 ≤ ((asType<int>(\$heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;752,8.p2) <
(int)0)))) + asType<int>(\$heap724,1;752,8.p2))

→ [const static or extern object]

[1.2] -32768 ≤ ((asType<int>(\$heap_{init}.M2) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;752,8.p2) <
(int)0)))) + asType<int>(\$heap724,1;752,8.p2))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[1.3] -32768 ≤ ((asType<int>(asType<short int>((int)30307)) *
asType<int>(static_cast<integer>(asType<int>(\$heap724,1;752,8.p2) <
(int)0)))) + asType<int>(\$heap724,1;752,8.p2))

→ [simplify]

[1.11] -32768 ≤ ((30307 * asType<int>([0 < -\$heap724,1;752,8.p2]: 1, []: 0)))
+ asType<int>(\$heap724,1;752,8.p2))

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.12] -32768 ≤ ((30307 * asType<int>([0 < -\$heap724,1;752,8.p2]: 1, [!(0 <

$-\$heap_{724,1;752,8.p2}]: 0))) + \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;752,8.p2}))$
 $\rightarrow [simplify]$
 $[1.16] -32768 \leq (([0 < -\$heap_{724,1;752,8.p2}]: 1, [-1 < \$heap_{724,1;752,8.p2}]: 0)) + \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;752,8.p2}))$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.17] -32768 \leq (([0 < -\$heap_{724,1;752,8.p2}]: 1 * 30307, [-1 < \$heap_{724,1;752,8.p2}]: 0 * 30307) + \mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;752,8.p2}))$
 $\rightarrow [simplify]$
 $[1.20] -32768 \leq (([0 < -\$heap_{724,1;752,8.p2}]: 30307, [-1 < \$heap_{724,1;752,8.p2}]: 0) + \$heap_{724,1;752,8.p2})$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.21] -32768 \leq ([0 < -\$heap_{724,1;752,8.p2}]: 30307 + \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: 0 + \$heap_{724,1;752,8.p2})$
 $\rightarrow [simplify]$
 $[1.24] -32769 < ([0 < -\$heap_{724,1;752,8.p2}]: 30307 + \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: \$heap_{724,1;752,8.p2})$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.25] ([0 < -\$heap_{724,1;752,8.p2}]: -32769 < (30307 + \$heap_{724,1;752,8.p2}), [-1 < \$heap_{724,1;752,8.p2}]: -32769 < \$heap_{724,1;752,8.p2})$
 $\rightarrow [simplify]$
 $[1.27] ([0 < -\$heap_{724,1;752,8.p2}]: -63076 < \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: -32769 < \$heap_{724,1;752,8.p2})$
 $\rightarrow [from\ guard,\ literal\ a < \$heap_{724,1;752,8.p2}\ is\ true\ whenever\ (-1 + literal\ a) < -1]$

Proof of rule precondition:

$[1.27.0] (-32769 + -1) < -1$
 $\rightarrow [simplify]$
 $[1.27.2] \mathbf{true}$
 $[1.28] ([0 < -\$heap_{724,1;752,8.p2}]: -63076 < \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: \mathbf{true})$
 $\rightarrow [negate\ goal\ and\ search\ for\ contradiction]$
 $[1.29] !([0 < -\$heap_{724,1;752,8.p2}]: -63076 < \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: \mathbf{true})$
 $\rightarrow [move\ guard\ outside\ expression]$
 $[1.30] ([0 < -\$heap_{724,1;752,8.p2}]: !(-63076 < \$heap_{724,1;752,8.p2}), [-1 < \$heap_{724,1;752,8.p2}]: \mathbf{!true})$

\rightarrow [simplify]
 [1.35] $(0 < -\$heap_{724,1;752,8}.p2) \wedge (63075 < -\$heap_{724,1;752,8}.p2)$
 [Work on sub-term 2 of conjunction in term 1.35]
 [72.0] $63075 < -\$heap_{724,1;752,8}.p2$
 [Assume known post-assertion, class invariant or type constraint for term 1.35]
 [73.0] **minof**(short int) $\leq \$heap_{724,1;752,8}.p2$
 \rightarrow [simplify]
 [73.3] $-32769 < \$heap_{724,1;752,8}.p2$
 \rightarrow [from term 72.0, literal $a < \$heap_{724,1;752,8}.p2$ is false whenever $-2 < (63075 + literal a)$]
Proof of rule precondition:
 [73.3.0] $-2 < (-32769 + 63075)$
 \rightarrow [simplify]
 [73.3.2] **true**
 [73.4] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,8)

Condition defined at:

To prove: $((\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.M2) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int}0)))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2)) \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$

```

$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

```

```

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

```

```

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

Proof:

[Take goal term]

[1.0] ((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)) ≤ maxof(short int)

→ [const static or extern object]

[1.1] ((asType<int>($heapinit.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)) ≤ maxof(short int)

→ [expand definition of constant 'M2' at prang.c (19,20)]

[1.2] ((asType<int>(asType<short int>((int)30307)) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)) ≤ maxof(short int)

→ [simplify]

[1.10] ((30307 * asType<int>([0 < -$heap724,1;752,8.p2]: 1, []: 0))) +
asType<int>($heap724,1;752,8.p2)) ≤ maxof(short int)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.11] ((30307 * asType<int>([0 < -$heap724,1;752,8.p2]: 1, [!(0 <
-$heap724,1;752,8.p2]): 0])) + asType<int>($heap724,1;752,8.p2)) ≤
maxof(short int)

→ [simplify]

[1.15] ((30307 * ([0 < -$heap724,1;752,8.p2]: 1, [-1 < $heap724,1;752,8.p2]: 0)) +
asType<int>($heap724,1;752,8.p2)) ≤ maxof(short int)

```


\rightarrow [move guard outside expression]
 [1.16] $(([0 < -\$heap_{724,1;752,8.p2}]: 1 * 30307, [-1 < \$heap_{724,1;752,8.p2}]: 0 * 30307) + \mathbf{asType<int>}(\$heap_{724,1;752,8.p2})) \leq \mathbf{maxof(short\ int)}$
 \rightarrow [simplify]
 [1.19] $(([0 < -\$heap_{724,1;752,8.p2}]: 30307, [-1 < \$heap_{724,1;752,8.p2}]: 0) + \$heap_{724,1;752,8.p2}) \leq \mathbf{maxof(short\ int)}$
 \rightarrow [move guard outside expression]
 [1.20] $([0 < -\$heap_{724,1;752,8.p2}]: 30307 + \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: 0 + \$heap_{724,1;752,8.p2}) \leq \mathbf{maxof(short\ int)}$
 \rightarrow [simplify]
 [1.23] $(-1 + ([0 < -\$heap_{724,1;752,8.p2}]: 30307 + \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: \$heap_{724,1;752,8.p2})) < 32767$
 \rightarrow [move guard outside expression]
 [1.24] $([0 < -\$heap_{724,1;752,8.p2}]: -1 + (30307 + \$heap_{724,1;752,8.p2}), [-1 < \$heap_{724,1;752,8.p2}]: -1 + \$heap_{724,1;752,8.p2}) < 32767$
 \rightarrow [simplify]
 [1.27] $0 < (32767 + -([0 < -\$heap_{724,1;752,8.p2}]: 30306 + \$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: -1 + \$heap_{724,1;752,8.p2}))$
 \rightarrow [move guard outside expression]
 [1.28] $0 < (32767 + ([0 < -\$heap_{724,1;752,8.p2}]: -(30306 + \$heap_{724,1;752,8.p2}), [-1 < \$heap_{724,1;752,8.p2}]: -(-1 + \$heap_{724,1;752,8.p2})))$
 \rightarrow [simplify]
 [1.32] $0 < (32767 + ([0 < -\$heap_{724,1;752,8.p2}]: -30306 + -\$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: 1 + -\$heap_{724,1;752,8.p2}))$
 \rightarrow [move guard outside expression]
 [1.33] $0 < ([0 < -\$heap_{724,1;752,8.p2}]: 32767 + (-30306 + -\$heap_{724,1;752,8.p2}), [-1 < \$heap_{724,1;752,8.p2}]: 32767 + (1 + -\$heap_{724,1;752,8.p2}))$
 \rightarrow [simplify]
 [1.37] $0 < ([0 < -\$heap_{724,1;752,8.p2}]: 2461 + -\$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: 32768 + -\$heap_{724,1;752,8.p2})$
 \rightarrow [move guard outside expression]
 [1.38] $([0 < -\$heap_{724,1;752,8.p2}]: 0 < (2461 + -\$heap_{724,1;752,8.p2}), [-1 < \$heap_{724,1;752,8.p2}]: 0 < (32768 + -\$heap_{724,1;752,8.p2}))$
 \rightarrow [simplify]
 [1.40] $([0 < -\$heap_{724,1;752,8.p2}]: -2461 < -\$heap_{724,1;752,8.p2}, [-1 < \$heap_{724,1;752,8.p2}]: 0 < (32768 + -\$heap_{724,1;752,8.p2}))$

→ [from guard, $\text{literal}_a < -\$heap_{724,1;752,8}.p2$ is true whenever $(-1 + \text{literal}_a) < 0$]

Proof of rule precondition:

[1.40.0] $(-2461 + -1) < 0$

→ [simplify]

[1.40.2] **true**

[1.41] $([0 < -\$heap_{724,1;752,8}.p2]: \text{true}, [-1 < \$heap_{724,1;752,8}.p2]: 0 < (32768 + -\$heap_{724,1;752,8}.p2))$

→ [simplify]

[1.43] $([0 < -\$heap_{724,1;752,8}.p2]: \text{true}, [-1 < \$heap_{724,1;752,8}.p2]: -32768 < -\$heap_{724,1;752,8}.p2)$

→ [negate goal and search for contradiction]

[1.44] $!([0 < -\$heap_{724,1;752,8}.p2]: \text{true}, [-1 < \$heap_{724,1;752,8}.p2]: -32768 < -\$heap_{724,1;752,8}.p2)$

→ [move guard outside expression]

[1.45] $([0 < -\$heap_{724,1;752,8}.p2]: \text{!true}, [-1 < \$heap_{724,1;752,8}.p2]: !(-32768 < -\$heap_{724,1;752,8}.p2))$

→ [simplify]

[1.51] $(-1 < \$heap_{724,1;752,8}.p2) \wedge (32767 < \$heap_{724,1;752,8}.p2)$

[Work on sub-term 2 of conjunction in term 1.51]

[72.0] $32767 < \$heap_{724,1;752,8}.p2$

[Assume known post-assertion, class invariant or type constraint for term 1.51]

[73.0] $\$heap_{724,1;752,8}.p2 \leq \text{maxof}(\text{short int})$

→ [simplify]

[73.9] $-32768 < -\$heap_{724,1;752,8}.p2$

→ [from term 72.0, $\text{literal}_a < -\$heap_{724,1;752,8}.p2$ is false whenever $-2 < (32767 + \text{literal}_a)$]

Proof of rule precondition:

[73.9.0] $-2 < (-32768 + 32767)$

→ [simplify]

[73.9.2] **true**

[73.10] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,27)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \text{\$heap}_{724,1;753,8}.\text{M3}$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{init}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{init}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{init}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$

$\text{\$heap}_{init}.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$

$\text{\$heap}_{init}.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$

$\text{\$heap}_{init}.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$

$\text{\$heap}_{init}.\text{p1} == \text{asType}<\text{short int}>((\text{int})1)$

$\text{\$heap}_{init}.\text{p2} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{p3} == \text{asType}<\text{short int}>((\text{int})3)$

$\text{invariant1}(\text{heapIs } \text{\$heap}_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$

$\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{p1}),$

$\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{a1}))$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{p1})) /$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{a1}))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{quot})$

$(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{p1})) \%$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\text{\$heap}_{funcstart_724,1}.\text{a1}))) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{rem})$

$(\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{p1}) <$
 $\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{a1})) ==>$
 $(\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{p1}) ==$
 $\text{asType}<\text{integer}>(\text{div1}.\text{rem}))$

$(\text{asType}<\text{integer}>(\text{\$heap}_{funcstart_724,1}.\text{a1}) \leq$

```

asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

```

```

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

[1.0] **minof**(**int**) ≤ \$heap724,1;753,8.M3

\rightarrow [simplify]
 [1.1] $-32768 \leq \$heap_{724,1;753,8}.M3$
 \rightarrow [const static or extern object]
 [1.2] $-32768 \leq \$heap_{init}.M3$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
 [1.3] $-32768 \leq \text{asType}\langle \text{short int} \rangle((\text{int})30323)$
 \rightarrow [simplify]
 [1.6] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,27)

Condition defined at:

To prove: $\$heap_{724,1;753,8}.M3 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle \text{short int} \rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle \text{short int} \rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle \text{short int} \rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle \text{short int} \rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle \text{short int} \rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle \text{short int} \rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle \text{short int} \rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle \text{short int} \rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle \text{short int} \rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle \text{short int} \rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle \text{short int} \rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle \text{short int} \rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle \text{short int} \rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle \text{short int} \rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

```

asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==

```

```

asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <

```



```

asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

[1.0] \$heap724,1;753,8.M3 ≤ maxof(int)

→ [const static or extern object]

[1.1] \$heap_{init}.M3 ≤ maxof(int)

→ [expand definition of constant 'M3' at prang.c (24,20)]

[1.2] asType<short int>((int)30323) ≤ maxof(int)

→ [simplify]

[1.6] true

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,17)

Condition defined at:

To prove: minof(int) ≤ \$heap724,1;753,8.p3

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)

```

```

$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

```

```

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

```

```

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

[1.0] minof(int) ≤ \$heap724,1;753,8.p3

→ [simplify]

[1.3] -32769 < \$heap724,1;753,8.p3

→ [negate goal and search for contradiction]

[1.4] !(-32769 < \$heap724,1;753,8.p3)

→ [simplify]

[1.6] 32768 < -\$heap724,1;753,8.p3

[Assume known post-assertion, class invariant or type constraint for term 1.6]

[75.0] minof(short int) ≤ \$heap724,1;753,8.p3

→ [simplify]

[75.3] -32769 < \$heap724,1;753,8.p3

→ [from term 1.6, literal a < \$heap724,1;753,8.p3 is false whenever -2 < (32768 + literal a)]

Proof of rule precondition:

[75.3.0] -2 < (-32769 + 32768)

$\rightarrow [simplify]$
 $[75.3.2] \text{ true}$
 $[75.4] \text{ false}$

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,17)

Condition defined at:

To prove: $\$heap_{724,1;753,8}.p3 \leq \text{maxof}(\text{int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1)) /$
 $\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}<\text{integer}>(\text{div1.quot})$
 $(\text{asType}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{funcstart_724,1}.p1)) \%$

```

asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>

```

```

(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short

```

int>((**asType**<**int**>(\$heap_{724,1;752,8}.M2) *
asType<**int**>(static_cast<**integer**>(asType<**int**>(\$heap_{724,1;752,8}.p2) <
(int)0))) + asType<**int**>(\$heap_{724,1;752,8}.p2)))

Proof:

[Take goal term]

[1.0] \$heap_{724,1;753,8}.p3 ≤ **maxof**(**int**)

→ [simplify]

[1.9] -32768 < -\$heap_{724,1;753,8}.p3

→ [negate goal and search for contradiction]

[1.10] !(-32768 < -\$heap_{724,1;753,8}.p3)

→ [simplify]

[1.13] 32767 < \$heap_{724,1;753,8}.p3

[Assume known post-assertion, class invariant or type constraint for term 1.13]

[75.0] \$heap_{724,1;753,8}.p3 ≤ **maxof**(**short int**)

→ [simplify]

[75.9] -32768 < -\$heap_{724,1;753,8}.p3

→ [from term 1.13, literal a < -\$heap_{724,1;753,8}.p3 is false whenever -2 <
(32767 + literal a)]

Proof of rule precondition:

[75.9.0] -2 < (-32768 + 32767)

→ [simplify]

[75.9.2] **true**

[75.10] **false**

Proof of verification condition: Type constraint satisfied in explicit
conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,11)

Condition defined at:

To prove: minof(**int**) ≤

static_cast<**integer**>(asType<**int**>(\$heap_{724,1;753,8}.p3) < (**int**)0)

Given:

\$heap_{init}.LIMIT == (**int**)80

\$heap_{init}.M1 == asType<**short int**>((**int**)30269)

\$heap_{init}.r1 == asType<**short int**>((**int**)171)


```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==

```

```

asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

```

```

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))
$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2))))

Proof:
[Take goal term]
[1.0] minof(int) ≤ static.cast<integer>(asType<int>($heap724,1;753,8.p3)
< (int)0)
→ [simplify]
[1.6] -32768 ≤ ([0 < -$heap724,1;753,8.p3]: 1, []: 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.7] -32768 ≤ ([0 < -$heap724,1;753,8.p3]: 1, [!(0 < -$heap724,1;753,8.p3]): 0)
→ [simplify]
[1.12] -32769 < ([0 < -$heap724,1;753,8.p3]: 1, [-1 < $heap724,1;753,8.p3]: 0)
→ [move guard outside expression]

```

[1.13] $([0 < -\$heap_{724,1;753,8}.p3]: -32769 < 1, [-1 < \$heap_{724,1;753,8}.p3]: -32769 < 0)$

→ [simplify]

[1.15] $([0 < -\$heap_{724,1;753,8}.p3]: \mathbf{true}, [-1 < \$heap_{724,1;753,8}.p3]: \mathbf{true})$

→ [all guards have equal guarded terms]

[1.16] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,11)

Condition defined at:

To prove: $\mathbf{static_cast}\langle\mathbf{integer}\rangle(\mathbf{asType}\langle\mathbf{int}\rangle(\$heap_{724,1;753,8}.p3) < (\mathbf{int})0) \leq \mathbf{maxof}(\mathbf{int})$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %

```

```

asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short

```

```

int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

[1.0] static_cast<integer>(asType<int>(\$heap724,1;753,8.p3) < (**int**)0) ≤
maxof(**int**)

→ [simplify]

[1.5] ([0 < -\$heap724,1;753,8.p3]: 1, []: 0) ≤ maxof(**int**)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.6] ([0 < -\$heap724,1;753,8.p3]: 1, [!(0 < -\$heap724,1;753,8.p3)]: 0) ≤
maxof(**int**)

→ [simplify]

[1.11] (-1 + ([0 < -\$heap724,1;753,8.p3]: 1, [-1 < \$heap724,1;753,8.p3]: 0)) <
32767

→ [move guard outside expression]

[1.12] ([0 < -\$heap724,1;753,8.p3]: -1 + 1, [-1 < \$heap724,1;753,8.p3]: -1 + 0) <
32767

→ [simplify]

[1.15] 0 < (32767 + -([0 < -\$heap724,1;753,8.p3]: 0, [-1 < \$heap724,1;753,8.p3]:
-1))

→ [move guard outside expression]

[1.16] 0 < (32767 + ([0 < -\$heap724,1;753,8.p3]: -0, [-1 < \$heap724,1;753,8.p3]:
--1))

→ [simplify]

[1.18] 0 < (32767 + ([0 < -\$heap724,1;753,8.p3]: 0, [-1 < \$heap724,1;753,8.p3]:
1))

→ [move guard outside expression]

[1.19] 0 < ([0 < -\$heap724,1;753,8.p3]: 0 + 32767, [-1 < \$heap724,1;753,8.p3]: 1
+ 32767)

→ [simplify]

[1.21] 0 < ([0 < -\$heap724,1;753,8.p3]: 32767, [-1 < \$heap724,1;753,8.p3]: 32768)

→ [move guard outside expression]

[1.22] ([0 < -\$heap_{724,1;753,8}.p3]: 0 < 32767, [-1 < \$heap_{724,1;753,8}.p3]: 0 < 32768)

→ [simplify]

[1.24] ([0 < -\$heap_{724,1;753,8}.p3]: **true**, [-1 < \$heap_{724,1;753,8}.p3]: **true**)

→ [all guards have equal guarded terms]

[1.25] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,25)

Condition defined at:

To prove: minof(int) ≤ (asType<int>(\$heap_{724,1;753,8}.M3) *
asType<int>(static.cast<integer>(asType<int>(\$heap_{724,1;753,8}.p3) <
(int)0)))

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

\$heap_{init}.p3 == asType<short int>((int)3)

invariant1(heapIs \$heap_{funcstart_724,1})

div1 == div(heapIs \$heap_{funcstart_724,1},


```

asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==

```

```

asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <

```

```

asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

```

[1.0] minof(int) ≤ (asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0)))

```

→ [simplify]

```

[1.1] -32768 ≤ (asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0)))

```

→ [const static or extern object]

```

[1.2] -32768 ≤ (asType<int>($heapinit.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0)))

```

→ [expand definition of constant 'M3' at prang.c (24,20)]

```

[1.3] -32768 ≤ (asType<int>(asType<short int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0)))

```

→ [simplify]

```

[1.11] -32768 ≤ (30323 * asType<int>([(0 < -$heap724,1;753,8.p3]: 1, []: 0)))

```

→ [explicitly assert falsehood of skipped guards in subsequent guards]

```

[1.12] -32768 ≤ (30323 * asType<int>([(0 < -$heap724,1;753,8.p3]: 1, [!(0 <
-$heap724,1;753,8.p3]): 0])))

```

→ [simplify]

```

[1.16] -32768 ≤ (30323 * ([0 < -$heap724,1;753,8.p3]: 1, [-1 <
$heap724,1;753,8.p3]: 0))

```

→ [move guard outside expression]

```

[1.17] -32768 ≤ ([0 < -$heap724,1;753,8.p3]: 1 * 30323, [-1 <
$heap724,1;753,8.p3]: 0 * 30323)

```

→ [simplify]
 [1.21] $-32769 < ([0 < -\$heap_{724,1;753,8}.p3]: 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0)$
 → [move guard outside expression]
 [1.22] $([0 < -\$heap_{724,1;753,8}.p3]: -32769 < 30323, [-1 < \$heap_{724,1;753,8}.p3]: -32769 < 0)$
 → [simplify]
 [1.24] $([0 < -\$heap_{724,1;753,8}.p3]: \mathbf{true}, [-1 < \$heap_{724,1;753,8}.p3]: \mathbf{true})$
 → [all guards have equal guarded terms]
 [1.25] **true**

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,25)

Condition defined at:

To prove: $(\mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;753,8}.M3) * \mathbf{asType}\langle \mathbf{int} \rangle(\mathbf{static_cast}\langle \mathbf{integer} \rangle(\mathbf{asType}\langle \mathbf{int} \rangle(\$heap_{724,1;753,8}.p3) < (\mathbf{int})0))) \leq \mathbf{maxof}(\mathbf{int})$

Given:

$\$heap_{init}.LIMIT == (\mathbf{int})80$
 $\$heap_{init}.M1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})30269)$
 $\$heap_{init}.r1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})171)$
 $\$heap_{init}.a1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})177)$
 $\$heap_{init}.b1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})2)$
 $\$heap_{init}.M2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})30307)$
 $\$heap_{init}.r2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})172)$
 $\$heap_{init}.a2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})176)$
 $\$heap_{init}.b2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})35)$
 $\$heap_{init}.M3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})30323)$
 $\$heap_{init}.r3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})170)$
 $\$heap_{init}.a3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})178)$
 $\$heap_{init}.b3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})63)$
 $\$heap_{init}.p1 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})1)$
 $\$heap_{init}.p2 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})2)$
 $\$heap_{init}.p3 == \mathbf{asType}\langle \mathbf{short\ int} \rangle((\mathbf{int})3)$

```

invariant1(heapIs $heap_funcstart_724,1)

div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

```

```

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

```

[1.0] (asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) ≤ maxof(int)

```

→ [const static or extern object]

```

[1.1] (asType<int>($heapinit.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) ≤ maxof(int)

```

→ [expand definition of constant 'M3' at prang.c (24,20)]

```

[1.2] (asType<int>(asType<short int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) ≤ maxof(int)

```

→ [simplify]

```

[1.10] (30323 * asType<int>([0 < -$heap724,1;753,8.p3]: 1, []: 0))) ≤
maxof(int)

```

→ [explicitly assert falsehood of skipped guards in subsequent guards]

```

[1.11] (30323 * asType<int>([0 < -$heap724,1;753,8.p3]: 1, [!(0 <
-$heap724,1;753,8.p3]): 0))) ≤ maxof(int)

```

→ [simplify]

```

[1.15] (30323 * ([0 < -$heap724,1;753,8.p3]: 1, [-1 < $heap724,1;753,8.p3]: 0)) ≤
maxof(int)

```

→ [move guard outside expression]

```

[1.16] ([0 < -$heap724,1;753,8.p3]: 1 * 30323, [-1 < $heap724,1;753,8.p3]: 0 *
30323) ≤ maxof(int)

```

→ [simplify]

[1.20] $(-1 + ([0 < -\$heap_{724,1;753,8.p3}: 30323, [-1 < \$heap_{724,1;753,8.p3}: 0)]) < 32767$

→ [move guard outside expression]

[1.21] $([0 < -\$heap_{724,1;753,8.p3}: -1 + 30323, [-1 < \$heap_{724,1;753,8.p3}: -1 + 0]) < 32767$

→ [simplify]

[1.24] $0 < (32767 + -([0 < -\$heap_{724,1;753,8.p3}: 30322, [-1 < \$heap_{724,1;753,8.p3}: -1)])$

→ [move guard outside expression]

[1.25] $0 < (32767 + ([0 < -\$heap_{724,1;753,8.p3}: -30322, [-1 < \$heap_{724,1;753,8.p3}: -1)])$

→ [simplify]

[1.27] $0 < (32767 + ([0 < -\$heap_{724,1;753,8.p3}: -30322, [-1 < \$heap_{724,1;753,8.p3}: 1)])$

→ [move guard outside expression]

[1.28] $0 < ([0 < -\$heap_{724,1;753,8.p3}: -30322 + 32767, [-1 < \$heap_{724,1;753,8.p3}: 1 + 32767])$

→ [simplify]

[1.30] $0 < ([0 < -\$heap_{724,1;753,8.p3}: 2445, [-1 < \$heap_{724,1;753,8.p3}: 32768])$

→ [move guard outside expression]

[1.31] $([0 < -\$heap_{724,1;753,8.p3}: 0 < 2445, [-1 < \$heap_{724,1;753,8.p3}: 0 < 32768])$

→ [simplify]

[1.33] $([0 < -\$heap_{724,1;753,8.p3}: \mathbf{true}, [-1 < \$heap_{724,1;753,8.p3}: \mathbf{true}])$

→ [all guards have equal guarded terms]

[1.34] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,5)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq \$heap_{724,1;753,8.p3}$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$


```

$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

```

```

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2))))

```

Proof:

[Take goal term]

[1.0] minof(int) ≤ \$heap724,1;753,8.p3

→ [simplify]

[1.3] -32769 < \$heap724,1;753,8.p3

→ [negate goal and search for contradiction]

[1.4] !(-32769 < \$heap724,1;753,8.p3)

→ [simplify]

[1.6] 32768 < -\$heap724,1;753,8.p3

[Assume known post-assertion, class invariant or type constraint for term 1.6]

[75.0] **minof**(**short int**) \leq \$heap_{724,1;753,8}.p3

→ [simplify]

[75.3] -32769 < \$heap_{724,1;753,8}.p3

→ [from term 1.6, literal_a < \$heap_{724,1;753,8}.p3 is false whenever -2 < (32768 + literal_a)]

Proof of rule precondition:

[75.3.0] -2 < (-32769 + 32768)

→ [simplify]

[75.3.2] **true**

[75.4] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,5)

Condition defined at:

To prove: \$heap_{724,1;753,8}.p3 \leq **maxof**(**int**)

Given:

\$heap_{init}.LIMIT == (**int**)80

\$heap_{init}.M1 == **asType**<**short int**>((**int**)30269)

\$heap_{init}.r1 == **asType**<**short int**>((**int**)171)

\$heap_{init}.a1 == **asType**<**short int**>((**int**)177)

\$heap_{init}.b1 == **asType**<**short int**>((**int**)2)

\$heap_{init}.M2 == **asType**<**short int**>((**int**)30307)

\$heap_{init}.r2 == **asType**<**short int**>((**int**)172)

\$heap_{init}.a2 == **asType**<**short int**>((**int**)176)

\$heap_{init}.b2 == **asType**<**short int**>((**int**)35)

\$heap_{init}.M3 == **asType**<**short int**>((**int**)30323)

\$heap_{init}.r3 == **asType**<**short int**>((**int**)170)

\$heap_{init}.a3 == **asType**<**short int**>((**int**)178)

\$heap_{init}.b3 == **asType**<**short int**>((**int**)63)

\$heap_{init}.p1 == **asType**<**short int**>((**int**)1)

\$heap_{init}.p2 == **asType**<**short int**>((**int**)2)

```

$heapinit.p3 == asType<short int>((int)3)

invariant1(heapIs $heapfuncstart_724,1)

div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p3),

```

```

asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))

-asType<integer const>($heap724,1;749,8.M3) <

```

```

asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

```

[Take goal term]
[1.0] $heap724,1;753,8.p3 ≤ maxof(int)
→ [simplify]
[1.9] -32768 < -$heap724,1;753,8.p3
→ [negate goal and search for contradiction]
[1.10] !(-32768 < -$heap724,1;753,8.p3)
→ [simplify]
[1.13] 32767 < $heap724,1;753,8.p3
[Assume known post-assertion, class invariant or type constraint for term 1.13]
[75.0] $heap724,1;753,8.p3 ≤ maxof(short int)
→ [simplify]
[75.9] -32768 < -$heap724,1;753,8.p3
→ [from term 1.13, literal a < -$heap724,1;753,8.p3 is false whenever -2 <
(32767 + literal a)]

```

Proof of rule precondition:

```

[75.9.0] -2 < (-32768 + 32767)
→ [simplify]
[75.9.2] true
[75.10] false

```

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,8)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq ((\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.M3) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)
$heap_init.r2 == asType<short int>((int)172)
$heap_init.a2 == asType<short int>((int)176)
$heap_init.b2 == asType<short int>((int)35)
$heap_init.M3 == asType<short int>((int)30323)
$heap_init.r3 == asType<short int>((int)170)
$heap_init.a3 == asType<short int>((int)178)
$heap_init.b3 == asType<short int>((int)63)
$heap_init.p1 == asType<short int>((int)1)
$heap_init.p2 == asType<short int>((int)2)
$heap_init.p3 == asType<short int>((int)3)
invariant1(heapIs $heap_funcstart_724,1)
div1 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))
```



```

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==

```

```

asType<integer>(div3.quot))

$heap724,1;745,8 == $heapfuncstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heapfuncstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heapfuncstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

```

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq ((\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.M3) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [simplify]

[1.1] $-32768 \leq ((\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.M3) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [const static or extern object]

[1.2] $-32768 \leq ((\text{asType}\langle\text{int}\rangle(\$heap_{init}.M3) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]

[1.3] $-32768 \leq ((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30323)) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [simplify]

[1.11] $-32768 \leq ((30323 * \text{asType}\langle\text{int}\rangle([0 < -\$heap_{724,1;753,8}.p3]: 1, []: 0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[1.12] $-32768 \leq ((30323 * \text{asType}\langle\text{int}\rangle([0 < -\$heap_{724,1;753,8}.p3]: 1, [!(0 < -\$heap_{724,1;753,8}.p3]): 0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [simplify]

[1.16] $-32768 \leq ((30323 * ([0 < -\$heap_{724,1;753,8}.p3]: 1, [-1 < \$heap_{724,1;753,8}.p3]: 0)) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [move guard outside expression]

[1.17] $-32768 \leq (([0 < -\$heap_{724,1;753,8}.p3]: 1 * 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0 * 30323) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3))$
 \rightarrow [simplify]

[1.20] $-32768 \leq (([0 < -\$heap_{724,1;753,8}.p3]: 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0) + \$heap_{724,1;753,8}.p3)$
 \rightarrow [move guard outside expression]

[1.21] $-32768 \leq ([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 < \$heap_{724,1;753,8}.p3]: 0 + \$heap_{724,1;753,8}.p3)$
 \rightarrow [simplify]

[1.24] $-32769 < ([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 < \$heap_{724,1;753,8}.p3]: \$heap_{724,1;753,8}.p3)$
 \rightarrow [move guard outside expression]

[1.25] $([0 < -\$heap_{724,1;753,8.p3}]: -32769 < (30323 + \$heap_{724,1;753,8.p3}), [-1 < \$heap_{724,1;753,8.p3}]: -32769 < \$heap_{724,1;753,8.p3})$

→ [simplify]

[1.27] $([0 < -\$heap_{724,1;753,8.p3}]: -63092 < \$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: -32769 < \$heap_{724,1;753,8.p3})$

→ [from guard, *literal* $a < \$heap_{724,1;753,8.p3}$ is true whenever $(-1 + \text{literal}) < -1$]

Proof of rule precondition:

[1.27.0] $(-32769 + -1) < -1$

→ [simplify]

[1.27.2] **true**

[1.28] $([0 < -\$heap_{724,1;753,8.p3}]: -63092 < \$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: \mathbf{true})$

→ [negate goal and search for contradiction]

[1.29] $!([0 < -\$heap_{724,1;753,8.p3}]: -63092 < \$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: \mathbf{true})$

→ [move guard outside expression]

[1.30] $([0 < -\$heap_{724,1;753,8.p3}]: !(-63092 < \$heap_{724,1;753,8.p3}), [-1 < \$heap_{724,1;753,8.p3}]: \mathbf{!true})$

→ [simplify]

[1.35] $(0 < -\$heap_{724,1;753,8.p3}) \wedge (63091 < -\$heap_{724,1;753,8.p3})$

[Work on sub-term 2 of conjunction in term 1.35]

[75.0] $63091 < -\$heap_{724,1;753,8.p3}$

[Assume known post-assertion, class invariant or type constraint for term 1.35]

[76.0] $\mathbf{minof}(\mathbf{short\ int}) \leq \$heap_{724,1;753,8.p3}$

→ [simplify]

[76.3] $-32769 < \$heap_{724,1;753,8.p3}$

→ [from term 75.0, *literal* $a < \$heap_{724,1;753,8.p3}$ is false whenever $-2 < (63091 + \text{literal})$]

Proof of rule precondition:

[76.3.0] $-2 < (-32769 + 63091)$

→ [simplify]

[76.3.2] **true**

[76.4] **false**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (70,8)

Condition defined at:

To prove: $((\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.M3) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;753,8}.p3)) \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}\langle\text{short int}\rangle((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}\langle\text{short int}\rangle((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}\langle\text{short int}\rangle((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}\langle\text{short int}\rangle((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}\langle\text{short int}\rangle((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}\langle\text{short int}\rangle((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}\langle\text{short int}\rangle((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}\langle\text{short int}\rangle((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}\langle\text{short int}\rangle((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}\langle\text{short int}\rangle((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}\langle\text{short int}\rangle((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}\langle\text{short int}\rangle((\text{int})1)$
 $\$heap_{init}.p2 == \text{asType}\langle\text{short int}\rangle((\text{int})2)$
 $\$heap_{init}.p3 == \text{asType}\langle\text{short int}\rangle((\text{int})3)$
 $\text{invariant1}(\text{heapIs } \$heap_{funcstart_724,1})$
 $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1),$
 $\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) /$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1.quot})$
 $(\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.p1)) \%$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{funcstart_724,1}.a1))) ==$
 $\text{asType}\langle\text{integer}\rangle(\text{div1.rem})$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_724,1}.p1) <$

```

asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤

```

```

asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8.replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1))))

$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2))))

```

Proof:

[Take goal term]

[1.0] ((asType<int>(\$heap_{724,1;753,8}.M3) *
asType<int>(static_cast<integer>(asType<int>(\$heap_{724,1;753,8}.p3) <
(int)0))) + asType<int>(\$heap_{724,1;753,8}.p3)) ≤ maxof(short int)

→ [const static or extern object]

[1.1] ((asType<int>(\$heap_{init}.M3) *
asType<int>(static_cast<integer>(asType<int>(\$heap_{724,1;753,8}.p3) <
(int)0))) + asType<int>(\$heap_{724,1;753,8}.p3)) ≤ maxof(short int)

→ [expand definition of constant 'M3' at prang.c (24,20)]

[1.2] ((asType<int>(asType<short int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>(\$heap_{724,1;753,8}.p3) <
(int)0))) + asType<int>(\$heap_{724,1;753,8}.p3)) ≤ maxof(short int)

→ [simplify]

[1.10] ((30323 * asType<int>([0 < -\$heap_{724,1;753,8}.p3]: 1, []: 0))) +
asType<int>(\$heap_{724,1;753,8}.p3)) ≤ maxof(short int)

→ [explicitly assert falsehood of skipped guards in subsequent guards]

[1.11] ((30323 * asType<int>([0 < -\$heap_{724,1;753,8}.p3]: 1, [!(0 <
-\$heap_{724,1;753,8}.p3]): 0))) + asType<int>(\$heap_{724,1;753,8}.p3)) ≤
maxof(short int)

→ [simplify]

[1.15] ((30323 * ([0 < -\$heap_{724,1;753,8}.p3]: 1, [-1 < \$heap_{724,1;753,8}.p3]: 0)) +
asType<int>(\$heap_{724,1;753,8}.p3)) ≤ maxof(short int)

→ [move guard outside expression]

[1.16] ((([0 < -\$heap_{724,1;753,8}.p3]: 1 * 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0 *
30323) + asType<int>(\$heap_{724,1;753,8}.p3)) ≤ maxof(short int)

→ [simplify]

[1.19] ((([0 < -\$heap_{724,1;753,8}.p3]: 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0) +
\$heap_{724,1;753,8}.p3) ≤ maxof(short int)

→ [move guard outside expression]

[1.20] ([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 <
\$heap_{724,1;753,8}.p3]: 0 + \$heap_{724,1;753,8}.p3) ≤ maxof(short int)

→ [simplify]

[1.23] (-1 + ([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 <
\$heap_{724,1;753,8}.p3]: \$heap_{724,1;753,8}.p3)) < 32767

→ [move guard outside expression]

[1.24] $([0 < -\$heap_{724,1;753,8.p3}]: -1 + (30323 + \$heap_{724,1;753,8.p3}), [-1 < \$heap_{724,1;753,8.p3}]: -1 + \$heap_{724,1;753,8.p3}) < 32767$
 \rightarrow [simplify]
[1.27] $0 < (32767 + -([0 < -\$heap_{724,1;753,8.p3}]: 30322 + \$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: -1 + \$heap_{724,1;753,8.p3}))$
 \rightarrow [move guard outside expression]
[1.28] $0 < (32767 + ([0 < -\$heap_{724,1;753,8.p3}]: -(30322 + \$heap_{724,1;753,8.p3}), [-1 < \$heap_{724,1;753,8.p3}]: -(-1 + \$heap_{724,1;753,8.p3})))$
 \rightarrow [simplify]
[1.32] $0 < (32767 + ([0 < -\$heap_{724,1;753,8.p3}]: -30322 + -\$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: 1 + -\$heap_{724,1;753,8.p3}))$
 \rightarrow [move guard outside expression]
[1.33] $0 < ([0 < -\$heap_{724,1;753,8.p3}]: 32767 + (-30322 + -\$heap_{724,1;753,8.p3}), [-1 < \$heap_{724,1;753,8.p3}]: 32767 + (1 + -\$heap_{724,1;753,8.p3}))$
 \rightarrow [simplify]
[1.37] $0 < ([0 < -\$heap_{724,1;753,8.p3}]: 2445 + -\$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: 32768 + -\$heap_{724,1;753,8.p3})$
 \rightarrow [move guard outside expression]
[1.38] $([0 < -\$heap_{724,1;753,8.p3}]: 0 < (2445 + -\$heap_{724,1;753,8.p3}), [-1 < \$heap_{724,1;753,8.p3}]: 0 < (32768 + -\$heap_{724,1;753,8.p3}))$
 \rightarrow [simplify]
[1.40] $([0 < -\$heap_{724,1;753,8.p3}]: -2445 < -\$heap_{724,1;753,8.p3}, [-1 < \$heap_{724,1;753,8.p3}]: 0 < (32768 + -\$heap_{724,1;753,8.p3}))$
 \rightarrow [from guard, *literal* $< -\$heap_{724,1;753,8.p3}$ is true whenever $(-1 + \text{literal}) < 0$]

Proof of rule precondition:

[1.40.0] $(-2445 + -1) < 0$

\rightarrow [simplify]

[1.40.2] **true**

[1.41] $([0 < -\$heap_{724,1;753,8.p3}]: \mathbf{true}, [-1 < \$heap_{724,1;753,8.p3}]: 0 < (32768 + -\$heap_{724,1;753,8.p3}))$

\rightarrow [simplify]

[1.43] $([0 < -\$heap_{724,1;753,8.p3}]: \mathbf{true}, [-1 < \$heap_{724,1;753,8.p3}]: -32768 < -\$heap_{724,1;753,8.p3})$

\rightarrow [negate goal and search for contradiction]

[1.44] $!([0 < -\$heap_{724,1;753,8.p3}]: \mathbf{true}, [-1 < \$heap_{724,1;753,8.p3}]: -32768 <$

$-\$heap_{724,1;753,8}.p3)$
 \rightarrow [move guard outside expression]
 [1.45] $([0 < -\$heap_{724,1;753,8}.p3]: \text{!true}, [-1 < \$heap_{724,1;753,8}.p3]: \text{!}(-32768 < -\$heap_{724,1;753,8}.p3))$
 \rightarrow [simplify]
 [1.51] $(-1 < \$heap_{724,1;753,8}.p3) \wedge (32767 < \$heap_{724,1;753,8}.p3)$
 [Work on sub-term 2 of conjunction in term 1.51]
 [75.0] $32767 < \$heap_{724,1;753,8}.p3$
 [Assume known post-assertion, class invariant or type constraint for term 1.51]
 [76.0] $\$heap_{724,1;753,8}.p3 \leq \text{maxof}(\text{short int})$
 \rightarrow [simplify]
 [76.9] $-32768 < -\$heap_{724,1;753,8}.p3$
 \rightarrow [from term 75.0, literal $a < -\$heap_{724,1;753,8}.p3$ is false whenever $-2 < (32767 + \text{literal})$]
Proof of rule precondition:
 [76.9.0] $-2 < (-32768 + 32767)$
 \rightarrow [simplify]
 [76.9.2] **true**
 [76.10] **false**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (76,12)

To prove: invariant1(heapIs \$heap_{funcend_724,1})

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==

```

```

asType<integer>(div2.rem))
(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))
(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))
$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

```

```

!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

$heapfuncend_724,1 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))

```

Proof:

[Take goal term]

[1.0] invariant1(heapIs \$heap_{funcend_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[1.1] (((((0 < asType<integer>(\$heap_{funcend_724,1}.p1)) &&
(asType<integer>(\$heap_{funcend_724,1}.p1) <
asType<integer>(\$heap_{funcend_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p2))) &&
(asType<integer>(\$heap_{funcend_724,1}.p2) <
asType<integer>(\$heap_{funcend_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p3))) &&
(asType<integer>(\$heap_{funcend_724,1}.p3) <
asType<integer>(\$heap_{funcend_724,1}.M3)))

→ [simplify]

[1.3] (((((0 < \$heap_{funcend_724,1}.p1) && (\$heap_{funcend_724,1}.p1 <

```

asType<integer>($heap_funcend_724,1.M1))) && (0 <
asType<integer>($heap_funcend_724,1.p2))) &&
(asType<integer>($heap_funcend_724,1.p2) <
asType<integer>($heap_funcend_724,1.M2))) && (0 <
asType<integer>($heap_funcend_724,1.p3))) &&
(asType<integer>($heap_funcend_724,1.p3) <
asType<integer>($heap_funcend_724,1.M3))
→ [const static or extern object]

[1.4] (((((0 < $heap_funcend_724,1.p1) && ($heap_funcend_724,1.p1 <
asType<integer>($heap_init.M1))) && (0 <
asType<integer>($heap_funcend_724,1.p2))) &&
(asType<integer>($heap_funcend_724,1.p2) <
asType<integer>($heap_funcend_724,1.M2))) && (0 <
asType<integer>($heap_funcend_724,1.p3))) &&
(asType<integer>($heap_funcend_724,1.p3) <
asType<integer>($heap_funcend_724,1.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.5] (((((0 < $heap_funcend_724,1.p1) && ($heap_funcend_724,1.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heap_funcend_724,1.p2))) &&
(asType<integer>($heap_funcend_724,1.p2) <
asType<integer>($heap_funcend_724,1.M2))) && (0 <
asType<integer>($heap_funcend_724,1.p3))) &&
(asType<integer>($heap_funcend_724,1.p3) <
asType<integer>($heap_funcend_724,1.M3))
→ [simplify]

[1.16] (((((-30269 < -$heap_funcend_724,1.p1) ∧ (0 < $heap_funcend_724,1.p1) ∧ (0
< $heap_funcend_724,1.p2)) && ($heap_funcend_724,1.p2 <
asType<integer>($heap_funcend_724,1.M2))) && (0 <
asType<integer>($heap_funcend_724,1.p3))) &&
(asType<integer>($heap_funcend_724,1.p3) <
asType<integer>($heap_funcend_724,1.M3))
→ [const static or extern object]

[1.17] (((((-30269 < -$heap_funcend_724,1.p1) ∧ (0 < $heap_funcend_724,1.p1) ∧ (0
< $heap_funcend_724,1.p2)) && ($heap_funcend_724,1.p2 <
asType<integer>($heap_init.M2))) && (0 <
asType<integer>($heap_funcend_724,1.p3))) &&
(asType<integer>($heap_funcend_724,1.p3) <
asType<integer>($heap_funcend_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[1.18] (((((-30269 < -$heap_funcend_724,1.p1) ∧ (0 < $heap_funcend_724,1.p1) ∧ (0

```

$\lt \$heap_{funcend_724,1}.p2)) \&\& (\$heap_{funcend_724,1}.p2 \lt$
asType<integer>(**asType<short int>**((**int**)30307)))) $\&\& (0 \lt$
asType<integer>($\$heap_{funcend_724,1}.p3)) \&\&$
asType<integer>($\$heap_{funcend_724,1}.p3 \lt$
asType<integer>($\$heap_{funcend_724,1}.M3))$
 \rightarrow [simplify]
[1.30] $((-30307 \lt -\$heap_{funcend_724,1}.p2) \wedge (-30269 \lt -\$heap_{funcend_724,1}.p1)$
 $\wedge (0 \lt \$heap_{funcend_724,1}.p1) \wedge (0 \lt \$heap_{funcend_724,1}.p2) \wedge (0 \lt$
 $\$heap_{funcend_724,1}.p3)) \&\& (\$heap_{funcend_724,1}.p3 \lt$
asType<integer>($\$heap_{funcend_724,1}.M3))$
 \rightarrow [const static or extern object]
[1.31] $((-30307 \lt -\$heap_{funcend_724,1}.p2) \wedge (-30269 \lt -\$heap_{funcend_724,1}.p1)$
 $\wedge (0 \lt \$heap_{funcend_724,1}.p1) \wedge (0 \lt \$heap_{funcend_724,1}.p2) \wedge (0 \lt$
 $\$heap_{funcend_724,1}.p3)) \&\& (\$heap_{funcend_724,1}.p3 \lt$
asType<integer>($\$heap_{init}.M3))$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.32] $((-30307 \lt -\$heap_{funcend_724,1}.p2) \wedge (-30269 \lt -\$heap_{funcend_724,1}.p1)$
 $\wedge (0 \lt \$heap_{funcend_724,1}.p1) \wedge (0 \lt \$heap_{funcend_724,1}.p2) \wedge (0 \lt$
 $\$heap_{funcend_724,1}.p3)) \&\& (\$heap_{funcend_724,1}.p3 \lt$
asType<integer>(**asType<short int>**((**int**)30323)))
 \rightarrow [simplify]
[1.40] $(-30323 \lt -\$heap_{funcend_724,1}.p3) \wedge (-30307 \lt -\$heap_{funcend_724,1}.p2)$
 $\wedge (-30269 \lt -\$heap_{funcend_724,1}.p1) \wedge (0 \lt \$heap_{funcend_724,1}.p1) \wedge (0 \lt$
 $\$heap_{funcend_724,1}.p2) \wedge (0 \lt \$heap_{funcend_724,1}.p3)$
 \rightarrow [negate goal and search for contradiction]
[1.41] $!(-30323 \lt -\$heap_{funcend_724,1}.p3) \vee !(-30307 \lt -\$heap_{funcend_724,1}.p2)$
 $\vee !(-30269 \lt -\$heap_{funcend_724,1}.p1) \vee !(0 \lt \$heap_{funcend_724,1}.p1) \vee !(0 \lt$
 $\$heap_{funcend_724,1}.p2) \vee !(0 \lt \$heap_{funcend_724,1}.p3)$
 \rightarrow [simplify]
[1.56] $(30322 \lt \$heap_{funcend_724,1}.p3) \vee (30306 \lt \$heap_{funcend_724,1}.p2) \vee$
 $(30268 \lt \$heap_{funcend_724,1}.p1) \vee (-1 \lt -\$heap_{funcend_724,1}.p1) \vee (-1 \lt$
 $-\$heap_{funcend_724,1}.p2) \vee (-1 \lt -\$heap_{funcend_724,1}.p3)$
[Take given term]
[11.0] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
asType<int>($\$heap_{funcstart_724,1}.p1),$
asType<int>($\$heap_{funcstart_724,1}.a1))$
 \rightarrow [simplify]
[11.1] $\text{div1} == \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
asType<int>($\$heap_{funcstart_724,1}.a1))$

→ [const static or extern object]

[11.2] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>($heap_init.a1))`

→ [expand definition of constant 'a1' at prang.c (16,20)]

[11.3] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, asType<int>(asType<short int>((int)177)))`

→ [simplify]

[11.6] `div1 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177)`

[Take given term]

[27.0] `div2 == div(heapIs $heap_funcstart_724,1, asType<int>($heap_funcstart_724,1.p2), asType<int>($heap_funcstart_724,1.a2))`

→ [simplify]

[27.1] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, asType<int>($heap_funcstart_724,1.a2))`

→ [const static or extern object]

[27.2] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, asType<int>($heap_init.a2))`

→ [expand definition of constant 'a2' at prang.c (21,20)]

[27.3] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, asType<int>(asType<short int>((int)176)))`

→ [simplify]

[27.6] `div2 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176)`

[Take given term]

[43.0] `div3 == div(heapIs $heap_funcstart_724,1, asType<int>($heap_funcstart_724,1.p3), asType<int>($heap_funcstart_724,1.a3))`

→ [simplify]

[43.1] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, asType<int>($heap_funcstart_724,1.a3))`

→ [const static or extern object]

[43.2] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, asType<int>($heap_init.a3))`

→ [expand definition of constant 'a3' at prang.c (26,20)]

[43.3] `div3 == div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, asType<int>(asType<short int>((int)178)))`

→ [simplify]

[43.6] $\text{div3} == \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178)$

[Take given term]

[59.0] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{rem})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{b1}))))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.1] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{b1}))))))$

→ [simplify]

[59.3] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{r1})) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{b1}))))))$

→ [const static or extern object]

[59.4] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle (\$ \text{heap_init}.\text{r1})) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{b1}))))))$

→ [expand definition of constant 'r1' at prang.c (15,20)]

[59.5] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * \text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle ((\text{int})171))) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{b1}))))))$

→ [simplify]

[59.8] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem} * 171) - (\text{asType}\langle \text{int} \rangle (\text{asType}\langle \text{short int} \rangle (\text{div1}.\text{quot})) * \text{asType}\langle \text{int} \rangle (\$ \text{heap_funcstart_724,1}.\text{b1}))))))$

→ [from term 11.6, div1 is equal to $\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177)$]

[59.9] $\$ \text{heap}_{724,1;745,8} == \$ \text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle ((171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})$

– (asType<int>(asType<short int>(div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).quot)) *
 asType<int>(\$heap_funcstart_724,1.b1))))
 → [simplify]
 [59.11] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
 int>((171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)
 – (div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot *
 asType<int>(\$heap_funcstart_724,1.b1))))
 → [const static or extern object]
 [59.12] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
 int>((171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)
 – (div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot *
 asType<int>(\$heap_init.b1))))
 → [expand definition of constant 'b1' at prang.c (17,20)]
 [59.13] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → asType<short
 int>((171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)
 – (div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot *
 asType<int>(asType<short int>((int)2)))))
 → [simplify]
 [59.19] \$heap_724,1;745,8 == \$heap_funcstart_724,1.**replace**(p1 → ((-2 *
 div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
 div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))
 [Take given term]
 [60.0] –asType<integer const>(\$heap_724,1;745,8.M1) <
 asType<integer>(\$heap_724,1;745,8.p1)
 → [from term 59.19, \$heap_724,1;745,8 is equal to
 \$heap_funcstart_724,1.**replace**(p1 → (-2 * div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
 \$heap_funcstart_724,1.p1, 177).rem))]
 [60.1] –asType<integer const>(\$heap_funcstart_724,1.**replace**(p1 → ((-2 *
 div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
 div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).M1) <
 asType<integer>(\$heap_724,1;745,8.p1)
 → [const member of object with modified fields]
 [60.2] –asType<integer const>(\$heap_funcstart_724,1.M1) <
 asType<integer>(\$heap_724,1;745,8.p1)
 → [const static or extern object]
 [60.3] –asType<integer const>(\$heap_init.M1) <
 asType<integer>(\$heap_724,1;745,8.p1)

→ [expand definition of constant 'M1' at prang.c (14,20)]

[60.4] $\text{asType}\langle\text{integer const}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30269)) <$
 $\text{asType}\langle\text{integer}\rangle(\text{heap}_{724,1;745,8}.\text{p1})$

→ [simplify]

[60.8] $-30269 < \text{asType}\langle\text{integer}\rangle(\text{heap}_{724,1;745,8}.\text{p1})$

→ [from term 59.19, $\text{heap}_{724,1;745,8}$ is equal to
 $\text{heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}},$
 $\text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}},$
 $\text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem}))]$

[60.9] $-30269 < \text{asType}\langle\text{integer}\rangle(\text{heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem})))).\text{p1})$

→ [simplify]

[60.11] $-30269 < ((-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem})))$

[Take given term]

[61.0] $!(0 == \text{asType}\langle\text{integer}\rangle(\text{heap}_{724,1;745,8}.\text{p1}))$

→ [from term 59.19, $\text{heap}_{724,1;745,8}$ is equal to
 $\text{heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}},$
 $\text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}},$
 $\text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem}))]$

[61.1] $!(0 == \text{asType}\langle\text{integer}\rangle(\text{heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem})))).\text{p1}))$

→ [simplify]

[61.3] $!(0 == ((-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem}))))$

[Take given term]

[62.0] $\text{asType}\langle\text{integer}\rangle(\text{heap}_{724,1;745,8}.\text{p1}) <$
 $\text{asType}\langle\text{integer}\rangle(\text{heap}_{724,1;745,8}.\text{M1})$

→ [from term 59.19, $\text{heap}_{724,1;745,8}$ is equal to
 $\text{heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}},$
 $\text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}},$
 $\text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem}))]$

[62.1] $\text{asType}\langle\text{integer}\rangle(\text{heap}_{\text{funcstart}_{724,1}}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{heap}_{\text{funcstart}_{724,1}}, \text{heap}_{\text{funcstart}_{724,1}.\text{p1}, 177}).\text{rem})))).\text{p1}))$

$\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{rem}))\text{.p1}) <$
 $\text{asType<integer>}(\$ \text{heap}_{724,1;745,8}.\text{M1})$
 $\rightarrow [\text{simplify}]$
 $[62.3] ((-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{rem})) < \text{asType<integer>}(\$ \text{heap}_{724,1;745,8}.\text{M1})$
 $\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to}$
 $\$ \text{heap}_{\text{funcstart_724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{rem}))]$
 $[62.4] ((-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{rem})) < \text{asType<integer>}(\$ \text{heap}_{\text{funcstart_724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{rem})))\text{.M1})$
 $\rightarrow [\text{const member of object with modified fields}]$
 $[62.5] ((-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{rem})) < \text{asType<integer>}(\$ \text{heap}_{\text{funcstart_724,1}}.\text{M1})$
 $\rightarrow [\text{const static or extern object}]$
 $[62.6] ((-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{rem})) < \text{asType<integer>}(\$ \text{heap}_{\text{init}}.\text{M1})$
 $\rightarrow [\text{expand definition of constant 'M1' at prang.c (14,20)}]$
 $[62.7] ((-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1.p1}},$
 $177).\text{rem})) < \text{asType<integer>}(\text{asType<short int>}((\text{int})30269))$
 $\rightarrow [\text{simplify}]$
 $[62.17] -30269 < ((-171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{quot}))$
 $[\text{Take given term}]$
 $[63.0] \$ \text{heap}_{724,1;747,8} == \$ \text{heap}_{724,1;745,8}.\text{replace}(p2 \rightarrow \text{asType<short}$
 $\text{int>}((\text{asType<int>}(\text{asType<short int>}(\text{div2}.\text{rem})) * \text{asType<int>}(\$ \text{heap}_{724,1;745,8}.\text{r2})) - (\text{asType<int>}(\text{asType<short}$
 $\text{int>}(\text{div2}.\text{quot})) * \text{asType<int>}(\$ \text{heap}_{724,1;745,8}.\text{b2}))))$
 $\rightarrow [\text{from term 59.19, } \$\text{heap}_{724,1;745,8} \text{ is equal to}$
 $\$ \text{heap}_{\text{funcstart_724,1}}.\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$
 $\$ \text{heap}_{\text{funcstart_724,1.p1}}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}},$

$\$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.1] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short \ int>((asType<int>(asType<short \ int>(\div2.rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short \ int>(\div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [from \ term \ 27.6, \ \div2 \ is \ equal \ to \ \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176)]$
 $[63.2] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short \ int>((asType<int>(asType<short \ int>(\div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem)) * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short \ int>(\div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [simplify]$
 $[63.4] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short \ int>((\div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(\$heap_{724,1;745,8}.r2)) - (asType<int>(asType<short \ int>(\div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [from \ term \ 59.19, \ \$heap_{724,1;745,8} \ is \ equal \ to$
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow (-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))]$
 $[63.5] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short \ int>((\div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).r2)) - (asType<int>(asType<short \ int>(\div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))))$
 $\rightarrow [const \ member \ of \ object \ with \ modified \ fields]$
 $[63.6] \ \$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow asType<short \ int>((\div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p2, 176).rem * asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \div(heapIs \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1}.p1, 177).rem))).r2)) - (asType<int>(asType<short \ int>(\div2.quot)) * asType<int>(\$heap_{724,1;745,8}.b2))))))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap_funcstart_724,1.r2})) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{const static or extern object}]$
 $[63.7] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{init}.r2)) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{expand definition of constant 'r2' at prang.c (20,20)}]$
 $[63.8] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * \text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})172))) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{simplify}]$
 $[63.11] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem} * 172) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div2.quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{from term 27.6, div2 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176)]$
 $[63.12] \$\text{heap}_{724,1;747,8} == \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) - (\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})) * \text{asType}\langle\text{int}\rangle(\$ \text{heap}_{724,1;745,8}.b2))))$
 $\rightarrow [\text{simplify}]$

[63.14] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{724,1;745,8}.b2))))$

→ [from term 59.19, $\$heap_{724,1;745,8}$ is equal to $\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$

[63.15] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot b2))))$

→ [const member of object with modified fields]

[63.16] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}.b2))))$

→ [const static or extern object]

[63.17] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b2))))$

→ [expand definition of constant 'b2' at prang.c (22,20)]

[63.18] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem) - (\text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot * \text{asType}\langle \text{int} \rangle(\$heap_{init}.b2))))$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot *$
asType<int>(**asType<short int>**((int)35))))
 → [simplify]
 [63.24] $\$heap_{724,1;747,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))))$
 [Take given term]
 [64.0] **asType<integer const>**($\$heap_{724,1;747,8}.M2$) <
asType<integer>($\$heap_{724,1;747,8}.p2$)
 → [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))]$
 [64.1] **asType<integer const>**($\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).M2$) <
asType<integer>($\$heap_{724,1;747,8}.p2$)
 → [const member of object with modified fields]
 [64.3] **asType<integer const>**($\$heap_{funcstart_724,1}.M2$) <
asType<integer>($\$heap_{724,1;747,8}.p2$)
 → [const static or extern object]
 [64.4] **asType<integer const>**($\$heap_{init}.M2$) <
asType<integer>($\$heap_{724,1;747,8}.p2$)
 → [expand definition of constant 'M2' at prang.c (19,20)]
 [64.5] **asType<integer const>**(**asType<short int>**((int)30307)) <
asType<integer>($\$heap_{724,1;747,8}.p2$)
 → [simplify]
 [64.9] $-30307 < \text{asType<integer>}(\$heap_{724,1;747,8}.p2)$
 → [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow (-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$]
 [64.10] $-30307 < \mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$). $p2$)
 \rightarrow [simplify]
 [64.12] $-30307 < ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$
 [Take given term]
 [65.0] $!(0 == \mathbf{asType}<\mathbf{integer}>(\$heap_{724,1;747,8}.p2))$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow (-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$]
 [65.1] $!(0 == \mathbf{asType}<\mathbf{integer}>(\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$). $p2$)
 \rightarrow [simplify]
 [65.3] $!(0 == ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))))$
 [Take given term]
 [66.0] $\mathbf{asType}<\mathbf{integer}>(\$heap_{724,1;747,8}.p2) < \mathbf{asType}<\mathbf{integer}>(\$heap_{724,1;747,8}.M2)$
 \rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
 $\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow (-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$]

[66.1] **asType<integer>**(\$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).p2) < **asType<integer>**(\$heap724,1;747,8.M2)

→ [simplify]

[66.3] ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) < **asType<integer>**(\$heap724,1;747,8.M2)

→ [from term 63.24, \$heap724,1;747,8 is equal to

\$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → (-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))]

[66.4] ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) < **asType<integer>**(\$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).M2)

→ [const member of object with modified fields]

[66.6] ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) < **asType<integer>**(\$heap_funcstart_724,1.M2)

→ [const static or extern object]

[66.7] ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) < **asType<integer>**(\$heap_init.M2)

→ [expand definition of constant 'M2' at prang.c (19,20)]

[66.8] ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) < **asType<integer>**(**asType<short int>**((int)30307))

→ [simplify]

[66.18] -30307 < ((-172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) + (35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot))

[67.0] \$heap_{724,1;749,8} == \\$heap_{724,1;747,8}.replace(p3 \rightarrow asType<short int>((asType<int>(asType<short int>(div3.rem)) * asType<int>(\\$heap_{724,1;747,8.r3})) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8.b3}))))

\(\rightarrow\) [from term 63.24, \$heap_{724,1;747,8}\$ is equal to
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).rem))).replace(p2 \rightarrow (-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).rem)))]$

[67.1] \$heap_{724,1;749,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p1}, 177).quot) + (171 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p1}, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p2}, 176).quot) + (172 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p2}, 176).rem))).replace(p3 \rightarrow asType<short int>((asType<int>(asType<short int>(div3.rem)) * asType<int>(\\$heap_{724,1;747,8.r3})) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8.b3}))))

\(\rightarrow\) [from term 43.6, div3 is equal to div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178)]

[67.2] \$heap_{724,1;749,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p1}, 177).quot) + (171 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p1}, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p2}, 176).quot) + (172 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p2}, 176).rem))).replace(p3 \rightarrow asType<short int>((asType<int>(asType<short int>(div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p3}, 178).rem)) * asType<int>(\\$heap_{724,1;747,8.r3})) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8.b3}))))

\(\rightarrow\) [simplify]

[67.4] \$heap_{724,1;749,8} == \\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p1}, 177).quot) + (171 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p1}, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p2}, 176).quot) + (172 * div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p2}, 176).rem))).replace(p3 \rightarrow asType<short int>((div(heapIs \\$heap_{funcstart_724,1}, \\$heap_{funcstart_724,1.p3}, 178).rem) * asType<int>(\\$heap_{724,1;747,8.r3})) - (asType<int>(asType<short int>(div3.quot)) * asType<int>(\\$heap_{724,1;747,8.b3}))))

→ [from term 63.24, \$heap_{724,1;747,8} is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})))]$

[67.5] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))]$

→ [const member of object with modified fields]

[67.7] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem} * \text{asType}<\text{int}>(\$heap_{funcstart_724,1}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))]$

→ [const static or extern object]

[67.8] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem} * \text{asType}<\text{int}>(\$heap_{init}.r3)) - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3))))]$

→ [expand definition of constant 'r3' at prang.c (25,20)]

[67.9] $\$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$$\begin{aligned} & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short} \\ & \text{int}>((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * \\ & \text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})170))) - \\ & (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \\ & \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{simplify}] \\ & [67.12] \$heap_{724,1;749,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short} \\ & \text{int}>((\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem} * 170) \\ & - (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div3.quot})) * \\ & \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{from term 43.6, div3 is equal to } \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p3}, 178)] \\ & [67.13] \$heap_{724,1;749,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 \\ & * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\ & (\text{asType}<\text{int}>(\text{asType}<\text{short int}>(\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p3}, 178).\text{quot})) * \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{simplify}] \\ & [67.15] \$heap_{724,1;749,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow \text{asType}<\text{short int}>((170 \\ & * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) - \\ & (\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot} * \\ & \text{asType}<\text{int}>(\$heap_{724,1;747,8}.b3)))) \\ & \rightarrow [\text{from term 63.24, } \$heap_{724,1;747,8} \text{ is equal to} \\ & \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow (-35 * \text{div}(\text{heapIs }
\end{aligned}$$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))]$

$[67.16] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * asType<int>(\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).b3))))$

$\rightarrow [const\ member\ of\ object\ with\ modified\ fields]$

$[67.18] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * asType<int>(\$heap_{funcstart_724,1}.b3))))$

$\rightarrow [const\ static\ or\ extern\ object]$

$[67.19] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) - (div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot * asType<int>(\$heap_{init}.b3))))$

$\rightarrow [expand\ definition\ of\ constant\ 'b3'\ at\ prang.c\ (27,20)]$

$[67.20] \$heap_{724,1;749,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType<short int>((170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) -$

(div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot *
asType<int>(asType<short int>((int)63))))

→ [simplify]

[67.26] \$heap724,1;749,8 == \$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))

[Take given term]

[68.0] -asType<integer const>(\$heap724,1;749,8.M3) <
asType<integer>(\$heap724,1;749,8.p3)

→ [from term 67.26, \$heap724,1;749,8 is equal to

\$heap_funcstart_724,1._replace(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 → ((-35 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → (-63 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))]

[68.1] -asType<integer const>(\$heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).M3) <
asType<integer>(\$heap724,1;749,8.p3)

→ [const member of object with modified fields]

[68.4] -asType<integer const>(\$heap_funcstart_724,1.M3) <
asType<integer>(\$heap724,1;749,8.p3)

→ [const static or extern object]

[68.5] -asType<integer const>(\$heap_init.M3) <
asType<integer>(\$heap724,1;749,8.p3)

→ [expand definition of constant 'M3' at prang.c (24,20)]

[68.6] -asType<integer const>(asType<short int>((int)30323)) <
asType<integer>(\$heap724,1;749,8.p3)

→ [simplify]

[68.10] -30323 < asType<integer>(\$heap_{724,1;749,8}.p3)

→ [from term 67.26, \$heap_{724,1;749,8} is equal to

\$heap_{funcstart_724,1}.replace(p1 → ((-2 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 → ((-35 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 → (-63 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))]

[68.11] -30323 < asType<integer>(\$heap_{funcstart_724,1}.replace(p1 → ((-2
* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem))).replace(p2 → ((-35 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 → ((-63 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).p3)

→ [simplify]

[68.13] -30323 < ((-63 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p3, 178).rem))

[Take given term]

[69.0] !(0 == asType<integer>(\$heap_{724,1;749,8}.p3))

→ [from term 67.26, \$heap_{724,1;749,8} is equal to

\$heap_{funcstart_724,1}.replace(p1 → ((-2 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 → ((-35 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 → (-63 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))]

[69.1] !(0 == asType<integer>(\$heap_{funcstart_724,1}.replace(p1 → ((-2 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem))).replace(p2 → ((-35 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1},
\$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 → ((-63 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs
\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).p3))

→ [simplify]

$\$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$.M3)

→ [const member of object with modified fields]

[70.7] $((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)) < \text{asType}\langle \text{integer} \rangle(\$heap_{funcstart_724,1}.M3)$

→ [const static or extern object]

[70.8] $((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)) < \text{asType}\langle \text{integer} \rangle(\$heap_{init}.M3)$

→ [expand definition of constant 'M3' at prang.c (24,20)]

[70.9] $((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)) < \text{asType}\langle \text{integer} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30323))$

→ [simplify]

[70.19] $-30323 < ((-170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem) + (63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot))$

[Take given term]

[71.0] $\$heap_{724,1;752,8} == \$heap_{724,1;749,8}$.**replace**($p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.M1) * \text{asType}\langle \text{int} \rangle(\text{static_cast}\langle \text{integer} \rangle(\text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.p1) < (\text{int})0))) + \text{asType}\langle \text{int} \rangle(\$heap_{724,1;749,8}.p1)))$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

$\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$

[71.2] $\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$.**replace**($p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{asType}\langle \text{int} \rangle(\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 *$

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* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem))).M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
→ [const member of object with modified fields]

[71.5] $heap724,1;752,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem)))._replace(p1 →
asType<short int>((asType<int>($heap_funcstart_724,1.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
→ [const static or extern object]

[71.6] $heap724,1;752,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem)))._replace(p1 →
asType<short int>((asType<int>($heap_init.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
→ [expand definition of constant 'M1' at prang.c (14,20)]

[71.7] $heap724,1;752,8 == $heap_funcstart_724,1._replace(p1 → ((-2 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).rem)))._replace(p1 →
asType<short int>((asType<int>(asType<short int>((int)30269)) *

```

$$\rightarrow [\textit{simplify}]$$

→ [from term 67.26, $\$heap_{724,1;749,8}$ is equal to

```
[71.11] $heap724,1;752,8 == $heapfuncstart_724,1._replace(p1 → ((-2 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) + (171 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem)))._replace(p1 →
asType<short int>((30269 *
asType<int>(static_cast<integer>(asType<int>($heapfuncstart_724,1._replace(p1
→ ((-2 * div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1, 177).quot) +
(171 * div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p1,
177).rem)))._replace(p2 → ((-35 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → ((-63 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot) + (170 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).rem))).p1) < (int)0))) +
asType<int>($heap724,1;749,8.p1)))
```

→ [simplify]

972

$\text{div}(\text{heapIs } \$\text{heap_funcstart}_{724,1}, \$\text{heap_funcstart}_{724,1}.p1,$
 $177).\text{rem})))). \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p2, 176).\text{rem}))). \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p3, 178).\text{rem}))). \text{replace}(p1 \rightarrow$
asType<short int>((30269 * **asType<int>**(([0 < ((-171 * $\text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot})]$: 1, []: 0))) +
asType<int>($\$ \text{heap}_{724,1;749,8}.p1))$)

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[71.24] $\$ \text{heap}_{724,1;752,8} == \$ \text{heap_funcstart}_{724,1}. \text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1,$
 $177).\text{rem}))). \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p2, 176).\text{rem}))). \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p3, 178).\text{rem}))). \text{replace}(p1 \rightarrow$
asType<short int>((30269 * **asType<int>**(([0 < ((-171 * $\text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot})]$: 1, [$!(0 < ((-171 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{rem}) + (2 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot}))]$: 0))) +
asType<int>($\$ \text{heap}_{724,1;749,8}.p1))$)

\rightarrow [simplify]

[71.29] $\$ \text{heap}_{724,1;752,8} == \$ \text{heap_funcstart}_{724,1}. \text{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1,$
 $177).\text{rem}))). \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p2, 176).\text{rem}))). \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p3, 178).\text{rem}))). \text{replace}(p1 \rightarrow$
asType<short int>((30269 * **asType<int>**(([0 < ((-171 * $\text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}$
 $\$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot})]$: 1, [$-1 < ((171 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{rem}) + (-2 *$
 $\text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1}, \$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot}))]$: 0))) +
asType<int>($\$ \text{heap}_{724,1;749,8}.p1))$)

\rightarrow [from term 61.3, $-1 < ((-2 * \text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$ \text{heap_funcstart}_{724,1},$
 $\$ \text{heap_funcstart}_{724,1}.p1, 177).\text{rem}))$ is true if and only if $0 < ((-2 * \text{div}(\text{heapIs }$

$\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))]$

[71.30] $\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow$
 $asType<short int>((30269 * asType<int>([0 < ((-171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: 1, [0 < ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))]: 0))) +$
 $asType<int>(\$heap_{724,1;749,8}.p1)))$

$\rightarrow [simplify]$

[71.31] $\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow$
 $asType<short int>((30269 * ([0 < ((-171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: 1, [0 < ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))]: 0))) +$
 $asType<int>(\$heap_{724,1;749,8}.p1)))$

$\rightarrow [move\ guard\ outside\ expression]$

[71.32] $\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow$
 $asType<short int>([0 < ((-171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem) + (2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: 1 * 30269, [0 < ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot))]: 1 * 30269, [0 < ((-2 * div(heapIs$

176).rem))).**_replace**(p3 → ((-63 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem))).p1)))

→ [simplify]

[71.40] \$heap724,1;752,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**_replace**(p1 →
asType<**short int**>((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem) + ([0 < ((-171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 30269, [0 < ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0)))

→ [move guard outside expression]

[71.41] \$heap724,1;752,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**_replace**(p1 →
asType<**short int**>([0 < ((-171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem) + (2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot))]: 30269 + (-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem), [0 < ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: 0 + (-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))))

→ [simplify]

[71.43] \$heap724,1;752,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,

$\$heap_funcstart_724,1.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$).replace($p1 \rightarrow ([0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: 30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))$)

\rightarrow [move guard outside expression]

$[71.45] [0 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))]: \$heap_{724,1;752,8} == \$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$).replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$).replace($p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))), [0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]: \$heap_{724,1;752,8} == \$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$).replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$).replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))$))

[Take given term]

$[72.0] \$heap_{724,1;753,8} == \$heap_{724,1;752,8}$.replace($p2 \rightarrow \text{asType}<\text{short int}>((\text{asType}<\text{int}>(\$heap_{724,1;752,8}.M2) * \text{asType}<\text{int}>(\text{static_cast}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{724,1;752,8}.p2) < (\text{int})0))) + \text{asType}<\text{int}>(\$heap_{724,1;752,8}.p2))$)

\rightarrow [const static or extern object]

[72.1] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\$heap_{init}.M2) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2))))$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]

[72.2] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{asType}\langle\text{int}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)) * \text{asType}\langle\text{int}\rangle(\text{static_cast}\langle\text{integer}\rangle(\text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2) < (\text{int})0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2))))$
 \rightarrow [simplify]

[72.10] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((30307 * \text{asType}\langle\text{int}\rangle((\text{int})0 < -\$heap_{724,1;752,8}.p2]: 1, []: 0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2))))$
 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[72.11] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((30307 * \text{asType}\langle\text{int}\rangle((\text{int})0 < -\$heap_{724,1;752,8}.p2]: 1, [!(0 < -\$heap_{724,1;752,8}.p2]): 0))) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2))))$
 \rightarrow [simplify]

[72.15] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((30307 * ([0 < -\$heap_{724,1;752,8}.p2]: 1, [-1 < \$heap_{724,1;752,8}.p2]: 0)) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2))))$
 \rightarrow [move guard outside expression]

[72.16] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle([(0 < -\$heap_{724,1;752,8}.p2]: 1 * 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0 * 30307) + \text{asType}\langle\text{int}\rangle(\$heap_{724,1;752,8}.p2))))$
 \rightarrow [simplify]

[72.19] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle([(0 < -\$heap_{724,1;752,8}.p2]: 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0) + \$heap_{724,1;752,8}.p2))$
 \rightarrow [move guard outside expression]

[72.20] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle([(0 < -\$heap_{724,1;752,8}.p2]: 30307 + \$heap_{724,1;752,8}.p2, [-1 < \$heap_{724,1;752,8}.p2]: 0 + \$heap_{724,1;752,8}.p2))))$
 \rightarrow [simplify]

[72.22] $\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow ([0 < -\$heap_{724,1;752,8}.p2]: 30307 + \$heap_{724,1;752,8}.p2, [-1 < \$heap_{724,1;752,8}.p2]: \$heap_{724,1;752,8}.p2))$
 \rightarrow [move guard outside expression]

[72.24] $([0 < -\$heap_{724,1;752,8}.p2]: \$heap_{724,1;753,8} ==$
 $\$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)), [-1 <$
 $\$heap_{724,1;752,8}.p2]: \$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow$
 $\$heap_{724,1;752,8}.p2))$

[Take given term]

[75.0] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>((\text{asType}<\text{int}>(\$heap_{724,1;753,8}.M3) *$
 $\text{asType}<\text{int}>(\text{static_cast}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3) <$
 $(\text{int})0))) + \text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [const static or extern object]

[75.1] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>((\text{asType}<\text{int}>(\$heap_{init}.M3) *$
 $\text{asType}<\text{int}>(\text{static_cast}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3) <$
 $(\text{int})0))) + \text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]

[75.2] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>((\text{asType}<\text{int}>(\text{asType}<\text{short int}>((\text{int})30323)) *$
 $\text{asType}<\text{int}>(\text{static_cast}<\text{integer}>(\text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3) <$
 $(\text{int})0))) + \text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [simplify]

[75.10] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>((30323 * \text{asType}<\text{int}>([0 < -\$heap_{724,1;753,8}.p3]: 1, []: 0))) +$
 $\text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]

[75.11] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>((30323 * \text{asType}<\text{int}>([0 < -\$heap_{724,1;753,8}.p3]: 1, [!(0 <$
 $-\$heap_{724,1;753,8}.p3]: 0))) + \text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [simplify]

[75.15] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>((30323 * ([0 < -\$heap_{724,1;753,8}.p3]: 1, [-1 < \$heap_{724,1;753,8}.p3]: 0)) +$
 $\text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [move guard outside expression]

[75.16] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>([(0 < -\$heap_{724,1;753,8}.p3]: 1 * 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0 *$
 $30323) + \text{asType}<\text{int}>(\$heap_{724,1;753,8}.p3)))$

\rightarrow [simplify]

[75.19] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short}$
 $\text{int}>([(0 < -\$heap_{724,1;753,8}.p3]: 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0) +$
 $\$heap_{724,1;753,8}.p3))$

→ [move guard outside expression]

[75.20] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \mathbf{asType}<\mathbf{short\ int}>(([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 < \$heap_{724,1;753,8}.p3]: 0 + \$heap_{724,1;753,8}.p3)))$

→ [simplify]

[75.22] $\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow ([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 < \$heap_{724,1;753,8}.p3]: \$heap_{724,1;753,8}.p3))$

→ [move guard outside expression]

[75.24] $([0 < -\$heap_{724,1;753,8}.p3]: \$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3)), [-1 < \$heap_{724,1;753,8}.p3]: \$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3))$

[Branch on disjunction or conditional in term 75.24]

[78.0] $(\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3))) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3)$

[Branch on disjunction or conditional in term 75.24]

[79.0] $(0 < -\$heap_{724,1;753,8}.p3) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3)$

[Copy term 1.56]

[80.0] $((-1 < -\$heap_{funcend_724,1}.p1) \vee (-1 < -\$heap_{funcend_724,1}.p2) \vee (-1 < -\$heap_{funcend_724,1}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3)$

→ [from term 78.0, $\$heap_{funcend_724,1}$ is equal to $\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow 30323 + \$heap_{724,1;753,8}.p3)$]

[80.1] $((-1 < -\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3)).p1) \vee (-1 < -\$heap_{funcend_724,1}.p2) \vee (-1 < -\$heap_{funcend_724,1}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$

→ [simplify]

[80.2] $((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{funcend_724,1}.p2) \vee (-1 < -\$heap_{funcend_724,1}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$

→ [from term 78.0, $\$heap_{funcend_724,1}$ is equal to $\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow 30323 + \$heap_{724,1;753,8}.p3)$]

$[80.3] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3)).p2) \vee (-1 < -\$heap_{funcend_724,1}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[80.4] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (-1 < -\$heap_{funcend_724,1}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 78.0, \$heap_{funcend_724,1}\ is\ equal\ to\ \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow 30323 + \$heap_{724,1;753,8}.p3)]$
 $[80.5] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (-1 < -\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3)).p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[80.10] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 78.0, \$heap_{funcend_724,1}\ is\ equal\ to\ \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow 30323 + \$heap_{724,1;753,8}.p3)]$
 $[80.11] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3)).p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[80.12] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 78.0, \$heap_{funcend_724,1}\ is\ equal\ to\ \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow 30323 + \$heap_{724,1;753,8}.p3)]$
 $[80.13] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \$heap_{724,1;753,8}.p3)).p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[80.14] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 78.0, \$heap_{funcend_724,1}\ is\ equal\ to\ \$heap_{724,1;753,8}.\mathbf{replace}(p3$

$\rightarrow 30323 + \text{\$heap}_{724,1;753,8}.p3]$
 $[80.15] ((-1 < -\text{\$heap}_{724,1;753,8}.p1) \vee (-1 < -\text{\$heap}_{724,1;753,8}.p2) \vee (30322 < -\text{\$heap}_{724,1;753,8}.p3) \vee (30268 < \text{\$heap}_{724,1;753,8}.p1) \vee (30306 < \text{\$heap}_{724,1;753,8}.p2) \vee (30322 < \text{\$heap}_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow (30323 + \text{\$heap}_{724,1;753,8}.p3)).p3)) \vee \dots$
 $\rightarrow [\text{simplify}]$
 $[80.18] ((-1 < -\text{\$heap}_{724,1;753,8}.p1) \vee (-1 < -\text{\$heap}_{724,1;753,8}.p2) \vee (30322 < -\text{\$heap}_{724,1;753,8}.p3) \vee (30268 < \text{\$heap}_{724,1;753,8}.p1) \vee (30306 < \text{\$heap}_{724,1;753,8}.p2) \vee (-1 < \text{\$heap}_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [\text{from term 79.0, literal } a < \text{\$heap}_{724,1;753,8}.p3 \text{ is false whenever } -2 < (0 + \text{literal})]$

Proof of rule precondition:

$[80.18.0] -2 < (-1 + 0)$
 $\rightarrow [\text{simplify}]$
 $[80.18.2] \mathbf{true}$
 $[80.19] ((-1 < -\text{\$heap}_{724,1;753,8}.p1) \vee (-1 < -\text{\$heap}_{724,1;753,8}.p2) \vee (30322 < -\text{\$heap}_{724,1;753,8}.p3) \vee (30268 < \text{\$heap}_{724,1;753,8}.p1) \vee (30306 < \text{\$heap}_{724,1;753,8}.p2) \vee \mathbf{false}) \vee \dots$
 $\rightarrow [\text{simplify}]$
 $[80.20] ((-1 < -\text{\$heap}_{724,1;753,8}.p1) \vee (-1 < -\text{\$heap}_{724,1;753,8}.p2) \vee (30268 < \text{\$heap}_{724,1;753,8}.p1) \vee (30306 < \text{\$heap}_{724,1;753,8}.p2) \vee (30322 < -\text{\$heap}_{724,1;753,8}.p3)) \vee \dots$
 $[\text{Branch on disjunction or conditional in term 72.24}]$
 $[81.0] (\text{\$heap}_{724,1;753,8} == \text{\$heap}_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow (30307 + \text{\$heap}_{724,1;752,8}.p2))) \vee (\text{\$heap}_{724,1;753,8} == \text{\$heap}_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow \text{\$heap}_{724,1;752,8}.p2)) \vee (-1 < \text{\$heap}_{724,1;752,8}.p2)$
 $[\text{Branch on disjunction or conditional in term 72.24}]$
 $[82.0] (0 < -\text{\$heap}_{724,1;752,8}.p2) \vee (\text{\$heap}_{724,1;753,8} == \text{\$heap}_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow \text{\$heap}_{724,1;752,8}.p2)) \vee (-1 < \text{\$heap}_{724,1;752,8}.p2)$
 $[\text{Copy term 80.20}]$
 $[89.0] ((-1 < -\text{\$heap}_{724,1;753,8}.p1) \vee (-1 < -\text{\$heap}_{724,1;753,8}.p2) \vee (30268 < \text{\$heap}_{724,1;753,8}.p1) \vee (30306 < \text{\$heap}_{724,1;753,8}.p2) \vee (30322 < -\text{\$heap}_{724,1;753,8}.p3)) \vee (\text{\$heap}_{\text{funcend_724,1}} == \text{\$heap}_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \text{\$heap}_{724,1;753,8}.p3)) \vee (-1 < \text{\$heap}_{724,1;753,8}.p3) \vee (\text{\$heap}_{724,1;753,8} == \text{\$heap}_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow \text{\$heap}_{724,1;752,8}.p2)) \vee (-1 < \text{\$heap}_{724,1;752,8}.p2)$
 $\rightarrow [\text{from term 81.0, } \text{\$heap}_{724,1;753,8} \text{ is equal to } \text{\$heap}_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow 30307 + \text{\$heap}_{724,1;752,8}.p2)]$
 $[89.1] ((-1 < -\text{\$heap}_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow (30307 +$

$\$heap_{724,1;752,8}.p2)).p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 <$
 $\$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $-\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[89.2] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 <$
 $\$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $-\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 81.0,\ \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow$
 $30307 + \$heap_{724,1;752,8}.p2)]$
 $[89.3] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow$
 $(30307 + \$heap_{724,1;752,8}.p2)).p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 <$
 $\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[89.8] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268$
 $< \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $-\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 81.0,\ \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow$
 $30307 + \$heap_{724,1;752,8}.p2)]$
 $[89.9] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268$
 $< \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p1) \vee (30306$
 $< \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[89.10] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268$
 $< \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $-\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 81.0,\ \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow$
 $30307 + \$heap_{724,1;752,8}.p2)]$
 $[89.11] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268$
 $< \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow (30307 +$
 $\$heap_{724,1;752,8}.p2)).p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[89.14] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268$
 $< \$heap_{724,1;752,8}.p1) \vee (-1 < \$heap_{724,1;752,8}.p2) \vee (30322 <$
 $-\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 82.0,\ literal_a < \$heap_{724,1;752,8}.p2\ is\ false\ whenever\ -2 < (0 +$
 $literal_a)]$

Proof of rule precondition:

$[89.14.0] -2 < (-1 + 0)$

\rightarrow [simplify]
 [89.14.2] **true**
 [89.15] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee \mathbf{false} \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [from term 81.0, $\$heap_{724,1;753,8}$ is equal to $\$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow 30307 + \$heap_{724,1;752,8}.p2)$]
 [89.16] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee \mathbf{false} \vee (30322 < -\$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p3)) \vee \dots$
 \rightarrow [simplify]
 [89.18] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$
 [Branch on disjunction or conditional in term 71.45]
 [90.0] $(\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\mathbf{replace}(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\mathbf{replace}(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\mathbf{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\mathbf{replace}(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\mathbf{replace}(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))) \vee (0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))$
 [Branch on disjunction or conditional in term 71.45]
 [91.0] $(0 < ((-171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}))) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))))$

177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**_replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))) ∨ (0 <
((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) +
(171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))

[Copy term 81.0]

[92.0] (\$heap724,1;753,8 == \$heap724,1;752,8.**_replace**(p2 → (30307 +
\$heap724,1;752,8.p2))) ∨ (\$heap724,1;753,8 == \$heap724,1;752,8.**_replace**(p2 →
\$heap724,1;752,8.p2)) ∨ (-1 < \$heap724,1;752,8.p2) ∨ (\$heap724,1;752,8 ==
\$heap_funcstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63
* div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,
178).rem))).**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem)))) ∨ (0 < ((-2 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))

→ [from term 90.0, \$heap724,1;752,8 is equal to \$heap_funcstart_724,1.**_replace**(p1
→ ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) +
(171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**_replace**(p1 → 30269
+ (-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) +
(171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))]

[92.2] (\$heap724,1;753,8 == \$heap_funcstart_724,1.**_replace**(p1 → ((-2 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,
177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**_replace**(p1 →
(30269 + (-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1,

$(171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem})))._replace(p1 \rightarrow 30269 + (-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))$
 $[94.1] (0 < -\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem})))._replace(p1 \rightarrow (30269 + (-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).p2) \vee \dots$
 $\rightarrow [\text{simplify}]$
 $[94.7] (0 < ((35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (-172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))) \vee \dots$
 $[\text{Copy term 89.18}]$
 $[96.0] ((-1 < -\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee (\$heap_funcend_724,1 == \$heap_{724,1;753,8}._replace(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3) \vee (\$heap_{724,1;753,8} == \$heap_{724,1;752,8}._replace(p2 \rightarrow \$heap_{724,1;752,8}.p2)) \vee (-1 < \$heap_{724,1;752,8}.p2) \vee (\$heap_{724,1;752,8} == \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem})))._replace(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem})))) \vee (0 < ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))))$
 $\rightarrow [\text{from term 90.0, } \$heap_{724,1;752,8} \text{ is equal to } \$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))))$

$177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$).**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem)))$).**replace**($p1 \rightarrow 30269$
 $+ (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) +$
 $(171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$]
 $[96.1] ((-1 < -\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$).**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem)))$).**replace**($p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem)))$. $p1 \vee (30268 <$
 $\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 <$
 $-\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [simplify]

$[96.10] ((30268 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot))) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306$
 $< -\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [from term 60.11, $\text{literal} < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot))$ is false whenever $-2 < (-30269 + \text{literal})$]

Proof of rule precondition:

$[96.10.0] -2 < (-30269 + 30268)$

\rightarrow [simplify]

$[96.10.2] \text{true}$

$[96.11] (\text{false} \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2)$
 $\vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [from term 90.0, $\$heap_{724,1;752,8}$ is equal to $\$heap_{funcstart_724,1}$.**replace**($p1$
 $\rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) +$
 $(171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))$.**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem)))$.**replace**($p1 \rightarrow 30269$

$+ (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) +$
 $(171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))]$
 $[96.12] (\text{false} \vee (30268 < \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))) \cdot \text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \cdot p1) \vee (30306 < -\$heap_{724,1;752,8.p2}) \vee (30322 < -\$heap_{724,1;752,8.p3})) \vee \dots$
 $\rightarrow [\text{simplify}]$
 $[96.15] (\text{false} \vee (-1 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \vee (30306 < -\$heap_{724,1;752,8.p2}) \vee (30322 < -\$heap_{724,1;752,8.p3})) \vee \dots$
 $\rightarrow [\text{from term 91.0, literal} < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})) \text{ is false whenever } -2 < (0 + \text{literal})]$

Proof of rule precondition:

$[96.15.0] -2 < (-1 + 0)$

$\rightarrow [\text{simplify}]$

$[96.15.2] \text{ true}$

$[96.16] (\text{false} \vee \text{false} \vee (30306 < -\$heap_{724,1;752,8.p2}) \vee (30322 < -\$heap_{724,1;752,8.p3})) \vee \dots$
 $\rightarrow [\text{from term 90.0, } \$heap_{724,1;752,8} \text{ is equal to } \$heap_funcstart_724,1 \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))) \cdot \text{replace}(p1 \rightarrow 30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))))]$
 $[96.17] (\text{false} \vee \text{false} \vee (30306 < -\$heap_funcstart_724,1 \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1},$

$\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$).replace($p1 \rightarrow (30269 + (-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$). $p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [simplify]

$[96.23] (\mathbf{false} \vee \mathbf{false} \vee (30306 < ((35 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (-172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [from term 64.12, $literal_a < ((-172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) + (35 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot))$ is false whenever $-2 < (-30307 + literal_a)$]

Proof of rule precondition:

$[96.23.0] -2 < (-30307 + 30306)$

\rightarrow [simplify]

$[96.23.2] \mathbf{true}$

$[96.24] (\mathbf{false} \vee \mathbf{false} \vee \mathbf{false} \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [from term 90.0, $\$heap_{724,1;752,8}$ is equal to $\$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$.replace($p1 \rightarrow 30269 + (-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))$)]

$[96.25] (\mathbf{false} \vee \mathbf{false} \vee \mathbf{false} \vee (30322 < -\$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$.replace($p1 \rightarrow (30269 + (-2 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(\mathbf{heapIs} \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$). $p3)) \vee \dots$

\rightarrow [simplify]

[96.30] (**false** \vee **false** \vee **false** \vee (30322 < ((63 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (-170 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))) \vee ...

\rightarrow [from term 68.13, literal $a < ((-170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}) + (63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}))$ is false whenever $-2 < (-30323 + \text{literal } a)$]

Proof of rule precondition:

[96.30.0] $-2 < (-30323 + 30322)$

\rightarrow [simplify]

[96.30.2] **true**

[96.31] (**false** \vee **false** \vee **false** \vee **false**) \vee ...

\rightarrow [simplify]

[96.32] **false** \vee ...

[Remove 'false' term 96.32 and fetch new term from containing clause]

[97.0] (\$heap724,1;752,8 == \$heap_funcstart_724,1.**replace**(p1 \rightarrow ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))).**replace**(p2 \rightarrow ((-35 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))).**replace**(p3 \rightarrow ((-63 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))).**replace**(p1 \rightarrow ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))) \vee (\$heap_funcend_724,1 == \$heap724,1;753,8.**replace**(p3 \rightarrow \$heap724,1;753,8.p3)) \vee (-1 < \$heap724,1;753,8.p3) \vee (\$heap724,1;753,8 == \$heap724,1;752,8.**replace**(p2 \rightarrow \$heap724,1;752,8.p2)) \vee (-1 < \$heap724,1;752,8.p2)

[Remove 'false' term 96.32 and fetch new term from containing clause]

[98.0] (0 < ((-2 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))) \vee (\$heap_funcend_724,1 == \$heap724,1;753,8.**replace**(p3 \rightarrow \$heap724,1;753,8.p3)) \vee (-1 < \$heap724,1;753,8.p3) \vee (\$heap724,1;753,8 == \$heap724,1;752,8.**replace**(p2 \rightarrow \$heap724,1;752,8.p2)) \vee (-1 < \$heap724,1;752,8.p2)

[Copy term 80.20]

[89.18] ((-1 < -\$heap724,1;752,8.p1) \vee (30268 < \$heap724,1;752,8.p1) \vee (30306 < -\$heap724,1;752,8.p2) \vee (30322 < -\$heap724,1;752,8.p3)) \vee (\$heap_funcend_724,1 == \$heap724,1;753,8.**replace**(p3 \rightarrow \$heap724,1;753,8.p3)) \vee (-1 < \$heap724,1;753,8.p3) \vee (\$heap724,1;753,8 == \$heap724,1;752,8.**replace**(p2 \rightarrow \$heap724,1;752,8.p2)) \vee (-1 < \$heap724,1;752,8.p2)

→ [from term 97.0, $\$heap_{724,1;752,8}$ is equal to $\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)))$).**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem)))$).**replace**($p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$]

[89.19] $((-1 < -\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$).**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)))$).**replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem)))$).**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$). $p1 \vee (30268 < \$heap_{724,1;752,8} \cdot p1) \vee (30306 < -\$heap_{724,1;752,8} \cdot p2) \vee (30322 < -\$heap_{724,1;752,8} \cdot p3)) \vee \dots$

→ [simplify]

[89.23] $((-1 < ((2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \vee (30268 < \$heap_{724,1;752,8} \cdot p1) \vee (30306 < -\$heap_{724,1;752,8} \cdot p2) \vee (30322 < -\$heap_{724,1;752,8} \cdot p3)) \vee \dots$

→ [from term 98.0, $\text{literal} < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot))$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[89.23.0] $-2 < (-1 + 0)$

→ [simplify]

[89.23.2] **true**

[89.24] $(\text{false} \vee (30268 < \$heap_{724,1;752,8} \cdot p1) \vee (30306 < -\$heap_{724,1;752,8} \cdot p2) \vee (30322 < -\$heap_{724,1;752,8} \cdot p3)) \vee \dots$

→ [from term 97.0, $\$heap_{724,1;752,8}$ is equal to $\$heap_{funcstart_724,1}$.**replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))$.**replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem)))$

$\$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$).replace($p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$)

[89.25] ($\text{false} \vee (30268 < \$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$).replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$).replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$).p1) $\vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [simplify]

[89.26] ($\text{false} \vee (30268 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [from term 62.17, $\text{literal} < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))$ is false whenever $-2 < (-30269 + \text{literal})$]

Proof of rule precondition:

[89.26.0] $-2 < (-30269 + 30268)$

\rightarrow [simplify]

[89.26.2] **true**

[89.27] ($\text{false} \vee \text{false} \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

\rightarrow [from term 97.0, $\$heap_{724,1;752,8}$ is equal to $\$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem)))$.replace($p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$]

[89.28] ($\text{false} \vee \text{false} \vee (30306 < -\$heap_{funcstart_724,1}$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))$

$\text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))) \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

$\rightarrow [\text{simplify}]$

$[89.34] (\text{false} \vee \text{false} \vee (30306 < ((35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

$\rightarrow [\text{from term 64.12, literal } a < ((-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})) \text{ is false whenever } -2 < (-30307 + \text{literal})]$

Proof of rule precondition:

$[89.34.0] -2 < (-30307 + 30306)$

$\rightarrow [\text{simplify}]$

$[89.34.2] \text{true}$

$[89.35] (\text{false} \vee \text{false} \vee \text{false} \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

$\rightarrow [\text{from term 97.0, } \$\text{heap}_{724,1;752,8} \text{ is equal to } \$\text{heap_funcstart_724,1} \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))) \cdot \text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))]$

$[89.36] (\text{false} \vee \text{false} \vee \text{false} \vee (30322 < -\$heap_funcstart_724,1 \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))) \cdot \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) \cdot \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))) \cdot \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))))]$

$\text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p1}, 177).\text{rem}))\text{.p3})) \vee \dots$

$\rightarrow [\text{simplify}]$

[89.41] (**false** \vee **false** \vee **false** \vee ($30322 < ((63 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p3}, 178).\text{quot}) + (-170 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p3}, 178).\text{rem}))) \vee \dots$

$\rightarrow [\text{from term 68.13, literal } a < ((-170 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p3}, 178).\text{rem}) + (63 * \text{div}(\text{heapIs } \$\text{heap}_{\text{funcstart_724,1}}, \$\text{heap}_{\text{funcstart_724,1}}.\text{p3}, 178).\text{quot})) \text{ is false whenever } -2 < (-30323 + \text{literal})]$

Proof of rule precondition:

[89.41.0] $-2 < (-30323 + 30322)$

$\rightarrow [\text{simplify}]$

[89.41.2] **true**

[89.42] (**false** \vee **false** \vee **false** \vee **false**) $\vee \dots$

$\rightarrow [\text{simplify}]$

[89.43] **false** $\vee \dots$

[Remove 'false' term 89.43 and fetch new term from containing clause]

[101.0] ($\$ \text{heap}_{724,1;753,8} == \$ \text{heap}_{724,1;752,8}.\text{replace}(\text{p2} \rightarrow \$ \text{heap}_{724,1;752,8}.\text{p2})) \vee (\$ \text{heap}_{\text{funcend_724,1}} == \$ \text{heap}_{724,1;753,8}.\text{replace}(\text{p3} \rightarrow \$ \text{heap}_{724,1;753,8}.\text{p3})) \vee (-1 < \$ \text{heap}_{724,1;753,8}.\text{p3})$

[Copy term 1.56]

[80.20] ($(-1 < -\$ \text{heap}_{724,1;753,8}.\text{p1}) \vee (-1 < -\$ \text{heap}_{724,1;753,8}.\text{p2}) \vee (30268 < \$ \text{heap}_{724,1;753,8}.\text{p1}) \vee (30306 < \$ \text{heap}_{724,1;753,8}.\text{p2}) \vee (30322 < -\$ \text{heap}_{724,1;753,8}.\text{p3})) \vee (\$ \text{heap}_{\text{funcend_724,1}} == \$ \text{heap}_{724,1;753,8}.\text{replace}(\text{p3} \rightarrow \$ \text{heap}_{724,1;753,8}.\text{p3})) \vee (-1 < \$ \text{heap}_{724,1;753,8}.\text{p3})$

$\rightarrow [\text{from term 101.0, } \$ \text{heap}_{724,1;753,8} \text{ is equal to } \$ \text{heap}_{724,1;752,8}.\text{replace}(\text{p2} \rightarrow \$ \text{heap}_{724,1;752,8}.\text{p2})]$

[80.21] ($(-1 < -\$ \text{heap}_{724,1;752,8}.\text{replace}(\text{p2} \rightarrow \$ \text{heap}_{724,1;752,8}.\text{p2}).\text{p1}) \vee (-1 < -\$ \text{heap}_{724,1;753,8}.\text{p2}) \vee (30268 < \$ \text{heap}_{724,1;753,8}.\text{p1}) \vee (30306 < \$ \text{heap}_{724,1;753,8}.\text{p2}) \vee (30322 < -\$ \text{heap}_{724,1;753,8}.\text{p3})) \vee \dots$

$\rightarrow [\text{simplify}]$

[80.22] ($(-1 < -\$ \text{heap}_{724,1;752,8}.\text{p1}) \vee (-1 < -\$ \text{heap}_{724,1;753,8}.\text{p2}) \vee (30268 < \$ \text{heap}_{724,1;753,8}.\text{p1}) \vee (30306 < \$ \text{heap}_{724,1;753,8}.\text{p2}) \vee (30322 < -\$ \text{heap}_{724,1;753,8}.\text{p3})) \vee \dots$

$\rightarrow [\text{from term 101.0, } \$ \text{heap}_{724,1;753,8} \text{ is equal to } \$ \text{heap}_{724,1;752,8}.\text{replace}(\text{p2} \rightarrow \$ \text{heap}_{724,1;752,8}.\text{p2})]$

[80.23] ($(-1 < -\$ \text{heap}_{724,1;752,8}.\text{p1}) \vee (-1 < -\$ \text{heap}_{724,1;752,8}.\text{replace}(\text{p2} \rightarrow \$ \text{heap}_{724,1;752,8}.\text{p2}).\text{p2}) \vee (30268 < \$ \text{heap}_{724,1;753,8}.\text{p1}) \vee (30306 <$

$\$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [simplify]
[80.24] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
[Remove 'false' term 89.43 and fetch new term from containing clause]
[102.0] $(-1 < \$heap_{724,1;752,8}.p2) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\texttt{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3)$
[Copy term 101.0]
[104.0] $(\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\texttt{replace}(p2 \rightarrow \$heap_{724,1;752,8}.p2)) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\texttt{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{quot}) + (171 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{rem}))).\texttt{replace}(p2 \rightarrow ((-35 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\texttt{quot}) + (172 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\texttt{rem}))).\texttt{replace}(p3 \rightarrow ((-63 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\texttt{quot}) + (170 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\texttt{rem}))).\texttt{replace}(p1 \rightarrow ((-2 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{quot}) + (171 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{rem})))) \vee (0 < ((-2 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{quot}) + (171 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{rem}))))$
 \rightarrow [from term 90.0, $\$heap_{724,1;752,8}$ is equal to $\$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{quot}) + (171 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{rem}))).\texttt{replace}(p2 \rightarrow ((-35 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\texttt{quot}) + (172 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\texttt{rem}))).\texttt{replace}(p3 \rightarrow ((-63 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\texttt{quot}) + (170 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\texttt{rem}))).\texttt{replace}(p1 \rightarrow 30269 + (-2 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{quot}) + (171 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{rem})))]$
[104.2] $(\$heap_{724,1;753,8} == \$heap_{funcstart_724,1}.\texttt{replace}(p1 \rightarrow ((-2 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{quot}) + (171 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\texttt{rem}))).\texttt{replace}(p2 \rightarrow ((-35 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\texttt{quot}) + (172 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\texttt{rem}))).\texttt{replace}(p3 \rightarrow ((-63 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\texttt{quot}) + (170 * \texttt{div}(\texttt{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\texttt{rem}))).\texttt{replace}(p1 \rightarrow$

$\rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem})).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{rem})).\text{replace}(p1 \rightarrow 30269 + (-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem})))$

$[105.1] (-1 < \$\text{heapfuncstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem})).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{rem})).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem}))).p2) \vee \dots$

$\rightarrow [\text{simplify}]$

$[105.4] (-1 < ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem}))) \vee \dots$

$\rightarrow [\text{from term 65.3, } -1 < ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem})) \text{ is true if and only if } 0 < ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem})))$

$[105.5] (0 < ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem}))) \vee \dots$

$[\text{Copy term 80.20}]$

$[108.0] ((-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\text{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (-1 < \$heap_{724,1;753,8}.p3) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem})).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3},$

$178).rem)))$.**_replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))) \vee (0 < ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))$)

\rightarrow [from term 104.5, $\$heap_{724,1;753,8}$ is equal to
 $\$heap_funcstart_724,1$.**_replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))$.**_replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))))$.**_replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))$.**_replace**($p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))$.**_replace**($p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))))$]
 [108.1] $((-1 < -\$heap_funcstart_724,1$.**_replace**($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))$.**_replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))))$.**_replace**($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))))$.**_replace**($p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))))$.**_replace**($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))))$. $p1 \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [simplify]
 [108.11] $((30268 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)))) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [from term 60.11, $literal_a < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))$ is false whenever $-2 < (-30269 + literal_a)$]

Proof of rule precondition:

[108.11.0] $-2 < (-30269 + 30268)$

\rightarrow [simplify]
 [108.11.2] true
 [108.12] ($\text{false} \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [from term 104.5, $\$heap_{724,1;753,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))$
 [108.13] ($\text{false} \vee (-1 < -\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [simplify]
 [108.17] ($\text{false} \vee (-1 < ((35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (-172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 \rightarrow [from term 105.5, $\text{literal} < ((-172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}))$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[108.17.0] $-2 < (-1 + 0)$

\rightarrow [simplify]
 [108.17.2] **true**
 [108.18] (**false** \vee **false** \vee ($30268 < \$heap_{724,1;753,8}.p1$) \vee ($30306 < \$heap_{724,1;753,8}.p2$) \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...
 \rightarrow [from term 104.5, $\$heap_{724,1;753,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))$
 [108.19] (**false** \vee **false** \vee ($30268 < \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).p1$) \vee ($30306 < \$heap_{724,1;753,8}.p2$) \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...
 \rightarrow [simplify]
 [108.23] (**false** \vee **false** \vee ($-1 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$) \vee ($30306 < \$heap_{724,1;753,8}.p2$) \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...
 \rightarrow [from term 91.0, $\text{literal} < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$ is false whenever $-2 < (0 + \text{literal})$]

Proof of rule precondition:

[108.23.0] $-2 < (-1 + 0)$

\rightarrow [simplify]
 [108.23.2] **true**
 [108.24] (**false** \vee **false** \vee **false** \vee ($30306 < \$heap_{724,1;753,8}.p2$) \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...
 \rightarrow [from term 104.5, $\$heap_{724,1;753,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))$
 [108.25] (**false** \vee **false** \vee **false** \vee ($30306 < \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).p2$) \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...
 \rightarrow [simplify]
 [108.26] (**false** \vee **false** \vee **false** \vee ($30306 < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))$) \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...
 \rightarrow [from term 66.18, *literal* $< ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))$ is false whenever $-2 < (-30307 + \text{literal})$]

Proof of rule precondition:

[108.26.0] $-2 < (-30307 + 30306)$

\rightarrow [simplify]

[108.26.2] **true**

[108.27] (**false** \vee **false** \vee **false** \vee **false** \vee ($30322 < -\$heap_{724,1;753,8}.p3$)) \vee ...

\rightarrow [from term 104.5, $\$heap_{724,1;753,8}$ is equal to

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem})))]$

[108.28] (**false** \vee **false** \vee **false** \vee **false** \vee ($30322 < -\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).p3$)) \vee ...

\rightarrow [simplify]

[108.34] (**false** \vee **false** \vee **false** \vee **false** \vee ($30322 < ((63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (-170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem})))$)) \vee ...

\rightarrow [from term 68.13, $\text{literal} < ((-170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) + (63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}))$ is false whenever $-2 < (-30323 + \text{literal})$]

Proof of rule precondition:

[108.34.0] $-2 < (-30323 + 30322)$

\rightarrow [simplify]

[108.34.2] **true**

[108.35] (**false** \vee **false** \vee **false** \vee **false** \vee **false**) \vee ...

\rightarrow [simplify]

[108.36] **false** \vee ...

[Remove 'false' term 108.36 and fetch new term from containing clause]

[109.0] ($\$heap_{724,1;752,8} == \$heap_{funcstart_724,1} \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \cdot \mathbf{replace}(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p2, 176).rem))) \cdot \mathbf{replace}(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p3, 178).rem))) \cdot \mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem)))) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8} \cdot \mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8} \cdot p3)) \vee (-1 < \$heap_{724,1;753,8} \cdot p3)$)

[Remove 'false' term 108.36 and fetch new term from containing clause]

[110.0] ($0 < ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).quot) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1} \cdot p1, 177).rem))) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8} \cdot \mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8} \cdot p3)) \vee (-1 < \$heap_{724,1;753,8} \cdot p3)$)

[Copy term 1.56]

[80.24] ($(-1 < -\$heap_{724,1;752,8} \cdot p1) \vee (-1 < -\$heap_{724,1;752,8} \cdot p2) \vee (30268 < \$heap_{724,1;753,8} \cdot p1) \vee (30306 < \$heap_{724,1;753,8} \cdot p2) \vee (30322 < -\$heap_{724,1;753,8} \cdot p3) \vee (\$heap_{funcend_724,1} == \$heap_{724,1;753,8} \cdot \mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8} \cdot p3)) \vee (-1 < \$heap_{724,1;753,8} \cdot p3)$)

\rightarrow [from term 102.0, $-1 < -\$heap_{724,1;752,8} \cdot p2$ is true if and only if $0 == \$heap_{724,1;752,8} \cdot p2$]

[80.25] ($(-1 < -\$heap_{724,1;752,8} \cdot p1) \vee (0 == \$heap_{724,1;752,8} \cdot p2) \vee (30268 < \$heap_{724,1;753,8} \cdot p1) \vee (30306 < \$heap_{724,1;753,8} \cdot p2) \vee (30322 < -\$heap_{724,1;753,8} \cdot p3) \vee \dots$)

\rightarrow [from term 101.0, $\$heap_{724,1;753,8}$ is equal to $\$heap_{724,1;752,8} \cdot \mathbf{replace}(p2 \rightarrow \$heap_{724,1;752,8} \cdot p2)$]

[80.26] ($(-1 < -\$heap_{724,1;752,8} \cdot p1) \vee (0 == \$heap_{724,1;752,8} \cdot p2) \vee (30268 < \$heap_{724,1;752,8} \cdot \mathbf{replace}(p2 \rightarrow \$heap_{724,1;752,8} \cdot p2) \cdot p1) \vee (30306 < \$heap_{724,1;753,8} \cdot p2) \vee (30322 < -\$heap_{724,1;753,8} \cdot p3) \vee \dots$)

\rightarrow [simplify]

[80.27] ($(-1 < -\$heap_{724,1;752,8} \cdot p1) \vee (0 == \$heap_{724,1;752,8} \cdot p2) \vee (30268 < \$heap_{724,1;752,8} \cdot p1) \vee (30306 < \$heap_{724,1;753,8} \cdot p2) \vee (30322 < -\$heap_{724,1;753,8} \cdot p3) \vee \dots$)

\rightarrow [from term 101.0, $\$heap_{724,1;753,8}$ is equal to $\$heap_{724,1;752,8} \cdot \mathbf{replace}(p2 \rightarrow \$heap_{724,1;752,8} \cdot p2)$]

[80.28] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (0 == \$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2).p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$

[80.29] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (0 == \$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 101.0, \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2)]$

[80.30] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (0 == \$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2).p3)) \vee \dots$
 $\rightarrow [simplify]$

[80.31] $((-1 < -\$heap_{724,1;752,8}.p1) \vee (0 == \$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 109.0, \$heap_{724,1;752,8}\ is\ equal\ to$
 $\$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63$
 $* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,$
 $178).rem))).replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))]$

[80.32] $((0 == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35$
 $* div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$
 $176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow ((-2 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).p2) \vee (-1 <$
 $-\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 <$
 $\$heap_{724,1;752,8}.p2) \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$

[80.35] $((0 == ((-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2,$

176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) ∨ (-1 < -\$heap724,1;752,8.p1) ∨ (30268 < \$heap724,1;752,8.p1) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [from term 65.3, 0 == ((-35 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)) is false]

[80.36] (false ∨ (-1 < -\$heap724,1;752,8.p1) ∨ (30268 < \$heap724,1;752,8.p1) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [from term 109.0, \$heap724,1;752,8 is equal to

\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**.replace**(p1 → (-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]

[80.37] (false ∨ (-1 < -\$heap_funcstart_724,1.**.replace**(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).**.replace**(p1 → ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).p1) ∨ (30268 < \$heap724,1;752,8.p1) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [simplify]

[80.41] (false ∨ (-1 < ((2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))) ∨ (30268 < \$heap724,1;752,8.p1) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [from term 110.0, literal < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot)) is false whenever -2 < (0 + literal)]

Proof of rule precondition:

[80.41.0] -2 < (-1 + 0)

→ [simplify]

[80.41.2] **true**

[80.42] (**false** ∨ **false** ∨ (30268 < \$heap724,1;752,8.p1) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [from term 109.0, \$heap724,1;752,8 is equal to

\$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem))).**.replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)))]

[80.43] (**false** ∨ **false** ∨ (30268 < \$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem))).**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).p1) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [simplify]

[80.44] (**false** ∨ **false** ∨ (30268 < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))) ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [from term 62.17, literal < ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)) is false whenever -2 < (-30269 + literal)]

Proof of rule precondition:

[80.44.0] -2 < (-30269 + 30268)

→ [simplify]

[80.44.2] **true**

[80.45] (**false** ∨ **false** ∨ **false** ∨ (30306 < \$heap724,1;752,8.p2) ∨ (30322 < -\$heap724,1;752,8.p3)) ∨ ...

→ [from term 109.0, $\$heap_{724,1;752,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})))]$

[80.46] ($\text{false} \vee \text{false} \vee \text{false} \vee (30306 < \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow$
 $((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) +$
 $(171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,$
 $177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).p2) \vee$
 $(30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

→ [simplify]

[80.49] ($\text{false} \vee \text{false} \vee \text{false} \vee (30306 < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))) \vee (30322 <$
 $-\$heap_{724,1;752,8}.p3)) \vee \dots$

→ [from term 66.18, $\text{literal} < ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))$ is false whenever $-2 < (-30307 + \text{literal})]$

Proof of rule precondition:

[80.49.0] $-2 < (-30307 + 30306)$

→ [simplify]

[80.49.2] **true**

[80.50] ($\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

→ [from term 109.0, $\$heap_{724,1;752,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}))).p2) \vee$
 $(30322 < -\$heap_{724,1;752,8}.p3)) \vee \dots$

* div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3,
178).rem)))._replace(p1 → (-2 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem)))

[80.51] (false ∨ false ∨ false ∨ false ∨ (30322 <
-\$heapfuncstart_724,1._replace(p1 → ((-2 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem)))._replace(p2 → ((-35 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem)))._replace(p3 → ((-63
* div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 *
div(heapIs \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3,
178).rem)))._replace(p1 → ((-2 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem))).p3)) ∨ ...

→ [simplify]

[80.56] (false ∨ false ∨ false ∨ false ∨ (30322 < ((63 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (-170 * div(heapIs
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem)))) ∨ ...

→ [from term 68.13, literal a < ((-170 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p3, 178).rem) + (63 * div(heapIs \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p3, 178).quot)) is false whenever -2 < (-30323 + literal a)]

Proof of rule precondition:

[80.56.0] -2 < (-30323 + 30322)

→ [simplify]

[80.56.2] true

[80.57] (false ∨ false ∨ false ∨ false ∨ false) ∨ ...

→ [simplify]

[80.58] false ∨ ...

[Remove 'false' term 80.58 and fetch new term from containing clause]

[112.0] \$heapfuncend_724,1 == \$heap724,1;753,8._replace(p3 →
\$heap724,1;753,8.p3)

[Take goal term]

[1.56] (30322 < \$heapfuncend_724,1.p3) ∨ (30306 < \$heapfuncend_724,1.p2) ∨
(30268 < \$heapfuncend_724,1.p1) ∨ (-1 < -\$heapfuncend_724,1.p1) ∨ (-1 <
-\$heapfuncend_724,1.p2) ∨ (-1 < -\$heapfuncend_724,1.p3)

→ [from term 112.0, \$heapfuncend_724,1 is equal to \$heap724,1;753,8._replace(p3
→ \$heap724,1;753,8.p3)]

$[1.57] (-1 < \neg \text{heap}_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{heap}_{724,1;753,8}.p3).p1) \vee (-1 < \neg \text{heap}_{\text{funcend_724,1}}.p2) \vee (-1 < \neg \text{heap}_{\text{funcend_724,1}}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $\rightarrow [\text{simplify}]$
 $[1.58] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{\text{funcend_724,1}}.p2) \vee (-1 < \neg \text{heap}_{\text{funcend_724,1}}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $\rightarrow [\text{from term 112.0, } \text{heap}_{\text{funcend_724,1}} \text{ is equal to } \text{heap}_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{heap}_{724,1;753,8}.p3)]$
 $[1.59] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{heap}_{724,1;753,8}.p3).p2) \vee (-1 < \neg \text{heap}_{\text{funcend_724,1}}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $\rightarrow [\text{simplify}]$
 $[1.60] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p2) \vee (-1 < \neg \text{heap}_{\text{funcend_724,1}}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $\rightarrow [\text{from term 112.0, } \text{heap}_{\text{funcend_724,1}} \text{ is equal to } \text{heap}_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{heap}_{724,1;753,8}.p3)]$
 $[1.61] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p2) \vee (-1 < \neg \text{heap}_{724,1;753,8}.\text{replace}(p3 \rightarrow \text{heap}_{724,1;753,8}.p3).p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $\rightarrow [\text{simplify}]$
 $[1.62] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p2) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $[\text{Remove 'false' term 80.58 and fetch new term from containing clause}]$
 $[113.0] -1 < \text{heap}_{724,1;753,8}.p3$
 $[\text{Take goal term}]$
 $[1.62] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p2) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$
 $\rightarrow [\text{from term 113.0, } -1 < \neg \text{heap}_{724,1;753,8}.p3 \text{ is true if and only if } 0 == \text{heap}_{724,1;753,8}.p3]$
 $[1.63] (-1 < \neg \text{heap}_{724,1;753,8}.p1) \vee (-1 < \neg \text{heap}_{724,1;753,8}.p2) \vee (0 == \text{heap}_{724,1;753,8}.p3) \vee (30268 < \text{heap}_{\text{funcend_724,1}}.p1) \vee (30306 < \text{heap}_{\text{funcend_724,1}}.p2) \vee (30322 < \text{heap}_{\text{funcend_724,1}}.p3)$

\rightarrow [from term 112.0, $\$heap_{funcend_724,1}$ is equal to $\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)$]

[1.64] $(-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (0 == \$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)$

\rightarrow [simplify]

[1.65] $(-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (0 == \$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)$

\rightarrow [from term 112.0, $\$heap_{funcend_724,1}$ is equal to $\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)$]

[1.66] $(-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (0 == \$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)$

\rightarrow [simplify]

[1.67] $(-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (0 == \$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)$

\rightarrow [from term 112.0, $\$heap_{funcend_724,1}$ is equal to $\$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)$]

[1.68] $(-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (0 == \$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)$

\rightarrow [simplify]

[1.69] $(-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (0 == \$heap_{724,1;753,8}.p3) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$

[Copy term 112.0]

[115.0] $(\$heap_{funcend_724,1} == \$heap_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \$heap_{724,1;753,8}.p3)) \vee (\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow \$heap_{724,1;752,8}.p2)) \vee (-1 < \$heap_{724,1;752,8}.p2) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\mathbf{replace}(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\mathbf{replace}(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 *$

→ [simplify]

[115.5] (\$heap_{funcend}_724,1 == \$heap_{funcstart}_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).rem))).**.replace**(p1 → (30269 + (-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem))).**.replace**(p2 → (30307 + (-35 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).rem)))))) ∨ ...

[Copy term 113.0]

[116.0] (-1 < \$heap_{724,1;753,8}.p3) ∨ (\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.**.replace**(p2 → \$heap_{724,1;752,8}.p2)) ∨ (-1 < \$heap_{724,1;752,8}.p2) ∨ (\$heap_{724,1;752,8} == \$heap_{funcstart}_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).rem))).**.replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem)))))) ∨ (0 < ((-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem))))

→ [from term 92.6, \$heap_{724,1;753,8} is equal to \$heap_{funcstart}_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p3, 178).rem))).**.replace**(p1 → (30269 + (-2 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p1, 177).rem))).**.replace**(p2 → 30307 + (-35 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heap_{funcstart}_724,1, \$heap_{funcstart}_724,1.p2, 176).rem))))]

```
[116.1] (-1 < $heap_funcstart_724,1..replace(p1 → ((-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem))))..replace(p2 → ((-35
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).rem))))..replace(p3 → ((-63 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p3, 178).rem))))..replace(p1 → (30269 + (-2 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p1, 177).rem))))..replace(p2 →
(30307 + (-35 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).quot) + (172 * div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).rem))))).p3) ∨ ...
```

→ [simplify]

$$[116.4] \text{ } (-1 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1.p3}, 178).\text{rem}))) \vee \dots$$

→ [from term 69.3, $-1 < ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$ is true if and only if $0 < ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$]

$$[116.5] \ (0 < ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \ \$heap_{funcstart_724,1.p3}, 178).\text{rem}))) \vee \dots$$

[Copy term 1.56]

$$\begin{aligned} & [117.0] \left((-1 < -\$heap_{funcend_724,1}.p1) \vee (-1 < -\$heap_{funcend_724,1}.p2) \vee (-1 < \right. \\ & \left. -\$heap_{funcend_724,1}.p3) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \right. \\ & \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee (\$heap_{724,1;753,8} \\ & == \$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2)) \vee (-1 < \\ & \$heap_{724,1;752,8}.p2) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow \\ & ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + \\ & (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, \\ & 177).rem))).replace(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \\ & \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \\ & \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs} \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\mathbf{heapIs} \\ & \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow ((-2 * \\ & \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \\ & \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))) \vee (0 < \\ & ((-2 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + \\ & (171 * \text{div}(\mathbf{heapIs} \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))) \end{aligned}$$

→ [from term 115.5, $\$heap_{funcend_724,1}$ is equal to

$\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem})))]$

$[117.1] ((-1 < -\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem}))).p1) \vee (-1 < -\$heap_funcend_724,1.p2) \vee (-1 < -\$heap_funcend_724,1.p3) \vee (30268 < \$heap_funcend_724,1.p1) \vee (30306 < \$heap_funcend_724,1.p2) \vee (30322 < \$heap_funcend_724,1.p3)) \vee \dots$

→ [simplify]

$[117.12] ((30268 < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}))) \vee (-1 < -\$heap_funcend_724,1.p2) \vee (-1 < -\$heap_funcend_724,1.p3) \vee (30268 < \$heap_funcend_724,1.p1) \vee (30306 < \$heap_funcend_724,1.p2) \vee (30322 < \$heap_funcend_724,1.p3)) \vee \dots$

→ [from term 60.11, literal $a < ((-171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}))$ is false whenever $-2 < (-30269 + \text{literal } a)$]

Proof of rule precondition:

$[117.12.0] -2 < (-30269 + 30268)$

\rightarrow [simplify]
 [117.12.2] **true**
 [117.13] (**false** \vee ($-1 < -\$heap_funcend_724,1.p2$) \vee ($-1 < -\$heap_funcend_724,1.p3$) \vee ($30268 < \$heap_funcend_724,1.p1$) \vee ($30306 < \$heap_funcend_724,1.p2$) \vee ($30322 < \$heap_funcend_724,1.p3$)) \vee ...
 \rightarrow [from term 115.5, $\$heap_funcend_724,1$ is equal to
 $\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem})))]$
 [117.14] (**false** \vee ($-1 < -\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).\text{rem}))).p2$) \vee ($-1 < -\$heap_funcend_724,1.p3$) \vee ($30268 < \$heap_funcend_724,1.p1$) \vee ($30306 < \$heap_funcend_724,1.p2$) \vee ($30322 < \$heap_funcend_724,1.p3$)) \vee ...
 \rightarrow [simplify]
 [117.24] (**false** \vee ($30306 < ((-172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).\text{quot})))$) \vee ($-1 < -\$heap_funcend_724,1.p3$) \vee ($30268 < \$heap_funcend_724,1.p1$) \vee ($30306 < \$heap_funcend_724,1.p2$) \vee ($30322 <$

$\$heap_funcend_724,1.p3)) \vee \dots$

$\rightarrow [from \text{ term } 64.12, \text{ literal } a < ((-172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem) + (35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot)) \text{ is false whenever } -2 < (-30307 + \text{literal})]$

Proof of rule precondition:

$[117.24.0] -2 < (-30307 + 30306)$

$\rightarrow [simplify]$

$[117.24.2] \text{ true}$

$[117.25] (\text{false} \vee \text{false} \vee (-1 < -\$heap_funcend_724,1.p3) \vee (30268 < \$heap_funcend_724,1.p1) \vee (30306 < \$heap_funcend_724,1.p2) \vee (30322 < \$heap_funcend_724,1.p3)) \vee \dots$

$\rightarrow [from \text{ term } 115.5, \$heap_funcend_724,1 \text{ is equal to}$

$\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))]$

$[117.26] (\text{false} \vee \text{false} \vee (-1 < -\$heap_funcstart_724,1.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).p3) \vee (30268 <$

$\$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$

$\rightarrow [simplify]$

[117.30] (**false** \vee **false** \vee $(-1 < ((63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (-170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))) \vee (30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$

$\rightarrow [from \text{ term } 116.5, \text{ literal } a < ((-170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}) + (63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot})) \text{ is false whenever } -2 < (0 + \text{literal})]$

Proof of rule precondition:

[117.30.0] $-2 < (-1 + 0)$

$\rightarrow [simplify]$

[117.30.2] **true**

[117.31] (**false** \vee **false** \vee **false** \vee $(30268 < \$heap_{funcend_724,1}.p1) \vee (30306 < \$heap_{funcend_724,1}.p2) \vee (30322 < \$heap_{funcend_724,1}.p3)) \vee \dots$

$\rightarrow [from \text{ term } 115.5, \$heap_{funcend_724,1} \text{ is equal to}$

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem})))]$

[117.32] (**false** \vee **false** \vee **false** \vee $(30268 < \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))).\text{replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))).\text{replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))))$

$177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem)))$.
 $\text{.replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).rem))))$.
 $\text{.replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).quot) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).rem))))$.
 $p1) \vee (30306 < \$\text{heap_funcend_724,1.p2}) \vee (30322 < \$\text{heap_funcend_724,1.p3})) \vee \dots$

\rightarrow [simplify]

$[117.37] (\text{false} \vee \text{false} \vee \text{false} \vee (-1 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem)))) \vee (30306 < \$\text{heap_funcend_724,1.p2}) \vee (30322 < \$\text{heap_funcend_724,1.p3})) \vee \dots$

\rightarrow [from term 91.0, $\text{literal}_a < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem)))$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

$[117.37.0] -2 < (-1 + 0)$

\rightarrow [simplify]

$[117.37.2] \text{true}$

$[117.38] (\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee (30306 < \$\text{heap_funcend_724,1.p2}) \vee (30322 < \$\text{heap_funcend_724,1.p3})) \vee \dots$

\rightarrow [from term 115.5, $\$heap_funcend_724,1$ is equal to

$\$heap_funcstart_724,1$.
 $\text{.replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem))))$.
 $\text{.replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).rem))))$.
 $\text{.replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).quot) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).rem))))$.
 $\text{.replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem))))$.
 $\text{.replace}(p2 \rightarrow (30307 + (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).rem))))$.
 $\text{.replace}(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).quot) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).rem))))$

$[117.39] (\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee (30306 < \$\text{heap_funcstart_724,1.p1}, 177).quot) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).rem))))$.
 $\text{.replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).quot) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).rem))))$.
 $\text{.replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).quot) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).rem))))$

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) _replace(p3 \rightarrow ((-63$
 $* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem))) _replace(p1 \rightarrow (30269 + (-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))) _replace(p2 \rightarrow (30307 + (-35 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).rem))) _replace(p3 \rightarrow ((-63 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).rem))) .p2) \vee (30322 < \$heap_funcend_724,1.p3)) \vee$
 \dots

$\rightarrow [simplify]$

$[117.43] (false \vee false \vee false \vee false \vee (-1 < ((-35 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) \vee (30322 <$
 $\$heap_funcend_724,1.p3)) \vee \dots$

$\rightarrow [from\ term\ 94.7, literala < ((-35 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p2, 176).rem))\ is\ false\ whenever\ -2 < (0 + literala)]$

Proof of rule precondition:

$[117.43.0] -2 < (-1 + 0)$

$\rightarrow [simplify]$

$[117.43.2] true$

$[117.44] (false \vee false \vee false \vee false \vee false \vee (30322 <$
 $\$heap_funcend_724,1.p3)) \vee \dots$

$\rightarrow [from\ term\ 115.5, \$heap_funcend_724,1\ is\ equal\ to$
 $\$heap_funcstart_724,1 _replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))) _replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) _replace(p3 \rightarrow ((-63$
 $* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem))) _replace(p1 \rightarrow (30269 + (-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem))) _replace(p2 \rightarrow (30307 + (-35 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2,$
 $176).rem))) _replace(p3 \rightarrow (-63 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1,$

```

[117.45] (false  $\vee$  false  $\vee$  false  $\vee$  false  $\vee$  (30322 <
$heap_funcstart_724,1._replace(p1  $\rightarrow$  ((-2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem))))._replace(p2  $\rightarrow$  ((-35 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs
$heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).rem))))._replace(p3  $\rightarrow$  ((-63
* div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3, 178).quot) + (170 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
178).rem))))._replace(p1  $\rightarrow$  (30269 + (-2 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p1, 177).rem))))._replace(p2  $\rightarrow$  (30307 + (-35 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2, 176).quot) + (172 *
div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).rem))))._replace(p3  $\rightarrow$  ((-63 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs $heap_funcstart_724,1,
$heap_funcstart_724,1.p3, 178).rem))))).p3))  $\vee$  ...
 $\rightarrow$  [simplify]

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→ [from term 70.19, literal_a < ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)) is false whenever -2 < (-30323 + literal_a)]

$$[117.46.0] - 2 < (-30323 + 30322) \\ \rightarrow [simplify]$$
$$[117.47] (\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee \text{false}) \vee \dots$$

$$\rightarrow [\text{simplify}]$$

[Remove 'false' term 117.48 and fetch new term from containing clause]

1021

div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 *
div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))) ∨
(\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.**replace**(p2 → \$heap_{724,1;752,8}.p2)) ∨ (-1
< \$heap_{724,1;752,8}.p2)

[Remove 'false' term 117.48 and fetch new term from containing clause]

[119.0] (0 < ((-2 * div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).quot) + (171 * div(**heapIs** \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1,
177).rem))) ∨ (\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.**replace**(p2 →
\$heap_{724,1;752,8}.p2)) ∨ (-1 < \$heap_{724,1;752,8}.p2)

[Copy term 1.69]

[120.0] ((0 == \$heap_{724,1;753,8}.p3) ∨ (-1 < -\$heap_{724,1;753,8}.p1) ∨ (-1 <
-\$heap_{724,1;753,8}.p2) ∨ (30268 < \$heap_{724,1;753,8}.p1) ∨ (30306 <
\$heap_{724,1;753,8}.p2) ∨ (30322 < \$heap_{724,1;753,8}.p3)) ∨ (\$heap_{724,1;753,8} ==
\$heap_{724,1;752,8}.**replace**(p2 → \$heap_{724,1;752,8}.p2)) ∨ (-1 < \$heap_{724,1;752,8}.p2)

→ [from term 81.0, \$heap_{724,1;753,8} is equal to \$heap_{724,1;752,8}.**replace**(p2 →
30307 + \$heap_{724,1;752,8}.p2)]

[120.1] ((0 == \$heap_{724,1;752,8}.**replace**(p2 → (30307 +
\$heap_{724,1;752,8}.p2)).p3) ∨ (-1 < -\$heap_{724,1;753,8}.p1) ∨ (-1 <
-\$heap_{724,1;753,8}.p2) ∨ (30268 < \$heap_{724,1;753,8}.p1) ∨ (30306 <
\$heap_{724,1;753,8}.p2) ∨ (30322 < \$heap_{724,1;753,8}.p3)) ∨ ...

→ [simplify]

[120.2] ((0 == \$heap_{724,1;752,8}.p3) ∨ (-1 < -\$heap_{724,1;753,8}.p1) ∨ (-1 <
-\$heap_{724,1;753,8}.p2) ∨ (30268 < \$heap_{724,1;753,8}.p1) ∨ (30306 <
\$heap_{724,1;753,8}.p2) ∨ (30322 < \$heap_{724,1;753,8}.p3)) ∨ ...

→ [from term 81.0, \$heap_{724,1;753,8} is equal to \$heap_{724,1;752,8}.**replace**(p2 →
30307 + \$heap_{724,1;752,8}.p2)]

[120.3] ((0 == \$heap_{724,1;752,8}.p3) ∨ (-1 < -\$heap_{724,1;752,8}.**replace**(p2 →
(30307 + \$heap_{724,1;752,8}.p2)).p1) ∨ (-1 < -\$heap_{724,1;753,8}.p2) ∨ (30268 <
\$heap_{724,1;753,8}.p1) ∨ (30306 < \$heap_{724,1;753,8}.p2) ∨ (30322 <
\$heap_{724,1;753,8}.p3)) ∨ ...

→ [simplify]

[120.4] ((0 == \$heap_{724,1;752,8}.p3) ∨ (-1 < -\$heap_{724,1;752,8}.p1) ∨ (-1 <
-\$heap_{724,1;753,8}.p2) ∨ (30268 < \$heap_{724,1;753,8}.p1) ∨ (30306 <
\$heap_{724,1;753,8}.p2) ∨ (30322 < \$heap_{724,1;753,8}.p3)) ∨ ...

→ [from term 81.0, \$heap_{724,1;753,8} is equal to \$heap_{724,1;752,8}.**replace**(p2 →
30307 + \$heap_{724,1;752,8}.p2)]

[120.5] ((0 == \$heap_{724,1;752,8}.p3) ∨ (-1 < -\$heap_{724,1;752,8}.p1) ∨ (-1 <
-\$heap_{724,1;752,8}.**replace**(p2 → (30307 + \$heap_{724,1;752,8}.p2)).p2) ∨ (30268 <
\$heap_{724,1;753,8}.p1) ∨ (30306 < \$heap_{724,1;753,8}.p2) ∨ (30322 <
\$heap_{724,1;753,8}.p3)) ∨ ...

$\rightarrow [simplify]$
 $[120.10] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 81.0, \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.replace(p2 \rightarrow 30307 + \$heap_{724,1;752,8}.p2)]$
 $[120.11] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.replace(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[120.12] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 81.0, \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.replace(p2 \rightarrow 30307 + \$heap_{724,1;752,8}.p2)]$
 $[120.13] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.replace(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [simplify]$
 $[120.16] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (-1 < \$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 82.0, literal_a < \$heap_{724,1;752,8}.p2\ is\ false\ whenever\ -2 < (0 + literal_a)]$

Proof of rule precondition:

$[120.16.0] -2 < (-1 + 0)$
 $\rightarrow [simplify]$
 $[120.16.2] \mathbf{true}$
 $[120.17] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee \mathbf{false} \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$
 $\rightarrow [from\ term\ 81.0, \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.replace(p2 \rightarrow 30307 + \$heap_{724,1;752,8}.p2)]$
 $[120.18] ((0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee \mathbf{false} \vee (30322 < \$heap_{724,1;752,8}.replace(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p3)) \vee \dots$

$$[120.20] ((0 == \text{\$heap}_{724,1;752,8.p3}) \vee (-1 < -\text{\$heap}_{724,1;752,8.p1}) \vee (30268 < \text{\$heap}_{724,1;752,8.p1}) \vee (30306 < -\text{\$heap}_{724,1;752,8.p2}) \vee (30322 < \text{\$heap}_{724,1;752,8.p3})) \vee \dots$$

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$heapfuncstart_724,1..replace(p1 → ((-2 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).rem)))..replace(p2 → ((-35 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).quot) + (172 * div(heapIs
$heapfuncstart_724,1, $heapfuncstart_724,1.p2, 176).rem)))..replace(p3 → ((-63
* div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3, 178).quot) + (170 *
div(heapIs $heapfuncstart_724,1, $heapfuncstart_724,1.p3,
178).rem)))..replace(p1 → (-2 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).quot) + (171 * div(heapIs $heapfuncstart_724,1,
$heapfuncstart_724,1.p1, 177).rem))]

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$$\rightarrow [\textit{simplify}]$$

→ [from term 69.3, 0 == ((-63 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem)) is false]

$$\text{heap}_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{heap}_{funcstart_724,1}, \\ \text{heap}_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \text{heap}_{funcstart_724,1}, \\ \text{heap}_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs}$$

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))._replace(p1 \rightarrow (-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))]$

$[120.25] (false \vee (-1 < -\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem))).p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)) \vee \dots$

$\rightarrow [simplify]$

$[120.29] (false \vee (-1 < ((2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)) \vee \dots$

$\rightarrow [from\ term\ 119.0, literal_a < ((-171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem) + (2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot))\ is\ false\ whenever\ -2 < (0 + literal_a)]$

Proof of rule precondition:

$[120.29.0] -2 < (-1 + 0)$

$\rightarrow [simplify]$

$[120.29.2] true$

$[120.30] (false \vee false \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < -\$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)) \vee \dots$

$\rightarrow [from\ term\ 118.0, \$heap_{724,1;752,8}\ is\ equal\ to$

$\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem))).]$

178).rem))).**_replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem))))]

[120.31] (**false** ∨ **false** ∨ (30268 < \$heapfuncstart_724,1.**_replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1,
177).rem))).**_replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem))).**_replace**(p1 → ((-2 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).p1) ∨
(30306 < -\$heap724,1;752,8.p2) ∨ (30322 < \$heap724,1;752,8.p3)) ∨ ...

→ [simplify]

[120.32] (**false** ∨ **false** ∨ (30268 < ((-2 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem)))) ∨ (30306 < -\$heap724,1;752,8.p2) ∨ (30322
< \$heap724,1;752,8.p3)) ∨ ...

→ [from term 62.17, literal a < ((-2 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem)) is false whenever -2 < (-30269 + literal a)]

Proof of rule precondition:

[120.32.0] -2 < (-30269 + 30268)

→ [simplify]

[120.32.2] **true**

[120.33] (**false** ∨ **false** ∨ **false** ∨ (30306 < -\$heap724,1;752,8.p2) ∨ (30322 <
\$heap724,1;752,8.p3)) ∨ ...

→ [from term 118.0, \$heap724,1;752,8 is equal to

\$heapfuncstart_724,1.**_replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem))).**_replace**(p2 → ((-35 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs**
\$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).**_replace**(p3 → ((-63
* div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 *
div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3,
178).rem))).**_replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1,
\$heapfuncstart_724,1.p1, 177).rem))))]

[120.34] (**false** ∨ **false** ∨ **false** ∨ (30306 < -\$heapfuncstart_724,1.**_replace**(p1
→ ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) +

$(171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).p2) \vee (30322 < \$\text{heap724,1;752,8.p3})) \vee \dots$

$\rightarrow [\text{simplify}]$

$[120.40] (\text{false} \vee \text{false} \vee \text{false} \vee (30306 < ((35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))) \vee (30322 < \$\text{heap724,1;752,8.p3})) \vee \dots$

$\rightarrow [\text{from term 64.12, literal} < ((-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot})) \text{ is false whenever } -2 < (-30307 + \text{literal})]$

Proof of rule precondition:

$[120.40.0] -2 < (-30307 + 30306)$

$\rightarrow [\text{simplify}]$

$[120.40.2] \text{true}$

$[120.41] (\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee (30322 < \$\text{heap724,1;752,8.p3})) \vee \dots$

$\rightarrow [\text{from term 118.0, } \$\text{heap724,1;752,8} \text{ is equal to}$

$\$ \text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))._replace(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))]$

$[120.42] (\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee (30322 < \$\text{heap_funcstart_724,1}._replace(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))._replace(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))._replace(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))) \vee (30322 < \$\text{heap724,1;752,8.p3})) \vee \dots$

178).rem))).**_replace**(p1 → ((-2 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p1, 177).rem))).p3)) ∨ ...

→ [simplify]

[120.44] (**false** ∨ **false** ∨ **false** ∨ **false** ∨ (30322 < ((-63 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs**
\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))) ∨ ...

→ [from term 70.19, literal a < ((-63 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heap_funcstart_724,1,
\$heap_funcstart_724,1.p3, 178).rem)) is false whenever -2 < (-30323 + literal a)]

Proof of rule precondition:

[120.44.0] -2 < (-30323 + 30322)

→ [simplify]

[120.44.2] **true**

[120.45] (**false** ∨ **false** ∨ **false** ∨ **false** ∨ **false**) ∨ ...

→ [simplify]

[120.46] **false** ∨ ...

[Remove 'false' term 120.46 and fetch new term from containing clause]

[123.0] \$heap724,1;753,8 == \$heap724,1;752,8.**_replace**(p2 → \$heap724,1;752,8.p2)

[Take goal term]

[1.69] (-1 < -\$heap724,1;753,8.p1) ∨ (-1 < -\$heap724,1;753,8.p2) ∨ (0 ==
\$heap724,1;753,8.p3) ∨ (30268 < \$heap724,1;753,8.p1) ∨ (30306 <
\$heap724,1;753,8.p2) ∨ (30322 < \$heap724,1;753,8.p3)

→ [from term 123.0, \$heap724,1;753,8 is equal to \$heap724,1;752,8.**_replace**(p2 →
\$heap724,1;752,8.p2)]

[1.70] (0 == \$heap724,1;752,8.**_replace**(p2 → \$heap724,1;752,8.p2).p3) ∨ (-1 <
-\$heap724,1;753,8.p1) ∨ (-1 < -\$heap724,1;753,8.p2) ∨ (30268 <
\$heap724,1;753,8.p1) ∨ (30306 < \$heap724,1;753,8.p2) ∨ (30322 <
\$heap724,1;753,8.p3)

→ [simplify]

[1.71] (0 == \$heap724,1;752,8.p3) ∨ (-1 < -\$heap724,1;753,8.p1) ∨ (-1 <
-\$heap724,1;753,8.p2) ∨ (30268 < \$heap724,1;753,8.p1) ∨ (30306 <
\$heap724,1;753,8.p2) ∨ (30322 < \$heap724,1;753,8.p3)

→ [from term 123.0, \$heap724,1;753,8 is equal to \$heap724,1;752,8.**_replace**(p2 →
\$heap724,1;752,8.p2)]

[1.72] (0 == \$heap724,1;752,8.p3) ∨ (-1 < -\$heap724,1;752,8.**_replace**(p2 →
\$heap724,1;752,8.p2).p1) ∨ (-1 < -\$heap724,1;753,8.p2) ∨ (30268 <

$\$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$
 $\rightarrow [simplify]$
 $[1.73] (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$
 $\rightarrow [from\ term\ 123.0, \$heap_{724,1;753,8}\ is\ equal\ to\ \$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2)]$
 $[1.74] (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2).p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$
 $\rightarrow [simplify]$
 $[1.75] (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$
 $[Remove\ 'false'\ term\ 120.46\ and\ fetch\ new\ term\ from\ containing\ clause]$
 $[124.0] -1 < \$heap_{724,1;752,8}.p2$
 $[Copy\ term\ 123.0]$
 $[126.0] (\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.replace(p2 \rightarrow \$heap_{724,1;752,8}.p2)) \vee (\$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem)))) \vee (0 < ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))))$
 $\rightarrow [from\ term\ 90.0, \$heap_{724,1;752,8}\ is\ equal\ to\ \$heap_{funcstart_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) + (171 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).quot) + (172 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).quot) + (170 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).rem))).replace(p1 \rightarrow 30269 + (-2 * div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).quot) +$

$$\begin{aligned} & * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, \\ & 178).\text{rem}))._ \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \vee (0 < ((-2 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))) \\ & \rightarrow [\text{from term 90.0, } \$\text{heap}_{724,1;752,8} \text{ is equal to } \$\text{heap_funcstart_724,1}._ \text{replace}(p1 \\ & \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + \\ & (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, \\ & 177).\text{rem}))._ \text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))._ \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))._ \text{replace}(p1 \rightarrow 30269 \\ & + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + \\ & (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))] \\ & [127.1] (-1 < \$\text{heap_funcstart_724,1}._ \text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))._ \text{replace}(p2 \rightarrow ((-35 \\ & * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \\ & \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \\ & 176).\text{rem}))._ \text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))._ \text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})).p2) \vee \dots \\ & \rightarrow [\text{simplify}] \\ & [127.4] (-1 < ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \\ & 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \\ & 176).\text{rem})))) \vee \dots \\ & \rightarrow [\text{from term 65.3, } -1 < ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \\ & \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))) \text{ is true if and only if } 0 < ((-35 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \\ & \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))] \\ & [127.5] (0 < ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \\ & 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, \\ & 176).\text{rem})))) \vee \dots \\ & [\text{Copy term 1.69}] \\ & [129.0] ((0 == \$\text{heap}_{724,1;753,8}.p3) \vee (-1 < -\$ \text{heap}_{724,1;753,8}.p1) \vee (-1 < \\ & -\$ \text{heap}_{724,1;753,8}.p2) \vee (30268 < \$\text{heap}_{724,1;753,8}.p1) \vee (30306 <
\end{aligned}$$

$(178).\text{rem})) \vee (-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee$
 $(30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $\$heap_{724,1;753,8}.p3)) \vee \dots$

\rightarrow [from term 69.3, $0 == ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem}))$ is false]

[129.5] ($\text{false} \vee (-1 < -\$heap_{724,1;753,8}.p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee$
 $(30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $\$heap_{724,1;753,8}.p3)) \vee \dots$

\rightarrow [from term 126.5, $\$heap_{724,1;753,8}$ is equal to
 $\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem})).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem}))]$

[129.6] ($\text{false} \vee (-1 < -\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).\text{rem})).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem})).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).\text{rem})).p1) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 <$
 $\$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$

\rightarrow [simplify]

[129.16] ($\text{false} \vee (30268 < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{rem}) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).\text{quot})) \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 <$
 $\$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $\$heap_{724,1;753,8}.p3)) \vee \dots$

\rightarrow [from term 60.11, $\text{literal} < ((-171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$

$\$heap_{funcstart_724,1}.p1, 177).rem) + (2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot))$ is false whenever $-2 < (-30269 + \text{literal}_a)]$

Proof of rule precondition:

$[129.16.0] -2 < (-30269 + 30268)$

$\rightarrow [\text{simplify}]$

$[129.16.2] \text{ true}$

$[129.17] (\text{false} \vee \text{false} \vee (-1 < -\$heap_{724,1;753,8}.p2) \vee (30268 <$
 $\$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 <$
 $\$heap_{724,1;753,8}.p3)) \vee \dots$

$\rightarrow [\text{from term } 126.5, \$heap_{724,1;753,8} \text{ is equal to}$

$\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem)))]$

$[129.18] (\text{false} \vee \text{false} \vee (-1 < -\$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p3, 178).rem))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p1, 177).rem))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))).p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee$
 $(30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$

$\rightarrow [\text{simplify}]$

$[129.22] (\text{false} \vee \text{false} \vee (-1 < ((35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).quot) + (-172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1}.p2, 176).rem))) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 <$
 $\$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)) \vee \dots$

→ [from term 127.5, $\text{literal}_a < ((-172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}) + (35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}))$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[129.22.0] $-2 < (-1 + 0)$

→ [simplify]

[129.22.2] **true**

[129.23] (**false** \vee **false** \vee **false** \vee ($30268 < \$\text{heap}_{724,1;753,8.p1}$) \vee ($30306 < \$\text{heap}_{724,1;753,8.p2}$) \vee ($30322 < \$\text{heap}_{724,1;753,8.p3}$)) \vee ...

→ [from term 126.5, $\$ \text{heap}_{724,1;753,8}$ is equal to

$\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))$

[129.24] (**false** \vee **false** \vee **false** \vee ($30268 < \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).p1$) \vee ($30306 < \$\text{heap}_{724,1;753,8.p2}$) \vee ($30322 < \$\text{heap}_{724,1;753,8.p3}$)) \vee ...

→ [simplify]

[129.28] (**false** \vee **false** \vee **false** \vee ($-1 < ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem})))$) \vee ($30306 < \$\text{heap}_{724,1;753,8.p2}$) \vee ($30322 < \$\text{heap}_{724,1;753,8.p3}$)) \vee ...

→ [from term 91.0, $\text{literal}_a < ((-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem}))$ is false whenever $-2 < (0 + \text{literal}_a)$]

Proof of rule precondition:

[129.28.0] $-2 < (-1 + 0)$

→ [simplify]

[129.28.2] **true**

[129.29] (**false** \vee **false** \vee **false** \vee **false** \vee ($30306 < \$\text{heap}_{724,1;753,8}.p2$) \vee ($30322 < \$\text{heap}_{724,1;753,8}.p3$)) \vee ...

→ [from term 126.5, $\$ \text{heap}_{724,1;753,8}$ is equal to

$\$ \text{heapfuncstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem})))$

[129.30] (**false** \vee **false** \vee **false** \vee **false** \vee ($30306 < \$\text{heapfuncstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p3}, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem}))).p2 \vee (30322 < \$\text{heap}_{724,1;753,8}.p3))$ \vee ...

→ [simplify]

[129.31] (**false** \vee **false** \vee **false** \vee **false** \vee ($30306 < ((-35 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heapfuncstart_724,1}, \$\text{heapfuncstart_724,1.p2}, 176).\text{rem}))) \vee (30322 < \$\text{heap}_{724,1;753,8}.p3)$) \vee ...

→ [from term 66.18, $\text{literal}_a < ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))$ is false whenever $-2 < (-30307 + \text{literal}_a)$]

Proof of rule precondition:

[129.31.0] $-2 < (-30307 + 30306)$

→ [simplify]

[129.31.2] **true**

[129.32] (**false** \vee **false** \vee **false** \vee **false** \vee **false** \vee ($30322 < \$\text{heap}_{724,1;753,8}.\text{p3}$))
 $\vee \dots$

→ [from term 126.5, $\$ \text{heap}_{724,1;753,8}$ is equal to

$\$ \text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow (-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem})))$]

[129.33] (**false** \vee **false** \vee **false** \vee **false** \vee **false** \vee ($30322 < \$\text{heap_funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))).\text{replace}(p1 \rightarrow (30269 + (-2 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p1}, 177).\text{rem}))).\text{replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p2}, 176).\text{rem}))).\text{p3})) \vee \dots$

→ [simplify]

[129.36] (**false** \vee **false** \vee **false** \vee **false** \vee **false** \vee ($30322 < ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem})))$) $\vee \dots$

→ [from term 70.19, $\text{literal}_a < ((-63 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$\text{heap_funcstart_724,1}, \$\text{heap_funcstart_724,1.p3}, 178).\text{rem}))$

$\$heap_{funcstart_724,1}.p3, 178).rem))$ is false whenever $-2 < (-30323 + literal_a)]$

Proof of rule precondition:

$[129.36.0] -2 < (-30323 + 30322)$

$\rightarrow [simplify]$

$[129.36.2] \text{ true}$

$[129.37] (\text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee \text{false} \vee \text{false}) \vee \dots$

$\rightarrow [simplify]$

$[129.38] \text{ false} \vee \dots$

[Remove 'false' term 129.38 and fetch new term from containing clause]

$[130.0] \$heap_{724,1;752,8} == \$heap_{funcstart_724,1}.\text{replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))) \text{.replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p2, 176).\text{rem}))) \text{.replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3, 178).\text{rem}))) \text{.replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem})))$

[Remove 'false' term 129.38 and fetch new term from containing clause]

$[131.0] 0 < ((-2 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p1, 177).\text{rem}))$

[Take goal term]

$[1.75] (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (-1 < -\$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$

$\rightarrow [from \text{ term } 124.0, -1 < -\$heap_{724,1;752,8}.p2 \text{ is true if and only if } 0 == \$heap_{724,1;752,8}.p2]$

$[1.76] (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (0 == \$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;753,8}.p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$

$\rightarrow [from \text{ term } 123.0, \$heap_{724,1;753,8} \text{ is equal to } \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \$heap_{724,1;752,8}.p2)]$

$[1.77] (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (0 == \$heap_{724,1;752,8}.p2) \vee (30268 < \$heap_{724,1;752,8}.\text{replace}(p2 \rightarrow \$heap_{724,1;752,8}.p2).p1) \vee (30306 < \$heap_{724,1;753,8}.p2) \vee (30322 < \$heap_{724,1;753,8}.p3)$

$\$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).p2) $\vee (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)$

\rightarrow [simplify]

$[1.86] (0 == ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem))) \vee (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)$

\rightarrow [from term 65.3, $0 == ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$ is false]

$[1.87] \text{false} \vee (0 == \$heap_{724,1;752,8}.p3) \vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)$

\rightarrow [from term 130.0, $\$heap_{724,1;752,8}$ is equal to

$\$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$.replace($p1 \rightarrow (-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$]

$[1.88] \text{false} \vee (0 == \$heap_funcstart_724,1$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$.replace($p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))$.replace($p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$.replace($p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).quot) + (171 * \text{div}(\text{heapIs } \$heap_funcstart_724,1, \$heap_funcstart_724,1.p1, 177).rem)))$).p3) $\vee (-1 < -\$heap_{724,1;752,8}.p1) \vee (30268 < \$heap_{724,1;752,8}.p1) \vee (30306 < \$heap_{724,1;752,8}.p2) \vee (30322 < \$heap_{724,1;752,8}.p3)$

\rightarrow [simplify]

[1.90] **false** \vee ($0 == ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p3}, 178).\text{rem})) \vee (-1 < -\$heap_{724,1;752,8.p1}) \vee (30268 <$
 $\$heap_{724,1;752,8.p1}) \vee (30306 < \$heap_{724,1;752,8.p2}) \vee (30322 <$
 $\$heap_{724,1;752,8.p3})$

\rightarrow [from term 69.3, $0 == ((-63 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p3}, 178).\text{rem}))$ is false]

[1.91] **false** \vee **false** \vee ($-1 < -\$heap_{724,1;752,8.p1}) \vee (30268 <$
 $\$heap_{724,1;752,8.p1}) \vee (30306 < \$heap_{724,1;752,8.p2}) \vee (30322 <$
 $\$heap_{724,1;752,8.p3})$

\rightarrow [from term 130.0, $\$heap_{724,1;752,8}$ is equal to
 $\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{rem})).\mathbf{replace}(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p2}, 176).\text{rem})).\mathbf{replace}(p3 \rightarrow ((-63$
 $* \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178).\text{quot}) + (170 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3},$
 $178).\text{rem})).\mathbf{replace}(p1 \rightarrow (-2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{quot}) + (171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{rem}))]$

[1.92] **false** \vee **false** \vee ($-1 < -\$heap_{funcstart_724,1}.\mathbf{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1},$
 $177).\text{rem})).\mathbf{replace}(p2 \rightarrow ((-35 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p2}, 176).\text{rem})).\mathbf{replace}(p3 \rightarrow ((-63 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178).\text{quot}) + (170 * \text{div}(\mathbf{heapIs}$
 $\$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p3}, 178).\text{rem})).\mathbf{replace}(p1 \rightarrow ((-2 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).\text{quot}) + (171 *$
 $\text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1.p1}, 177).\text{rem})).p1) \vee$
 $(30268 < \$heap_{724,1;752,8.p1}) \vee (30306 < \$heap_{724,1;752,8.p2}) \vee (30322 <$
 $\$heap_{724,1;752,8.p3})$

\rightarrow [simplify]

[1.96] **false** \vee **false** \vee ($-1 < ((2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{quot}) + (-171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{rem})) \vee (30268 < \$heap_{724,1;752,8.p1}) \vee (30306 <$
 $\$heap_{724,1;752,8.p2}) \vee (30322 < \$heap_{724,1;752,8.p3})$

\rightarrow [from term 131.0, $\text{literal} < ((-171 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{rem}) + (2 * \text{div}(\mathbf{heapIs} \ \$heap_{funcstart_724,1},$
 $\$heap_{funcstart_724,1.p1}, 177).\text{quot}))$ is false whenever $-2 < (0 + \text{literal})]$

Proof of rule precondition:

[1.96.0] $-2 < (-1 + 0)$

\rightarrow [simplify]

[1.96.2] **true**

[1.97] **false** \vee **false** \vee **false** \vee $(30268 < \text{\$heap}_{724,1;752,8}.p1) \vee (30306 < \text{\$heap}_{724,1;752,8}.p2) \vee (30322 < \text{\$heap}_{724,1;752,8}.p3)$

\rightarrow [from term 130.0, $\text{\$heap}_{724,1;752,8}$ is equal to

$\text{\$heap_funcstart}_{724,1}.\text{_replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{rem}))).\text{_replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p2, 176).\text{rem}))).\text{_replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p3, 178).\text{rem}))).\text{_replace}(p1 \rightarrow (-2 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{rem})))]$

[1.98] **false** \vee **false** \vee **false** \vee $(30268 < \text{\$heap_funcstart}_{724,1}.\text{_replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{rem}))).\text{_replace}(p2 \rightarrow ((-35 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p2, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p2, 176).\text{rem}))).\text{_replace}(p3 \rightarrow ((-63 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p3, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p3, 178).\text{rem}))).\text{_replace}(p1 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{rem}))).p1) \vee (30306 < \text{\$heap}_{724,1;752,8}.p2) \vee (30322 < \text{\$heap}_{724,1;752,8}.p3)$

\rightarrow [simplify]

[1.99] **false** \vee **false** \vee **false** \vee $(30268 < ((-2 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{rem}))) \vee (30306 < \text{\$heap}_{724,1;752,8}.p2) \vee (30322 < \text{\$heap}_{724,1;752,8}.p3)$

\rightarrow [from term 62.17, $\text{literal} < ((-2 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{\$heap_funcstart}_{724,1}, \text{\$heap_funcstart}_{724,1}.p1, 177).\text{rem}))$ is false whenever $-2 < (-30269 + \text{literal})]$

Proof of rule precondition:

[1.99.0] $-2 < (-30269 + 30268)$

\rightarrow [simplify]

[1.99.2] **true**

[1.100] **false** \vee **false** \vee **false** \vee **false** \vee (30306 < \$heap724,1;752,8.p2) \vee (30322 < \$heap724,1;752,8.p3)

→ [from term 130.0, \$heap724,1;752,8 is equal to

\$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem))).**.replace**(p1 → (-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem)))])

[1.101] **false** \vee **false** \vee **false** \vee **false** \vee (30306 <

\$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))).**.replace**(p3 → ((-63 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).quot) + (170 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p3, 178).rem))).**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).p2) \vee (30322 < \$heap724,1;752,8.p3)

→ [simplify]

[1.104] **false** \vee **false** \vee **false** \vee **false** \vee (30306 < ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))) \vee (30322 < \$heap724,1;752,8.p3)

→ [from term 66.18, literal < ((-35 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).quot) + (172 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p2, 176).rem))) is false whenever -2 < (-30307 + literal)]

Proof of rule precondition:

[1.104.0] -2 < (-30307 + 30306)

→ [simplify]

[1.104.2] **true**

[1.105] **false** \vee **false** \vee **false** \vee **false** \vee **false** \vee (30322 < \$heap724,1;752,8.p3)

→ [from term 130.0, \$heap724,1;752,8 is equal to

\$heapfuncstart_724,1.**.replace**(p1 → ((-2 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).quot) + (171 * div(**heapIs** \$heapfuncstart_724,1, \$heapfuncstart_724,1.p1, 177).rem))).**.replace**(p2 → ((-35 * div(**heapIs**

$\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))_replace(p3 \rightarrow ((-63$
 $* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem)))_replace(p1 \rightarrow (-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem)))$

$[1.106] \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false} \vee (30322 <$
 $\$heap_funcstart_724,1._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem)))_replace(p2 \rightarrow ((-35 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).quot) + (172 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p2, 176).rem)))_replace(p3 \rightarrow ((-63$
 $* div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 *$
 $div(heapIs \$heap_funcstart_724,1, \$heap_funcstart_724,1.p3,$
 $178).rem)))_replace(p1 \rightarrow ((-2 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).quot) + (171 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p1, 177).rem)))p3)$

$\rightarrow [simplify]$

$[1.108] \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false} \vee (30322 < ((-63 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs$
 $\$heap_funcstart_724,1, \$heap_funcstart_724,1.p3, 178).rem)))$

$\rightarrow [from \text{ term } 70.19, \text{ literal } a < ((-63 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).quot) + (170 * div(heapIs \$heap_funcstart_724,1,$
 $\$heap_funcstart_724,1.p3, 178).rem)) \text{ is false whenever } -2 < (-30323 + \text{literal } a)]$

Proof of rule precondition:

$[1.108.0] -2 < (-30323 + 30322)$

$\rightarrow [simplify]$

$[1.108.2] \text{ true}$

$[1.109] \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false} \vee \text{ false}$

$\rightarrow [simplify]$

$[1.110] \text{ false}$

Proof of verification condition: Precondition of 'operator /' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (80,34)

Condition defined at: built in declaration

To prove: $!(0.0 ==$

$asType<double>(static_cast<real>(\$heap_funcend_724,1.M1)))$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,

```

```

asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <

```

```

asType<integer>($heap724,1;745,8.p1)
!(0 == asType<integer>($heap724,1;745,8.p1))
asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)
$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)
!(0 == asType<integer>($heap724,1;747,8.p2))
asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)
$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))
$heapfuncend_724,1 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))
invariant1(heapIs $heapfuncend_724,1)

```

Proof:

[Take goal term]

[1.0] !(0.0 ==

`asType<double>(static_cast<real>($heapfuncend_724,1.M1)))`
 \rightarrow [const static or extern object]
`[1.1] !(0.0 == asType<double>(static_cast<real>($heapinit.M1)))`
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
`[1.2] !(0.0 == asType<double>(static_cast<real>(asType<short int>((int)30269))))`
 \rightarrow [simplify]
`[1.9] true`

Proof of verification condition: Precondition of 'operator /' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (81,34)

Condition defined at: built in declaration

To prove: `!(0.0 == asType<double>(static_cast<real>($heapfuncend_724,1.M2)))`

Given:

`$heapinit.LIMIT == (int)80`
`$heapinit.M1 == asType<short int>((int)30269)`
`$heapinit.r1 == asType<short int>((int)171)`
`$heapinit.a1 == asType<short int>((int)177)`
`$heapinit.b1 == asType<short int>((int)2)`
`$heapinit.M2 == asType<short int>((int)30307)`
`$heapinit.r2 == asType<short int>((int)172)`
`$heapinit.a2 == asType<short int>((int)176)`
`$heapinit.b2 == asType<short int>((int)35)`
`$heapinit.M3 == asType<short int>((int)30323)`
`$heapinit.r3 == asType<short int>((int)170)`
`$heapinit.a3 == asType<short int>((int)178)`
`$heapinit.b3 == asType<short int>((int)63)`
`$heapinit.p1 == asType<short int>((int)1)`
`$heapinit.p2 == asType<short int>((int)2)`
`$heapinit.p3 == asType<short int>((int)3)`
`invariant1(heapIs $heapfuncstart_724,1)`
`div1 == div(heapIs $heapfuncstart_724,1,`


```

asType<int>($heap_funcstart_724,1.p1),
asType<int>($heap_funcstart_724,1.a1))

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==

```

```

asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <

```

```

asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))
$heap_funcend_724,1 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))
invariant1(heapIs $heap_funcend_724,1)
raux1 == asType<double>(static_cast<real>($heap_funcend_724,1.p1)) /
asType<double>(static_cast<real>($heap_funcend_724,1.M1))

```

Proof:

```

[Take goal term]
[1.0] !(0.0 ==
asType<double>(static_cast<real>($heap_funcend_724,1.M2)))
→ [const static or extern object]
[1.1] !(0.0 == asType<double>(static_cast<real>($heap_init.M2)))
→ [expand definition of constant 'M2' at prang.c (19,20)]
[1.2] !(0.0 == asType<double>(static_cast<real>(asType<short
int>((int)30307))))
→ [simplify]
[1.9] true

```

Proof of verification condition: Precondition of 'operator /' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (82,34)

Condition defined at: built in declaration

To prove: !(0.0 ==
asType<double>(static_cast<real>(\$heap_funcend_724,1.M3)))

Given:

```

$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)

```

```

$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))

```

```

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

```

```

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

$heap724,1;753,8 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))

invariant1(heapIs $heap724,1)

raux1 == asType<double>(static_cast<real>($heap724,1.p1)) /
asType<double>(static_cast<real>($heap724,1.M1))

raux2 == asType<double>(static_cast<real>($heap724,1.p2)) /
asType<double>(static_cast<real>($heap724,1.M2))

```

Proof:

[Take goal term]

[1.0] !(0.0 ==
asType<**double**>(**static_cast**<**real**>(\$heap_{funcend_724,1}.M3)))
 → [const static or extern object]
 [1.1] !(0.0 == **asType**<**double**>(**static_cast**<**real**>(\$heap_{init}.M3)))
 → [expand definition of constant 'M3' at prang.c (24,20)]
 [1.2] !(0.0 == **asType**<**double**>(**static_cast**<**real**>(**asType**<**short int**>((**int**)30323))))
 → [simplify]
 [1.9] **true**

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (86,30)

To prove: **asType**<**real**>((**double**)0.0) < ((**asType**<**real**>(raux2) + **asType**<**real**>(raux1)) + **asType**<**real**>(raux3))

Given:

\$heap_{init}.LIMIT == (**int**)80
 \$heap_{init}.M1 == **asType**<**short int**>((**int**)30269)
 \$heap_{init}.r1 == **asType**<**short int**>((**int**)171)
 \$heap_{init}.a1 == **asType**<**short int**>((**int**)177)
 \$heap_{init}.b1 == **asType**<**short int**>((**int**)2)
 \$heap_{init}.M2 == **asType**<**short int**>((**int**)30307)
 \$heap_{init}.r2 == **asType**<**short int**>((**int**)172)
 \$heap_{init}.a2 == **asType**<**short int**>((**int**)176)
 \$heap_{init}.b2 == **asType**<**short int**>((**int**)35)
 \$heap_{init}.M3 == **asType**<**short int**>((**int**)30323)
 \$heap_{init}.r3 == **asType**<**short int**>((**int**)170)
 \$heap_{init}.a3 == **asType**<**short int**>((**int**)178)
 \$heap_{init}.b3 == **asType**<**short int**>((**int**)63)
 \$heap_{init}.p1 == **asType**<**short int**>((**int**)1)
 \$heap_{init}.p2 == **asType**<**short int**>((**int**)2)
 \$heap_{init}.p3 == **asType**<**short int**>((**int**)3)
 invariant1(**heapIs** \$heap_{funcstart_724,1})
 div1 == div(**heapIs** \$heap_{funcstart_724,1},
asType<**int**>(\$heap_{funcstart_724,1}.p1),

```

asType<int>($heap_funcstart_724,1.a1))
(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p1)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a1))) ==
asType<integer>(div1.rem)

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

```



```

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

```

```

$heap724,1;752,8 == $heap724,1;749,8.replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8.replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

$heapfuncend_724,1 == $heap724,1;753,8.replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))

invariant1(heapIs $heapfuncend_724,1)

raux1 == asType<double>(static_cast<real>($heapfuncend_724,1.p1)) /
asType<double>(static_cast<real>($heapfuncend_724,1.M1))

raux2 == asType<double>(static_cast<real>($heapfuncend_724,1.p2)) /
asType<double>(static_cast<real>($heapfuncend_724,1.M2))

raux3 == asType<double>(static_cast<real>($heapfuncend_724,1.p3)) /
asType<double>(static_cast<real>($heapfuncend_724,1.M3))

asType<real>((double)0.0) < asType<real>(raux1)
asType<real>((double)0.0) < asType<real>(raux2)
asType<real>((double)0.0) < asType<real>(raux3)

Proof:

[Take given term]

[84.0] (asType<double>(static_cast<real>($heapfuncend_724,1.p1)) /
asType<double>(static_cast<real>($heapfuncend_724,1.M1))) == raux1
→ [simplify]

[84.2] (real($heapfuncend_724,1.p1) /
asType<double>(static_cast<real>($heapfuncend_724,1.M1))) == raux1
→ [const static or extern object]

[84.3] (real($heapfuncend_724,1.p1) /
asType<double>(static_cast<real>($heapinit.M1))) == raux1
→ [expand definition of constant 'M1' at prang.c (14,20)]

[84.4] (real($heapfuncend_724,1.p1) /
asType<double>(static_cast<real>(asType<short int>((int)30269))))
== raux1
→ [simplify]

```

[84.10] $0.0 == (-\text{raux1} + (\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0))$
 [Take given term]
 [85.0] $(\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.p2)) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.M2))) == \text{raux2}$
 \rightarrow [simplify]
 [85.2] $(\text{real}(\$heap_{funcend_724,1}.p2) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.M2))) == \text{raux2}$
 \rightarrow [const static or extern object]
 [85.3] $(\text{real}(\$heap_{funcend_724,1}.p2) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{init}.M2))) == \text{raux2}$
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
 [85.4] $(\text{real}(\$heap_{funcend_724,1}.p2) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\text{asType}<\text{short int}>((\text{int})30307))))$
 $== \text{raux2}$
 \rightarrow [simplify]
 [85.10] $0.0 == (-\text{raux2} + (\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0))$
 [Take given term]
 [86.0] $(\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.p3)) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.M3))) == \text{raux3}$
 \rightarrow [simplify]
 [86.2] $(\text{real}(\$heap_{funcend_724,1}.p3) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.M3))) == \text{raux3}$
 \rightarrow [const static or extern object]
 [86.3] $(\text{real}(\$heap_{funcend_724,1}.p3) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{init}.M3))) == \text{raux3}$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
 [86.4] $(\text{real}(\$heap_{funcend_724,1}.p3) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\text{asType}<\text{short int}>((\text{int})30323))))$
 $== \text{raux3}$
 \rightarrow [simplify]
 [86.10] $0.0 == (-\text{raux3} + (\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0))$
 [Take goal term]
 [1.0] $\text{asType}<\text{real}>((\text{double})0.0) < ((\text{asType}<\text{real}>(\text{raux2}) +$
 $\text{asType}<\text{real}>(\text{raux1})) + \text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [simplify]
 [1.2] $0.0 < ((\text{asType}<\text{real}>(\text{raux2}) + \text{asType}<\text{real}>(\text{raux1})) +$

$\text{asType<real>}(\text{raux3})$
 \rightarrow [from term 85.10, raux2 is equal to $\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0$]
[1.3] $0.0 < ((\text{asType<real>}(\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $\text{asType<real>}(\text{raux1})) + \text{asType<real>}(\text{raux3}))$
 \rightarrow [simplify]
[1.4] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $\text{asType<real>}(\text{raux1})) + \text{asType<real>}(\text{raux3}))$
 \rightarrow [from term 84.10, raux1 is equal to $\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0$]
[1.5] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $\text{asType<real>}(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0)) +$
 $\text{asType<real>}(\text{raux3}))$
 \rightarrow [simplify]
[1.6] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0)) + \text{asType<real>}(\text{raux3}))$
 \rightarrow [from term 86.10, raux3 is equal to $\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0$]
[1.7] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0) +$
 $(\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0)) +$
 $\text{asType<real>}(\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0))$
 \rightarrow [simplify]
[1.9] $0.0 < ((\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0) +$
 $(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0) + (\text{real}(\$heap_{funcend_724,1}.p2) /$
 $30307.0))$
 \rightarrow [negate goal and search for contradiction]
[1.10] $!(0.0 < ((\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0) +$
 $(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0) + (\text{real}(\$heap_{funcend_724,1}.p2) /$
 $30307.0)))$
 \rightarrow [simplify]
[1.17] $0.0 \leq (-(\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0) +$
 $-(\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) + -(\text{real}(\$heap_{funcend_724,1}.p1) /$
 $30269.0))$
[Take given term]
[87.0] $\text{asType<real>}((\text{double})0.0) < \text{asType<real>}(\text{raux1})$
 \rightarrow [simplify]
[87.2] $0.0 < \text{asType<real>}(\text{raux1})$
 \rightarrow [from term 84.10, raux1 is equal to $\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0$]
[87.3] $0.0 < \text{asType<real>}(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0)$

\rightarrow [simplify]
 [87.4] $0.0 < (\mathbf{real}(\$heap_{funcend_724,1}.p1) / 30269.0)$
 [Take given term]
 [88.0] $\mathbf{asType}<\mathbf{real}>((\mathbf{double})0.0) < \mathbf{asType}<\mathbf{real}>(\mathbf{raux2})$
 \rightarrow [simplify]
 [88.2] $0.0 < \mathbf{asType}<\mathbf{real}>(\mathbf{raux2})$
 \rightarrow [from term 85.10, *raux2* is equal to $\mathbf{real}(\$heap_{funcend_724,1}.p2) / 30307.0$]
 [88.3] $0.0 < \mathbf{asType}<\mathbf{real}>(\mathbf{real}(\$heap_{funcend_724,1}.p2) / 30307.0)$
 \rightarrow [simplify]
 [88.4] $0.0 < (\mathbf{real}(\$heap_{funcend_724,1}.p2) / 30307.0)$
 [Take given term]
 [89.0] $\mathbf{asType}<\mathbf{real}>((\mathbf{double})0.0) < \mathbf{asType}<\mathbf{real}>(\mathbf{raux3})$
 \rightarrow [simplify]
 [89.2] $0.0 < \mathbf{asType}<\mathbf{real}>(\mathbf{raux3})$
 \rightarrow [from term 86.10, *raux3* is equal to $\mathbf{real}(\$heap_{funcend_724,1}.p3) / 30323.0$]
 [89.3] $0.0 < \mathbf{asType}<\mathbf{real}>(\mathbf{real}(\$heap_{funcend_724,1}.p3) / 30323.0)$
 \rightarrow [simplify]
 [89.4] $0.0 < (\mathbf{real}(\$heap_{funcend_724,1}.p3) / 30323.0)$
 [Create new term from terms 1.17, 89.4 using rule: *transitivity 2b*]
 [209.0] $(0.0 + 0.0) < (-(\mathbf{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $-(\mathbf{real}(\$heap_{funcend_724,1}.p1) / 30269.0))$
 \rightarrow [simplify]
 [209.1] $0.0 < (-(\mathbf{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $-(\mathbf{real}(\$heap_{funcend_724,1}.p1) / 30269.0))$
 [Create new term from terms 209.1, 88.4 using rule: *transitivity 2a*]
 [219.0] $(0.0 + 0.0) < -(\mathbf{real}(\$heap_{funcend_724,1}.p1) / 30269.0)$
 \rightarrow [simplify]
 [219.1] $0.0 < -(\mathbf{real}(\$heap_{funcend_724,1}.p1) / 30269.0)$
 \rightarrow [from term 87.4, *literal* $< -(\mathbf{real}(\$heap_{funcend_724,1}.p1) / 30269.0)$ is false
 whenever $-0.0 \leq \mathbf{literal}$]

Proof of rule precondition:

[219.1.0] $-0.0 \leq 0.0$

\rightarrow [simplify]

[219.1.1] true

[219.2] false

Proof of verification condition: Precondition of 'fmod' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (87,25)

Condition defined at: C:\Escher\ecv\standard\math.h (84,16)

To prove: $\text{!(asType<real>((double)1.0) == asType<real>((double)0.0))}$

Given:

$\text{\$heap}_{init}.LIMIT == (\text{int})80$

$\text{\$heap}_{init}.M1 == \text{asType<short int>}((\text{int})30269)$

$\text{\$heap}_{init}.r1 == \text{asType<short int>}((\text{int})171)$

$\text{\$heap}_{init}.a1 == \text{asType<short int>}((\text{int})177)$

$\text{\$heap}_{init}.b1 == \text{asType<short int>}((\text{int})2)$

$\text{\$heap}_{init}.M2 == \text{asType<short int>}((\text{int})30307)$

$\text{\$heap}_{init}.r2 == \text{asType<short int>}((\text{int})172)$

$\text{\$heap}_{init}.a2 == \text{asType<short int>}((\text{int})176)$

$\text{\$heap}_{init}.b2 == \text{asType<short int>}((\text{int})35)$

$\text{\$heap}_{init}.M3 == \text{asType<short int>}((\text{int})30323)$

$\text{\$heap}_{init}.r3 == \text{asType<short int>}((\text{int})170)$

$\text{\$heap}_{init}.a3 == \text{asType<short int>}((\text{int})178)$

$\text{\$heap}_{init}.b3 == \text{asType<short int>}((\text{int})63)$

$\text{\$heap}_{init}.p1 == \text{asType<short int>}((\text{int})1)$

$\text{\$heap}_{init}.p2 == \text{asType<short int>}((\text{int})2)$

$\text{\$heap}_{init}.p3 == \text{asType<short int>}((\text{int})3)$

$\text{invariant1}(\text{heapIs } \text{\$heap}_{funcstart_724,1})$

$\text{div1} == \text{div}(\text{heapIs } \text{\$heap}_{funcstart_724,1},$

$\text{asType<int>}(\text{\$heap}_{funcstart_724,1}.p1),$

$\text{asType<int>}(\text{\$heap}_{funcstart_724,1}.a1))$

$(\text{asType<integer>}(\text{asType<int>}(\text{\$heap}_{funcstart_724,1}.p1)) /$

$\text{asType<integer>}(\text{asType<int>}(\text{\$heap}_{funcstart_724,1}.a1)))) ==$

$\text{asType<integer>}(\text{div1.quot})$

$(\text{asType<integer>}(\text{asType<int>}(\text{\$heap}_{funcstart_724,1}.p1)) \%$

$\text{asType<integer>}(\text{asType<int>}(\text{\$heap}_{funcstart_724,1}.a1)))) ==$

$\text{asType<integer>}(\text{div1.rem})$

```

(asType<integer>($heap_funcstart_724,1.p1) <
asType<integer>($heap_funcstart_724,1.a1)) =>
(asType<integer>($heap_funcstart_724,1.p1) ==
asType<integer>(div1.rem))

(asType<integer>($heap_funcstart_724,1.a1) ≤
asType<integer>($heap_funcstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))

!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))

div2 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p2),
asType<int>($heap_funcstart_724,1.a2))

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p2)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a2))) ==
asType<integer>(div2.rem)

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

```

```

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))
-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))
-asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <

```



```

(int)0))) + asType<int>($heap724,1;752,8.p2)))
$heap_funcend_724,1 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))
invariant1(heapIs $heap_funcend_724,1)
raux1 == asType<double>(static_cast<real>($heap_funcend_724,1.p1)) /
asType<double>(static_cast<real>($heap_funcend_724,1.M1))
raux2 == asType<double>(static_cast<real>($heap_funcend_724,1.p2)) /
asType<double>(static_cast<real>($heap_funcend_724,1.M2))
raux3 == asType<double>(static_cast<real>($heap_funcend_724,1.p3)) /
asType<double>(static_cast<real>($heap_funcend_724,1.M3))
asType<real>((double)0.0) < asType<real>(raux1)
asType<real>((double)0.0) < asType<real>(raux2)
asType<real>((double)0.0) < asType<real>(raux3)
asType<real>((double)0.0) < ((asType<real>(raux2) +
asType<real>(raux1)) + asType<real>(raux3))

```

Proof:

[Take goal term]

[1.0] !(asType<real>((double)1.0) == asType<real>((double)0.0))

→ [simplify]

[1.6] true

Proof of verification condition: Postcondition satisfied when function 'WHprang' returns

Condition generated at: C:\Escher\Customers\prang\prang.c (89,9)

Condition defined at: C:\Escher\Customers\prang\prang.c (43,25)

To prove: asType<real>(result) < asType<real>((double)1.0)

Given:

```

$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
$heap_init.a1 == asType<short int>((int)177)
$heap_init.b1 == asType<short int>((int)2)
$heap_init.M2 == asType<short int>((int)30307)

```

```

$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)

```

```

(asType<integer>($heap_funcstart_724,1.p2) <
asType<integer>($heap_funcstart_724,1.a2)) =>
(asType<integer>($heap_funcstart_724,1.p2) ==
asType<integer>(div2.rem))

(asType<integer>($heap_funcstart_724,1.a2) ≤
asType<integer>($heap_funcstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap724,1;745,8 == $heap_funcstart_724,1.replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap724,1;745,8.M1) <
asType<integer>($heap724,1;745,8.p1)

!(0 == asType<integer>($heap724,1;745,8.p1))

asType<integer>($heap724,1;745,8.p1) <
asType<integer>($heap724,1;745,8.M1)

$heap724,1;747,8 == $heap724,1;745,8.replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap724,1;745,8.b2))))

```

```

--asType<integer const>($heap724,1;747,8.M2) <
asType<integer>($heap724,1;747,8.p2)

!(0 == asType<integer>($heap724,1;747,8.p2))

asType<integer>($heap724,1;747,8.p2) <
asType<integer>($heap724,1;747,8.M2)

$heap724,1;749,8 == $heap724,1;747,8._replace(p3 → asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))

--asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)

!(0 == asType<integer>($heap724,1;749,8.p3))

asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)

$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))

$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))

$heapfuncend_724,1 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static.cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))

invariant1(heapIs $heapfuncend_724,1)

raux1 == asType<double>(static.cast<real>($heapfuncend_724,1.p1)) /
asType<double>(static.cast<real>($heapfuncend_724,1.M1))

raux2 == asType<double>(static.cast<real>($heapfuncend_724,1.p2)) /
asType<double>(static.cast<real>($heapfuncend_724,1.M2))

raux3 == asType<double>(static.cast<real>($heapfuncend_724,1.p3)) /
asType<double>(static.cast<real>($heapfuncend_724,1.M3))

asType<real>((double)0.0) < asType<real>(raux1)
asType<real>((double)0.0) < asType<real>(raux2)
asType<real>((double)0.0) < asType<real>(raux3)

asType<real>((double)0.0) < ((asType<real>(raux2) +
asType<real>(raux1)) + asType<real>(raux3))

```

```

result == fmod(heapIs $heap_funcend_724,1, (raux1 + raux2) + raux3,
(double)1.0)

((asType<real>((double)0.0) ≤ asType<real>((raux1 + raux2) +
raux3)) && (asType<real>((double)0.0) ≤ asType<real>((double)1.0)))
=> ((asType<real>((double)0.0) ≤ asType<real>(result)) &&
(asType<real>(result) < asType<real>((double)1.0)))

```

Proof:

[Take given term]

```

[84.0] (asType<double>(static_cast<real>($heap_funcend_724,1.p1)) /
asType<double>(static_cast<real>($heap_funcend_724,1.M1))) == raux1

```

→ [simplify]

```

[84.2] (real($heap_funcend_724,1.p1) /
asType<double>(static_cast<real>($heap_funcend_724,1.M1))) == raux1

```

→ [const static or extern object]

```

[84.3] (real($heap_funcend_724,1.p1) /
asType<double>(static_cast<real>($heap_init.M1))) == raux1

```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```

[84.4] (real($heap_funcend_724,1.p1) /
asType<double>(static_cast<real>(asType<short int>((int)30269))))
== raux1

```

→ [simplify]

```

[84.10] 0.0 == (-raux1 + (real($heap_funcend_724,1.p1) / 30269.0))

```

[Take given term]

```

[85.0] (asType<double>(static_cast<real>($heap_funcend_724,1.p2)) /
asType<double>(static_cast<real>($heap_funcend_724,1.M2))) == raux2

```

→ [simplify]

```

[85.2] (real($heap_funcend_724,1.p2) /
asType<double>(static_cast<real>($heap_funcend_724,1.M2))) == raux2

```

→ [const static or extern object]

```

[85.3] (real($heap_funcend_724,1.p2) /
asType<double>(static_cast<real>($heap_init.M2))) == raux2

```

→ [expand definition of constant 'M2' at prang.c (19,20)]

```

[85.4] (real($heap_funcend_724,1.p2) /
asType<double>(static_cast<real>(asType<short int>((int)30307))))
== raux2

```

→ [simplify]

[85.10] $0.0 == (-\text{raux2} + (\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0))$
 [Take given term]
 [86.0] $(\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.p3)) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.M3))) == \text{raux3}$
 \rightarrow [simplify]
 [86.2] $(\text{real}(\$heap_{funcend_724,1}.p3) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{funcend_724,1}.M3))) == \text{raux3}$
 \rightarrow [const static or extern object]
 [86.3] $(\text{real}(\$heap_{funcend_724,1}.p3) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\$heap_{init}.M3))) == \text{raux3}$
 \rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
 [86.4] $(\text{real}(\$heap_{funcend_724,1}.p3) /$
 $\text{asType}<\text{double}>(\text{static_cast}<\text{real}>(\text{asType}<\text{short int}>((\text{int})30323))))$
 $== \text{raux3}$
 \rightarrow [simplify]
 [86.10] $0.0 == (-\text{raux3} + (\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0))$
 [Take given term]
 [90.0] $\text{asType}<\text{real}>((\text{double})0.0) < ((\text{asType}<\text{real}>(\text{raux2}) +$
 $\text{asType}<\text{real}>(\text{raux1})) + \text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [simplify]
 [90.2] $0.0 < ((\text{asType}<\text{real}>(\text{raux2}) + \text{asType}<\text{real}>(\text{raux1})) +$
 $\text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [from term 85.10, raux2 is equal to $\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0$]
 [90.3] $0.0 < ((\text{asType}<\text{real}>(\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $\text{asType}<\text{real}>(\text{raux1})) + \text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [simplify]
 [90.4] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $\text{asType}<\text{real}>(\text{raux1})) + \text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [from term 84.10, raux1 is equal to $\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0$]
 [90.5] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $\text{asType}<\text{real}>(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0)) +$
 $\text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [simplify]
 [90.6] $0.0 < (((\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) +$
 $(\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0)) + \text{asType}<\text{real}>(\text{raux3}))$
 \rightarrow [from term 86.10, raux3 is equal to $\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0$]

[90.7] $0.0 < (((\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0)) +$
 $\text{asType<real>}(\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0))$
 → [simplify]
 [90.9] $0.0 < ((\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) /$
 $30307.0))$
 [Take given term]
 [91.0] $\text{result} == \text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1}, (\text{raux1} + \text{raux2}) + \text{raux3},$
 $(\text{double})1.0)$
 → [from term 84.10, *raux1* is equal to $\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0]$
 [91.1] $\text{result} == \text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $((\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0) + \text{raux2}) + \text{raux3}, (\text{double})1.0)$
 → [from term 85.10, *raux2* is equal to $\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0]$
 [91.2] $\text{result} == \text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1}, ((\text{real}(\text{\$heap_funcend_724,1.p1})$
 $/ 30269.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0)) + \text{raux3}, (\text{double})1.0)$
 → [from term 86.10, *raux3* is equal to $\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0]$
 [91.3] $\text{result} == \text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $((\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$
 $30269.0)) + (\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0), (\text{double})1.0)$
 → [simplify]
 [91.6] $0.0 == (-\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1}, (\text{real}(\text{\$heap_funcend_724,1.p3})$
 $/ 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0) + \text{result})$
 [Assume known post-assertion, class invariant or type constraint for term 91.6]
 [94.0] $((\text{asType<real>}((\text{double})0.0) \leq$
 $\text{asType<real>}((\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$
 $30269.0))) \ \&\& \ (\text{asType<real>}((\text{double})0.0) \leq \text{asType<real>}(1.0))) \Rightarrow$
 $((\text{asType<real>}((\text{double})0.0) \leq \text{asType<real>}(\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $(\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$
 $30269.0), 1.0))) \ \&\& \ (\text{asType<real>}(\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $(\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) /$
 $30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0)) <$
 $\text{asType<real>}(1.0)))$
 → [simplify]
 [94.3] $((0.0 \leq ((\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$

$30269.0))) \ \&\& \ (\text{asType}\langle\text{real}\rangle((\text{double})0.0) \leq \text{asType}\langle\text{real}\rangle(1.0))) \Rightarrow$
 $((\text{asType}\langle\text{real}\rangle((\text{double})0.0) \leq \text{asType}\langle\text{real}\rangle(\text{fmod}(\text{heapIs}$
 $\text{\$heap_funcend_724,1}, (\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$
 $30269.0), 1.0))) \ \&\& \ (\text{asType}\langle\text{real}\rangle(\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $(\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) /$
 $30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0)) <$
 $\text{asType}\langle\text{real}\rangle(1.0)))$
 \rightarrow [from term 90.9, $\text{literal} \leq ((\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) /$
 $30307.0))$ is true whenever $\text{literal} \leq 0.0]$

Proof of rule precondition:

[94.3.0] $0.0 \leq 0.0$

\rightarrow [simplify]

[94.3.1] **true**

$[94.4] \ (\text{true} \ \&\& \ (\text{asType}\langle\text{real}\rangle((\text{double})0.0) \leq \text{asType}\langle\text{real}\rangle(1.0))) \Rightarrow$
 $((\text{asType}\langle\text{real}\rangle((\text{double})0.0) \leq \text{asType}\langle\text{real}\rangle(\text{fmod}(\text{heapIs}$
 $\text{\$heap_funcend_724,1}, (\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$
 $30269.0), 1.0))) \ \&\& \ (\text{asType}\langle\text{real}\rangle(\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $(\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) /$
 $30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0)) <$
 $\text{asType}\langle\text{real}\rangle(1.0)))$

\rightarrow [simplify]

$[94.21] \ (-1.0 < -\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1}, (\text{real}(\text{\$heap_funcend_724,1.p3})$
 $/ 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0)) \wedge (0.0 \leq \text{fmod}(\text{heapIs}$
 $\text{\$heap_funcend_724,1}, (\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) /$
 $30269.0), 1.0))$

\rightarrow [separate conjunction and work on first sub-term]

$[94.22] \ -1.0 < -\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1}, (\text{real}(\text{\$heap_funcend_724,1.p3})$
 $/ 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) / 30307.0) +$
 $(\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0)$

[Take goal term]

[1.0] $\text{asType}\langle\text{real}\rangle(\text{result}) < \text{asType}\langle\text{real}\rangle((\text{double})1.0)$

\rightarrow [from term 91.6, result is equal to $\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$
 $(\text{real}(\text{\$heap_funcend_724,1.p3}) / 30323.0) + (\text{real}(\text{\$heap_funcend_724,1.p2}) /$
 $30307.0) + (\text{real}(\text{\$heap_funcend_724,1.p1}) / 30269.0), 1.0)]$

[1.1] $\text{asType}\langle\text{real}\rangle(\text{fmod}(\text{heapIs } \text{\$heap_funcend_724,1},$

$(\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0) + (\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) + (\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0), 1.0)) <$
asType<real>((double)1.0)
 \rightarrow [simplify]
 $[1.7] -1.0 < -\text{fmod}(\text{heapIs } \$heap_{funcend_724,1}, (\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0) + (\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) + (\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0), 1.0)$
 \rightarrow [from term 94.22, literal $a < -\text{fmod}(\text{heapIs } \$heap_{funcend_724,1}, (\text{real}(\$heap_{funcend_724,1}.p3) / 30323.0) + (\text{real}(\$heap_{funcend_724,1}.p2) / 30307.0) + (\text{real}(\$heap_{funcend_724,1}.p1) / 30269.0), 1.0)$ is true whenever $literal a \leq -1.0]$

Proof of rule precondition:

$[1.7.0] -1.0 \leq -1.0$

\rightarrow [simplify]

$[1.7.1]$ **true**

$[1.8]$ **true**

Proof of verification condition: Postcondition satisfied when function 'WHprang' returns

Condition generated at: C:\Escher\Customers\prang\prang.c (89,9)

Condition defined at: C:\Escher\Customers\prang\prang.c (43,44)

To prove: invariant1(heapIs \$heap_{funcend_724,1})

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

```

$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
invariant1(heapIs $heapfuncstart_724,1)
div1 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p1),
asType<int>($heapfuncstart_724,1.a1))
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p1)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a1))) ==
asType<integer>(div1.rem)
(asType<integer>($heapfuncstart_724,1.p1) <
asType<integer>($heapfuncstart_724,1.a1)) =>
(asType<integer>($heapfuncstart_724,1.p1) ==
asType<integer>(div1.rem))
(asType<integer>($heapfuncstart_724,1.a1) ≤
asType<integer>($heapfuncstart_724,1.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType<integer>(div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(heapIs $heapfuncstart_724,1,
asType<int>($heapfuncstart_724,1.p2),
asType<int>($heapfuncstart_724,1.a2))
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) /
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heapfuncstart_724,1.p2)) %
asType<integer>(asType<int>($heapfuncstart_724,1.a2))) ==
asType<integer>(div2.rem)
(asType<integer>($heapfuncstart_724,1.p2) <
asType<integer>($heapfuncstart_724,1.a2)) =>
(asType<integer>($heapfuncstart_724,1.p2) ==
asType<integer>(div2.rem))
(asType<integer>($heapfuncstart_724,1.a2) ≤
asType<integer>($heapfuncstart_724,1.p2)) => !(0 ==
asType<integer>(div2.quot))

```

```

!(0 == asType<integer>(div2.rem)) || !(0 ==
asType<integer>(div2.quot))

div3 == div(heapIs $heap_funcstart_724,1,
asType<int>($heap_funcstart_724,1.p3),
asType<int>($heap_funcstart_724,1.a3))

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) /
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.quot)

(asType<integer>(asType<int>($heap_funcstart_724,1.p3)) %
asType<integer>(asType<int>($heap_funcstart_724,1.a3))) ==
asType<integer>(div3.rem)

(asType<integer>($heap_funcstart_724,1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType<integer>($heap_funcstart_724,1.p3) ==
asType<integer>(div3.rem))

(asType<integer>($heap_funcstart_724,1.a3) ≤
asType<integer>($heap_funcstart_724,1.p3)) => !(0 ==
asType<integer>(div3.quot))

!(0 == asType<integer>(div3.rem)) || !(0 ==
asType<integer>(div3.quot))

$heap_724,1;745,8 == $heap_funcstart_724,1._replace(p1 → asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_funcstart_724,1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType<int>($heap_funcstart_724,1.b1))))

-asType<integer const>($heap_724,1;745,8.M1) <
asType<integer>($heap_724,1;745,8.p1)

!(0 == asType<integer>($heap_724,1;745,8.p1))

asType<integer>($heap_724,1;745,8.p1) <
asType<integer>($heap_724,1;745,8.M1)

$heap_724,1;747,8 == $heap_724,1;745,8._replace(p2 → asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType<int>($heap_724,1;745,8.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap_724,1;745,8.b2))))

-asType<integer const>($heap_724,1;747,8.M2) <
asType<integer>($heap_724,1;747,8.p2)

!(0 == asType<integer>($heap_724,1;747,8.p2))

asType<integer>($heap_724,1;747,8.p2) <
asType<integer>($heap_724,1;747,8.M2)

$heap_724,1;749,8 == $heap_724,1;747,8._replace(p3 → asType<short

```

```

int>((asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap724,1;747,8.r3)) - (asType<int>(asType<short
int>(div3.quot)) * asType<int>($heap724,1;747,8.b3))))
-asType<integer const>($heap724,1;749,8.M3) <
asType<integer>($heap724,1;749,8.p3)
!(0 == asType<integer>($heap724,1;749,8.p3))
asType<integer>($heap724,1;749,8.p3) <
asType<integer>($heap724,1;749,8.M3)
$heap724,1;752,8 == $heap724,1;749,8._replace(p1 → asType<short
int>((asType<int>($heap724,1;749,8.M1) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;749,8.p1) <
(int)0))) + asType<int>($heap724,1;749,8.p1)))
$heap724,1;753,8 == $heap724,1;752,8._replace(p2 → asType<short
int>((asType<int>($heap724,1;752,8.M2) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;752,8.p2) <
(int)0))) + asType<int>($heap724,1;752,8.p2)))
$heap724,1;753,8 == $heap724,1;753,8._replace(p3 → asType<short
int>((asType<int>($heap724,1;753,8.M3) *
asType<int>(static_cast<integer>(asType<int>($heap724,1;753,8.p3) <
(int)0))) + asType<int>($heap724,1;753,8.p3)))
invariant1(heapIs $heap724,1)
raux1 == asType<double>(static_cast<real>($heap724,1.p1)) /
asType<double>(static_cast<real>($heap724,1.M1))
raux2 == asType<double>(static_cast<real>($heap724,1.p2)) /
asType<double>(static_cast<real>($heap724,1.M2))
raux3 == asType<double>(static_cast<real>($heap724,1.p3)) /
asType<double>(static_cast<real>($heap724,1.M3))
asType<real>((double)0.0) < asType<real>(raux1)
asType<real>((double)0.0) < asType<real>(raux2)
asType<real>((double)0.0) < asType<real>(raux3)
asType<real>((double)0.0) < ((asType<real>(raux2) +
asType<real>(raux1)) + asType<real>(raux3))
result == fmod(heapIs $heap724,1, (raux1 + raux2) + raux3,
(double)1.0)
((asType<real>((double)0.0) ≤ asType<real>((raux1 + raux2) +
raux3)) && (asType<real>((double)0.0) ≤ asType<real>((double)1.0)))
=> ((asType<real>((double)0.0) ≤ asType<real>(result)) &&
(asType<real>(result) < asType<real>((double)1.0)))

```

Proof:

[Take given term]

[78.0] invariant1(heapIs \$heap_{funcend_724,1})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[78.1] (((((0 < asType<integer>(\$heap_{funcend_724,1}.p1)) &&
(asType<integer>(\$heap_{funcend_724,1}.p1) <
asType<integer>(\$heap_{funcend_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p2))) &&
(asType<integer>(\$heap_{funcend_724,1}.p2) <
asType<integer>(\$heap_{funcend_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p3))) &&
(asType<integer>(\$heap_{funcend_724,1}.p3) <
asType<integer>(\$heap_{funcend_724,1}.M3)))

→ [simplify]

[78.3] (((((0 < \$heap_{funcend_724,1}.p1) && (\$heap_{funcend_724,1}.p1 <
asType<integer>(\$heap_{funcend_724,1}.M1))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p2))) &&
(asType<integer>(\$heap_{funcend_724,1}.p2) <
asType<integer>(\$heap_{funcend_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p3))) &&
(asType<integer>(\$heap_{funcend_724,1}.p3) <
asType<integer>(\$heap_{funcend_724,1}.M3)))

→ [const static or extern object]

[78.4] (((((0 < \$heap_{funcend_724,1}.p1) && (\$heap_{funcend_724,1}.p1 <
asType<integer>(\$heap_{init}.M1))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p2))) &&
(asType<integer>(\$heap_{funcend_724,1}.p2) <
asType<integer>(\$heap_{funcend_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p3))) &&
(asType<integer>(\$heap_{funcend_724,1}.p3) <
asType<integer>(\$heap_{funcend_724,1}.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[78.5] (((((0 < \$heap_{funcend_724,1}.p1) && (\$heap_{funcend_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p2))) &&
(asType<integer>(\$heap_{funcend_724,1}.p2) <
asType<integer>(\$heap_{funcend_724,1}.M2))) && (0 <
asType<integer>(\$heap_{funcend_724,1}.p3))) &&
(asType<integer>(\$heap_{funcend_724,1}.p3) <
asType<integer>(\$heap_{funcend_724,1}.M3)))

→ [simplify]

[78.16] ((((-30269 < -\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧
(0 < \$heap_funcend_724,1.p2)) && (\$heap_funcend_724,1.p2 <
asType<integer>(\$heap_funcend_724,1.M2))) && (0 <
asType<integer>(\$heap_funcend_724,1.p3))) &&
(**asType<integer>**(\$heap_funcend_724,1.p3) <
asType<integer>(\$heap_funcend_724,1.M3))
→ [const static or extern object]

[78.17] ((((-30269 < -\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧
(0 < \$heap_funcend_724,1.p2)) && (\$heap_funcend_724,1.p2 <
asType<integer>(\$heap_init.M2))) && (0 <
asType<integer>(\$heap_funcend_724,1.p3))) &&
(**asType<integer>**(\$heap_funcend_724,1.p3) <
asType<integer>(\$heap_funcend_724,1.M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[78.18] ((((-30269 < -\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧
(0 < \$heap_funcend_724,1.p2)) && (\$heap_funcend_724,1.p2 <
asType<integer>(**asType<short int>**((**int**)30307)))) && (0 <
asType<integer>(\$heap_funcend_724,1.p3))) &&
(**asType<integer>**(\$heap_funcend_724,1.p3) <
asType<integer>(\$heap_funcend_724,1.M3))
→ [simplify]

[78.30] ((-30307 < -\$heap_funcend_724,1.p2) ∧ (-30269 <
-\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧ (0 <
\$heap_funcend_724,1.p2) ∧ (0 < \$heap_funcend_724,1.p3)) &&
(\$heap_funcend_724,1.p3 < **asType<integer>**(\$heap_funcend_724,1.M3))
→ [const static or extern object]

[78.31] ((-30307 < -\$heap_funcend_724,1.p2) ∧ (-30269 <
-\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧ (0 <
\$heap_funcend_724,1.p2) ∧ (0 < \$heap_funcend_724,1.p3)) &&
(\$heap_funcend_724,1.p3 < **asType<integer>**(\$heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]

[78.32] ((-30307 < -\$heap_funcend_724,1.p2) ∧ (-30269 <
-\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧ (0 <
\$heap_funcend_724,1.p2) ∧ (0 < \$heap_funcend_724,1.p3)) &&
(\$heap_funcend_724,1.p3 < **asType<integer>**(**asType<short
int>**((**int**)30323))))
→ [simplify]

[78.40] (-30323 < -\$heap_funcend_724,1.p3) ∧ (-30307 < -\$heap_funcend_724,1.p2)
∧ (-30269 < -\$heap_funcend_724,1.p1) ∧ (0 < \$heap_funcend_724,1.p1) ∧ (0 <
\$heap_funcend_724,1.p2) ∧ (0 < \$heap_funcend_724,1.p3)

\rightarrow [separate conjunction and work on first sub-term]
 [78.41] $-30323 < -\$heap_{funcend_724,1}.p3$
 [Work on sub-term 2 of conjunction in term 78.40]
 [79.0] $-30307 < -\$heap_{funcend_724,1}.p2$
 [Work on sub-term 3 of conjunction in term 78.40]
 [80.0] $-30269 < -\$heap_{funcend_724,1}.p1$
 [Work on sub-term 4 of conjunction in term 78.40]
 [81.0] $0 < \$heap_{funcend_724,1}.p1$
 [Work on sub-term 5 of conjunction in term 78.40]
 [82.0] $0 < \$heap_{funcend_724,1}.p2$
 [Work on sub-term 6 of conjunction in term 78.40]
 [83.0] $0 < \$heap_{funcend_724,1}.p3$
 [Take goal term]
 [1.0] **invariant1**(**heapIs** $\$heap_{funcend_724,1}$)
 \rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 [1.1] (((((0 < **asType**<**integer**>($\$heap_{funcend_724,1}.p1$)) &&
 (**asType**<**integer**>($\$heap_{funcend_724,1}.p1$) <
asType<**integer**>($\$heap_{funcend_724,1}.M1$))) && (0 <
asType<**integer**>($\$heap_{funcend_724,1}.p2$))) &&
 (**asType**<**integer**>($\$heap_{funcend_724,1}.p2$) <
asType<**integer**>($\$heap_{funcend_724,1}.M2$))) && (0 <
asType<**integer**>($\$heap_{funcend_724,1}.p3$))) &&
 (**asType**<**integer**>($\$heap_{funcend_724,1}.p3$) <
asType<**integer**>($\$heap_{funcend_724,1}.M3$)))
 \rightarrow [simplify]
 [1.2] (((((0 < $\$heap_{funcend_724,1}.p1$) &&
 (**asType**<**integer**>($\$heap_{funcend_724,1}.p1$) <
asType<**integer**>($\$heap_{funcend_724,1}.M1$))) && (0 <
asType<**integer**>($\$heap_{funcend_724,1}.p2$))) &&
 (**asType**<**integer**>($\$heap_{funcend_724,1}.p2$) <
asType<**integer**>($\$heap_{funcend_724,1}.M2$))) && (0 <
asType<**integer**>($\$heap_{funcend_724,1}.p3$))) &&
 (**asType**<**integer**>($\$heap_{funcend_724,1}.p3$) <
asType<**integer**>($\$heap_{funcend_724,1}.M3$)))
 \rightarrow [from term 81.0, $literal_a < \$heap_{funcend_724,1}.p1$ is true whenever $(-1 +$
 $literal_a) < 0$]

Proof of rule precondition:

[1.2.0] $(-1 + 0) < 0$

→ [simplify]

[1.2.2] **true**

[1.3] (((**true** && (**asType**<**integer**>(\$heap_funcend_724,1.p1) <
asType<**integer**>(\$heap_funcend_724,1.M1))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p2) <
asType<**integer**>(\$heap_funcend_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p3) <
asType<**integer**>(\$heap_funcend_724,1.M3)))

→ [simplify]

[1.4] ((((**true** && (\$heap_funcend_724,1.p1 <
asType<**integer**>(\$heap_funcend_724,1.M1))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p2) <
asType<**integer**>(\$heap_funcend_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p3) <
asType<**integer**>(\$heap_funcend_724,1.M3)))

→ [const static or extern object]

[1.5] ((((**true** && (\$heap_funcend_724,1.p1 <
asType<**integer**>(\$heap_init.M1))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p2) <
asType<**integer**>(\$heap_funcend_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p3) <
asType<**integer**>(\$heap_funcend_724,1.M3)))

→ [expand definition of constant 'M1' at prang.c (14,20)]

[1.6] ((((**true** && (\$heap_funcend_724,1.p1 <
asType<**integer**>(**asType**<**short int**>((**int**)30269)))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p2))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p2) <
asType<**integer**>(\$heap_funcend_724,1.M2))) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p3))) &&
(**asType**<**integer**>(\$heap_funcend_724,1.p3) <
asType<**integer**>(\$heap_funcend_724,1.M3)))

→ [simplify]

[1.12] ((((**true** && (-30269 < -\$heap_funcend_724,1.p1)) && (0 <
asType<**integer**>(\$heap_funcend_724,1.p2))) &&

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$

\rightarrow [from term 80.0, $literal_a < -\$heap_{funcend_724,1}.p1$ is true whenever $(-1 +$
 $literal_a) < -30269]$

Proof of rule precondition:

[1.12.0] $(-30269 + -1) < -30269$

\rightarrow [simplify]

[1.12.2] **true**

[1.13] $((((\text{true} \&\& \text{true}) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p2))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$

\rightarrow [simplify]

[1.15] $((((\text{true} \&\& (0 < \$heap_{funcend_724,1}.p2)) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$

\rightarrow [from term 82.0, $literal_a < \$heap_{funcend_724,1}.p2$ is true whenever $(-1 +$
 $literal_a) < 0]$

Proof of rule precondition:

[1.15.0] $(-1 + 0) < 0$

\rightarrow [simplify]

[1.15.2] **true**

[1.16] $((((\text{true} \&\& \text{true}) \&\& (\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p2) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M2))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$

\rightarrow [simplify]

[1.18] $((\text{true} \&\& (\$heap_{funcend_724,1}.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M2))) \&\& (0 <$

$\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$
 $\rightarrow [\text{const static or extern object}]$
 $[1.19] ((\text{true} \&\& (\$heap_{funcend_724,1}.p2 < \text{asType}\langle\text{integer}\rangle(\$heap_{init}.M2)))$
 $\&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$
 $\rightarrow [\text{expand definition of constant 'M2' at prang.c (19,20)}]$
 $[1.20] ((\text{true} \&\& (\$heap_{funcend_724,1}.p2 <$
 $\text{asType}\langle\text{integer}\rangle(\text{asType}\langle\text{short int}\rangle((\text{int})30307)))) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$
 $\rightarrow [\text{simplify}]$
 $[1.26] ((\text{true} \&\& (-30307 < -\$heap_{funcend_724,1}.p2)) \&\& (0 <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3))) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$
 $\rightarrow [\text{from term 79.0, literal } < -\$heap_{funcend_724,1}.p2 \text{ is true whenever } (-1 +$
 $\text{literal}) < -30307]$

Proof of rule precondition:

$[1.26.0] (-30307 + -1) < -30307$
 $\rightarrow [\text{simplify}]$
 $[1.26.2] \text{true}$
 $[1.27] ((\text{true} \&\& \text{true}) \&\& (0 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3)))$
 $\&\& (\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$
 $\rightarrow [\text{simplify}]$
 $[1.29] (\text{true} \&\& (0 < \$heap_{funcend_724,1}.p3)) \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.p3) <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcend_724,1}.M3))$
 $\rightarrow [\text{from term 83.0, literal } < \$heap_{funcend_724,1}.p3 \text{ is true whenever } (-1 +$
 $\text{literal}) < 0]$

Proof of rule precondition:

$[1.29.0] (-1 + 0) < 0$
 $\rightarrow [\text{simplify}]$
 $[1.29.2] \text{true}$

[1.30] **true** && **true**) && (**asType**<**integer**>(\$heap_{funcend_724,1}.p3) <
asType<**integer**>(\$heap_{funcend_724,1}.M3))
→ [simplify]
[1.32] **true** && (\$heap_{funcend_724,1}.p3 <
asType<**integer**>(\$heap_{funcend_724,1}.M3))
→ [const static or extern object]
[1.33] **true** && (\$heap_{funcend_724,1}.p3 < **asType**<**integer**>(\$heap_{init}.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[1.34] **true** && (\$heap_{funcend_724,1}.p3 < **asType**<**integer**>(**asType**<**short**
int>((**int**)30323)))
→ [simplify]
[1.40] **true** && (-30323 < -\$heap_{funcend_724,1}.p3)
→ [from term 78.41, literal a < -\$heap_{funcend_724,1}.p3 is true whenever (-1 +
literal a) < -30323]

Proof of rule precondition:

[1.40.0] (-30323 + -1) < -30323
→ [simplify]
[1.40.2] **true**
[1.41] **true** && **true**
→ [simplify]
[1.42] **true**

Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (102,10)

Condition defined at:

To prove: minof(short int) ≤ (int)1

Given:

\$heap_{init}.LIMIT == (**int**)80
\$heap_{init}.M1 == **asType**<**short int**>((**int**)30269)
\$heap_{init}.r1 == **asType**<**short int**>((**int**)171)
\$heap_{init}.a1 == **asType**<**short int**>((**int**)177)
\$heap_{init}.b1 == **asType**<**short int**>((**int**)2)
\$heap_{init}.M2 == **asType**<**short int**>((**int**)30307)

```

$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)1

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (102,10)

Condition defined at:

To prove: (int)1 ≤ maxof(short int)

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)

```

```

$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)

```

Proof:

[Take goal term]

[1.0] (int)1 ≤ maxof(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (103,10)

Condition defined at:

To prove: minof(short int) ≤ (int)2

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)

```

$\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((\text{int})1))$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})2$

\rightarrow *[simplify]*

[1.3] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (103,10)

Condition defined at:

To prove: $(\text{int})2 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.p3 == \text{asType}<\text{short int}>((\text{int})3)$

$\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((\text{int})1))$

Proof:

[Take goal term]

[1.0] (int)2 ≤ maxof(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (104,10)

Condition defined at:

To prove: minof(short int) ≤ (int)3

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

\$heap_{init}.p3 == asType<short int>((int)3)

\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.replace(p1 → asType<short int>((int)1))

\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.replace(p2 → asType<short int>((int)2))

Proof:

[Take goal term]

[1.0] **minof**(short int) ≤ (int)3

→ [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (104,10)

Condition defined at:

To prove: (int)3 ≤ **maxof**(short int)

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == **asType**<short int>((int)30269)

\$heap_{init}.r1 == **asType**<short int>((int)171)

\$heap_{init}.a1 == **asType**<short int>((int)177)

\$heap_{init}.b1 == **asType**<short int>((int)2)

\$heap_{init}.M2 == **asType**<short int>((int)30307)

\$heap_{init}.r2 == **asType**<short int>((int)172)

\$heap_{init}.a2 == **asType**<short int>((int)176)

\$heap_{init}.b2 == **asType**<short int>((int)35)

\$heap_{init}.M3 == **asType**<short int>((int)30323)

\$heap_{init}.r3 == **asType**<short int>((int)170)

\$heap_{init}.a3 == **asType**<short int>((int)178)

\$heap_{init}.b3 == **asType**<short int>((int)63)

\$heap_{init}.p1 == **asType**<short int>((int)1)

\$heap_{init}.p2 == **asType**<short int>((int)2)

\$heap_{init}.p3 == **asType**<short int>((int)3)

\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.**replace**(p1 → **asType**<short int>((int)1))

\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.**replace**(p2 → **asType**<short int>((int)2))

Proof:

[Take goal term]

[1.0] (int)3 ≤ **maxof**(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Loop initialisation establishes end condition or a valid variant

Condition generated at: C:\Escher\Customers\prang\prang.c (111,5)

Condition defined at: C:\Escher\Customers\prang\prang.c (114,20)

To prove: $0 \leq (\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}))$

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

\$heap_{init}.p3 == asType<short int>((int)3)

\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.replace(p1 → asType<short int>((int)1))

\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.replace(p2 → asType<short int>((int)2))

\$heap_{780,1;785,8} == \$heap_{780,1;784,8}.replace(p3 → asType<short int>((int)3))

limit == \$heap_{780,1;785,8}.LIMIT

minof(int const) ≤ limit

$\text{limit} \leq \mathbf{maxof}(\mathbf{int} \text{ const})$
 $\text{count} == (\mathbf{int})0$
 $\mathbf{minof}(\mathbf{int}) \leq \text{count}$
 $\text{count} \leq \mathbf{maxof}(\mathbf{int})$
 $\$heap_{780,1;790,5} == \$heap_{780,1;785,8}.\mathbf{replace}((\&\$heap_{780,1;785,8}.\mathbf{ecv_files}[1]).\$r \rightarrow \mathbf{writes_790_5})$
 $\text{count} < \text{limit}$
Proof:
[Take given term]
 $[5.0] \$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow \mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})1))$
 $\rightarrow [simplify]$
 $[5.2] \$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1)$
[Take given term]
 $[6.0] \$heap_{780,1;784,8} == \$heap_{780,1;783,8}.\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})2))$
 $\rightarrow [from \text{ term } 5.2, \$heap_{780,1;783,8} \text{ is equal to } \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1)]$
 $[6.1] \$heap_{780,1;784,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow \mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})2))$
 $\rightarrow [simplify]$
 $[6.3] \$heap_{780,1;784,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2)$
[Take given term]
 $[7.0] \$heap_{780,1;785,8} == \$heap_{780,1;784,8}.\mathbf{replace}(p3 \rightarrow \mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})3))$
 $\rightarrow [from \text{ term } 6.3, \$heap_{780,1;784,8} \text{ is equal to } \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2)]$
 $[7.1] \$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow \mathbf{asType}<\mathbf{short} \mathbf{int}>((\mathbf{int})3))$
 $\rightarrow [simplify]$
 $[7.3] \$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3)$
[Take given term]
 $[8.0] \$heap_{780,1;785,8}.\mathbf{LIMIT} == \text{limit}$

\rightarrow [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$]
 [8.1] $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{LIMIT} == \text{limit}$
 \rightarrow [const member of object with modified fields]
 [8.4] $\$heap_{funcstart_780,1}.\text{LIMIT} == \text{limit}$
 \rightarrow [const static or extern object]
 [8.5] $\$heap_{init}.\text{LIMIT} == \text{limit}$
 \rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]
 [8.6] $(\text{int})80 == \text{limit}$
 \rightarrow [simplify]
 [8.7] $80 == \text{limit}$
 [Take given term]
 [9.0] $(\text{int})0 == \text{count}$
 \rightarrow [simplify]
 [9.1] $0 == \text{count}$
 [Take goal term]
 [1.0] $0 \leq (\text{asType}\langle \text{integer const} \rangle(\text{limit}) - \text{asType}\langle \text{integer} \rangle(\text{count}))$
 \rightarrow [from term 8.7, limit is equal to 80]
 [1.1] $0 \leq (\text{asType}\langle \text{integer const} \rangle(80) - \text{asType}\langle \text{integer} \rangle(\text{count}))$
 \rightarrow [simplify]
 [1.2] $0 \leq (80 - \text{asType}\langle \text{integer} \rangle(\text{count}))$
 \rightarrow [from term 9.1, count is equal to 0]
 [1.3] $0 \leq (80 - \text{asType}\langle \text{integer} \rangle(0))$
 \rightarrow [simplify]
 [1.6] **true**

Proof of verification condition: Loop body establishes end condition or decreases variant

Condition generated at: C:\Escher\Customers\prang\prang.c (115,5)

Condition defined at: C:\Escher\Customers\prang\prang.c (114,5)

To prove: $(\text{asType}\langle \text{integer const} \rangle(\text{limit}) - \text{asType}\langle \text{integer} \rangle(\text{count}_{loopend})) < (\text{asType}\langle \text{integer const} \rangle(\text{limit}) - \text{asType}\langle \text{integer} \rangle(\text{count}_{loopstart_792,5}))$

Given:

```
$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
$heap780,1;783,8 == $heapfuncstart_780,1._replace(p1 → asType<short
int>((int)1))
$heap780,1;784,8 == $heap780,1;783,8._replace(p2 → asType<short
int>((int)2))
$heap780,1;785,8 == $heap780,1;784,8._replace(p3 → asType<short
int>((int)3))
limit == $heap780,1;785,8.LIMIT
minof(int const) ≤ limit
limit ≤ maxof(int const)
count == (int)0
minof(int) ≤ count
count ≤ maxof(int)
$heap780,1;790,5 == $heap780,1;785,8._replace((&$heap780,1;785,8._ecv_files[1]).$r
→ writes_790_5)
$heaploopstart_792,5 == $heap780,1;790,5._replace(p1 →
writes_793_12)._replace(p2 → writes_793_12)._replace(p3 →
writes_793_12)._replace(_ecv_files → writes_793_12)
```

```

#writes_793_12 == #heap780,1;790,5.ecv_files
minof(int) ≤ countloopstart_792,5
countloopstart_792,5 ≤ maxof(int)
invariant1(heapIs $heaploopstart_792,5)
countloopstart_792,5 < limit
0 ≤ (asType<integer const>(limit) -
asType<integer>(countloopstart_792,5))
(asType<integer const>(limit) - asType<integer>(countloopstart_792,5))
≤ (asType<integer const>(limit) - asType<integer>(count))
(++countloopstart_792,5 == countloopend) ∧ ($heap797,16 ==
$heaploopstart_792,5..replace(p1 → writes_797_25)..replace(p2 →
writes_797_25)..replace(p3 → writes_797_25)) ∧ ($heaploopend ==
$heap797,16..replace((&$heap797,16.ecv_files[1]).$r → writes_797_9)) ∧
(asType<real>((double)0.0) < asType<real>($result_797_25)) ∧
(asType<real>($result_797_25) < asType<real>((double)1.0)) ∧
invariant1(heapIs $heap797,16)
countloopend < limit

```

Proof:

[Take given term]

[5.0] \$heap780,1;783,8 == \$heap_{funcstart_780,1}..**replace**(p1 → **asType**<**short int**>((**int**)1))

→ [simplify]

[5.2] \$heap780,1;783,8 == \$heap_{funcstart_780,1}..**replace**(p1 → 1)

[Take given term]

[6.0] \$heap780,1;784,8 == \$heap780,1;783,8..**replace**(p2 → **asType**<**short int**>((**int**)2))

→ [from term 5.2, \$heap780,1;783,8 is equal to \$heap_{funcstart_780,1}..**replace**(p1 → 1)]

[6.1] \$heap780,1;784,8 == \$heap_{funcstart_780,1}..**replace**(p1 → 1)..**replace**(p2 → **asType**<**short int**>((**int**)2))

→ [simplify]

[6.3] \$heap780,1;784,8 == \$heap_{funcstart_780,1}..**replace**(p1 → 1)..**replace**(p2 → 2)

[Take given term]

[7.0] \$heap780,1;785,8 == \$heap780,1;784,8..**replace**(p3 → **asType**<**short int**>((**int**)3))

→ [from term 6.3, $\$heap_{780,1;784,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$]
 [7.1] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})3))$
 → [simplify]
 [7.3] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$
 [Take given term]
 [8.0] $\$heap_{780,1;785,8}.\text{LIMIT} == \text{limit}$
 → [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$]
 [8.1] $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{LIMIT} == \text{limit}$
 → [const member of object with modified fields]
 [8.4] $\$heap_{funcstart_780,1}.\text{LIMIT} == \text{limit}$
 → [const static or extern object]
 [8.5] $\$heap_{init}.\text{LIMIT} == \text{limit}$
 → [expand definition of constant 'LIMIT' at prang.c (12,18)]
 [8.6] $(\text{int})80 == \text{limit}$
 → [simplify]
 [8.7] $80 == \text{limit}$
 [Take given term]
 [10.0] $\$heap_{780,1;790,5} == \$heap_{780,1;785,8}.\text{replace}((\&\$heap_{780,1;785,8}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 → [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$]
 [10.1] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap_{780,1;785,8}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 → [simplify]
 [10.2] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 → [attribute value is known from postcondition]
 [10.3] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}(\&\$heap.\text{ecv_files}[1] \rightarrow \text{writes_790_5})$
 [Take given term]

[11.0] $\$heap_{loopstart_792,5} == \$heap_{780,1;790,5} \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12})$

\rightarrow [from term 10.3, $\$heap_{780,1;790,5}$ is equal to $\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap_ecv_files[1] \rightarrow \text{writes_790_5})$]

[11.1] $\$heap_{loopstart_792,5} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap_ecv_files[1] \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12})$

[Take given term]

[29.0] $(++count_{loopstart_792,5} == count_{loopend}) \wedge (\$heap_{797,16} == \$heap_{loopstart_792,5} \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}(\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}<\text{real}>((\text{double})0.0) < \text{asType}<\text{real}>(\$result_797_25)) \wedge (\text{asType}<\text{real}>(\$result_797_25) < \text{asType}<\text{real}>((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

\rightarrow [simplify]

[29.8] $(1 == (count_{loopend} + -count_{loopstart_792,5})) \wedge (\$heap_{797,16} == \$heap_{loopstart_792,5} \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}(\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}<\text{real}>((\text{double})0.0) < \text{asType}<\text{real}>(\$result_797_25)) \wedge (\text{asType}<\text{real}>(\$result_797_25) < \text{asType}<\text{real}>((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

\rightarrow [from term 11.1, $\$heap_{loopstart_792,5}$ is equal to $\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap_ecv_files[1] \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12})$]

[29.9] $(1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_{797,16} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap_ecv_files[1] \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}(\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}<\text{real}>((\text{double})0.0) < \text{asType}<\text{real}>(\$result_797_25)) \wedge (\text{asType}<\text{real}>(\$result_797_25) < \text{asType}<\text{real}>((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

→ [simplify]

[29.10] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**((&\$heap._ecv_files[1]).\$r → writes_797_9)) ∧ (asType<real>((double)0.0) < asType<real>(\$result_797_25)) ∧ (asType<real>(\$result_797_25) < asType<real>((double)1.0)) ∧ invariant1(heapIs \$heap_{797,16})

→ [attribute value is known from postcondition]

[29.11] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9)) ∧ (asType<real>((double)0.0) < asType<real>(\$result_797_25)) ∧ (asType<real>(\$result_797_25) < asType<real>((double)1.0)) ∧ invariant1(heapIs \$heap_{797,16})

→ [simplify]

[29.20] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9)) ∧ (0.0 < \$result_797_25) ∧ (-1.0 < -\$result_797_25) ∧ invariant1(heapIs \$heap_{797,16})

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[29.21] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9)) ∧ (0.0 < \$result_797_25) ∧ (-1.0 < -\$result_797_25) ∧ ((((((0 < asType<integer>(\$heap_{797,16}.p1)) && (asType<integer>(\$heap_{797,16}.p1) < asType<integer>(\$heap_{797,16}.M1))) && (0 <


```

asType<integer>($heap797,16.p2))) && (asType<integer>($heap797,16.p2)
< asType<integer>($heap797,16.M2))) && (0 <
asType<integer>($heap797,16.p3))) && (asType<integer>($heap797,16.p3)
< asType<integer>($heap797,16.M3)))
→ [simplify]
[29.23] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap._ecv_files[1] → writes_790.5).replace(p1 →
writes_793.12).replace(p2 → writes_793.12).replace(p3 →
writes_793.12).replace(_ecv_files → writes_793.12).replace(p1 →
writes_797.25).replace(p2 → writes_797.25).replace(p3 → writes_797.25))
∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] →
writes_797.9)) ∧ (0.0 < $result_797.25) ∧ (-1.0 < -$result_797.25) ∧ (((((0 <
$heap797,16.p1) && ($heap797,16.p1 < asType<integer>($heap797,16.M1)))
&& (0 < asType<integer>($heap797,16.p2))) &&
(asType<integer>($heap797,16.p2) < asType<integer>($heap797,16.M2)))
&& (0 < asType<integer>($heap797,16.p3))) &&
(asType<integer>($heap797,16.p3) < asType<integer>($heap797,16.M3)))
→ [const static or extern object]
[29.24] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap._ecv_files[1] → writes_790.5).replace(p1 →
writes_793.12).replace(p2 → writes_793.12).replace(p3 →
writes_793.12).replace(_ecv_files → writes_793.12).replace(p1 →
writes_797.25).replace(p2 → writes_797.25).replace(p3 → writes_797.25))
∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] →
writes_797.9)) ∧ (0.0 < $result_797.25) ∧ (-1.0 < -$result_797.25) ∧ ((((((0 <
$heap797,16.p1) && ($heap797,16.p1 < asType<integer>($heapinit.M1))) &&
(0 < asType<integer>($heap797,16.p2))) &&
(asType<integer>($heap797,16.p2) < asType<integer>($heap797,16.M2)))
&& (0 < asType<integer>($heap797,16.p3))) &&
(asType<integer>($heap797,16.p3) < asType<integer>($heap797,16.M3)))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[29.25] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap._ecv_files[1] → writes_790.5).replace(p1 →
writes_793.12).replace(p2 → writes_793.12).replace(p3 →
writes_793.12).replace(_ecv_files → writes_793.12).replace(p1 →
writes_797.25).replace(p2 → writes_797.25).replace(p3 → writes_797.25))
∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] →
writes_797.9)) ∧ (0.0 < $result_797.25) ∧ (-1.0 < -$result_797.25) ∧ ((((((0 <
$heap797,16.p1) && ($heap797,16.p1 < asType<integer>(asType<short
int>((int)30269)))) && (0 < asType<integer>($heap797,16.p2))) &&

```

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(asType<integer>($heap797,16.p2) < asType<integer>($heap797,16.M2)))
&& (0 < asType<integer>($heap797,16.p3))) &&
(asType<integer>($heap797,16.p3) < asType<integer>($heap797,16.M3)))
→ [simplify]

[29.36] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap.ecv_files[1]) → writes790,5).replace(p1 →
writes793,12).replace(p2 → writes793,12).replace(p3 →
writes793,12).replace(ecv_files → writes793,12).replace(p1 →
writes797,25).replace(p2 → writes797,25).replace(p3 → writes797,25))
∧ ($heaploopend == $heap797,16.replace(&$heap.ecv_files[1] →
writes797,9)) ∧ (0.0 < $result797,25) ∧ (-1.0 < -$result797,25) ∧
(((((-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0 < $heap797,16.p2))
&& ($heap797,16.p2 < asType<integer>($heap797,16.M2))) && (0 <
asType<integer>($heap797,16.p3))) && (asType<integer>($heap797,16.p3)
< asType<integer>($heap797,16.M3)))
→ [const static or extern object]

[29.37] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap.ecv_files[1]) → writes790,5).replace(p1 →
writes793,12).replace(p2 → writes793,12).replace(p3 →
writes793,12).replace(ecv_files → writes793,12).replace(p1 →
writes797,25).replace(p2 → writes797,25).replace(p3 → writes797,25))
∧ ($heaploopend == $heap797,16.replace(&$heap.ecv_files[1] →
writes797,9)) ∧ (0.0 < $result797,25) ∧ (-1.0 < -$result797,25) ∧
(((((-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0 < $heap797,16.p2))
&& ($heap797,16.p2 < asType<integer>($heapinit.M2))) && (0 <
asType<integer>($heap797,16.p3))) && (asType<integer>($heap797,16.p3)
< asType<integer>($heap797,16.M3)))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[29.38] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap.ecv_files[1]) → writes790,5).replace(p1 →
writes793,12).replace(p2 → writes793,12).replace(p3 →
writes793,12).replace(ecv_files → writes793,12).replace(p1 →
writes797,25).replace(p2 → writes797,25).replace(p3 → writes797,25))
∧ ($heaploopend == $heap797,16.replace(&$heap.ecv_files[1] →
writes797,9)) ∧ (0.0 < $result797,25) ∧ (-1.0 < -$result797,25) ∧
(((((-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0 < $heap797,16.p2))
&& ($heap797,16.p2 < asType<integer>(asType<short
int>((int)30307)))) && (0 < asType<integer>($heap797,16.p3))) &&
(asType<integer>($heap797,16.p3) < asType<integer>($heap797,16.M3)))
→ [simplify]

```

[29.50] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9)) ∧ (0.0 < \$result_797_25) ∧ (-1.0 < -\$result_797_25) ∧ (((-30307 < -\$heap_{797,16}.p2) ∧ (-30269 < -\$heap_{797,16}.p1) ∧ (0 < \$heap_{797,16}.p1) ∧ (0 < \$heap_{797,16}.p2) ∧ (0 < \$heap_{797,16}.p3)) && (\$heap_{797,16}.p3 < asType<integer>(\$heap_{797,16}.M3)))

→ [const static or extern object]

[29.51] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9)) ∧ (0.0 < \$result_797_25) ∧ (-1.0 < -\$result_797_25) ∧ (((-30307 < -\$heap_{797,16}.p2) ∧ (-30269 < -\$heap_{797,16}.p1) ∧ (0 < \$heap_{797,16}.p1) ∧ (0 < \$heap_{797,16}.p2) ∧ (0 < \$heap_{797,16}.p3)) && (\$heap_{797,16}.p3 < asType<integer>(\$heap_{init}.M3)))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[29.52] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9)) ∧ (0.0 < \$result_797_25) ∧ (-1.0 < -\$result_797_25) ∧ (((-30307 < -\$heap_{797,16}.p2) ∧ (-30269 < -\$heap_{797,16}.p1) ∧ (0 < \$heap_{797,16}.p1) ∧ (0 < \$heap_{797,16}.p2) ∧ (0 < \$heap_{797,16}.p3)) && (\$heap_{797,16}.p3 < asType<integer>(asType<short int>((int)30323))))

→ [simplify]

[29.61] (1 == (-count_{loopstart_792,5} + count_{loopend})) ∧ (\$heap_{797,16} == \$heap_{funcstart_780,1}.**replace**(p1 → 1).**replace**(p2 → 2).**replace**(p3 → 3).**replace**((&\$heap._ecv_files[1]) → writes_790_5).**replace**(p1 → writes_793_12).**replace**(p2 → writes_793_12).**replace**(p3 → writes_793_12).**replace**(ecv_files → writes_793_12).**replace**(p1 → writes_797_25).**replace**(p2 → writes_797_25).**replace**(p3 → writes_797_25)) ∧ (\$heap_{loopend} == \$heap_{797,16}.**replace**(&\$heap._ecv_files[1] → writes_797_9))

$\wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge (-30323 < -\$heap_{797,16}.p3) \wedge (-30307 < -\$heap_{797,16}.p2) \wedge (-30269 < -\$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p2) \wedge (0 < \$heap_{797,16}.p3)$
 \rightarrow [separate conjunction and work on first sub-term]
[29.62] $1 == (-count_{loopstart_792,5} + count_{loopend})$
[Take goal term]
[1.0] $(asType<integer\ const>(limit) - asType<integer>(count_{loopend})) < (asType<integer\ const>(limit) - asType<integer>(count_{loopstart_792,5}))$
 \rightarrow [from term 8.7, limit is equal to 80]
[1.1] $(asType<integer\ const>(80) - asType<integer>(count_{loopend})) < (asType<integer\ const>(limit) - asType<integer>(count_{loopstart_792,5}))$
 \rightarrow [simplify]
[1.2] $(80 - asType<integer>(count_{loopend})) < (asType<integer\ const>(limit) - asType<integer>(count_{loopstart_792,5}))$
 \rightarrow [from term 29.62, $count_{loopend}$ is equal to $1 + count_{loopstart_792,5}$]
[1.3] $(80 - asType<integer>(1 + count_{loopstart_792,5})) < (asType<integer\ const>(limit) - asType<integer>(count_{loopstart_792,5}))$
 \rightarrow [simplify]
[1.9] $(79 + -count_{loopstart_792,5}) < (asType<integer\ const>(limit) - asType<integer>(count_{loopstart_792,5}))$
 \rightarrow [from term 8.7, limit is equal to 80]
[1.10] $(79 + -count_{loopstart_792,5}) < (asType<integer\ const>(80) - asType<integer>(count_{loopstart_792,5}))$
 \rightarrow [simplify]
[1.22] **true**

Proof of verification condition: Loop body establishes end condition or preserves validity of variant

Condition generated at: C:\Escher\Customers\prang\prang.c (115,5)

Condition defined at: C:\Escher\Customers\prang\prang.c (114,20)

To prove: $0 \leq (asType<integer\ const>(limit) - asType<integer>(count_{loopend}))$

Given:

$\$heap_{init}.LIMIT == (int)80$

$\$heap_{init}.M1 == asType<short\ int>((int)30269)$

$\$heap_{init}.r1 == asType<short\ int>((int)171)$

```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
$heap780,1;783,8 == $heapfuncstart_780,1.replace(p1 → asType<short
int>((int)1))
$heap780,1;784,8 == $heap780,1;783,8.replace(p2 → asType<short
int>((int)2))
$heap780,1;785,8 == $heap780,1;784,8.replace(p3 → asType<short
int>((int)3))
limit == $heap780,1;785,8.LIMIT
minof(int const) ≤ limit
limit ≤ maxof(int const)
count == (int)0
minof(int) ≤ count
count ≤ maxof(int)
$heap780,1;790,5 == $heap780,1;785,8.replace((&$heap780,1;785,8.ecv_files[1]).$r
→ writes_790_5)
$heaploopstart_792,5 == $heap780,1;790,5.replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(_ecv_files → writes_793_12)
#writes_793_12 == # $heap780,1;790,5.ecv_files
minof(int) ≤ countloopstart_792,5
countloopstart_792,5 ≤ maxof(int)
invariant1(heapIs $heaploopstart_792,5)

```

$\text{count}_{\text{loopstart_792,5}} < \text{limit}$
 $0 \leq (\text{asType}\langle \text{integer const} \rangle(\text{limit}) - \text{asType}\langle \text{integer} \rangle(\text{count}_{\text{loopstart_792,5}}))$
 $(\text{asType}\langle \text{integer const} \rangle(\text{limit}) - \text{asType}\langle \text{integer} \rangle(\text{count}_{\text{loopstart_792,5}}))$
 $\leq (\text{asType}\langle \text{integer const} \rangle(\text{limit}) - \text{asType}\langle \text{integer} \rangle(\text{count}))$
 $(++\text{count}_{\text{loopstart_792,5}} == \text{count}_{\text{loopend}}) \wedge (\$heap_{797,16} ==$
 $\$heap_{\text{loopstart_792,5}}.\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow$
 $\text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} ==$
 $\$heap_{797,16}.\text{replace}((\&\$heap_{797,16}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_797_9})) \wedge$
 $(\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge$
 $(\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge$
 $\text{invariant1}(\text{heapIs } \$heap_{797,16})$

$\text{count}_{\text{loopend}} < \text{limit}$

Proof:

[Take given term]

[5.0] $\$heap_{780,1;783,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})1))$

\rightarrow [simplify]

[5.2] $\$heap_{780,1;783,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1)$

[Take given term]

[6.0] $\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})2))$

\rightarrow [from term 5.2, $\$heap_{780,1;783,8}$ is equal to $\$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1)$]

[6.1] $\$heap_{780,1;784,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})2))$

\rightarrow [simplify]

[6.3] $\$heap_{780,1;784,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$

[Take given term]

[7.0] $\$heap_{780,1;785,8} == \$heap_{780,1;784,8}.\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})3))$

\rightarrow [from term 6.3, $\$heap_{780,1;784,8}$ is equal to $\$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$]

[7.1] $\$heap_{780,1;785,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})3))$

\rightarrow [simplify]

[7.3] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3)$

[Take given term]

[8.0] $\$heap_{780,1;785,8}.LIMIT == \text{limit}$

\rightarrow [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3)$]

[8.1] $\$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3).LIMIT == \text{limit}$

\rightarrow [const member of object with modified fields]

[8.4] $\$heap_{funcstart_780,1}.LIMIT == \text{limit}$

\rightarrow [const static or extern object]

[8.5] $\$heap_{init}.LIMIT == \text{limit}$

\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]

[8.6] $(\mathbf{int})80 == \text{limit}$

\rightarrow [simplify]

[8.7] $80 == \text{limit}$

[Take given term]

[10.0] $\$heap_{780,1;790,5} ==$
 $\$heap_{780,1;785,8}.\mathbf{replace}((\&\$heap_{780,1;785,8}.\mathbf{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$

\rightarrow [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3)$]

[10.1] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3).\mathbf{replace}((\&\$heap_{780,1;785,8}.\mathbf{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$

\rightarrow [simplify]

[10.2] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3).\mathbf{replace}((\&\$heap.\mathbf{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$

\rightarrow [attribute value is known from postcondition]

[10.3] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3).\mathbf{replace}(\&\$heap.\mathbf{ecv_files}[1] \rightarrow \text{writes_790_5})$

[Take given term]

[11.0] $\$heap_{loopstart_792,5} == \$heap_{780,1;790,5}.\mathbf{replace}(p1 \rightarrow \text{writes_793_12}).\mathbf{replace}(p2 \rightarrow \text{writes_793_12}).\mathbf{replace}(p3 \rightarrow \text{writes_793_12}).\mathbf{replace}(\mathbf{ecv_files} \rightarrow \text{writes_793_12})$

\rightarrow [from term 10.3, $\$heap_{780,1;790,5}$ is equal to $\$heap_{funcstart_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2).\mathbf{replace}(p3 \rightarrow 3).\mathbf{replace}(\&\$heap.\mathbf{ecv_files}[1] \rightarrow$

writes_790_5)]

[11.1] $\$heap_{loopstart_792,5} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap_ecv_files[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12})$

[Take given term]

[29.0] $(++count_{loopstart_792,5} == count_{loopend}) \wedge (\$heap_{797,16} == \$heap_{loopstart_792,5} \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}((\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

\rightarrow [simplify]

[29.8] $(1 == (count_{loopend} + -count_{loopstart_792,5})) \wedge (\$heap_{797,16} == \$heap_{loopstart_792,5} \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}((\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

\rightarrow [from term 11.1, $\$heap_{loopstart_792,5}$ is equal to

$\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap_ecv_files[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12})]$

[29.9] $(1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_{797,16} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap_ecv_files[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}((\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

\rightarrow [simplify]

[29.10] $(1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_{797,16} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap_ecv_files[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(_ecv_files \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{loopend} == \$heap_{797,16} \cdot \text{replace}((\&\$heap_{797,16} \cdot _ecv_files[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

`writes_793_12).`**replace**`(_ecv_files \rightarrow writes_793_12).replace(p1 \rightarrow
writes_797_25).replace(p2 \rightarrow writes_797_25).replace(p3 \rightarrow writes_797_25))
 \wedge ($heaploopend $==$ $heap797,16.replace((&$heap._ecv_files[1]).$r \rightarrow
writes_797_9)) \wedge (asType<real>((double)0.0) <
asType<real>($result_797_25)) \wedge (asType<real>($result_797_25) <
asType<real>((double)1.0)) \wedge invariant1(heapIs $heap797,16)
 \rightarrow [attribute value is known from postcondition]`

[29.11] (`1 == (-countloopstart_792,5 + countloopend)`) \wedge (`$heap797,16` $==$
`$heapfuncstart_780,1`.`replace`(`p1` \rightarrow 1).`replace`(`p2` \rightarrow 2).`replace`(`p3` \rightarrow
3).`replace`(`(&$heap._ecv_files[1])` \rightarrow `writes_790_5`).`replace`(`p1` \rightarrow
`writes_793_12`).`replace`(`p2` \rightarrow `writes_793_12`).`replace`(`p3` \rightarrow
`writes_793_12`).`replace`(`_ecv_files` \rightarrow `writes_793_12`).`replace`(`p1` \rightarrow
`writes_797_25`).`replace`(`p2` \rightarrow `writes_797_25`).`replace`(`p3` \rightarrow `writes_797_25`))
 \wedge (`$heaploopend` $==$ `$heap797,16`.`replace`(`&$heap._ecv_files[1]` \rightarrow
`writes_797_9`)) \wedge (**asType**<**real**>((**double**)0.0) <
asType<**real**>(`$result_797_25`)) \wedge (**asType**<**real**>(`$result_797_25`) <
asType<**real**>((**double**)1.0)) \wedge `invariant1(heapIs $heap797,16)`
 \rightarrow [simplify]

[29.20] (`1 == (-countloopstart_792,5 + countloopend)`) \wedge (`$heap797,16` $==$
`$heapfuncstart_780,1`.`replace`(`p1` \rightarrow 1).`replace`(`p2` \rightarrow 2).`replace`(`p3` \rightarrow
3).`replace`(`(&$heap._ecv_files[1])` \rightarrow `writes_790_5`).`replace`(`p1` \rightarrow
`writes_793_12`).`replace`(`p2` \rightarrow `writes_793_12`).`replace`(`p3` \rightarrow
`writes_793_12`).`replace`(`_ecv_files` \rightarrow `writes_793_12`).`replace`(`p1` \rightarrow
`writes_797_25`).`replace`(`p2` \rightarrow `writes_797_25`).`replace`(`p3` \rightarrow `writes_797_25`))
 \wedge (`$heaploopend` $==$ `$heap797,16`.`replace`(`&$heap._ecv_files[1]` \rightarrow
`writes_797_9`)) \wedge (`0.0 < $result_797_25`) \wedge (`-1.0 < -$result_797_25`) \wedge
`invariant1(heapIs $heap797,16)`

\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]

[29.21] (`1 == (-countloopstart_792,5 + countloopend)`) \wedge (`$heap797,16` $==$
`$heapfuncstart_780,1`.`replace`(`p1` \rightarrow 1).`replace`(`p2` \rightarrow 2).`replace`(`p3` \rightarrow
3).`replace`(`(&$heap._ecv_files[1])` \rightarrow `writes_790_5`).`replace`(`p1` \rightarrow
`writes_793_12`).`replace`(`p2` \rightarrow `writes_793_12`).`replace`(`p3` \rightarrow
`writes_793_12`).`replace`(`_ecv_files` \rightarrow `writes_793_12`).`replace`(`p1` \rightarrow
`writes_797_25`).`replace`(`p2` \rightarrow `writes_797_25`).`replace`(`p3` \rightarrow `writes_797_25`))
 \wedge (`$heaploopend` $==$ `$heap797,16`.`replace`(`&$heap._ecv_files[1]` \rightarrow
`writes_797_9`)) \wedge (`0.0 < $result_797_25`) \wedge (`-1.0 < -$result_797_25`) \wedge ((((((`0 <`
asType<**integer**>(`$heap797,16.p1`)) && (**asType**<**integer**>(`$heap797,16.p1`)
< **asType**<**integer**>(`$heap797,16.M1`))) && (`0 <`
asType<**integer**>(`$heap797,16.p2`))) && (**asType**<**integer**>(`$heap797,16.p2`)
< **asType**<**integer**>(`$heap797,16.M2`))) && (`0 <`
asType<**integer**>(`$heap797,16.p3`))) && (**asType**<**integer**>(`$heap797,16.p3`)
< **asType**<**integer**>(`$heap797,16.M3`)))
 \rightarrow [simplify]

[29.23] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge ((((((0 < \$heap_{797,16} \cdot p1) \&\& (\$heap_{797,16} \cdot p1 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M1))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M2))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M3)))$

$\rightarrow [\text{const static or extern object}]$

[29.24] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge ((((((0 < \$heap_{797,16} \cdot p1) \&\& (\$heap_{797,16} \cdot p1 < \text{asType}\langle \text{integer} \rangle(\$heap_{\text{init}}, M1))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M2))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M3)))$

$\rightarrow [\text{expand definition of constant 'M1' at prang.c (14,20)}]$

[29.25] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge ((((((0 < \$heap_{797,16} \cdot p1) \&\& (\$heap_{797,16} \cdot p1 < \text{asType}\langle \text{integer} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30269)))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M2))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M3)))$

$\rightarrow [\text{simplify}]$

[29.36] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} ==$

$\$heap_{funcstart_780,1}.$ **replace**($p1 \rightarrow 1$).**replace**($p2 \rightarrow 2$).**replace**($p3 \rightarrow 3$).**replace**(($\&\$heap_ecv_files[1] \rightarrow writes_790_5$).**replace**($p1 \rightarrow writes_793_12$).**replace**($p2 \rightarrow writes_793_12$).**replace**($p3 \rightarrow writes_793_12$).**replace**($ecv_files \rightarrow writes_793_12$).**replace**($p1 \rightarrow writes_797_25$).**replace**($p2 \rightarrow writes_797_25$).**replace**($p3 \rightarrow writes_797_25$))
 $\wedge (\$heap_{loopend} == \$heap_{797,16}.$ **replace**($\&\$heap_ecv_files[1] \rightarrow writes_797_9$)) $\wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge$
 $((((-30269 < -\$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p2))$
 $\&\& (\$heap_{797,16}.p2 < \mathbf{asType<integer>}(\$heap_{797,16}.M2))) \&\& (0 <$
 $\mathbf{asType<integer>}(\$heap_{797,16}.p3))) \&\& (\mathbf{asType<integer>}(\$heap_{797,16}.p3)$
 $< \mathbf{asType<integer>}(\$heap_{797,16}.M3)))$
 $\rightarrow [const\ static\ or\ extern\ object]$
 $[29.37] (1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_{797,16} ==$
 $\$heap_{funcstart_780,1}.$ **replace**($p1 \rightarrow 1$).**replace**($p2 \rightarrow 2$).**replace**($p3 \rightarrow 3$).**replace**(($\&\$heap_ecv_files[1] \rightarrow writes_790_5$).**replace**($p1 \rightarrow writes_793_12$).**replace**($p2 \rightarrow writes_793_12$).**replace**($p3 \rightarrow writes_793_12$).**replace**($ecv_files \rightarrow writes_793_12$).**replace**($p1 \rightarrow writes_797_25$).**replace**($p2 \rightarrow writes_797_25$).**replace**($p3 \rightarrow writes_797_25$))
 $\wedge (\$heap_{loopend} == \$heap_{797,16}.$ **replace**($\&\$heap_ecv_files[1] \rightarrow writes_797_9$)) $\wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge$
 $((((-30269 < -\$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p2))$
 $\&\& (\$heap_{797,16}.p2 < \mathbf{asType<integer>}(\$heap_{init}.M2))) \&\& (0 <$
 $\mathbf{asType<integer>}(\$heap_{797,16}.p3))) \&\& (\mathbf{asType<integer>}(\$heap_{797,16}.p3)$
 $< \mathbf{asType<integer>}(\$heap_{797,16}.M3)))$
 $\rightarrow [expand\ definition\ of\ constant\ 'M2'\ at\ prang.c\ (19,20)]$
 $[29.38] (1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_{797,16} ==$
 $\$heap_{funcstart_780,1}.$ **replace**($p1 \rightarrow 1$).**replace**($p2 \rightarrow 2$).**replace**($p3 \rightarrow 3$).**replace**(($\&\$heap_ecv_files[1] \rightarrow writes_790_5$).**replace**($p1 \rightarrow writes_793_12$).**replace**($p2 \rightarrow writes_793_12$).**replace**($p3 \rightarrow writes_793_12$).**replace**($ecv_files \rightarrow writes_793_12$).**replace**($p1 \rightarrow writes_797_25$).**replace**($p2 \rightarrow writes_797_25$).**replace**($p3 \rightarrow writes_797_25$))
 $\wedge (\$heap_{loopend} == \$heap_{797,16}.$ **replace**($\&\$heap_ecv_files[1] \rightarrow writes_797_9$)) $\wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge$
 $((((-30269 < -\$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p1) \wedge (0 < \$heap_{797,16}.p2))$
 $\&\& (\$heap_{797,16}.p2 < \mathbf{asType<integer>}(\mathbf{asType<short\ int>}((\mathbf{int})30307)))) \&\& (0 < \mathbf{asType<integer>}(\$heap_{797,16}.p3))) \&\&$
 $(\mathbf{asType<integer>}(\$heap_{797,16}.p3) < \mathbf{asType<integer>}(\$heap_{797,16}.M3)))$
 $\rightarrow [simplify]$
 $[29.50] (1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_{797,16} ==$
 $\$heap_{funcstart_780,1}.$ **replace**($p1 \rightarrow 1$).**replace**($p2 \rightarrow 2$).**replace**($p3 \rightarrow 3$).**replace**(($\&\$heap_ecv_files[1] \rightarrow writes_790_5$).**replace**($p1 \rightarrow writes_793_12$).**replace**($p2 \rightarrow writes_793_12$).**replace**($p3 \rightarrow writes_793_12$).**replace**($ecv_files \rightarrow writes_793_12$).**replace**($p1 \rightarrow$

`writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))`
`∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] →`
`writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ (((-30307`
`< -$heap797,16.p2) ∧ (-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0`
`< $heap797,16.p2) ∧ (0 < $heap797,16.p3)) && ($heap797,16.p3 <`
`asType<integer>($heap797,16.M3)))`
`→ [const static or extern object]`
`[29.51] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==`
`$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →`
`3).replace((&$heap._ecv_files[1] → writes_790_5).replace(p1 →`
`writes_793_12).replace(p2 → writes_793_12).replace(p3 →`
`writes_793_12).replace(_ecv_files → writes_793_12).replace(p1 →`
`writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))`
`∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] →`
`writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ (((-30307`
`< -$heap797,16.p2) ∧ (-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0`
`< $heap797,16.p2) ∧ (0 < $heap797,16.p3)) && ($heap797,16.p3 <`
`asType<integer>($heapinit.M3)))`
`→ [expand definition of constant 'M3' at prang.c (24,20)]`
`[29.52] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==`
`$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →`
`3).replace((&$heap._ecv_files[1] → writes_790_5).replace(p1 →`
`writes_793_12).replace(p2 → writes_793_12).replace(p3 →`
`writes_793_12).replace(_ecv_files → writes_793_12).replace(p1 →`
`writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))`
`∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] →`
`writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ (((-30307`
`< -$heap797,16.p2) ∧ (-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0`
`< $heap797,16.p2) ∧ (0 < $heap797,16.p3)) && ($heap797,16.p3 <`
`asType<integer>(asType<short int>((int)30323))))`
`→ [simplify]`
`[29.61] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==`
`$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →`
`3).replace((&$heap._ecv_files[1] → writes_790_5).replace(p1 →`
`writes_793_12).replace(p2 → writes_793_12).replace(p3 →`
`writes_793_12).replace(_ecv_files → writes_793_12).replace(p1 →`
`writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))`
`∧ ($heaploopend == $heap797,16.replace(&$heap._ecv_files[1] → writes_797_9))`
`∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ (-30323 <`
`-$heap797,16.p3) ∧ (-30307 < -$heap797,16.p2) ∧ (-30269 < -$heap797,16.p1)`
`∧ (0 < $heap797,16.p1) ∧ (0 < $heap797,16.p2) ∧ (0 < $heap797,16.p3)`
`→ [separate conjunction and work on first sub-term]`

[29.62] $1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})$
 [Take given term]
 [48.0] $\text{count}_{\text{loopend}} < \text{limit}$
 \rightarrow [from term 29.62, $\text{count}_{\text{loopend}}$ is equal to $1 + \text{count}_{\text{loopstart_792,5}}$]
 [48.1] $(1 + \text{count}_{\text{loopstart_792,5}}) < \text{limit}$
 \rightarrow [from term 8.7, limit is equal to 80]
 [48.2] $(1 + \text{count}_{\text{loopstart_792,5}}) < 80$
 \rightarrow [simplify]
 [48.9] $-79 < -\text{count}_{\text{loopstart_792,5}}$
 [Take goal term]
 [1.0] $0 \leq (\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}_{\text{loopend}}))$
 \rightarrow [from term 8.7, limit is equal to 80]
 [1.1] $0 \leq (\text{asType}\langle\text{integer const}\rangle(80) - \text{asType}\langle\text{integer}\rangle(\text{count}_{\text{loopend}}))$
 \rightarrow [simplify]
 [1.2] $0 \leq (80 - \text{asType}\langle\text{integer}\rangle(\text{count}_{\text{loopend}}))$
 \rightarrow [from term 29.62, $\text{count}_{\text{loopend}}$ is equal to $1 + \text{count}_{\text{loopstart_792,5}}$]
 [1.3] $0 \leq (80 - \text{asType}\langle\text{integer}\rangle(1 + \text{count}_{\text{loopstart_792,5}}))$
 \rightarrow [simplify]
 [1.13] $-80 < -\text{count}_{\text{loopstart_792,5}}$
 \rightarrow [from term 48.9, $\text{literal} < -\text{count}_{\text{loopstart_792,5}}$ is true whenever $(-1 + \text{literal}) < -79$]

Proof of rule precondition:

[1.13.0] $(-80 + -1) < -79$
 \rightarrow [simplify]
 [1.13.2] **true**
 [1.14] **true**

Proof of verification condition: Loop body preserves loop invariant

Condition generated at: C:\Escher\Customers\prang\prang.c (115,5)

Condition defined at: C:\Escher\Customers\prang\prang.c (113,10)

To prove: $\text{invariant1}(\text{heapIs } \$\text{heap}_{\text{loopend}})$

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
$heap780,1;783,8 == $heapfuncstart_780,1.replace(p1 → asType<short
int>((int)1))
$heap780,1;784,8 == $heap780,1;783,8.replace(p2 → asType<short
int>((int)2))
$heap780,1;785,8 == $heap780,1;784,8.replace(p3 → asType<short
int>((int)3))
limit == $heap780,1;785,8.LIMIT
minof(int const) ≤ limit
limit ≤ maxof(int const)
count == (int)0
minof(int) ≤ count
count ≤ maxof(int)
$heap780,1;790,5 == $heap780,1;785,8.replace((&$heap780,1;785,8.ecv_files[1]).$r
→ writes_790_5)
$heaploopstart_792,5 == $heap780,1;790,5.replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(_ecv_files → writes_793_12)
#writes_793_12 == #heap780,1;790,5.ecv_files

```

$\text{minof}(\text{int}) \leq \text{count}_{\text{loopstart_792,5}}$
 $\text{count}_{\text{loopstart_792,5}} \leq \text{maxof}(\text{int})$
 $\text{invariant1}(\text{heapIs } \$\text{heap}_{\text{loopstart_792,5}})$
 $\text{count}_{\text{loopstart_792,5}} < \text{limit}$
 $0 \leq (\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}_{\text{loopstart_792,5}}))$
 $(\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}_{\text{loopstart_792,5}}))$
 $\leq (\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}))$
 $(++\text{count}_{\text{loopstart_792,5}} == \text{count}_{\text{loopend}}) \wedge (\$heap_{797,16} ==$
 $\$heap_{\text{loopstart_792,5}}.\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow$
 $\text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} ==$
 $\$heap_{797,16}.\text{replace}((\&\$heap_{797,16}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_797_9})) \wedge$
 $(\text{asType}\langle\text{real}\rangle((\text{double})0.0) < \text{asType}\langle\text{real}\rangle(\$result_797_25)) \wedge$
 $(\text{asType}\langle\text{real}\rangle(\$result_797_25) < \text{asType}\langle\text{real}\rangle((\text{double})1.0)) \wedge$
 $\text{invariant1}(\text{heapIs } \$heap_{797,16})$

Proof:

[Take given term]

[5.0] $\$heap_{780,1;783,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{int})1))$

→ [simplify]

[5.2] $\$heap_{780,1;783,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1)$

[Take given term]

[6.0] $\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{int})2))$

→ [from term 5.2, $\$heap_{780,1;783,8}$ is equal to $\$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1)$]

[6.1] $\$heap_{780,1;784,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{int})2))$

→ [simplify]

[6.3] $\$heap_{780,1;784,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$

[Take given term]

[7.0] $\$heap_{780,1;785,8} == \$heap_{780,1;784,8}.\text{replace}(p3 \rightarrow \text{asType}\langle\text{short int}\rangle((\text{int})3))$

→ [from term 6.3, $\$heap_{780,1;784,8}$ is equal to $\$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$]

[7.1] $\$heap_{780,1;785,8} == \$heap_{\text{funcstart_780,1}}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow$

$2).\text{.replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})3))$
 $\rightarrow [\text{simplify}]$
 $[7.3] \text{\$heap}_{780,1;785,8} == \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3)$
 $[\text{Take given term}]$
 $[10.0] \text{\$heap}_{780,1;790,5} ==$
 $\text{\$heap}_{780,1;785,8}.\text{.replace}((\&\text{\$heap}_{780,1;785,8}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 $\rightarrow [\text{from term 7.3, } \text{\$heap}_{780,1;785,8} \text{ is equal to } \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3)]$
 $[10.1] \text{\$heap}_{780,1;790,5} == \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3).\text{.replace}((\&\text{\$heap}_{780,1;785,8}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 $\rightarrow [\text{simplify}]$
 $[10.2] \text{\$heap}_{780,1;790,5} == \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3).\text{.replace}((\&\text{\$heap}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 $\rightarrow [\text{attribute value is known from postcondition}]$
 $[10.3] \text{\$heap}_{780,1;790,5} == \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3).\text{.replace}(\&\text{\$heap}.\text{ecv_files}[1] \rightarrow \text{writes_790_5})$
 $[\text{Take given term}]$
 $[11.0] \text{\$heap}_{loopstart_792,5} == \text{\$heap}_{780,1;790,5}.\text{.replace}(p1 \rightarrow \text{writes_793_12}).\text{.replace}(p2 \rightarrow \text{writes_793_12}).\text{.replace}(p3 \rightarrow \text{writes_793_12}).\text{.replace}(\text{ecv_files} \rightarrow \text{writes_793_12})$
 $\rightarrow [\text{from term 10.3, } \text{\$heap}_{780,1;790,5} \text{ is equal to } \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3).\text{.replace}(\&\text{\$heap}.\text{ecv_files}[1] \rightarrow \text{writes_790_5})]$
 $[11.1] \text{\$heap}_{loopstart_792,5} == \text{\$heap}_{funcstart_780,1}.\text{.replace}(p1 \rightarrow 1).\text{.replace}(p2 \rightarrow 2).\text{.replace}(p3 \rightarrow 3).\text{.replace}((\&\text{\$heap}.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{.replace}(p1 \rightarrow \text{writes_793_12}).\text{.replace}(p2 \rightarrow \text{writes_793_12}).\text{.replace}(p3 \rightarrow \text{writes_793_12}).\text{.replace}(\text{ecv_files} \rightarrow \text{writes_793_12})$
 $[\text{Take given term}]$
 $[29.0] (++\text{count}_{loopstart_792,5} == \text{count}_{loopend}) \wedge (\text{\$heap}_{797,16} == \text{\$heap}_{loopstart_792,5}.\text{.replace}(p1 \rightarrow \text{writes_797_25}).\text{.replace}(p2 \rightarrow \text{writes_797_25}).\text{.replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\text{\$heap}_{loopend} == \text{\$heap}_{797,16}.\text{.replace}((\&\text{\$heap}_{797,16}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_797_9})) \wedge$
 $(\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\text{\$result_797_25})) \wedge$
 $(\text{asType}\langle \text{real} \rangle(\text{\$result_797_25}) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge$
 $\text{invariant1}(\text{heapIs } \text{\$heap}_{797,16})$

→ [simplify]

[29.8] $(1 == (\text{count}_{\text{loopend}} + -\text{count}_{\text{loopstart_792,5}})) \wedge (\$heap_{797,16} == \$heap_{\text{loopstart_792,5}} \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}((\&\$heap_{797,16} \cdot \text{ecv_files}[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

→ [from term 11.1, $\$heap_{\text{loopstart_792,5}}$ is equal to $\$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12})]$

[29.9] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}((\&\$heap_{797,16} \cdot \text{ecv_files}[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

→ [simplify]

[29.10] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \cdot \$r \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) < \text{asType}\langle \text{real} \rangle(\$result_797_25)) \wedge (\text{asType}\langle \text{real} \rangle(\$result_797_25) < \text{asType}\langle \text{real} \rangle((\text{double})1.0)) \wedge \text{invariant1}(\text{heapIs } \$heap_{797,16})$

→ [attribute value is known from postcondition]

[29.11] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (\text{asType}\langle \text{real} \rangle((\text{double})0.0) <$

```

asType<real>($result_797_25)) ∧ (asType<real>($result_797_25) <
asType<real>((double)1.0)) ∧ invariant1(heapIs $heap797_16)
→ [simplify]
[29.20] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797_16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap.ecv_files[1] → writes_790_5).replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(ecv_files → writes_793_12).replace(p1 →
writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797_16.replace(&$heap.ecv_files[1] →
writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧
invariant1(heapIs $heap797_16)
→ [expand definition of function 'invariant1' at prang.c (34,1)]
[29.21] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797_16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap.ecv_files[1] → writes_790_5).replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(ecv_files → writes_793_12).replace(p1 →
writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797_16.replace(&$heap.ecv_files[1] →
writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ ((((((0 <
asType<integer>($heap797_16.p1)) && (asType<integer>($heap797_16.p1)
< asType<integer>($heap797_16.M1))) && (0 <
asType<integer>($heap797_16.p2))) && (asType<integer>($heap797_16.p2)
< asType<integer>($heap797_16.M2))) && (0 <
asType<integer>($heap797_16.p3))) && (asType<integer>($heap797_16.p3)
< asType<integer>($heap797_16.M3)))
→ [simplify]
[29.23] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797_16 ==
$heapfuncstart_780,1.replace(p1 → 1).replace(p2 → 2).replace(p3 →
3).replace((&$heap.ecv_files[1] → writes_790_5).replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(ecv_files → writes_793_12).replace(p1 →
writes_797_25).replace(p2 → writes_797_25).replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797_16.replace(&$heap.ecv_files[1] →
writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ ((((((0 <
$heap797_16.p1) && ($heap797_16.p1 < asType<integer>($heap797_16.M1)))
&& (0 < asType<integer>($heap797_16.p2))) &&
(asType<integer>($heap797_16.p2) < asType<integer>($heap797_16.M2)))
&& (0 < asType<integer>($heap797_16.p3))) &&
(asType<integer>($heap797_16.p3) < asType<integer>($heap797_16.M3)))
→ [const static or extern object]

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[29.24] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge ((((((0 < \$heap_{797,16} \cdot p1) \&\& (\$heap_{797,16} \cdot p1 < \text{asType}\langle \text{integer} \rangle(\$heap_{\text{init}}.M1))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M2))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M3)))$

\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]

[29.25] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge ((((((0 < \$heap_{797,16} \cdot p1) \&\& (\$heap_{797,16} \cdot p1 < \text{asType}\langle \text{integer} \rangle(\text{asType}\langle \text{short int} \rangle((\text{int})30269)))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p2) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M2))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M3)))$

\rightarrow [simplify]

[29.36] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}) \cdot \text{replace}(p1 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p2 \rightarrow \text{writes_793_12}) \cdot \text{replace}(p3 \rightarrow \text{writes_793_12}) \cdot \text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}) \cdot \text{replace}(p1 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p2 \rightarrow \text{writes_797_25}) \cdot \text{replace}(p3 \rightarrow \text{writes_797_25})) \wedge (\$heap_{\text{loopend}} == \$heap_{797,16} \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_797_9})) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge (((((-30269 < -\$heap_{797,16} \cdot p1) \wedge (0 < \$heap_{797,16} \cdot p1) \wedge (0 < \$heap_{797,16} \cdot p2)) \&\& (\$heap_{797,16} \cdot p2 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M2))) \&\& (0 < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3))) \&\& (\text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot p3) < \text{asType}\langle \text{integer} \rangle(\$heap_{797,16} \cdot M3)))$

\rightarrow [const static or extern object]

[29.37] $(1 == (-\text{count}_{\text{loopstart_792,5}} + \text{count}_{\text{loopend}})) \wedge (\$heap_{797,16} == \$heap_{\text{funcstart_780,1}} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow$

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3)._replace((&$heap._ecv_files[1] → writes_790_5)._replace(p1 →
writes_793_12)._replace(p2 → writes_793_12)._replace(p3 →
writes_793_12)._replace(._ecv_files → writes_793_12)._replace(p1 →
writes_797_25)._replace(p2 → writes_797_25)._replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797,16._replace(&$heap._ecv_files[1] →
writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧
(((((-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0 < $heap797,16.p2))
&& ($heap797,16.p2 < asType<integer>($heapinit.M2))) && (0 <
asType<integer>($heap797,16.p3))) && (asType<integer>($heap797,16.p3)
< asType<integer>($heap797,16.M3)))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[29.38] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 →
3)._replace((&$heap._ecv_files[1] → writes_790_5)._replace(p1 →
writes_793_12)._replace(p2 → writes_793_12)._replace(p3 →
writes_793_12)._replace(._ecv_files → writes_793_12)._replace(p1 →
writes_797_25)._replace(p2 → writes_797_25)._replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797,16._replace(&$heap._ecv_files[1] →
writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧
(((((-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0 < $heap797,16.p2))
&& ($heap797,16.p2 < asType<integer>(asType<short
int>((int)30307)))) && (0 < asType<integer>($heap797,16.p3))) &&
(asType<integer>($heap797,16.p3) < asType<integer>($heap797,16.M3)))
→ [simplify]

[29.50] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 →
3)._replace((&$heap._ecv_files[1] → writes_790_5)._replace(p1 →
writes_793_12)._replace(p2 → writes_793_12)._replace(p3 →
writes_793_12)._replace(._ecv_files → writes_793_12)._replace(p1 →
writes_797_25)._replace(p2 → writes_797_25)._replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797,16._replace(&$heap._ecv_files[1] →
writes_797_9)) ∧ (0.0 < $result_797_25) ∧ (-1.0 < -$result_797_25) ∧ (((-30307
< -$heap797,16.p2) ∧ (-30269 < -$heap797,16.p1) ∧ (0 < $heap797,16.p1) ∧ (0
< $heap797,16.p2) ∧ (0 < $heap797,16.p3)) && ($heap797,16.p3 <
asType<integer>($heap797,16.M3)))
→ [const static or extern object]

[29.51] (1 == (-countloopstart_792,5 + countloopend)) ∧ ($heap797,16 ==
$heapfuncstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 →
3)._replace((&$heap._ecv_files[1] → writes_790_5)._replace(p1 →
writes_793_12)._replace(p2 → writes_793_12)._replace(p3 →
writes_793_12)._replace(._ecv_files → writes_793_12)._replace(p1 →
writes_797_25)._replace(p2 → writes_797_25)._replace(p3 → writes_797_25))
∧ ($heaploopend == $heap797,16._replace(&$heap._ecv_files[1] →

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writes_797_9)) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge (((-30307 < -\$heap_797_16.p2) \wedge (-30269 < -\$heap_797_16.p1) \wedge (0 < \$heap_797_16.p1) \wedge (0 < \$heap_797_16.p2) \wedge (0 < \$heap_797_16.p3)) && (\$heap_797_16.p3 < asType<integer>(\$heap_init.M3)))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[29.52] (1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_797_16 == \$heap_funcstart_780,1.**.replace**(p1 → 1).**.replace**(p2 → 2).**.replace**(p3 → 3).**.replace**((&\$heap._ecv_files[1]) → writes_790_5).**.replace**(p1 → writes_793_12).**.replace**(p2 → writes_793_12).**.replace**(p3 → writes_793_12).**.replace**(_{ecv_files} → writes_793_12).**.replace**(p1 → writes_797_25).**.replace**(p2 → writes_797_25).**.replace**(p3 → writes_797_25)) \wedge (\$heap_{loopend} == \$heap_797_16.**.replace**(&\$heap._ecv_files[1] → writes_797_9)) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge (((-30307 < -\$heap_797_16.p2) \wedge (-30269 < -\$heap_797_16.p1) \wedge (0 < \$heap_797_16.p1) \wedge (0 < \$heap_797_16.p2) \wedge (0 < \$heap_797_16.p3)) && (\$heap_797_16.p3 < asType<integer>(asType<short int>((int)30323))))

→ [simplify]

[29.61] (1 == (-count_{loopstart_792,5} + count_{loopend})) \wedge (\$heap_797_16 == \$heap_funcstart_780,1.**.replace**(p1 → 1).**.replace**(p2 → 2).**.replace**(p3 → 3).**.replace**((&\$heap._ecv_files[1]) → writes_790_5).**.replace**(p1 → writes_793_12).**.replace**(p2 → writes_793_12).**.replace**(p3 → writes_793_12).**.replace**(_{ecv_files} → writes_793_12).**.replace**(p1 → writes_797_25).**.replace**(p2 → writes_797_25).**.replace**(p3 → writes_797_25)) \wedge (\$heap_{loopend} == \$heap_797_16.**.replace**(&\$heap._ecv_files[1] → writes_797_9)) \wedge (0.0 < \$result_797_25) \wedge (-1.0 < -\$result_797_25) \wedge (-30323 < -\$heap_797_16.p3) \wedge (-30307 < -\$heap_797_16.p2) \wedge (-30269 < -\$heap_797_16.p1) \wedge (0 < \$heap_797_16.p1) \wedge (0 < \$heap_797_16.p2) \wedge (0 < \$heap_797_16.p3)

[Work on sub-term 2 of conjunction in term 29.61]

[30.0] \$heap_797_16 == \$heap_funcstart_780,1.**.replace**(p1 → 1).**.replace**(p2 → 2).**.replace**(p3 → 3).**.replace**((&\$heap._ecv_files[1]) → writes_790_5).**.replace**(p1 → writes_793_12).**.replace**(p2 → writes_793_12).**.replace**(p3 → writes_793_12).**.replace**(_{ecv_files} → writes_793_12).**.replace**(p1 → writes_797_25).**.replace**(p2 → writes_797_25).**.replace**(p3 → writes_797_25)

[Work on sub-term 3 of conjunction in term 29.61]

[31.0] \$heap_{loopend} == \$heap_797_16.**.replace**(&\$heap._ecv_files[1] → writes_797_9)

→ [from term 30.0, \$heap_797_16 is equal to \$heap_funcstart_780,1.**.replace**(p1 → 1).**.replace**(p2 → 2).**.replace**(p3 → 3).**.replace**((&\$heap._ecv_files[1]) → writes_790_5).**.replace**(p1 → writes_793_12).**.replace**(p2 → writes_793_12).**.replace**(p3 → writes_793_12).**.replace**(_{ecv_files} → writes_793_12).**.replace**(p1 → writes_797_25).**.replace**(p2 → writes_797_25).**.replace**(p3 → writes_797_25)

$\text{writes_797_25})._replace(p3 \rightarrow \text{writes_797_25})]$

$[31.1] \text{ \$heap_loopend} == \text{ \$heap_funcstart_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\text{ \$heap}._ecv_files[1]) \rightarrow \text{writes_790_5})._replace(p1 \rightarrow \text{writes_793_12})._replace(p2 \rightarrow \text{writes_793_12})._replace(p3 \rightarrow \text{writes_793_12})._replace(_ecv_files \rightarrow \text{writes_793_12})._replace(p1 \rightarrow \text{writes_797_25})._replace(p2 \rightarrow \text{writes_797_25})._replace(p3 \rightarrow \text{writes_797_25})._replace(\&\text{ \$heap}._ecv_files[1] \rightarrow \text{writes_797_9})$

$[Work \text{ on sub-term 4 of conjunction in term } 29.61]$

$[32.0] -30323 < -\text{ \$heap}_{797,16}.p3$

$\rightarrow [from \text{ term } 30.0, \text{ \$heap}_{797,16} \text{ is equal to } \text{ \$heap_funcstart_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\text{ \$heap}._ecv_files[1]) \rightarrow \text{writes_790_5})._replace(p1 \rightarrow \text{writes_793_12})._replace(p2 \rightarrow \text{writes_793_12})._replace(p3 \rightarrow \text{writes_793_12})._replace(_ecv_files \rightarrow \text{writes_793_12})._replace(p1 \rightarrow \text{writes_797_25})._replace(p2 \rightarrow \text{writes_797_25})._replace(p3 \rightarrow \text{writes_797_25})]$

$[32.1] -30323 < -\text{ \$heap_funcstart_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\text{ \$heap}._ecv_files[1]) \rightarrow \text{writes_790_5})._replace(p1 \rightarrow \text{writes_793_12})._replace(p2 \rightarrow \text{writes_793_12})._replace(p3 \rightarrow \text{writes_793_12})._replace(_ecv_files \rightarrow \text{writes_793_12})._replace(p1 \rightarrow \text{writes_797_25})._replace(p2 \rightarrow \text{writes_797_25})._replace(p3 \rightarrow \text{writes_797_25}).p3$

$\rightarrow [simplify]$

$[32.2] -30323 < -\text{writes_797_25}$

$[Work \text{ on sub-term 5 of conjunction in term } 29.61]$

$[33.0] -30307 < -\text{ \$heap}_{797,16}.p2$

$\rightarrow [from \text{ term } 30.0, \text{ \$heap}_{797,16} \text{ is equal to } \text{ \$heap_funcstart_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\text{ \$heap}._ecv_files[1]) \rightarrow \text{writes_790_5})._replace(p1 \rightarrow \text{writes_793_12})._replace(p2 \rightarrow \text{writes_793_12})._replace(p3 \rightarrow \text{writes_793_12})._replace(_ecv_files \rightarrow \text{writes_793_12})._replace(p1 \rightarrow \text{writes_797_25})._replace(p2 \rightarrow \text{writes_797_25})._replace(p3 \rightarrow \text{writes_797_25})]$

$[33.1] -30307 < -\text{ \$heap_funcstart_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\text{ \$heap}._ecv_files[1]) \rightarrow \text{writes_790_5})._replace(p1 \rightarrow \text{writes_793_12})._replace(p2 \rightarrow \text{writes_793_12})._replace(p3 \rightarrow \text{writes_793_12})._replace(_ecv_files \rightarrow \text{writes_793_12})._replace(p1 \rightarrow \text{writes_797_25})._replace(p2 \rightarrow \text{writes_797_25})._replace(p3 \rightarrow \text{writes_797_25}).p2$

$\rightarrow [simplify]$

$[33.3] -30307 < -\text{writes_797_25}$

[Work on sub-term 6 of conjunction in term 29.61]

[34.0] $-30269 < -\$heap_{797,16}.p1$

→ [from term 30.0, $\$heap_{797,16}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}(\&\$heap._ecv_files[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(_ecv_files \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25})]$

[34.1] $-30269 < -\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}(\&\$heap._ecv_files[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(_ecv_files \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).p1$

→ [simplify]

[34.4] $-30269 < -\text{writes_797_25}$

[Work on sub-term 7 of conjunction in term 29.61]

[35.0] $0 < \$heap_{797,16}.p1$

→ [from term 30.0, $\$heap_{797,16}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}(\&\$heap._ecv_files[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(_ecv_files \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25})]$

[35.1] $0 < \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}(\&\$heap._ecv_files[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(_ecv_files \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).p1$

→ [simplify]

[35.4] $0 < \text{writes_797_25}$

[Work on sub-term 8 of conjunction in term 29.61]

[36.0] $0 < \$heap_{797,16}.p2$

→ [from term 30.0, $\$heap_{797,16}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}(\&\$heap._ecv_files[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(_ecv_files \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25})]$

$[36.1] \ 0 < \$heap_{funcstart_780,1} \cdot \mathbf{replace}(p1 \rightarrow 1) \cdot \mathbf{replace}(p2 \rightarrow 2) \cdot \mathbf{replace}(p3 \rightarrow 3) \cdot \mathbf{replace}((\&\$heap \cdot ecv_files[1]) \rightarrow writes_790_5) \cdot \mathbf{replace}(p1 \rightarrow writes_793_12) \cdot \mathbf{replace}(p2 \rightarrow writes_793_12) \cdot \mathbf{replace}(p3 \rightarrow writes_793_12) \cdot \mathbf{replace}(ecv_files \rightarrow writes_793_12) \cdot \mathbf{replace}(p1 \rightarrow writes_797_25) \cdot \mathbf{replace}(p2 \rightarrow writes_797_25) \cdot \mathbf{replace}(p3 \rightarrow writes_797_25) \cdot p2$
 $\rightarrow [simplify]$
 $[36.3] \ 0 < writes_797_25$
[Work on sub-term 9 of conjunction in term 29.61]
 $[37.0] \ 0 < \$heap_{797,16} \cdot p3$
 $\rightarrow [from \ term \ 30.0, \ \$heap_{797,16} \ is \ equal \ to \ \$heap_{funcstart_780,1} \cdot \mathbf{replace}(p1 \rightarrow 1) \cdot \mathbf{replace}(p2 \rightarrow 2) \cdot \mathbf{replace}(p3 \rightarrow 3) \cdot \mathbf{replace}((\&\$heap \cdot ecv_files[1]) \rightarrow writes_790_5) \cdot \mathbf{replace}(p1 \rightarrow writes_793_12) \cdot \mathbf{replace}(p2 \rightarrow writes_793_12) \cdot \mathbf{replace}(p3 \rightarrow writes_793_12) \cdot \mathbf{replace}(ecv_files \rightarrow writes_793_12) \cdot \mathbf{replace}(p1 \rightarrow writes_797_25) \cdot \mathbf{replace}(p2 \rightarrow writes_797_25) \cdot \mathbf{replace}(p3 \rightarrow writes_797_25)]$
 $[37.1] \ 0 < \$heap_{funcstart_780,1} \cdot \mathbf{replace}(p1 \rightarrow 1) \cdot \mathbf{replace}(p2 \rightarrow 2) \cdot \mathbf{replace}(p3 \rightarrow 3) \cdot \mathbf{replace}((\&\$heap \cdot ecv_files[1]) \rightarrow writes_790_5) \cdot \mathbf{replace}(p1 \rightarrow writes_793_12) \cdot \mathbf{replace}(p2 \rightarrow writes_793_12) \cdot \mathbf{replace}(p3 \rightarrow writes_793_12) \cdot \mathbf{replace}(ecv_files \rightarrow writes_793_12) \cdot \mathbf{replace}(p1 \rightarrow writes_797_25) \cdot \mathbf{replace}(p2 \rightarrow writes_797_25) \cdot \mathbf{replace}(p3 \rightarrow writes_797_25) \cdot p3$
 $\rightarrow [simplify]$
 $[37.2] \ 0 < writes_797_25$
[Take goal term]
 $[1.0] \ invariant1(heapIs \ \$heap_{loopend})$
 $\rightarrow [from \ term \ 31.1, \ \$heap_{loopend} \ is \ equal \ to \ \$heap_{funcstart_780,1} \cdot \mathbf{replace}(p1 \rightarrow 1) \cdot \mathbf{replace}(p2 \rightarrow 2) \cdot \mathbf{replace}(p3 \rightarrow 3) \cdot \mathbf{replace}((\&\$heap \cdot ecv_files[1]) \rightarrow writes_790_5) \cdot \mathbf{replace}(p1 \rightarrow writes_793_12) \cdot \mathbf{replace}(p2 \rightarrow writes_793_12) \cdot \mathbf{replace}(p3 \rightarrow writes_793_12) \cdot \mathbf{replace}(ecv_files \rightarrow writes_793_12) \cdot \mathbf{replace}(p1 \rightarrow writes_797_25) \cdot \mathbf{replace}(p2 \rightarrow writes_797_25) \cdot \mathbf{replace}(p3 \rightarrow writes_797_25) \cdot \mathbf{replace}(\&\$heap \cdot ecv_files[1]) \rightarrow writes_797_9)]$
 $[1.1] \ invariant1(heapIs \ \$heap_{funcstart_780,1} \cdot \mathbf{replace}(p1 \rightarrow 1) \cdot \mathbf{replace}(p2 \rightarrow 2) \cdot \mathbf{replace}(p3 \rightarrow 3) \cdot \mathbf{replace}((\&\$heap \cdot ecv_files[1]) \rightarrow writes_790_5) \cdot \mathbf{replace}(p1 \rightarrow writes_793_12) \cdot \mathbf{replace}(p2 \rightarrow writes_793_12) \cdot \mathbf{replace}(p3 \rightarrow writes_793_12) \cdot \mathbf{replace}(ecv_files \rightarrow writes_793_12) \cdot \mathbf{replace}(p1 \rightarrow writes_797_25) \cdot \mathbf{replace}(p2 \rightarrow writes_797_25) \cdot \mathbf{replace}(p3 \rightarrow writes_797_25) \cdot \mathbf{replace}(\&\$heap \cdot ecv_files[1]) \rightarrow writes_797_9))$

→ [expand definition of function 'invariant1' at prang.c (34,1)]

```

[1.2] (((((0 < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p1)) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p1) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M1)))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2)))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →

```


$\rightarrow 1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ **.replace**($p1 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$
 $writes_797_25).$ **.replace**($p3 \rightarrow writes_797_25).$ **.replace**(($\&\$heap_ecv_files[1]$
 $\rightarrow writes_797_9).M2))) \ \&\& \ (0 <$
asType<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow 1).$ **.replace**($p2 \rightarrow$
 $2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ **.replace**($p1 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$
 $writes_797_25).$ **.replace**($p3 \rightarrow writes_797_25).$ **.replace**(($\&\$heap_ecv_files[1]$
 $\rightarrow writes_797_9).p3))) \ \&\&$
(asType<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow 1).$ **.replace**($p2 \rightarrow$
 $2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ **.replace**($p1 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$
 $writes_797_25).$ **.replace**($p3 \rightarrow writes_797_25).$ **.replace**(($\&\$heap_ecv_files[1]$
 $\rightarrow writes_797_9).p3) < \mathbf{asType}$ <**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1$
 $\rightarrow 1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ **.replace**($p1 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$
 $writes_797_25).$ **.replace**($p3 \rightarrow writes_797_25).$ **.replace**(($\&\$heap_ecv_files[1]$
 $\rightarrow writes_797_9).M3)))$
 $\rightarrow [from \text{ term } 35.4, \text{ literal } a < writes_797_25 \text{ is true whenever } (-1 + \text{ literal } a) <$
 $0]$

Proof of rule precondition:

[1.7.0] $(-1 + 0) < 0$

$\rightarrow [simplify]$

[1.7.2] **true**

[1.8] (((**true** $\&\& (\mathbf{asType}$ <**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow$
 $1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ **.replace**($p1 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$
 $writes_797_25).$ **.replace**($p3 \rightarrow writes_797_25).$ **.replace**(($\&\$heap_ecv_files[1]$
 $\rightarrow writes_797_9).p1) < \mathbf{asType}$ <**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1$
 $\rightarrow 1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ **.replace**($p1 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$
 $writes_797_25).$ **.replace**($p3 \rightarrow writes_797_25).$ **.replace**($p2 \rightarrow$

```

writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M1))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
→ [simplify]

```

```

[1.13] (((true && (writes_797_25 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →

```

[illegible]

→ [const member of object with modified fields]

```
[1.25] (((true && (writes_797_25 <
asType<integer>($heap_funcstart_780,1.M1))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2)))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3)))
```

→ [const static or extern object]

```

[1.26] (((((true && (writes_797_25 < asType<integer>($heap_init.M1))) &&
(0 < asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]

```

```

[1.27] (((((true && (writes_797_25 < asType<integer>(asType<short
int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →

```

```

2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9.p2))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9.p2) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9.M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9.p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9.p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9.M3))
→ [simplify]

```

```

[1.33] (((true && (-30269 < -writes_797_25)) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →

```



```

writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
→ [from term 34.4, literal a < -writes_797_25 is true whenever (-1 + literal a)
< -30269]

```

Proof of rule precondition:

[1.33.0] $(-30269 + -1) < -30269$

→ [simplify]

[1.33.2] **true**

[1.34] $(((((\mathbf{true} \ \&\& \ \mathbf{true}) \ \&\& \ (0 <$


```

writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
→ [from term 36.3, literal a < writes_797_25 is true whenever (-1 + literal a) <
0]

```

Proof of rule precondition:

[1.39.0] $(-1 + 0) < 0$

→ [simplify]

[1.39.2] **true**

```

[1.40] (((true && true) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])

```

```

→ writes_797_9).p2) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
→ [simplify]
[1.45] ((true && (writes_797_25 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →

```

```
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
```

→ [const member of object with modified fields]

```
[1.57] ((true && (writes_797_25 <
asType<integer>($heap_funcstart_780,1.M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))
```

→ [const static or extern object]

```
[1.58] ((true && (writes_797_25 < asType<integer>($heap_init.M2))) && (0
< asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
```

```

2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))

```

→ [expand definition of constant 'M2' at prang.c (19,20)]

```

[1.59] ((true && (writes_797_25 < asType<integer>(asType<short
int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&
(asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).M3))

```

→ [simplify]

```

[1.65] ((true && (-30307 < -writes_797_25)) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12)._replace(p1 → writes_797_25)._replace(p2 →
writes_797_25)._replace(p3 → writes_797_25)._replace((&$heap._ecv_files[1])
→ writes_797_9).p3))) &&

```

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).p3) < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).M3))$

$\rightarrow [from\ term\ 33.3,\ literal_a < -\text{writes_797_25}\ is\ true\ whenever\ (-1 + literal_a) < -30307]$

Proof of rule precondition:

$[1.65.0] (-30307 + -1) < -30307$

$\rightarrow [simplify]$

$[1.65.2] \text{true}$

$[1.66] ((\text{true} \ \&\& \ \text{true}) \ \&\& \ (0 < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).p3))) \ \&\& \ (\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).p3) < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).M3))$

$\rightarrow [simplify]$

$[1.70] (\text{true} \ \&\& \ (0 < \text{writes_797_25})) \ \&\&$

$(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).p3) < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).M3))$
 $\rightarrow [from\ term\ 37.2,\ literal_a < \text{writes_797_25}\ is\ true\ whenever\ (-1 + literal_a) < 0]$

Proof of rule precondition:

$[1.70.0] (-1 + 0) < 0$

$\rightarrow [simplify]$

$[1.70.2] \text{true}$

$[1.71] (\text{true} \ \&\& \ \text{true}) \ \&\&$
 $(\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).p3) < \text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).M3))$
 $\rightarrow [simplify]$

$[1.75] \text{true} \ \&\& \ (\text{writes_797_25} <$
 $\text{asType}\langle\text{integer}\rangle(\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_790_5}).\text{replace}(p1 \rightarrow \text{writes_793_12}).\text{replace}(p2 \rightarrow \text{writes_793_12}).\text{replace}(p3 \rightarrow \text{writes_793_12}).\text{replace}(\text{ecv_files} \rightarrow \text{writes_793_12}).\text{replace}(p1 \rightarrow \text{writes_797_25}).\text{replace}(p2 \rightarrow \text{writes_797_25}).\text{replace}(p3 \rightarrow \text{writes_797_25}).\text{replace}((\&\$heap.\text{ecv_files}[1]) \rightarrow \text{writes_797_9}).M3))$

→ [const member of object with modified fields]
[1.87] **true** && (writes_797_25 < **asType**<**integer**>(\$heap_funcstart_780,1.M3))
→ [const static or extern object]
[1.88] **true** && (writes_797_25 < **asType**<**integer**>(\$heap_init.M3))
→ [expand definition of constant 'M3' at prang.c (24,20)]
[1.89] **true** && (writes_797_25 < **asType**<**integer**>(**asType**<**short int**>((**int**)30323)))
→ [simplify]
[1.95] **true** && (-30323 < -writes_797_25)
→ [from term 32.2, literal a < -writes_797_25 is true whenever (-1 + literal a) < -30323]

Proof of rule precondition:

[1.95.0] (-30323 + -1) < -30323
→ [simplify]
[1.95.2] **true**
[1.96] **true** && **true**
→ [simplify]
[1.97] **true**

Proof of verification condition: Precondition of 'WHprang' satisfied

Condition generated at: C:\Escher\Customers\prang\prang.c (116,25)

Condition defined at: C:\Escher\Customers\prang\prang.c (42,5)

To prove: invariant1(heapIs \$heap_loopstart_792,5)

Given:

\$heap_init.LIMIT == (**int**)80
\$heap_init.M1 == **asType**<**short int**>((**int**)30269)
\$heap_init.r1 == **asType**<**short int**>((**int**)171)
\$heap_init.a1 == **asType**<**short int**>((**int**)177)
\$heap_init.b1 == **asType**<**short int**>((**int**)2)
\$heap_init.M2 == **asType**<**short int**>((**int**)30307)
\$heap_init.r2 == **asType**<**short int**>((**int**)172)
\$heap_init.a2 == **asType**<**short int**>((**int**)176)
\$heap_init.b2 == **asType**<**short int**>((**int**)35)

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
$heap780,1;783,8 == $heapfuncstart_780,1.replace(p1 → asType<short
int>((int)1))
$heap780,1;784,8 == $heap780,1;783,8.replace(p2 → asType<short
int>((int)2))
$heap780,1;785,8 == $heap780,1;784,8.replace(p3 → asType<short
int>((int)3))
limit == $heap780,1;785,8.LIMIT
minof(int const) ≤ limit
limit ≤ maxof(int const)
count == (int)0
minof(int) ≤ count
count ≤ maxof(int)
$heap780,1;790,5 == $heap780,1;785,8.replace((&$heap780,1;785,8.ecv_files[1]).$r
→ writes_790_5)
$heaploopstart_792,5 == $heap780,1;790,5.replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(_ecv_files → writes_793_12)
#writes_793_12 == # $heap780,1;790,5.ecv_files
minof(int) ≤ countloopstart_792,5
countloopstart_792,5 ≤ maxof(int)
invariant1(heapIs $heaploopstart_792,5)
countloopstart_792,5 < limit
0 ≤ (asType<integer const>(limit) -
asType<integer>(countloopstart_792,5))
(asType<integer const>(limit) - asType<integer>(countloopstart_792,5))
≤ (asType<integer const>(limit) - asType<integer>(count))
Proof:
[Take given term]

```

[5.0] $\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow \text{asType}<\text{short int}>((\text{int})1))$
 \rightarrow [simplify]

[5.2] $\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1)$
[Take given term]

[6.0] $\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{int})2))$
 \rightarrow [from term 5.2, $\$heap_{780,1;783,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1)$]
[6.1] $\$heap_{780,1;784,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow \text{asType}<\text{short int}>((\text{int})2))$
 \rightarrow [simplify]

[6.3] $\$heap_{780,1;784,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$
[Take given term]

[7.0] $\$heap_{780,1;785,8} == \$heap_{780,1;784,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{int})3))$
 \rightarrow [from term 6.3, $\$heap_{780,1;784,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$]
[7.1] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{int})3))$
 \rightarrow [simplify]

[7.3] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$
[Take given term]

[10.0] $\$heap_{780,1;790,5} ==$
 $\$heap_{780,1;785,8}.\text{replace}((\&\$heap_{780,1;785,8}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 \rightarrow [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$]
[10.1] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap_{780,1;785,8}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 \rightarrow [simplify]

[10.2] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{replace}((\&\$heap.\text{ecv_files}[1]).\$r \rightarrow \text{writes_790_5})$
 \rightarrow [attribute value is known from postcondition]


```

asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).M3))

```

→ [const member of object with modified fields]

```

[21.20] (((((0 < writes_793_12) && (writes_793_12 <
asType<integer>($heap_funcstart_780,1.M1))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).p2))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).p2) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(._ecv_files →
writes_793_12).M3))

```

→ [const static or extern object]

```

[21.21] (((((0 < writes_793_12) && (writes_793_12 <

```

```

asType<integer>($heapinit.M1))) && (0 <
asType<integer>($heapfuncstart_780,1.replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.p2))) && (asType<integer>($heapfuncstart_780,1.replace(p1
→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.p2) < asType<integer>($heapfuncstart_780,1.replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.M2))) && (0 <
asType<integer>($heapfuncstart_780,1.replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heapfuncstart_780,1.replace(p1
→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heapfuncstart_780,1.replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.M3))
→ [expand definition of constant 'M1' at prang.c (14,20)]
[21.22] (((((0 < writes_793_12) && (writes_793_12 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType<integer>($heapfuncstart_780,1.replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.p2))) && (asType<integer>($heapfuncstart_780,1.replace(p1
→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.p2) < asType<integer>($heapfuncstart_780,1.replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12.M2))) && (0 <
asType<integer>($heapfuncstart_780,1.replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →

```

```

writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.M3))

```

→ [simplify]

```

[21.39] ((((-30269 < -writes_793_12) ∧ (0 < writes_793_12) ∧ (0 <
writes_793_12)) && (writes_793_12 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.M3))

```

→ [const member of object with modified fields]

```

[21.47] ((((-30269 < -writes_793_12) ∧ (0 < writes_793_12) ∧ (0 <
writes_793_12)) && (writes_793_12 <
asType<integer>($heap_funcstart_780,1.M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →

```



```

writes_793_12).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))
→ [const static or extern object]

[21.48] ((((-30269 < -writes_793_12) ∧ (0 < writes_793_12) ∧ (0 <
writes_793_12)) && (writes_793_12 < asType<integer>($heap_init.M2))) &&
(0 < asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))
→ [expand definition of constant 'M2' at prang.c (19,20)]

[21.49] ((((-30269 < -writes_793_12) ∧ (0 < writes_793_12) ∧ (0 <
writes_793_12)) && (writes_793_12 < asType<integer>(asType<short
int>((int)30307)))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))
→ [simplify]

[21.65] ((-30307 < -writes_793_12) ∧ (-30269 < -writes_793_12) ∧ (0 <
writes_793_12) ∧ (0 < writes_793_12) ∧ (0 < writes_793_12)) &&
(writes_793_12 < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →

```

`writes_790_5).`**replace**`(p1 → writes_793_12).`**replace**`(p2 →`
`writes_793_12).`**replace**`(p3 → writes_793_12).`**replace**`(_ecv_files →`
`writes_793_12).M3))`
→ *[const member of object with modified fields]*
`[21.73] ((-30307 < -writes_793_12) ∧ (-30269 < -writes_793_12) ∧ (0 <`
`writes_793_12) ∧ (0 < writes_793_12) ∧ (0 < writes_793_12)) &&`
`(writes_793_12 < asType<integer>($heap_funcstart_780,1.M3))`
→ *[const static or extern object]*
`[21.74] ((-30307 < -writes_793_12) ∧ (-30269 < -writes_793_12) ∧ (0 <`
`writes_793_12) ∧ (0 < writes_793_12) ∧ (0 < writes_793_12)) &&`
`(writes_793_12 < asType<integer>($heap_init.M3))`
→ *[expand definition of constant 'M3' at prang.c (24,20)]*
`[21.75] ((-30307 < -writes_793_12) ∧ (-30269 < -writes_793_12) ∧ (0 <`
`writes_793_12) ∧ (0 < writes_793_12) ∧ (0 < writes_793_12)) &&`
`(writes_793_12 < asType<integer>(asType<short int>((int)30323)))`
→ *[simplify]*
`[21.83] (-30323 < -writes_793_12) ∧ (-30307 < -writes_793_12) ∧ (-30269 <`
`-writes_793_12) ∧ (0 < writes_793_12) ∧ (0 < writes_793_12) ∧ (0 <`
`writes_793_12)`
→ *[separate conjunction and work on first sub-term]*
`[21.84] -30323 < -writes_793_12`
[Work on sub-term 2 of conjunction in term 21.83]
`[22.0] -30307 < -writes_793_12`
[Work on sub-term 3 of conjunction in term 21.83]
`[23.0] -30269 < -writes_793_12`
[Work on sub-term 4 of conjunction in term 21.83]
`[24.0] 0 < writes_793_12`
[Work on sub-term 5 of conjunction in term 21.83]
`[25.0] 0 < writes_793_12`
[Work on sub-term 6 of conjunction in term 21.83]
`[26.0] 0 < writes_793_12`
[Take goal term]
`[1.0] invariant1(heapIs $heap_loopstart_792,5)`
→ *[from term 11.1, \$heap_loopstart_792,5 is equal to*
`$heap_funcstart_780,1.`**replace**`(p1 → 1).`**replace**`(p2 → 2).`**replace**`(p3 →`
`3).`**replace**`((&$heap._ecv_files[1]) → writes_790_5).`**replace**`(p1 →`

```

writes_793_12)._replace(p2 → writes_793_12)._replace(p3 →
writes_793_12)._replace(_ecv_files → writes_793_12)]

[1.1] invariant1(heapIs $heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12))

→ [expand definition of function 'invariant1' at prang.c (34,1)]

[1.2] (((((0 < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p1)) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p1) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M1))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p2))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p2) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →

```

`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).M3))`
 \rightarrow [simplify]
`[1.7] (((((0 < writes_793_12) &&`
`(asType<integer>($heap_funcstart_780,1).replace(p1 → 1).replace(p2 →`
`2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).p1) < asType<integer>($heap_funcstart_780,1).replace(p1 →`
`1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).M1))) && (0 <`
`asType<integer>($heap_funcstart_780,1).replace(p1 → 1).replace(p2 →`
`2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).p2))) && (asType<integer>($heap_funcstart_780,1).replace(p1`
`→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).p2) < asType<integer>($heap_funcstart_780,1).replace(p1 →`
`1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).M2))) && (0 <`
`asType<integer>($heap_funcstart_780,1).replace(p1 → 1).replace(p2 →`
`2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1).replace(p1`
`→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).p3) < asType<integer>($heap_funcstart_780,1).replace(p1 →`
`1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →`
`writes_790_5).replace(p1 → writes_793_12).replace(p2 →`
`writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →`
`writes_793_12).M3))`
 \rightarrow [from term 24.0, *literal* $a < \text{writes_793_12}$ is true whenever $(-1 + \text{literal}) < 0]$

Proof of rule precondition:

[1.7.0] $(-1 + 0) < 0$

→ [simplify]

[1.7.2] **true**

```
[1.8] (((true && (asType<integer>($heap_funcstart_780,1).replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).p1) < asType<integer>($heap_funcstart_780,1).replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).M1))) && (0 <
asType<integer>($heap_funcstart_780,1).replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).p2))) && (asType<integer>($heap_funcstart_780,1).replace(p1
→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).p2) < asType<integer>($heap_funcstart_780,1).replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).M2))) && (0 <
asType<integer>($heap_funcstart_780,1).replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1).replace(p1
→ 1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1).replace(p1 →
1).replace(p2 → 2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
writes_793_12).replace(p3 → writes_793_12).replace(_ecv_files →
writes_793_12).M3)))
```

→ [simplify]

```
[1.13] (((true && (writes_793_12 <
asType<integer>($heap_funcstart_780,1).replace(p1 → 1).replace(p2 →
2).replace(p3 → 3).replace((&$heap._ecv_files[1]) →
writes_790_5).replace(p1 → writes_793_12).replace(p2 →
```

```

writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M1))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p2))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p2) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))

```

→ [const member of object with modified fields]

```

[1.21] (((true && (writes_793_12 <
asType<integer>($heap_funcstart_780,1).M1))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p2))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p2) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →

```

```

2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.M3))

```

→ [const static or extern object]

```

[1.22] (((((true && (writes_793_12 < asType<integer>($heap_init.M1))) &&
(0 < asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p2))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p2) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.M2))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1)._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.M3))

```

→ [expand definition of constant 'M1' at prang.c (14,20)]

```

[1.23] (((((true && (writes_793_12 < asType<integer>(asType<short
int>((int)30269)))) && (0 <
asType<integer>($heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →

```


$\rightarrow 1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $p3$) < **asType**<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow$
 $1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $M3$))

\rightarrow [from term 23.0, *literal* $a < -writes_793_12$ is true whenever $(-1 + literal) < -30269$]

Proof of rule precondition:

[1.29.0] $(-30269 + -1) < -30269$

\rightarrow [simplify]

[1.29.2] **true**

[1.30] (((**true** && **true**) && (0 <
asType<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow 1).$ **.replace**($p2 \rightarrow$
 $2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $p2$))) && (**asType**<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1$
 $\rightarrow 1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $p2$) < **asType**<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow$
 $1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $M2$))) && (0 <
asType<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow 1).$ **.replace**($p2 \rightarrow$
 $2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $p3$))) && (**asType**<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1$
 $\rightarrow 1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $p3$) < **asType**<**integer**>($\$heap_funcstart_780,1.$ **.replace**($p1 \rightarrow$
 $1).$ **.replace**($p2 \rightarrow 2).$ **.replace**($p3 \rightarrow 3).$ **.replace**(($\&\$heap_ecv_files[1] \rightarrow$
 $writes_790_5).$ **.replace**($p1 \rightarrow writes_793_12).$ **.replace**($p2 \rightarrow$
 $writes_793_12).$ **.replace**($p3 \rightarrow writes_793_12).$ **.replace**($_ecv_files \rightarrow$
 $writes_793_12).$ $M3$))

\rightarrow [simplify]

[1.35] (((**true** && (0 < writes_793_12)) &&
 (asType<integer>(\$heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).p2) < asType<integer>(\$heap_funcstart_780,1)._replace(p1 →
 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).M2))) && (0 <
 asType<integer>(\$heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).p3))) && (asType<integer>(\$heap_funcstart_780,1)._replace(p1
 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).p3) < asType<integer>(\$heap_funcstart_780,1)._replace(p1 →
 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).M3))
 → [from term 26.0, literal a < writes_793_12 is true whenever (-1 + literal a) <
 0]

Proof of rule precondition:

[1.35.0] (-1 + 0) < 0

→ [simplify]

[1.35.2] **true**

[1.36] (((**true** && **true**) &&
 (asType<integer>(\$heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).p2) < asType<integer>(\$heap_funcstart_780,1)._replace(p1 →
 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
 writes_793_12).M2))) && (0 <
 asType<integer>(\$heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
 writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
 writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →

```
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))
```

→ [simplify]

```
[1.41] ((true && (writes_793_12 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))
```

→ [const member of object with modified fields]

```
[1.49] ((true && (writes_793_12 <
asType<integer>($heap_funcstart_780,1.M2))) && (0 <
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12.p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
```

writes_793_12).M3))

→ [const static or extern object]

[1.50] ((true && (writes_793_12 < asType<integer>(\$heap_init.M2))) && (0 < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).p3))) && (asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).p3) < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).M3))

→ [expand definition of constant 'M2' at prang.c (19,20)]

[1.51] ((true && (writes_793_12 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).p3))) && (asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).p3) < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).M3))

→ [simplify]

[1.57] ((true && (-30307 < -writes_793_12)) && (0 < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).p3))) && (asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5)._replace(p1 → writes_793_12)._replace(p2 → writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files → writes_793_12).p3) < asType<integer>(\$heap_funcstart_780,1._replace(p1 →

$1).\texttt{_replace}(p2 \rightarrow 2).\texttt{_replace}(p3 \rightarrow 3).\texttt{_replace}((\&\$heap.\texttt{_ecv_files}[1]) \rightarrow$
 $\texttt{writes_790_5}).\texttt{_replace}(p1 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(p2 \rightarrow$
 $\texttt{writes_793_12}).\texttt{_replace}(p3 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(\texttt{_ecv_files} \rightarrow$
 $\texttt{writes_793_12}).M3))$
 \rightarrow [from term 22.0, $\texttt{literal}a < -\texttt{writes_793_12}$ is true whenever $(-1 + \texttt{literal}a) < -30307$]

Proof of rule precondition:

[1.57.0] $(-30307 + -1) < -30307$

\rightarrow [simplify]

[1.57.2] **true**

$[1.58] ((\texttt{true} \ \&\& \ \texttt{true}) \ \&\& \ (0 <$
 $\texttt{asType}<\texttt{integer}>(\$heap_{funcstart_780,1}.\texttt{_replace}(p1 \rightarrow 1).\texttt{_replace}(p2 \rightarrow$
 $2).\texttt{_replace}(p3 \rightarrow 3).\texttt{_replace}((\&\$heap.\texttt{_ecv_files}[1]) \rightarrow$
 $\texttt{writes_790_5}).\texttt{_replace}(p1 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(p2 \rightarrow$
 $\texttt{writes_793_12}).\texttt{_replace}(p3 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(\texttt{_ecv_files} \rightarrow$
 $\texttt{writes_793_12}).p3))) \ \&\& \ (\texttt{asType}<\texttt{integer}>(\$heap_{funcstart_780,1}.\texttt{_replace}(p1 \rightarrow$
 $1).\texttt{_replace}(p2 \rightarrow 2).\texttt{_replace}(p3 \rightarrow 3).\texttt{_replace}((\&\$heap.\texttt{_ecv_files}[1]) \rightarrow$
 $\texttt{writes_790_5}).\texttt{_replace}(p1 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(p2 \rightarrow$
 $\texttt{writes_793_12}).\texttt{_replace}(p3 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(\texttt{_ecv_files} \rightarrow$
 $\texttt{writes_793_12}).p3) < \texttt{asType}<\texttt{integer}>(\$heap_{funcstart_780,1}.\texttt{_replace}(p1 \rightarrow$
 $1).\texttt{_replace}(p2 \rightarrow 2).\texttt{_replace}(p3 \rightarrow 3).\texttt{_replace}((\&\$heap.\texttt{_ecv_files}[1]) \rightarrow$
 $\texttt{writes_790_5}).\texttt{_replace}(p1 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(p2 \rightarrow$
 $\texttt{writes_793_12}).\texttt{_replace}(p3 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(\texttt{_ecv_files} \rightarrow$
 $\texttt{writes_793_12}).M3))$

\rightarrow [simplify]

$[1.62] (\texttt{true} \ \&\& \ (0 < \texttt{writes_793_12})) \ \&\&$
 $(\texttt{asType}<\texttt{integer}>(\$heap_{funcstart_780,1}.\texttt{_replace}(p1 \rightarrow 1).\texttt{_replace}(p2 \rightarrow$
 $2).\texttt{_replace}(p3 \rightarrow 3).\texttt{_replace}((\&\$heap.\texttt{_ecv_files}[1]) \rightarrow$
 $\texttt{writes_790_5}).\texttt{_replace}(p1 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(p2 \rightarrow$
 $\texttt{writes_793_12}).\texttt{_replace}(p3 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(\texttt{_ecv_files} \rightarrow$
 $\texttt{writes_793_12}).p3) < \texttt{asType}<\texttt{integer}>(\$heap_{funcstart_780,1}.\texttt{_replace}(p1 \rightarrow$
 $1).\texttt{_replace}(p2 \rightarrow 2).\texttt{_replace}(p3 \rightarrow 3).\texttt{_replace}((\&\$heap.\texttt{_ecv_files}[1]) \rightarrow$
 $\texttt{writes_790_5}).\texttt{_replace}(p1 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(p2 \rightarrow$
 $\texttt{writes_793_12}).\texttt{_replace}(p3 \rightarrow \texttt{writes_793_12}).\texttt{_replace}(\texttt{_ecv_files} \rightarrow$
 $\texttt{writes_793_12}).M3))$

\rightarrow [from term 25.0, $\texttt{literal}a < \texttt{writes_793_12}$ is true whenever $(-1 + \texttt{literal}a) < 0$]

Proof of rule precondition:

[1.62.0] $(-1 + 0) < 0$

\rightarrow [simplify]

[1.62.2] **true**

[1.63] (**true** && **true**) &&
(**asType**<**integer**>(\$heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).p3) < **asType**<**integer**>(\$heap_funcstart_780,1)._replace(p1 →
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))

→ [simplify]

[1.67] **true** && (writes_793_12 <
asType<**integer**>(\$heap_funcstart_780,1)._replace(p1 → 1)._replace(p2 →
2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) →
writes_790_5)._replace(p1 → writes_793_12)._replace(p2 →
writes_793_12)._replace(p3 → writes_793_12)._replace(_ecv_files →
writes_793_12).M3))

→ [const member of object with modified fields]

[1.75] **true** && (writes_793_12 < **asType**<**integer**>(\$heap_funcstart_780,1.M3))

→ [const static or extern object]

[1.76] **true** && (writes_793_12 < **asType**<**integer**>(\$heap_init.M3))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[1.77] **true** && (writes_793_12 < **asType**<**integer**>(asType<**short**
int>((**int**)30323)))

→ [simplify]

[1.83] **true** && (-30323 < -writes_793_12)

→ [from term 21.84, literal < -writes_793_12 is true whenever (-1 + literal) < -30323]

Proof of rule precondition:

[1.83.0] (-30323 + -1) < -30323

→ [simplify]

[1.83.2] **true**

[1.84] **true** && **true**

→ [simplify]

[1.85] **true**

Proof of verification condition: Arithmetic result of operator '++' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (117,9)

Condition defined at:

To prove: $\text{minof}(\text{int}) \leq ++\text{count}_{\text{loopstart_792,5}}$

Given:

$\text{\$heap}_{\text{init}}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{\text{init}}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{\text{init}}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{\text{init}}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{\text{init}}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{\text{init}}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{\text{init}}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{\text{init}}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{\text{init}}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{\text{init}}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$

$\text{\$heap}_{\text{init}}.\text{r3} == \text{asType}<\text{short int}>((\text{int})170)$

$\text{\$heap}_{\text{init}}.\text{a3} == \text{asType}<\text{short int}>((\text{int})178)$

$\text{\$heap}_{\text{init}}.\text{b3} == \text{asType}<\text{short int}>((\text{int})63)$

$\text{\$heap}_{\text{init}}.\text{p1} == \text{asType}<\text{short int}>((\text{int})1)$

$\text{\$heap}_{\text{init}}.\text{p2} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{\text{init}}.\text{p3} == \text{asType}<\text{short int}>((\text{int})3)$

$\text{\$heap}_{780,1;783,8} == \text{\$heap}_{\text{funcstart_780,1}}.\text{replace}(\text{p1} \rightarrow \text{asType}<\text{short int}>((\text{int})1))$

$\text{\$heap}_{780,1;784,8} == \text{\$heap}_{780,1;783,8}.\text{replace}(\text{p2} \rightarrow \text{asType}<\text{short int}>((\text{int})2))$

$\text{\$heap}_{780,1;785,8} == \text{\$heap}_{780,1;784,8}.\text{replace}(\text{p3} \rightarrow \text{asType}<\text{short int}>((\text{int})3))$

$\text{limit} == \text{\$heap}_{780,1;785,8}.\text{LIMIT}$

$\text{minof}(\text{int const}) \leq \text{limit}$

$\text{limit} \leq \text{maxof}(\text{int const})$

$\text{count} == (\text{int})0$

$\text{minof}(\text{int}) \leq \text{count}$

```

count ≤ maxof(int)
$heap780,1;790,5 == $heap780,1;785,8.replace((&$heap780,1;785,8.ecv_files[1]).$r
→ writes790_5)

$heaploopstart_792,5 == $heap780,1;790,5.replace(p1 →
writes793_12).replace(p2 → writes793_12).replace(p3 →
writes793_12).replace(ecv_files → writes793_12)

#writes793_12 == # $heap780,1;790,5.ecv_files

minof(int) ≤ countloopstart_792,5
countloopstart_792,5 ≤ maxof(int)
invariant1(heapIs $heaploopstart_792,5)
countloopstart_792,5 < limit
0 ≤ (asType<integer const>(limit) –
asType<integer>(countloopstart_792,5))
(asType<integer const>(limit) – asType<integer>(countloopstart_792,5))
≤ (asType<integer const>(limit) – asType<integer>(count))
$heap797,16 == $heaploopstart_792,5.replace(p1 → writes797_25).replace(p2
→ writes797_25).replace(p3 → writes797_25)
$heaploopend == $heap797,16.replace((&$heap797,16.ecv_files[1]).$r →
writes797_9)
asType<real>((double)0.0) < asType<real>($result797_25)
asType<real>($result797_25) < asType<real>((double)1.0)
invariant1(heapIs $heap797,16)

Proof:
[Take given term]
[5.0] $heap780,1;783,8 == $heapfuncstart_780,1.replace(p1 → asType<short
int>((int)1))
→ [simplify]
[5.2] $heap780,1;783,8 == $heapfuncstart_780,1.replace(p1 → 1)
[Take given term]
[6.0] $heap780,1;784,8 == $heap780,1;783,8.replace(p2 → asType<short
int>((int)2))
→ [from term 5.2, $heap780,1;783,8 is equal to $heapfuncstart_780,1.replace(p1
→ 1)]
[6.1] $heap780,1;784,8 == $heapfuncstart_780,1.replace(p1 → 1).replace(p2 →
asType<short int>((int)2))
→ [simplify]

```


[6.3] $\$heap_{780,1;784,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$

[Take given term]

[7.0] $\$heap_{780,1;785,8} == \$heap_{780,1;784,8}.\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{int})3))$

\rightarrow [from term 6.3, $\$heap_{780,1;784,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$]

[7.1] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow \text{asType}<\text{short int}>((\text{int})3))$

\rightarrow [simplify]

[7.3] $\$heap_{780,1;785,8} == \$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$

[Take given term]

[8.0] $\$heap_{780,1;785,8}.\text{LIMIT} == \text{limit}$

\rightarrow [from term 7.3, $\$heap_{780,1;785,8}$ is equal to $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$]

[8.1] $\$heap_{funcstart_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3).\text{LIMIT} == \text{limit}$

\rightarrow [const member of object with modified fields]

[8.4] $\$heap_{funcstart_780,1}.\text{LIMIT} == \text{limit}$

\rightarrow [const static or extern object]

[8.5] $\$heap_{init}.\text{LIMIT} == \text{limit}$

\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]

[8.6] $(\text{int})80 == \text{limit}$

\rightarrow [simplify]

[8.7] $80 == \text{limit}$

[Take given term]

[9.0] $(\text{int})0 == \text{count}$

\rightarrow [simplify]

[9.1] $0 == \text{count}$

[Take given term]

[28.0] $(\text{asType}<\text{integer const}>(\text{limit}) - \text{asType}<\text{integer}>(\text{count}_{loopstart_792,5})) \leq (\text{asType}<\text{integer const}>(\text{limit}) - \text{asType}<\text{integer}>(\text{count}))$

\rightarrow [from term 8.7, limit is equal to 80]

[28.1] $(\text{asType}\langle\text{integer const}\rangle(80) - \text{asType}\langle\text{integer}\rangle(\text{count}_{\text{loopstart_792,5}})) \leq (\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}))$
 → [simplify]
 [28.4] $(80 + -\text{count}_{\text{loopstart_792,5}}) \leq (\text{asType}\langle\text{integer const}\rangle(\text{limit}) - \text{asType}\langle\text{integer}\rangle(\text{count}))$
 → [from term 8.7, limit is equal to 80]
 [28.5] $(80 + -\text{count}_{\text{loopstart_792,5}}) \leq (\text{asType}\langle\text{integer const}\rangle(80) - \text{asType}\langle\text{integer}\rangle(\text{count}))$
 → [simplify]
 [28.6] $(80 + -\text{count}_{\text{loopstart_792,5}}) \leq (80 - \text{asType}\langle\text{integer}\rangle(\text{count}))$
 → [from term 9.1, count is equal to 0]
 [28.7] $(80 + -\text{count}_{\text{loopstart_792,5}}) \leq (80 - \text{asType}\langle\text{integer}\rangle(0))$
 → [simplify]
 [28.20] $-1 < \text{count}_{\text{loopstart_792,5}}$
 [Take goal term]
 [1.0] $\text{minof}(\text{int}) \leq ++\text{count}_{\text{loopstart_792,5}}$
 → [simplify]
 [1.6] $-32770 < \text{count}_{\text{loopstart_792,5}}$
 → [from term 28.20, $\text{literal} < \text{count}_{\text{loopstart_792,5}}$ is true whenever $(-1 + \text{literal}) < -1$]

Proof of rule precondition:

[1.6.0] $(-32770 + -1) < -1$

→ [simplify]

[1.6.2] **true**

[1.7] **true**

Proof of verification condition: Arithmetic result of operator '++' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (117,9)

Condition defined at:

To prove: $++\text{count}_{\text{loopstart_792,5}} \leq \text{maxof}(\text{int})$

Given:

$\text{\$heap}_{\text{init}}.\text{LIMIT} == (\text{int})80$

```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)
$heapinit.p3 == asType<short int>((int)3)
$heap780,1;783,8 == $heapfuncstart_780,1.replace(p1 → asType<short
int>((int)1))
$heap780,1;784,8 == $heap780,1;783,8.replace(p2 → asType<short
int>((int)2))
$heap780,1;785,8 == $heap780,1;784,8.replace(p3 → asType<short
int>((int)3))
limit == $heap780,1;785,8.LIMIT
minof(int const) ≤ limit
limit ≤ maxof(int const)
count == (int)0
minof(int) ≤ count
count ≤ maxof(int)
$heap780,1;790,5 == $heap780,1;785,8.replace((&$heap780,1;785,8.ecv_files[1]).$r
→ writes_790_5)
$heaploopstart_792,5 == $heap780,1;790,5.replace(p1 →
writes_793_12).replace(p2 → writes_793_12).replace(p3 →
writes_793_12).replace(_ecv_files → writes_793_12)
#writes_793_12 == #heap780,1;790,5.ecv_files
minof(int) ≤ countloopstart_792,5

```

$\text{count}_{\text{loopstart_792,5}} \leq \mathbf{maxof}(\mathbf{int})$
 $\text{invariant1}(\mathbf{heapIs} \ \$\text{heap}_{\text{loopstart_792,5}})$
 $\text{count}_{\text{loopstart_792,5}} < \text{limit}$
 $0 \leq (\mathbf{asType}\langle\mathbf{integer\ const}\rangle(\text{limit}) - \mathbf{asType}\langle\mathbf{integer}\rangle(\text{count}_{\text{loopstart_792,5}}))$
 $(\mathbf{asType}\langle\mathbf{integer\ const}\rangle(\text{limit}) - \mathbf{asType}\langle\mathbf{integer}\rangle(\text{count}_{\text{loopstart_792,5}}))$
 $\leq (\mathbf{asType}\langle\mathbf{integer\ const}\rangle(\text{limit}) - \mathbf{asType}\langle\mathbf{integer}\rangle(\text{count}))$
 $\$\text{heap}_{797,16} == \$\text{heap}_{\text{loopstart_792,5}}.\mathbf{replace}(p1 \rightarrow \text{writes_797_25}).\mathbf{replace}(p2 \rightarrow \text{writes_797_25}).\mathbf{replace}(p3 \rightarrow \text{writes_797_25})$
 $\$\text{heap}_{\text{loopend}} == \$\text{heap}_{797,16}.\mathbf{replace}((\&\$\text{heap}_{797,16}.\text{ecv_files}[1]).\$r \rightarrow \text{writes_797_9})$
 $\mathbf{asType}\langle\mathbf{real}\rangle((\mathbf{double})0.0) < \mathbf{asType}\langle\mathbf{real}\rangle(\$\text{result_797_25})$
 $\mathbf{asType}\langle\mathbf{real}\rangle(\$\text{result_797_25}) < \mathbf{asType}\langle\mathbf{real}\rangle((\mathbf{double})1.0)$
 $\text{invariant1}(\mathbf{heapIs} \ \$\text{heap}_{797,16})$

Proof:

[Take given term]

[5.0] $\$\text{heap}_{780,1;783,8} == \$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})1))$

\rightarrow [simplify]

[5.2] $\$\text{heap}_{780,1;783,8} == \$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow 1)$

[Take given term]

[6.0] $\$\text{heap}_{780,1;784,8} == \$\text{heap}_{780,1;783,8}.\mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})2))$

\rightarrow [from term 5.2, $\$\text{heap}_{780,1;783,8}$ is equal to $\$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow 1)$]

[6.1] $\$\text{heap}_{780,1;784,8} == \$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})2))$

\rightarrow [simplify]

[6.3] $\$\text{heap}_{780,1;784,8} == \$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2)$

[Take given term]

[7.0] $\$\text{heap}_{780,1;785,8} == \$\text{heap}_{780,1;784,8}.\mathbf{replace}(p3 \rightarrow \mathbf{asType}\langle\mathbf{short\ int}\rangle((\mathbf{int})3))$

\rightarrow [from term 6.3, $\$\text{heap}_{780,1;784,8}$ is equal to $\$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow 2)$]

[7.1] $\$\text{heap}_{780,1;785,8} == \$\text{heap}_{\text{funcstart_780,1}}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow$

2)._replace(p3 → asType<short int>((int)3))
 → [simplify]
 [7.3] \$heap_{780,1;785,8} == \$heap_{funcstart_780,1}._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)
 [Take given term]
 [8.0] \$heap_{780,1;785,8}.LIMIT == limit
 → [from term 7.3, \$heap_{780,1;785,8} is equal to \$heap_{funcstart_780,1}._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)]
 [8.1] \$heap_{funcstart_780,1}._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3).LIMIT == limit
 → [const member of object with modified fields]
 [8.4] \$heap_{funcstart_780,1}.LIMIT == limit
 → [const static or extern object]
 [8.5] \$heap_{init}.LIMIT == limit
 → [expand definition of constant 'LIMIT' at prang.c (12,18)]
 [8.6] (int)80 == limit
 → [simplify]
 [8.7] 80 == limit
 [Take given term]
 [27.0] count_{loopstart_792,5} < limit
 → [from term 8.7, limit is equal to 80]
 [27.1] count_{loopstart_792,5} < 80
 → [simplify]
 [27.4] -80 < -count_{loopstart_792,5}
 [Take goal term]
 [1.0] ++count_{loopstart_792,5} ≤ maxof(int)
 → [simplify]
 [1.9] -32767 < -count_{loopstart_792,5}
 → [from term 27.4, literal a < -count_{loopstart_792,5} is true whenever (-1 + literal a) < -80]
Proof of rule precondition:
 [1.9.0] (-32767 + -1) < -80
 → [simplify]

[1.9.2] **true**

[1.10] **true**

Proof of verification condition: Loop initialisation establishes loop invariant

Condition generated at: C:\Escher\Customers\prang\prang.c (111,5)

Condition defined at: C:\Escher\Customers\prang\prang.c (113,10)

To prove: invariant1(heapIs \$heap_{780,1;790,5})

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

\$heap_{init}.M3 == asType<short int>((int)30323)

\$heap_{init}.r3 == asType<short int>((int)170)

\$heap_{init}.a3 == asType<short int>((int)178)

\$heap_{init}.b3 == asType<short int>((int)63)

\$heap_{init}.p1 == asType<short int>((int)1)

\$heap_{init}.p2 == asType<short int>((int)2)

\$heap_{init}.p3 == asType<short int>((int)3)

\$heap_{780,1;783,8} == \$heap_{funcstart_780,1}.replace(p1 → asType<short int>((int)1))

\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.replace(p2 → asType<short int>((int)2))

\$heap_{780,1;785,8} == \$heap_{780,1;784,8}.replace(p3 → asType<short int>((int)3))

limit == \$heap_{780,1;785,8}.LIMIT

minof(int const) ≤ limit

limit ≤ maxof(int const)

$\text{count} == (\text{int})0$
 $\text{minof}(\text{int}) \leq \text{count}$
 $\text{count} \leq \text{maxof}(\text{int})$
 $\text{\$heap}_{780,1;790,5} == \text{\$heap}_{780,1;785,8}.\text{replace}((\&\text{\$heap}_{780,1;785,8}.\text{ecv_files}[1]).\text{\$r} \rightarrow \text{writes_790_5})$
Proof:
[Take given term]
 $[5.0] \text{\$heap}_{780,1;783,8} == \text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})1))$
 \rightarrow *[simplify]*
 $[5.2] \text{\$heap}_{780,1;783,8} == \text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1)$
[Take given term]
 $[6.0] \text{\$heap}_{780,1;784,8} == \text{\$heap}_{780,1;783,8}.\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})2))$
 \rightarrow *[from term 5.2, $\text{\$heap}_{780,1;783,8}$ is equal to $\text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1)$]*
 $[6.1] \text{\$heap}_{780,1;784,8} == \text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})2))$
 \rightarrow *[simplify]*
 $[6.3] \text{\$heap}_{780,1;784,8} == \text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$
[Take given term]
 $[7.0] \text{\$heap}_{780,1;785,8} == \text{\$heap}_{780,1;784,8}.\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})3))$
 \rightarrow *[from term 6.3, $\text{\$heap}_{780,1;784,8}$ is equal to $\text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2)$]*
 $[7.1] \text{\$heap}_{780,1;785,8} == \text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow \text{asType}\langle \text{short int} \rangle((\text{int})3))$
 \rightarrow *[simplify]*
 $[7.3] \text{\$heap}_{780,1;785,8} == \text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$
[Take given term]
 $[10.0] \text{\$heap}_{780,1;790,5} == \text{\$heap}_{780,1;785,8}.\text{replace}((\&\text{\$heap}_{780,1;785,8}.\text{ecv_files}[1]).\text{\$r} \rightarrow \text{writes_790_5})$
 \rightarrow *[from term 7.3, $\text{\$heap}_{780,1;785,8}$ is equal to $\text{\$heap}_{\text{funcstart_780},1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow 2).\text{replace}(p3 \rightarrow 3)$]*

[10.1] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap_{780,1;785,8} \cdot \text{ecv_files}[1]) \cdot \$r \rightarrow \text{writes_790_5})$
 $\rightarrow [\text{simplify}]$

[10.2] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \cdot \$r \rightarrow \text{writes_790_5})$
 $\rightarrow [\text{attribute value is known from postcondition}]$

[10.3] $\$heap_{780,1;790,5} == \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_790_5})$
 $[Take\ goal\ term]$

[1.0] $\text{invariant1}(\text{heapIs } \$heap_{780,1;790,5})$
 $\rightarrow [\text{from term 10.3, } \$heap_{780,1;790,5} \text{ is equal to } \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_790_5})]$

[1.1] $\text{invariant1}(\text{heapIs } \$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}(\&\$heap \cdot \text{ecv_files}[1] \rightarrow \text{writes_790_5}))$
 $\rightarrow [\text{expand definition of function 'invariant1' at prang.c (34,1)}]$

[1.2] $(((((0 < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).p1)) \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).p1) < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).M1))) \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).p2))) \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).p2) < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).M2))) \&\& (0 < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).p3))) \&\& (\text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).p3) < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).M3)))$
 $\rightarrow [\text{simplify}]$

[1.13] $(((((\text{true} \&\& (1 < \text{asType}<\text{integer}>(\$heap_{funcstart_780,1} \cdot \text{replace}(p1 \rightarrow 1) \cdot \text{replace}(p2 \rightarrow 2) \cdot \text{replace}(p3 \rightarrow 3) \cdot \text{replace}((\&\$heap \cdot \text{ecv_files}[1]) \rightarrow \text{writes_790_5}).M1))) \&\& (0 <$

→ [expand definition of constant 'M1' at prang.c (14,20)]

```
[1.19] (((true && (1 < asType<integer>(asType<short  
int>((int)30269)))) && (0 <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p2)))  
&& (asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2  
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p2) <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).M2)))  
&& (0 < asType<integer>($heap_funcstart_780,1._replace(p1 →  
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →  
writes_790_5).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1  
→ 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →  
writes_790_5).p3) < asType<integer>($heap_funcstart_780,1._replace(p1 →  
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →  
writes_790_5).M3)))
```

→ [simplify]

```
[1.34] ((true && (2 < asType<integer>($heap_funcstart_780,1._replace(p1 →  
1)._replace(p2 → 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) →  
writes_790_5).M2))) && (0 <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p3)))  
&& (asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2  
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p3) <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).M3)))
```

→ [const member of object with modified fields]

```
[1.38] ((true && (2 < asType<integer>($heap_funcstart_780,1.M2))) && (0 <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p3)))  
&& (asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2  
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p3) <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).M3)))
```

→ [const static or extern object]

```
[1.39] ((true && (2 < asType<integer>($heap_init.M2))) && (0 <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p3)))  
&& (asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2  
→ 2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).p3) <  
asType<integer>($heap_funcstart_780,1._replace(p1 → 1)._replace(p2 →  
2)._replace(p3 → 3)._replace((&$heap._ecv_files[1]) → writes_790_5).M3)))
```

→ [expand definition of constant 'M2' at prang.c (19,20)]

[1.40] ((true && (2 < asType<integer>(asType<short int>((int)30307)))) && (0 < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5).p3))) && (asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5).p3) < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5).M3)))

→ [simplify]

[1.53] true && (3 < asType<integer>(\$heap_funcstart_780,1._replace(p1 → 1)._replace(p2 → 2)._replace(p3 → 3)._replace((&\$heap._ecv_files[1]) → writes_790_5).M3)))

→ [const member of object with modified fields]

[1.57] true && (3 < asType<integer>(\$heap_funcstart_780,1.M3)))

→ [const static or extern object]

[1.58] true && (3 < asType<integer>(\$heap_init.M3)))

→ [expand definition of constant 'M3' at prang.c (24,20)]

[1.59] true && (3 < asType<integer>(asType<short int>((int)30323)))

→ [simplify]

[1.64] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (31,19)

Condition defined at:

To prove: minof(short int) ≤ (int)3

Given:

\$heap_init.LIMIT == (int)80

\$heap_init.M1 == asType<short int>((int)30269)

\$heap_init.r1 == asType<short int>((int)171)

\$heap_init.a1 == asType<short int>((int)177)

\$heap_init.b1 == asType<short int>((int)2)

\$heap_init.M2 == asType<short int>((int)30307)

\$heap_init.r2 == asType<short int>((int)172)

\$heap_init.a2 == asType<short int>((int)176)

```

$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)
$heapinit.p2 == asType<short int>((int)2)

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)3

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (31,19)

Condition defined at:

To prove: (int)3 ≤ maxof(short int)

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)
$heapinit.p1 == asType<short int>((int)1)

```

$\$heap_{init}.p2 == \text{asType}<\text{short int}>((\text{int})2)$

Proof:

[Take goal term]

[1.0] $(\text{int})3 \leq \text{maxof}(\text{short int})$

\rightarrow *[simplify]*

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (30,19)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})2$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

$\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$

$\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})2$

\rightarrow *[simplify]*

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (30,19)

Condition defined at:

To prove: $(\text{int})2 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$
 $\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$
 $\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$
 $\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$
 $\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$
 $\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$
 $\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$
 $\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$
 $\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$
 $\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$
 $\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$
 $\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$
 $\$heap_{init}.b3 == \text{asType}<\text{short int}>((\text{int})63)$
 $\$heap_{init}.p1 == \text{asType}<\text{short int}>((\text{int})1)$

Proof:

[Take goal term]

[1.0] $(\text{int})2 \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (29,19)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})1$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)1

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (29,19)

Condition defined at:

To prove: (int)1 ≤ maxof(short int)

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)

```

```

$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)
$heapinit.b3 == asType<short int>((int)63)

```

Proof:

```

[Take goal term]
[1.0] (int)1 ≤ maxof(short int)
→ [simplify]
[1.3] true

```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (27,29)

Condition defined at:

To prove: minof(short int) ≤ (int)63

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)
$heapinit.a3 == asType<short int>((int)178)

```

Proof:

```

[Take goal term]
[1.0] minof(short int) ≤ (int)63
→ [simplify]
[1.3] true

```


Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (27,29)

Condition defined at:

To prove: $(\text{int})63 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

$\$heap_{init}.M2 == \text{asType}<\text{short int}>((\text{int})30307)$

$\$heap_{init}.r2 == \text{asType}<\text{short int}>((\text{int})172)$

$\$heap_{init}.a2 == \text{asType}<\text{short int}>((\text{int})176)$

$\$heap_{init}.b2 == \text{asType}<\text{short int}>((\text{int})35)$

$\$heap_{init}.M3 == \text{asType}<\text{short int}>((\text{int})30323)$

$\$heap_{init}.r3 == \text{asType}<\text{short int}>((\text{int})170)$

$\$heap_{init}.a3 == \text{asType}<\text{short int}>((\text{int})178)$

Proof:

[Take goal term]

[1.0] $(\text{int})63 \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (26,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})178$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)178

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (26,29)

Condition defined at:

To prove: (int)178 ≤ maxof(short int)

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)
$heapinit.r3 == asType<short int>((int)170)

```

Proof:

[Take goal term]

[1.0] $(\text{int})178 \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (25,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})170$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

$\text{\$heap}_{init}.\text{a2} == \text{asType}<\text{short int}>((\text{int})176)$

$\text{\$heap}_{init}.\text{b2} == \text{asType}<\text{short int}>((\text{int})35)$

$\text{\$heap}_{init}.\text{M3} == \text{asType}<\text{short int}>((\text{int})30323)$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})170$

\rightarrow [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (25,29)

Condition defined at:

To prove: $(\text{int})170 \leq \text{maxof}(\text{short int})$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

```

$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)
$heapinit.M3 == asType<short int>((int)30323)

```

Proof:

[Take goal term]

[1.0] (int)170 ≤ maxof(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (24,29)

Condition defined at:

To prove: minof(short int) ≤ (int)30323

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)
$heapinit.b2 == asType<short int>((int)35)

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)30323

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (24,29)

Condition defined at:

To prove: (int)30323 ≤ maxof(short int)

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

\$heap_{init}.a1 == asType<short int>((int)177)

\$heap_{init}.b1 == asType<short int>((int)2)

\$heap_{init}.M2 == asType<short int>((int)30307)

\$heap_{init}.r2 == asType<short int>((int)172)

\$heap_{init}.a2 == asType<short int>((int)176)

\$heap_{init}.b2 == asType<short int>((int)35)

Proof:

[Take goal term]

[1.0] (int)30323 ≤ maxof(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (22,29)

Condition defined at:

To prove: minof(short int) ≤ (int)35

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

\$heap_{init}.r1 == asType<short int>((int)171)

```

$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)

```

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)35

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (22,29)

Condition defined at:

To prove: (int)35 ≤ maxof(short int)

Given:

```

$heapinit.LIMIT == (int)80
$heapinit.M1 == asType<short int>((int)30269)
$heapinit.r1 == asType<short int>((int)171)
$heapinit.a1 == asType<short int>((int)177)
$heapinit.b1 == asType<short int>((int)2)
$heapinit.M2 == asType<short int>((int)30307)
$heapinit.r2 == asType<short int>((int)172)
$heapinit.a2 == asType<short int>((int)176)

```

Proof:

[Take goal term]

[1.0] (int)35 ≤ maxof(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (21,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})176$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})176$

\rightarrow *[simplify]*

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (21,29)

Condition defined at:

To prove: $(\text{int})176 \leq \text{maxof}(\text{short int})$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$

$\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$

$\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$

$\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$

$\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$

$\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

$\text{\$heap}_{init}.\text{r2} == \text{asType}<\text{short int}>((\text{int})172)$

Proof:

[Take goal term]

[1.0] $(\text{int})176 \leq \text{maxof}(\text{short int})$

→ [simplify]
 [1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (20,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})172$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$
 $\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$
 $\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$
 $\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$
 $\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$
 $\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

Proof:

[Take goal term]
 [1.0] $\text{minof}(\text{short int}) \leq (\text{int})172$
 → [simplify]
 [1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (20,29)

Condition defined at:

To prove: $(\text{int})172 \leq \text{maxof}(\text{short int})$

Given:

$\text{\$heap}_{init}.\text{LIMIT} == (\text{int})80$
 $\text{\$heap}_{init}.\text{M1} == \text{asType}<\text{short int}>((\text{int})30269)$
 $\text{\$heap}_{init}.\text{r1} == \text{asType}<\text{short int}>((\text{int})171)$
 $\text{\$heap}_{init}.\text{a1} == \text{asType}<\text{short int}>((\text{int})177)$
 $\text{\$heap}_{init}.\text{b1} == \text{asType}<\text{short int}>((\text{int})2)$
 $\text{\$heap}_{init}.\text{M2} == \text{asType}<\text{short int}>((\text{int})30307)$

Proof:

[Take goal term]

[1.0] $(\text{int})172 \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (19,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})30307$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})30307$

\rightarrow [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (19,29)

Condition defined at:

To prove: $(\text{int})30307 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

$\$heap_{init}.b1 == \text{asType}<\text{short int}>((\text{int})2)$

Proof:

[Take goal term]

[1.0] $(\text{int})30307 \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (17,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})2$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})2$

→ [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (17,29)

Condition defined at:

To prove: $(\text{int})2 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

$\$heap_{init}.a1 == \text{asType}<\text{short int}>((\text{int})177)$

Proof:

[Take goal term]

[1.0] $(\text{int})2 \leq \text{maxof}(\text{short int})$

\rightarrow [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (16,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})177$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})177$

\rightarrow [simplify]

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (16,29)

Condition defined at:

To prove: $(\text{int})177 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

$\$heap_{init}.M1 == \text{asType}<\text{short int}>((\text{int})30269)$

$\$heap_{init}.r1 == \text{asType}<\text{short int}>((\text{int})171)$

Proof:

[Take goal term]

[1.0] $(\text{int})177 \leq \text{maxof}(\text{short int})$

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (15,29)

Condition defined at:

To prove: minof(short int) ≤ (int)171

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

Proof:

[Take goal term]

[1.0] minof(short int) ≤ (int)171

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (15,29)

Condition defined at:

To prove: (int)171 ≤ maxof(short int)

Given:

\$heap_{init}.LIMIT == (int)80

\$heap_{init}.M1 == asType<short int>((int)30269)

Proof:

[Take goal term]

[1.0] (int)171 ≤ maxof(short int)

→ [simplify]

[1.3] true

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (14,29)

Condition defined at:

To prove: $\text{minof}(\text{short int}) \leq (\text{int})30269$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

Proof:

[Take goal term]

[1.0] $\text{minof}(\text{short int}) \leq (\text{int})30269$

\rightarrow *[simplify]*

[1.3] **true**

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (14,29)

Condition defined at:

To prove: $(\text{int})30269 \leq \text{maxof}(\text{short int})$

Given:

$\$heap_{init}.LIMIT == (\text{int})80$

Proof:

[Take goal term]

[1.0] $(\text{int})30269 \leq \text{maxof}(\text{short int})$

\rightarrow *[simplify]*

[1.3] **true**

End of proofs for file C:\Escher\Customers\prang\prang.c