The intcalc package

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Abstract

This package provides expandable arithmetic operations with integers.

Contents

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[*]Please report any issues at https://github.com/ho-tex/oberdiek/issues

1 Documentation

1.1 Introduction

Package intcalc defines arithmetic operations that deal with integers. Integers mean numbers in TeX. The same restrictions apply, the range is limited to [-2147483647, 2147483647].

The operations have the form of macros that take one or two integers as parameter and return the integer result. The macro name is a three letter operation name prefixed by the package name, e.g. \intcalcAdd{10}{43} returns 53.

The macros are fully expandable, exactly two expansion steps generate the result. Therefore the operations may be used nearly everywhere in TeX, even inside \number, \csname, file names, or other expandable contexts.

The package contains two implementations of the operations. If ε-TeX is detected then the macros are implemented using its features (\numexpr). Otherwise the slower implementation without ε-TeX's help is choosen.

1.2 Conditions

1.2.1 Preconditions

- Arguments can be anything that TeX interprets as "number". Examples: plain numbers, count or length register, macros that expands to a number.

- The arguments are limited to the range -2147483647 until 2147483647. These numbers belong to the range. Note that some operations have additionals restrictions to the range.

- The argument may be expressions that `\numexpr` understands if ε-TeX is available.

- The resulting number must fit in the allowed range.

1.2.2 Postconditions

Additional properties of the macros apart from calculating a correct result (of course ☺):

- The macros are fully expandable. Thus they can be used inside `\edef`, `\csname`, after `\number`, for example.

- Furthermore exactly two expansion steps calculate the result.

- The number consists of one optional minus sign and one to ten digits. The first digit is larger than zero for numbers that consists of more than one digit.

  In short, the number format is exactly the same as `\number` generates. And the tokens (minus sign, digits) have catcode 12 (other).

- Call by value is simulated. First the arguments are converted to numbers. Then these numbers are used in the calculations.

  Remember that arguments may contain expensive macros or ε-TeX expressions. This strategy avoids multiple evaluations of such arguments.

1.3 Error handling

There are two kinds of errors if a precondition is violated: Some errors are detected by the macros, example: division by zero. In this cases an undefined control sequence is called and causes a TeX error message, example: `\IntCalcError:DivisionByZero`. The name of the control sequence contains the reason for the error. The TeX error may be ignored. Then the operation returns zero as result. Because the macros are supposed to work in expandible contexts. An traditional error message, however, is not expandable and would break these contexts.

If a number exceeds the range of -2147483647 until 2147483647, then TeX throws an error "Number too big" and recovers by using biggest allowed value. Example for the negative number -3000000000 is replaced by -2147483647.

1.4 Operations

Some definition equations below use the function Int that converts a real number to an integer. The number is truncated that means rounding to zero:

$$\text{Int}(x) := \begin{cases} \lfloor x \rfloor & \text{if } x \geq 0 \\ \lceil x \rceil & \text{otherwise} \end{cases}$$

1.4.1 Num

`\intcalcNum {⟨x⟩}`

Macro `\intcalcNum` converts its argument to a normalized integer number without unnecessary leading zeros or signs. The result matches the regular expression:

    0|-?[1-9][0-9]*

1.4.2 Inv, Abs, Sgn

`\intcalcInv {⟨x⟩}`

Macro `\intcalcInv` switches the sign.

$$\mathrm{Inv}(x) := -x$$

`\intcalcAbs {⟨x⟩}`

Macro `\intcalcAbs` returns the absolute value of integer $\langle x \rangle$.

$$\mathrm{Abs}(x) := |x|$$

`\intcalcSgn {⟨x⟩}`

Macro `\intcalcSgn` encodes the sign of $\langle x \rangle$ as number.

$$\mathrm{Sgn}(x) := \begin{cases} -1 & \text{if } x < 0 \\ 0 & \text{if } x = 0 \\ 1 & \text{if } x > 0 \end{cases}$$

These return values can easily be distinguished by `\ifcase`:

```
\ifcase\intcalcSgn{<x>}
  $x=0$
\or
  $x>0$
\else
  $x<0$
\fi
```

1.4.3 Min, Max, Cmp

`\intcalcMin {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMin` returns the smaller of the two integers.

$$\mathrm{Min}(x, y) := \begin{cases} x & \text{if } x < y \\ y & \text{otherwise} \end{cases}$$

`\intcalcMax {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMax` returns the larger of the two integers.

$$\mathrm{Max}(x, y) := \begin{cases} x & \text{if } x > y \\ y & \text{otherwise} \end{cases}$$

`\intcalcCmp {⟨x⟩} {⟨y⟩}`

Macro `\intcalcCmp` encodes the comparison result as number:

$$\mathrm{Cmp}(x, y) := \begin{cases} -1 & \text{if } x < y \\ 0 & \text{if } x = y \\ 1 & \text{if } x > y \end{cases}$$

These values can be distinguished by `\ifcase`:

```
\ifcase\intcalcCmp{<x>}{<y>}
 $x=y$
\or
 $x>y$
\else
 $x<y$
\fi
```

1.4.4 Inc, Dec, Add, Sub

`\intcalcInc {⟨x⟩}`

Macro `\intcalcInc` increments $\langle x \rangle$ by one.

$$\mathrm{Inc}(x) := x + 1$$

`\intcalcDec {⟨x⟩}`

Macro `\intcalcDec` decrements $\langle x \rangle$ by one.

$$\mathrm{Dec}(x) := x - 1$$

`\intcalcAdd {⟨x⟩} {⟨y⟩}`

Macro `\intcalcAdd` adds the two numbers.

$$\mathrm{Add}(x, y) := x + y$$

`\intcalcSub {⟨x⟩} {⟨y⟩}`

Macro `\intcalcSub` calculates the difference.

$$\mathrm{Sub}(x, y) := x - y$$

1.4.5 Shl, Shr

`\intcalcShl {⟨x⟩}`

Macro `\intcalcShl` implements shifting to the left that means the number is multiplied by two. Overflow is possible. The sign is preserved.

$$\mathrm{Shl}(x) := x * 2$$

`\intcalcShr {⟨x⟩}`

Macro `\intcalcShr` implements shifting to the right. That is equivalent to an integer division by two. The sign is preserved.

$$\mathrm{Shr}(x) := \mathrm{Int}(x/2)$$

1.4.6 Mul, Sqr, Fac, Pow

`\intcalcMul {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMul` calculates the product of $\langle x \rangle$ and $\langle y \rangle$.

$$\mathrm{Mul}(x, y) := x * y$$

> `\intcalcSqr {⟨x⟩}`

Macro `\intcalcSqr` returns the square product.

$$\text{Sqr}(x) := x^2$$

> `\intcalcFac {⟨x⟩}`

Macro `\intcalcFac` returns the factorial of $⟨x⟩$. Negative numbers are not permitted.

$$\text{Fac}(x) := x! \qquad \text{for } x \geq 0$$

$(0! = 1)$

> `\intcalcPow {⟨x⟩} {⟨y⟩}`

Macro `\intcalcPow` calculates the value of $⟨x⟩$ to the power of $⟨y⟩$. The error "division by zero" is thrown if $⟨x⟩$ is zero and $⟨y⟩$ is negative. permitted:

$$\text{Pow}(x, y) := \text{Int}(x^y) \qquad \text{for } x \neq 0 \text{ or } y \geq 0$$

$(0^0 = 1)$

1.4.7 Div, Mod

> `\intcalcDiv {⟨x⟩} {⟨y⟩}`

Macro `\intcalcDiv` performs an integer division. Argument $⟨y⟩$ must not be zero.

$$\text{Div}(x, y) := \text{Int}(x/y) \qquad \text{for } y \neq 0$$

> `\intcalcMod {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMod` gets the remainder of the integer division. The sign follows the divisor $⟨y⟩$. Argument $⟨y⟩$ must not be zero.

$$\text{Mod}(x, y) := x \mathbin{\%} y \qquad \text{for } y \neq 0$$

The result ranges:

$$-|y| < \text{Mod}(x, y) \leq 0 \qquad \text{for } y < 0$$
$$0 \leq \text{Mod}(x, y) < y \qquad \text{for } y \geq 0$$

1.5 Interface for programmer

If the programmer can ensure some more properties about the arguments of the operations, then the following macros are a little more efficient.

In general numbers must obey the following constraints:

- Plain number: digit tokens only, no command tokens.

- Non-negative. Signs are forbidden.

- Arguments and the result must fit in range `0..2147483647`.

- Delimited by exclamation mark. Curly braces around the number are not allowed and will break the code.

\IntCalcInc ⟨*number*⟩ !

Incrementation, range: 0..2147483646.

\IntCalcDec ⟨*number*⟩ !

Decrementation, range: 1..2147483647.

\IntCalcAdd ⟨*number A*⟩ ! ⟨*number B*⟩ !

Addition, $A \geq B$.

\IntCalcSub ⟨*number A*⟩ ! ⟨*number B*⟩ !

Subtraction, $A \geq B$.

\IntCalcShl ⟨*number*⟩ !

Left shift (multiplication with two), range: 0..1073741823.

\IntCalcShr ⟨*number*⟩ !

Right shift (integer division by two).

\IntCalcMul ⟨*number A*⟩ ! ⟨*number B*⟩ !

Multiplication, $A \geq B$.

\IntCalcDiv ⟨*number A*⟩ ! ⟨*number B*⟩ !

Division operation.

\IntCalcMod ⟨*number A*⟩ ! ⟨*number B*⟩ !

Modulo operation.

2 Implementation

1 ⟨*package⟩

2.1 Reload check and package identification

Reload check, especially if the package is not used with LaTeX.

```
2 \begingroup\catcode61\catcode48\catcode32=10\relax%
3  \catcode13=5 % ^^M
4  \endlinechar=13 %
5  \catcode35=6 % #
6  \catcode39=12 % '
7  \catcode44=12 % ,
8  \catcode45=12 % -
9  \catcode46=12 % .
10  \catcode58=12 % :
11  \catcode64=11 % @
12  \catcode123=1 % {
13  \catcode125=2 % }
```

```
14  \expandafter\let\expandafter\x\csname ver@intcalc.sty\endcsname
15  \ifx\x\relax % plain-TeX, first loading
16  \else
17    \def\empty{}%
18    \ifx\x\empty % LaTeX, first loading,
19      % variable is initialized, but \ProvidesPackage not yet seen
20    \else
21      \expandafter\ifx\csname PackageInfo\endcsname\relax
22        \def\x#1#2{%
23          \immediate\write-1{Package #1 Info: #2.}%
24        }%
25      \else
26        \def\x#1#2{\PackageInfo{#1}{#2, stopped}}%
27      \fi
28      \x{intcalc}{The package is already loaded}%
29      \aftergroup\endinput
30    \fi
31  \fi
32  \endgroup%
```

Package identification:

```
33  \begingroup\catcode61\catcode48\catcode32=10\relax%
34    \catcode13=5 % ^^M
35    \endlinechar=13 %
36    \catcode35=6 % #
37    \catcode39=12 % '
38    \catcode40=12 % (
39    \catcode41=12 % )
40    \catcode44=12 % ,
41    \catcode45=12 % -
42    \catcode46=12 % .
43    \catcode47=12 % /
44    \catcode58=12 % :
45    \catcode64=11 % @
46    \catcode91=12 % [
47    \catcode93=12 % ]
48    \catcode123=1 % {
49    \catcode125=2 % }
50  \expandafter\ifx\csname ProvidesPackage\endcsname\relax
51    \def\x#1#2#3[#4]{\endgroup
52      \immediate\write-1{Package: #3 #4}%
53      \xdef#1{#4}%
54    }%
55  \else
56    \def\x#1#2[#3]{\endgroup
57      #2[{#3}]%
58      \ifx#1\@undefined
59        \xdef#1{#3}%
60      \fi
61      \ifx#1\relax
62        \xdef#1{#3}%
63      \fi
64    }%
65  \fi
66  \expandafter\x\csname ver@intcalc.sty\endcsname
67  \ProvidesPackage{intcalc}%
68    [2016/05/16 v1.2 Expandable calculations with integers (HO)]%
```

2.2   Catcodes

```
69  \begingroup\catcode61\catcode48\catcode32=10\relax%
70    \catcode13=5 % ^^M
71    \endlinechar=13 %
```

```
72 \catcode123=1 % {
73 \catcode125=2 % }
74 \catcode64=11 % @
75 \def\x{\endgroup
76   \expandafter\edef\csname InCa@AtEnd\endcsname{%
77     \endlinechar=\the\endlinechar\relax
78     \catcode13=\the\catcode13\relax
79     \catcode32=\the\catcode32\relax
80     \catcode35=\the\catcode35\relax
81     \catcode61=\the\catcode61\relax
82     \catcode64=\the\catcode64\relax
83     \catcode123=\the\catcode123\relax
84     \catcode125=\the\catcode125\relax
85   }%
86 }%
87 \x\catcode61\catcode48\catcode32=10\relax%
88 \catcode13=5 % ^^M
89 \endlinechar=13 %
90 \catcode35=6 % #
91 \catcode64=11 % @
92 \catcode123=1 % {
93 \catcode125=2 % }
94 \def\TMP@EnsureCode#1#2{%
95   \edef\InCa@AtEnd{%
96     \InCa@AtEnd
97     \catcode#1=\the\catcode#1\relax
98   }%
99   \catcode#1=#2\relax
100 }
101 \TMP@EnsureCode{33}{12}% !
102 \TMP@EnsureCode{40}{12}% (
103 \TMP@EnsureCode{41}{12}% )
104 \TMP@EnsureCode{42}{12}% *
105 \TMP@EnsureCode{43}{12}% +
106 \TMP@EnsureCode{45}{12}% -
107 \TMP@EnsureCode{47}{12}% /
108 \TMP@EnsureCode{58}{11}% : (letter!)
109 \TMP@EnsureCode{60}{12}% <
110 \TMP@EnsureCode{62}{12}% >
111 \TMP@EnsureCode{63}{14}% ? (comment!)
112 \edef\InCa@AtEnd{\InCa@AtEnd\noexpand\endinput}
113 \begingroup\expandafter\expandafter\expandafter\endgroup
114 \expandafter\ifx\csname InCa@TestMode\endcsname\relax
115 \else
116   \catcode63=9 % ? (ignore)
117 \fi
118 ? \let\InCa@@TestMode\InCa@TestMode
```

2.3 Macros independent of ε-TeX

2.3.1 Abs, Sgn

\InCa@Abs

```
119 \def\InCa@Abs#1#2!{%
120   \ifx#1-%
121     #2%
122   \else
123     #1#2%
124   \fi
125 }
```

\InCa@Sgn

```
126 \def\InCa@Sgn#1#2!{%
```

```
127  \ifx#1-%
128    -1%
129  \else
130    \ifx#10%
131      0%
132    \else
133      1%
134    \fi
135  \fi
136 }
```

2.3.2   Min, Max, Cmp

\InCa@Min

```
137 \def\InCa@Min#1!#2!{%
138  \ifnum#1<#2 %
139    #1%
140  \else
141    #2%
142  \fi
143 }
```

\InCa@Max

```
144 \def\InCa@Max#1!#2!{%
145  \ifnum#1>#2 %
146    #1%
147  \else
148    #2%
149  \fi
150 }
```

\InCa@Cmp

```
151 \def\InCa@Cmp#1!#2!{%
152  \ifnum#1=#2 %
153    0%
154  \else
155    \ifnum#1<#2 %
156      -%
157    \fi
158    1%
159  \fi
160 }
```

2.3.3   Fac

\InCa@Fac   It does not make much sense to calculate the faculty by an general algorithm. The allowed range of arguments is too low because of the limited integer domain.

```
161 \def\InCa@Fac#1!{%
162  \ifcase#1 1% 0!
163  \or 1% 1!
164  \or 2% 2!
165  \or 6% 3!
166  \or 24% 4!
167  \or 120% 5!
168  \or 720% 6!
169  \or 5040% 7!
170  \or 40320% 8!
171  \or 362880% 9!
172  \or 3628800% 10!
173  \or 39916800% 11!
174  \or 479001600% 12!
175  \else
```

10

```
176    \ifnum#1<\z@
177      0\IntCalcError:FacNegative%
178    \else
179      0\IntCalcError:FacOverflow%
180    \fi
181  \fi
182 }
```

2.4 Implementation based on ε-TeX

Only \numexpr is used from ε-TeX.

```
183 \begingroup\expandafter\expandafter\expandafter\endgroup
184 \expandafter\ifx\csname numexpr\endcsname\relax
185 \else
```

2.4.1 Num

\intcalcNum

```
186    \def\intcalcNum#1{%
187      \the\numexpr#1\relax
188    }%
```

2.4.2 Inv, Abs, Sgn

\intcalcInv

```
189    \def\intcalcInv#1{%
190      \number-\intcalcNum{#1} %
191    }%
```

\intcalcAbs

```
192    \def\intcalcAbs#1{%
193      \number\expandafter\InCa@Abs\the\numexpr#1! %
194    }%
```

\intcalcSgn

```
195    \def\intcalcSgn#1{%
196      \number\expandafter\InCa@Sgn\the\numexpr#1! %
197    }%
```

2.4.3 Min, Max, Cmp

\intcalcMin

```
198    \def\intcalcMin#1#2{%
199      \number\expandafter\InCa@Min
200      \the\numexpr#1\expandafter!%
201      \the\numexpr#2! %
202    }%
```

\intcalcMax

```
203    \def\intcalcMax#1#2{%
204      \number\expandafter\InCa@Max
205      \the\numexpr#1\expandafter!%
206      \the\numexpr#2! %
207    }%
```

\intcalcCmp

```
208    \def\intcalcCmp#1#2{%
209      \number\expandafter\InCa@Cmp
210      \the\numexpr#1\expandafter!\the\numexpr#2! %
211    }%
```

11

2.4.4 Inc, Dec

\intcalcInc

```
212 \def\intcalcInc#1{%
213   \the\numexpr#1+1\relax
214 }%
```

\intcalcDec

```
215 \def\intcalcDec#1{%
216   \the\numexpr#1-1\relax
217 }%
```

\IntCalcInc

```
218 \def\IntCalcInc#1!{%
219   \the\numexpr#1+1\relax
220 }%
```

\IntCalcDec

```
221 \def\IntCalcDec#1!{%
222   \the\numexpr#1-1\relax
223 }%
```

2.4.5 Add, Sub

\intcalcAdd

```
224 \def\intcalcAdd#1#2{%
225   \the\numexpr#1+(#2)\relax
226 }%
```

\intcalcSub

```
227 \def\intcalcSub#1#2{%
228   \the\numexpr#1-(#2)\relax
229 }%
```

\IntCalcAdd

```
230 \def\IntCalcAdd#1!#2!{%
231   \the\numexpr#1+#2\relax
232 }%
```

\IntCalcSub

```
233 \def\IntCalcSub#1!#2!{%
234   \the\numexpr#1-#2\relax
235 }%
```

2.4.6 Shl, Shr

\intcalcShl

```
236 \def\intcalcShl#1{%
237   \the\numexpr(#1)*2\relax
238 }%
```

\intcalcShr

```
239 \def\intcalcShr#1{%
240   \number\expandafter\InCa@Shr\the\numexpr#1! %
241 }%
```

\IntCalcShl

```
242 \def\IntCalcShl#1!{%
243   \the\numexpr#1*2\relax
244 }%
```

\IntCalcShr

```
245  \def\IntCalcShr#1!{%
246    \the\numexpr\ifodd#1 (#1-1)\else#1\fi/2\relax
247  }%
```

\InCa@Shr

```
248  \def\InCa@Shr#1#2!{%
249    \ifx#1-%
250      -\InCa@Shr#2!%
251    \else
252      \ifodd#1#2 %
253        \the\numexpr(#1#2-1)/2\relax
254      \else
255        \the\numexpr#1#2/2\relax
256      \fi
257    \fi
258  }%
```

2.4.7 Mul, Sqr, Fac

\intcalcMul

```
259  \def\intcalcMul#1#2{%
260    \the\numexpr(#1)*(#2)\relax
261  }%
```

\IntCalcMul

```
262  \def\IntCalcMul#1!#2!{%
263    \the\numexpr#1*#2\relax
264  }%
```

\intcalcSqr

```
265  \def\intcalcSqr#1{%
266    \number\expandafter\InCa@Sqr\the\numexpr#1! %
267  }%
```

\InCa@Sqr

```
268  \def\InCa@Sqr#1!{%
269    \the\numexpr#1*#1\relax
270  }%
```

\intcalcFac

```
271  \def\intcalcFac#1{%
272    \number\expandafter\InCa@Fac\the\numexpr#1! %
273  }%
```

2.4.8 Pow

\intcalcPow

```
274  \def\intcalcPow#1#2{%
275    \number\expandafter\InCa@Pow
276    \the\numexpr#1\expandafter!%
277    \the\numexpr#2! %
278  }%
```

\InCa@Pow

```
279  \def\InCa@Pow#1#2!#3#4!{%
280    \ifcase#3#4 % power = 0
281      1%
282    \or % power = 1
283      #1#2%
284    \or % power = 2
```

13

```
285        \the\numexpr#1#2*#1#2\relax
286      \else
287        \ifcase#1#2 % basis = 0, power <> 0
288          0%
289          \ifx#3-% power < 0
290            0\IntCalcError:DivisionByZero%
291          \fi
292        \or
293          1% basis = 1
294        \else
295          \ifnum#1#2=\m@ne % basis = -1
296            \ifodd#3#4 %
297              -%
298            \fi
299            1%
300          \else % |basis| > 1
301            \ifx#3-% power < 0
302              0%
303            \else % power > 2
304              \InCa@PowRec#1#2!#3#4!1!%
305            \fi
306          \fi
307        \fi
308      \fi
309    }%
```

\InCa@PowRec
```
             Pow(b, p) {
               PowRec(b, p, 1)
             }
             PowRec(b, p, r) {
               if p == 1 then
                 return r*b
               else
                 ifodd p then
                   return PowRec(b*b, (p-1)/2, r*b) % p div 2 = (p-1)/2
                 else
                   return PowRec(b*b, (p-1)/2, r)
                 fi
               fi
             }
```
```
310    \def\InCa@PowRec#1!#2!#3!{%
311      \ifnum#2=\@ne
312        \the\numexpr#1*#3\relax
313      \else
314        \ifodd#2 %
315          \expandafter\InCa@PowRec
316          \the\numexpr#1*#1\expandafter!%
317          \the\numexpr(#2-1)/2\expandafter!%
318          \the\numexpr#1*#3\expandafter\expandafter\expandafter!%
319        \else
320          \expandafter\InCa@PowRec
321          \the\numexpr#1*#1\expandafter!%
322          \the\numexpr(#2-1)/2\expandafter!%
323          \number#3\expandafter\expandafter\expandafter!%
324        \fi
325      \fi
326    }%
```

2.4.9 Div, Mod

TeX's \divide truncates, ε-TeX's \numexpr rounds the result of a division. The rounding method is called "Symmetric Arithmetic Rounding" or "Round-Half-Up" ("Kaufmännisches Runden" in German):

```
         1 =   3 divide 2 =   1.5 = numexpr  3/2 =  2
        -1 = -3 divide 2 = -1.5 = numexpr -3/2 = -2
```

Macro \intcalcDiv follows TEX and truncates. The calculation is done by the following formula:

$$\mathrm{Div}(X,Y) = (X - (Y-1)/2)/Y \qquad \text{for } X, Y > 0 \tag{1}$$

The operator '/' is \numexpr's division.

\intcalcDiv

```
327  \def\intcalcDiv#1#2{%
328    \number\expandafter\InCa@Div
329    \the\numexpr#1\expandafter!%
330    \the\numexpr#2! %
331  }%
```

\InCa@Div

```
332  \def\InCa@Div#1!#2!{%
333    \ifcase#2 %
334      0\IntCalcError:DivisionByZero%
335    \else
336      \ifcase#1 %
337        0%
338      \else
339        \expandafter\InCa@@Div
340        \romannumeral 0%
341        \ifnum#1<\z@
342          \expandafter-\number-#1%
343        \else
344          \expandafter+\number#1%
345        \fi
346        \expandafter!%
347        \romannumeral 0%
348        \ifnum#2<\z@
349          \expandafter-\number-#2%
350        \else
351          \expandafter+\number#2%
352        \fi
353        !%
354      \fi
355    \fi
356  }%
```

\IntCalcDiv

```
357  \def\InCa@Temp#1{%
358    \def\IntCalcDiv##1!##2!{%
359      \number
360      \ifcase##2 %
361        0\IntCalcError:DivisionByZero%
362      \else
363        \ifcase##1 %
364          0%
365        \else
366          \the\numexpr(##1-(##2-1)/2)/##2\relax
367        \fi
368      \fi
369      #1%
370    }%
371  }%
372  \InCa@Temp{ }%
```

15

```
373  \def\InCa@@Div#1#2!#3#4!{%
374    #1#3%
375    \the\numexpr(#2-(#4-1)/2)/#4\relax
376  }%
```

```
377  \def\intcalcMod#1#2{%
378    \number\expandafter\InCa@Mod
379    \the\numexpr#1\expandafter!%
380    \the\numexpr#2! %
381  }%
```

```
382  \def\InCa@Mod#1!#2!{%
383    \ifcase#2 %
384      0\IntCalcError:DivisionByZero%
385    \else
386     \ifcase#1 %
387       0%
388     \else
389       \expandafter\InCa@@Mod
390       \romannumeral 0%
391       \ifnum#1<\z@
392         \expandafter-\number-#1%
393       \else
394         \expandafter+\number#1%
395       \fi
396       \expandafter!%
397       \romannumeral 0%
398       \ifnum#2<\z@
399         \expandafter-\number-#2%
400       \else
401         \expandafter+\number#2%
402       \fi
403       !%
404     \fi
405    \fi
406  }%
```

```
407  \def\InCa@Temp#1{%
408    \def\IntCalcMod##1!##2!{%
409      \number
410      \ifcase##2 %
411        0\IntCalcError:DivisionByZero%
412      \else
413       \ifcase##1 %
414         0%
415       \else
416         \the\numexpr##1-(##1-(##2-1)/2)/##2*##2\relax
417       \fi
418      \fi
419      #1%
420    }%
421  }%
422  \InCa@Temp{ }%
```

```
423  \def\InCa@@Mod#1#2!#3#4!{%
424    \if#3+%
425      \if#1+%
```

16

```
426        \the\numexpr#2-\InCa@@Div+#2!+#4!*#4\relax
427      \else
428        \expandafter\InCa@ModX
429        \the\numexpr-#2+\InCa@@Div+#2!+#4!*#4!#4!%
430      \fi
431    \else
432      -%
433      \if#1+%
434        \expandafter\InCa@ModX
435        \the\numexpr-#2+\InCa@@Div+#2!+#4!*#4!#4!%
436      \else
437        \the\numexpr#2-\InCa@@Div+#2!+#4!*#4\relax
438      \fi
439    \fi
440  }%
```

\InCa@ModX

```
441  \def\InCa@ModX#1!#2!{%
442    \ifcase#1 %
443      0%
444    \else
445      \the\numexpr#1+#2\relax
446    \fi
447  }%
```

```
448    \expandafter\InCa@AtEnd
449  \fi%
```

2.5 Implementation without ε-TeX

2.5.1 Num

\intcalcNum

```
450  \def\intcalcNum#1{%
451    \number\expandafter\InCa@FirstOfOne\number#1! %
452  }
```

2.5.2 Inv, Abs, Sgn

\intcalcInv

```
453  \def\intcalcInv#1{%
454    \number\expandafter\InCa@FirstOfOne\number-#1! %
455  }
```

\InCa@FirstOfOne

```
456  \def\InCa@FirstOfOne#1!{#1}
```

\intcalcAbs

```
457  \def\intcalcAbs#1{%
458    \number\expandafter\InCa@Abs\number#1! %
459  }
```

\intcalcSgn

```
460  \def\intcalcSgn#1{%
461    \number\expandafter\InCa@Sgn\number#1! %
462  }
```

2.5.3 Min, Max, Cmp

\intcalcMin

```
463 \def\intcalcMin#1#2{%
464   \number\expandafter\InCa@Min
465   \number\number#1\expandafter!\number#2! %
466 }
```

\intcalcMax

```
467 \def\intcalcMax#1#2{%
468   \number\expandafter\InCa@Max
469   \number\number#1\expandafter!\number#2! %
470 }
```

\intcalcCmp

```
471 \def\intcalcCmp#1#2{%
472   \number\expandafter\InCa@Cmp
473   \number\number#1\expandafter!\number#2! %
474 }%
```

2.5.4 Inc, Dec

\intcalcInc

```
475 \def\intcalcInc#1{%
476   \number\expandafter\InCa@IncSwitch\number#1! %
477 }
```

\InCa@IncSwitch

```
478 \def\InCa@IncSwitch#1#2!{%
479   \ifx#1-%
480     -%
481     \csname InCa@Empty%
482     \InCa@Dec#2!%
483   \else
484     \csname InCa@Empty%
485     \InCa@Inc#1#2!%
486   \fi
487 }
```

\intcalcDec

```
488 \def\intcalcDec#1{%
489   \number\expandafter\InCa@DecSwitch\number#1! %
490 }
```

\InCa@DecSwitch

```
491 \def\InCa@DecSwitch#1#2!{%
492   \ifx#1-%
493     -%
494     \csname InCa@Empty%
495     \expandafter\InCa@Inc#2!%
496   \else
497     \ifx#10%
498       -1%
499     \else
500       \csname InCa@Empty%
501       \InCa@Dec#1#2!%
502     \fi
503   \fi
504 }
```

\IntCalcInc

```
505 \def\IntCalcInc#1!{%
506   \number\csname InCa@Empty\InCa@Inc#1! %
507 }
```

\IntCalcDec

```
508 \def\IntCalcDec#1!{%
509   \number\csname InCa@Empty\InCa@Dec#1! %
510 }
```

\InCa@Inc

```
511 \def\InCa@Inc#1#2{%
512 \ifx#2!%
513   \csname InCa@IncDigit#1\endcsname1%
514 \else
515   \csname InCa@IncDigit#1%
516   \expandafter\InCa@Inc\expandafter#2%
517 \fi
518 }
```

\InCa@IncDigit[0-8]

```
519 \def\InCa@Temp#1#2{%
520   \expandafter\def\csname InCa@IncDigit#1\endcsname##1{%
521     \endcsname
522     0%
523     \ifcase##1 %
524       #1%
525     \else
526       #2%
527     \fi
528   }%
529 }
530 \InCa@Temp 01
531 \InCa@Temp 12
532 \InCa@Temp 23
533 \InCa@Temp 34
534 \InCa@Temp 45
535 \InCa@Temp 56
536 \InCa@Temp 67
537 \InCa@Temp 78
538 \InCa@Temp 89
```

\InCa@IncDigit9

```
539 \expandafter\def\csname InCa@IncDigit9\endcsname#1{%
540   \expandafter\endcsname
541   \ifcase#1 %
542     09%
543   \else
544     10%
545   \fi
546 }
```

\InCa@Dec

```
547 \def\InCa@Dec#1#2{%
548 \ifx#2!%
549   \csname InCa@DecDigit#1\endcsname1%
550 \else
551   \csname InCa@DecDigit#1%
552   \expandafter\InCa@Dec\expandafter#2%
553 \fi
554 }
```

```
555 \def\InCa@Temp#1#2{%
556   \expandafter\def\csname InCa@DecDigit#1\endcsname##1{%
557     \endcsname
558     0%
559     \ifcase##1 %
560       #1%
561     \else
562       #2%
563     \fi
564   }%
565 }
566 \InCa@Temp 98
567 \InCa@Temp 87
568 \InCa@Temp 76
569 \InCa@Temp 65
570 \InCa@Temp 54
571 \InCa@Temp 43
572 \InCa@Temp 32
573 \InCa@Temp 21
574 \InCa@Temp 10
```

```
575 \expandafter\def\csname InCa@DecDigit0\endcsname#1{%
576   \expandafter\endcsname
577   \ifcase#1 %
578     00%
579   \else
580     19%
581   \fi
582 }
```

2.5.5 Add, Sub

```
583 \def\intcalcAdd#1#2{%
584   \number
585     \expandafter\InCa@AddSwitch
586     \number\number#1\expandafter!%
587     \number#2! %
588 }
```

```
589 \def\intcalcSub#1#2{%
590   \number
591     \expandafter\InCa@AddSwitch
592     \number\number#1\expandafter!%
593     \number-\number#2! %
594 }
```

Decision table for \InCa@AddSwitch. The sign of negative numbers can be removed by a simple \@gobble instead of the more expensive \number-.

$x < 0$	$y < 0$	$x < y$	$-$	Add$(-x, -y)$
		else		Add$(-y, -x)$
	else	$-x > y$	$-$	Sub$(-x, y)$
		else	$+$	Sub$(y, -x)$
else	$y < 0$	$x > -y$	$+$	Sub$(x, -y)$
		else	$-$	Sub$(-y, x)$
	else	$x > y$	$+$	Add(x, y)
		else		Add(y, x)

20

```
595 \def\InCa@AddSwitch#1!#2!{%
596   \ifnum#1<\z@
597     \ifnum#2<\z@
598       -%
599       \ifnum#1<#2 %
600         \expandafter\InCa@Add\number-#1\expandafter!%
601         \@gobble#2!%
602       \else
603         \expandafter\InCa@Add\number-#2\expandafter!%
604         \@gobble#1!%
605       \fi
606     \else
607       \ifnum-#1>#2 %
608         -%
609         \expandafter\InCa@Sub\@gobble#1!#2!%
610       \else
611         \expandafter\InCa@Sub\number#2\expandafter!%
612         \@gobble#1!%
613       \fi
614     \fi
615   \else
616     \ifnum#2<\z@
617     \ifnum#1>-#2 %
618       \expandafter\InCa@Sub\number#1\expandafter!%
619       \@gobble#2!%
620     \else
621       -%
622       \expandafter\InCa@Sub\@gobble#2!#1!%
623     \fi
624   \else
625     \ifnum#1>#2 %
626       \InCa@Add#1!#2!%
627     \else
628       \InCa@Add#2!#1!%
629     \fi
630   \fi
631 \fi
632 }
```

\IntCalcAdd

```
633 \def\IntCalcAdd#1!#2!{%
634   \number\InCa@Add#1!#2! %
635 }
```

\IntCalcSub

```
636 \def\IntCalcSub#1!#2!{%
637   \number\InCa@Sub#1!#2! %
638 }
```

\InCa@Space

```
639 \begingroup
640   \def\x#1{\endgroup
641     \let\InCa@Space= #1%
642   }%
643 \x{ }
```

\InCa@Add

```
644 \def\InCa@Add#1!#2!{%
645   \ifcase#2 %
646     #1%
647   \else
648     \InCa@@Add#1!#2!000000000\InCa@Space
```

```
649   \fi
650 }
```

```
651 \def\InCa@Sub#1!#2!{%
652   \ifnum#1=#2 %
653     0%
654   \else
655     \InCa@@Sub#1!#2!000000000\InCa@Space
656   \fi
657 }
```

```
658 \def\InCa@@Add#1!#2#3!{%
659   \ifx\InCa@Empty#3\InCa@Empty
660     \@ReturnAfterElseFi{%
661       \InCa@@@Add!!#1!#2%
662     }%
663   \else
664     \@ReturnAfterFi{%
665       \InCa@@Add#1!#3!#2%
666     }%
667   \fi
668 }
```

```
669 \def\InCa@@Sub#1!#2#3!{%
670   \ifx\InCa@Empty#3\InCa@Empty
671     \@ReturnAfterElseFi{%
672       \InCa@@@Sub!!#1!#2%
673     }%
674   \else
675     \@ReturnAfterFi{%
676       \InCa@@Sub#1!#3!#2%
677     }%
678   \fi
679 }
```

```
680 \def\InCa@@@Add#1!#2!#3#4!#5{%
681   \ifx\InCa@Empty#4\InCa@Empty
682     \csname InCa@Empty%
683     \@ReturnAfterElseFi{%
684       \InCa@ProcessAdd#1#3!#5#2%
685     }%
686   \else
687     \@ReturnAfterFi{%
688       \InCa@@@Add#1#3!#5#2!#4!%
689     }%
690   \fi
691 }
```

```
692 \def\InCa@@@Sub#1!#2!#3#4!#5{%
693   \ifx\InCa@Empty#4\InCa@Empty
694     \csname @gobble%
695     \@ReturnAfterElseFi{%
696       \InCa@ProcessSub#1#3!#5#2%
697     }%
698   \else
699     \@ReturnAfterFi{%
700       \InCa@@@Sub#1#3!#5#2!#4!%
```

```
701     }%
702   \fi
703 }
```

\InCa@ProcessAdd

```
704 \def\InCa@ProcessAdd#1#2!#3#4{%
705   \ifx\InCa@Empty#2\InCa@Empty
706     \csname InCa@AddDigit#1\endcsname#3%
707     \romannumeral0#4%
708   \else
709     \csname InCa@AddDigit#1\csname InCa@DigitCarry#3%
710     \@ReturnAfterFi{%
711       \InCa@ProcessAdd#2!#4%
712     }%
713   \fi
714 }
```

\InCa@ProcessSub

```
715 \def\InCa@ProcessSub#1#2!#3#4{%
716   \ifx\InCa@Empty#2\InCa@Empty
717     \csname InCa@SubDigit#1\endcsname#3%
718     \romannumeral0#4%
719   \else
720     \csname InCa@SubDigit#1\csname InCa@DigitCarry#3%
721     \@ReturnAfterFi{%
722       \InCa@ProcessSub#2!#4%
723     }%
724   \fi
725 }
```

\InCa@DigitCarry[0-9]

```
726 \def\InCa@Temp#1#2{%
727   \expandafter\def\csname InCa@DigitCarry#1\endcsname##1{%
728     \ifcase##1 %
729       \endcsname#1%
730     \else
731       \endcsname#2%
732     \fi
733   }%
734 }
735 \InCa@Temp 01
736 \InCa@Temp 12
737 \InCa@Temp 23
738 \InCa@Temp 34
739 \InCa@Temp 45
740 \InCa@Temp 56
741 \InCa@Temp 67
742 \InCa@Temp 78
743 \InCa@Temp 89
744 \InCa@Temp 9{{10}}
```

\InCa@AddDigit0

```
745 \expandafter\def\csname InCa@AddDigit0\endcsname#1{%
746   \ifnum#1>9 %
747     \endcsname10%
748   \else
749     \endcsname0#1%
750   \fi
751 }
```

\InCa@AddDigit[1-9]

```
752 \def\InCa@Temp#1#2#3{%
```

```
753  \expandafter\def\csname InCa@AddDigit#1\endcsname##1{%
754    \ifnum##1>#2 %
755      \endcsname 1%
756    \else
757      \endcsname 0%
758    \fi
759    \ifcase##1 #1% 0
760    #3%
761    \else #1% 10
762    \fi
763  }%
764 }
765 \InCa@Temp 18{%
766   \or 2% 1
767   \or 3% 2
768   \or 4% 3
769   \or 5% 4
770   \or 6% 5
771   \or 7% 6
772   \or 8% 7
773   \or 9% 8
774   \or 0% 9
775 }%
776 \InCa@Temp 27{%
777   \or 3% 1
778   \or 4% 2
779   \or 5% 3
780   \or 6% 4
781   \or 7% 5
782   \or 8% 6
783   \or 9% 7
784   \or 0% 8
785   \or 1% 9
786 }%
787 \InCa@Temp 36{%
788   \or 4% 1
789   \or 5% 2
790   \or 6% 3
791   \or 7% 4
792   \or 8% 5
793   \or 9% 6
794   \or 0% 7
795   \or 1% 8
796   \or 2% 9
797 }%
798 \InCa@Temp 45{%
799   \or 5% 1
800   \or 6% 2
801   \or 7% 3
802   \or 8% 4
803   \or 9% 5
804   \or 0% 6
805   \or 1% 7
806   \or 2% 8
807   \or 3% 9
808 }%
809 \InCa@Temp 54{%
810   \or 6% 1
811   \or 7% 2
812   \or 8% 3
813   \or 9% 4
814   \or 0% 5
```

```
815  \or 1% 6
816  \or 2% 7
817  \or 3% 8
818  \or 4% 9
819 }%
820 \InCa@Temp 63{%
821  \or 7% 1
822  \or 8% 2
823  \or 9% 3
824  \or 0% 4
825  \or 1% 5
826  \or 2% 6
827  \or 3% 7
828  \or 4% 8
829  \or 5% 9
830 }%
831 \InCa@Temp 72{%
832  \or 8% 1
833  \or 9% 2
834  \or 0% 3
835  \or 1% 4
836  \or 2% 5
837  \or 3% 6
838  \or 4% 7
839  \or 5% 8
840  \or 6% 9
841 }%
842 \InCa@Temp 81{%
843  \or 9% 1
844  \or 0% 2
845  \or 1% 3
846  \or 2% 4
847  \or 3% 5
848  \or 4% 6
849  \or 5% 7
850  \or 6% 8
851  \or 7% 9
852 }%
853 \InCa@Temp 90{%
854  \or 0% 1
855  \or 1% 2
856  \or 2% 3
857  \or 3% 4
858  \or 4% 5
859  \or 5% 6
860  \or 6% 7
861  \or 7% 8
862  \or 8% 9
863 }%
```

\InCa@SubDigit[0-9]

```
864 \def\InCa@Temp#1#2{%
865  \expandafter\def\csname InCa@SubDigit#1\endcsname##1{%
866   \ifnum##1>#1 %
867    \endcsname 1%
868   \else
869    \endcsname 0%
870   \fi
871   \ifcase##1 #1% 0
872   #2%
873   \else #1% 10
874   \fi
875  }%
```

25

```
876 }
877 \InCa@Temp 0{%
878   \or 9% 1
879   \or 8% 2
880   \or 7% 3
881   \or 6% 4
882   \or 5% 5
883   \or 4% 6
884   \or 3% 7
885   \or 2% 8
886   \or 1% 9
887 }
888 \InCa@Temp 1{%
889   \or 0% 1
890   \or 9% 2
891   \or 8% 3
892   \or 7% 4
893   \or 6% 5
894   \or 5% 6
895   \or 4% 7
896   \or 3% 8
897   \or 2% 9
898 }
899 \InCa@Temp 2{%
900   \or 1% 1
901   \or 0% 2
902   \or 9% 3
903   \or 8% 4
904   \or 7% 5
905   \or 6% 6
906   \or 5% 7
907   \or 4% 8
908   \or 3% 9
909 }
910 \InCa@Temp 3{%
911   \or 2% 1
912   \or 1% 2
913   \or 0% 3
914   \or 9% 4
915   \or 8% 5
916   \or 7% 6
917   \or 6% 7
918   \or 5% 8
919   \or 4% 9
920 }
921 \InCa@Temp 4{%
922   \or 3% 1
923   \or 2% 2
924   \or 1% 3
925   \or 0% 4
926   \or 9% 5
927   \or 8% 6
928   \or 7% 7
929   \or 6% 8
930   \or 5% 9
931 }
932 \InCa@Temp 5{%
933   \or 4% 1
934   \or 3% 2
935   \or 2% 3
936   \or 1% 4
937   \or 0% 5
```

```
938  \or 9% 6
939  \or 8% 7
940  \or 7% 8
941  \or 6% 9
942 }
943 \InCa@Temp 6{%
944  \or 5% 1
945  \or 4% 2
946  \or 3% 3
947  \or 2% 4
948  \or 1% 5
949  \or 0% 6
950  \or 9% 7
951  \or 8% 8
952  \or 7% 9
953 }
954 \InCa@Temp 7{%
955  \or 6% 1
956  \or 5% 2
957  \or 4% 3
958  \or 3% 4
959  \or 2% 5
960  \or 1% 6
961  \or 0% 7
962  \or 9% 8
963  \or 8% 9
964 }
965 \InCa@Temp 8{%
966  \or 7% 1
967  \or 6% 2
968  \or 5% 3
969  \or 4% 4
970  \or 3% 5
971  \or 2% 6
972  \or 1% 7
973  \or 0% 8
974  \or 9% 9
975 }
976 \InCa@Temp 9{%
977  \or 8% 1
978  \or 7% 2
979  \or 6% 3
980  \or 5% 4
981  \or 4% 5
982  \or 3% 6
983  \or 2% 7
984  \or 1% 8
985  \or 0% 9
986 }
```

2.5.6 Shl, Shr

\intcalcShl

```
987 \def\intcalcShl#1{%
988  \number\expandafter\InCa@ShlSwitch\number#1! %
989 }
```

\InCa@ShlSwitch

```
990 \def\InCa@ShlSwitch#1#2!{%
991  \ifx#1-%
992    -\csname InCa@Empty%
993    \InCa@Shl#2!%
```

```
994   \else
995     \csname InCa@Empty%
996     \InCa@Shl#1#2!%
997   \fi
998 }
```

\IntCalcShl

```
 999 \def\IntCalcShl#1!{%
1000   \number
1001   \csname InCa@Empty%
1002   \InCa@Shl#1! %
1003 }
```

\IntCal@ShlDigit

```
1004 \def\InCa@Shl#1#2{%
1005   \ifx#2!%
1006     \csname InCa@ShlDigit#1\endcsname0%
1007   \else
1008     \csname InCa@ShlDigit#1%
1009     \@ReturnAfterFi{%
1010       \InCa@Shl#2%
1011     }%
1012   \fi
1013 }
```

\InCa@ShlDigit0

```
1014 \expandafter\def\csname InCa@ShlDigit0\endcsname{%
1015   \endcsname0%
1016 }
```

\InCa@ShlDigit[1-9]

```
1017 \def\InCa@Temp#1#2#3#4#5{%
1018   \expandafter\def\csname InCa@ShlDigit#1\endcsname##1{%
1019     \expandafter\endcsname
1020     \ifcase##1 %
1021       #2#3%
1022     \else
1023       #4#5%
1024     \fi
1025   }%
1026 }
1027 \InCa@Temp 10203
1028 \InCa@Temp 20405
1029 \InCa@Temp 30607
1030 \InCa@Temp 40809
1031 \InCa@Temp 51011
1032 \InCa@Temp 61213
1033 \InCa@Temp 71415
1034 \InCa@Temp 81617
1035 \InCa@Temp 91819
```

\intcalcShr

```
1036 \def\intcalcShr#1{%
1037   \number\expandafter\InCa@ShrSwitch\number#1! %
1038 }
```

\InCa@ShrSwitch

```
1039 \def\InCa@ShrSwitch#1#2!{%
1040   \ifx#1-%
1041     -\InCa@Shr#2!%
1042   \else
1043     \InCa@Shr#1#2!%
```

```
1044    \fi
1045 }
```

\IntCalcShr

```
1046 \def\IntCalcShr#1!{%
1047   \number\InCa@Shr#1! %
1048 }
```

\InCa@Shr

```
1049 \def\InCa@Shr#1#2{%
1050   \InCa@ShrDigit#1!%
1051   \ifx#2!%
1052   \else
1053     \@ReturnAfterFi{%
1054       \ifodd#1 %
1055         \@ReturnAfterElseFi{%
1056           \InCa@Shr{1#2}%
1057         }%
1058       \else
1059         \expandafter\InCa@Shr\expandafter#2%
1060       \fi
1061     }%
1062   \fi
1063 }
```

```
1064 \def\InCa@ShrDigit#1!{%
1065   \ifcase#1 0% 0
1066   \or 0% 1
1067   \or 1% 2
1068   \or 1% 3
1069   \or 2% 4
1070   \or 2% 5
1071   \or 3% 6
1072   \or 3% 7
1073   \or 4% 8
1074   \or 4% 9
1075   \or 5% 10
1076   \or 5% 11
1077   \or 6% 12
1078   \or 6% 13
1079   \or 7% 14
1080   \or 7% 15
1081   \or 8% 16
1082   \or 8% 17
1083   \or 9% 18
1084   \or 9% 19
1085   \fi
1086 }
```

2.5.7 \InCa@Tim

\InCa@Tim   Macro \InCa@Tim implements "Number *tim*es digit".

```
1087 \def\InCa@Temp#1{%
1088   \def\InCa@Tim##1##2{%
1089     \number
1090     \ifcase##2 % 0
1091       0%
1092     \or % 1
1093       ##1%
1094     \else % 2-9
1095       \csname InCa@Empty%
1096       \InCa@ProcessTim##2##1!%
```

```
1097      \fi
1098      #1%
1099    }%
1100 }
1101 \InCa@Temp{ }
```

\InCa@ProcessTim

```
1102 \def\InCa@ProcessTim#1#2#3{%
1103   \ifx#3!%
1104     \csname InCa@TimDigit#2\endcsname#10%
1105   \else
1106     \csname InCa@TimDigit#2\csname InCa@Param#1%
1107     \@ReturnAfterFi{%
1108       \InCa@ProcessTim#1#3%
1109     }%
1110   \fi
1111 }
```

\InCa@Param[0-9]

```
1112 \def\InCa@Temp#1{%
1113   \expandafter\def\csname InCa@Param#1\endcsname{%
1114     \endcsname#1%
1115   }%
1116 }
1117 \InCa@Temp 0%
1118 \InCa@Temp 1%
1119 \InCa@Temp 2%
1120 \InCa@Temp 3%
1121 \InCa@Temp 4%
1122 \InCa@Temp 5%
1123 \InCa@Temp 6%
1124 \InCa@Temp 7%
1125 \InCa@Temp 8%
1126 \InCa@Temp 9%
```

\InCa@TimDigit0

```
1127 \expandafter\def\csname InCa@TimDigit0\endcsname#1#2{%
1128   \endcsname
1129   0#2%
1130 }
```

\InCa@TimDigit1

```
1131 \expandafter\def\csname InCa@TimDigit1\endcsname#1#2{%
1132   \ifcase#2 %
1133     \endcsname 0#1%
1134   \else
1135     \csname InCa@AddDigit#1\endcsname #2%
1136   \fi
1137 }
```

\InCa@TimDigit[2-9]

```
1138 \def\InCa@Temp#1#2{%
1139   \expandafter\def\csname InCa@TimDigit#1\endcsname##1{%
1140     \expandafter\InCa@TimDigitCarry
1141     \number
1142       \ifcase##1 0% 0
1143       #2%
1144       \fi
1145     !%
1146   }%
1147 }
1148 \InCa@Temp 2{%
```

```
1149   \or  2% 1
1150   \or  4% 2
1151   \or  6% 3
1152   \or  8% 4
1153   \or 10% 5
1154   \or 12% 6
1155   \or 14% 7
1156   \or 16% 8
1157   \or 18% 9
1158 }
1159 \InCa@Temp 3{%
1160   \or  3% 1
1161   \or  6% 2
1162   \or  9% 3
1163   \or 12% 4
1164   \or 15% 5
1165   \or 18% 6
1166   \or 21% 7
1167   \or 24% 8
1168   \or 27% 9
1169 }
1170 \InCa@Temp 4{%
1171   \or  4% 1
1172   \or  8% 2
1173   \or 12% 3
1174   \or 16% 4
1175   \or 20% 5
1176   \or 24% 6
1177   \or 28% 7
1178   \or 32% 8
1179   \or 36% 9
1180 }
1181 \InCa@Temp 5{%
1182   \or  5% 1
1183   \or 10% 2
1184   \or 15% 3
1185   \or 20% 4
1186   \or 25% 5
1187   \or 30% 6
1188   \or 35% 7
1189   \or 40% 8
1190   \or 45% 9
1191 }
1192 \InCa@Temp 6{%
1193   \or  6% 1
1194   \or 12% 2
1195   \or 18% 3
1196   \or 24% 4
1197   \or 30% 5
1198   \or 36% 6
1199   \or 42% 7
1200   \or 48% 8
1201   \or 54% 9
1202 }
1203 \InCa@Temp 7{%
1204   \or  7% 1
1205   \or 14% 2
1206   \or 21% 3
1207   \or 28% 4
1208   \or 35% 5
1209   \or 42% 6
1210   \or 49% 7
```

```
1211  \or 56% 8
1212  \or 63% 9
1213 }
1214 \InCa@Temp 8{%
1215  \or  8% 1
1216  \or 16% 2
1217  \or 24% 3
1218  \or 32% 4
1219  \or 40% 5
1220  \or 48% 6
1221  \or 56% 7
1222  \or 64% 8
1223  \or 72% 9
1224 }
1225 \InCa@Temp 9{%
1226  \or  9% 1
1227  \or 18% 2
1228  \or 27% 3
1229  \or 36% 4
1230  \or 45% 5
1231  \or 54% 6
1232  \or 63% 7
1233  \or 72% 8
1234  \or 81% 9
1235 }
```

\InCa@TimDigitCarry

```
1236 \def\InCa@TimDigitCarry#1!{%
1237  \ifnum#1<10 %
1238    \csname InCa@AddDigit#1\expandafter\endcsname
1239  \else
1240    \@ReturnAfterFi{%
1241      \InCa@@TimDigitCarry#1!%
1242    }%
1243  \fi
1244 }
```

\InCa@@TimDigitCarry

```
1245 \def\InCa@@TimDigitCarry#1#2!#3{%
1246  \csname InCa@DigitCarry#1%
1247  \csname InCa@AddDigit#2\endcsname #3%
1248 }
```

2.5.8 Mul

\intcalcMul

```
1249 \def\intcalcMul#1#2{%
1250  \number
1251    \expandafter\InCa@MulSwitch
1252    \number\number#1\expandafter!%
1253    \number#2! %
1254 }
```

\InCa@MulSwitch   Decision table for \InCa@MulSwitch.

$x < 0$	$y < 0$	$x < y$	$+$	$\text{Mul}(-x, -y)$
		else		$\text{Mul}(-y, -x)$
	else	$-x > y$	$-$	$\text{Mul}(-x, y)$
		else		$\text{Mul}(y, -x)$
else	$y < 0$	$x > -y$	$-$	$\text{Mul}(x, -y)$
		else		$\text{Mul}(-y, x)$
	else	$x > y$	$+$	$\text{Mul}(x, y)$
		else		$\text{Mul}(y, x)$

```
1255 \def\InCa@MulSwitch#1!#2!{%
1256  \ifnum#1<\z@
1257   \ifnum#2<\z@
1258    \ifnum#1<#2 %
1259     \expandafter\InCa@Mul\number-#1\expandafter!%
1260     \@gobble#2!%
1261    \else
1262     \expandafter\InCa@Mul\number-#2\expandafter!%
1263     \@gobble#1!%
1264    \fi
1265   \else
1266    -%
1267    \ifnum-#1>#2 %
1268     \expandafter\InCa@Mul\@gobble#1!#2!%
1269    \else
1270     \expandafter\InCa@Mul\number#2\expandafter!%
1271     \@gobble#1!%
1272    \fi
1273   \fi
1274  \else
1275   \ifnum#2<\z@
1276    -%
1277    \ifnum#1>-#2 %
1278     \expandafter\InCa@Mul\number#1\expandafter!%
1279     \@gobble#2!%
1280    \else
1281     \expandafter\InCa@Mul\@gobble#2!#1!%
1282    \fi
1283   \else
1284    \ifnum#1>#2 %
1285     \InCa@Mul#1!#2!%
1286    \else
1287     \InCa@Mul#2!#1!%
1288    \fi
1289   \fi
1290  \fi
1291 }
```

\IntCalcMul

```
1292 \def\IntCalcMul#1!#2!{%
1293  \number\InCa@Mul#1!#2! %
1294 }
```

\InCa@Mul

```
1295 \def\InCa@Mul#1!#2!{%
1296  \ifcase#2 %
1297   0%
1298  \or
1299   #1%
1300  \or
1301   \csname InCa@Empty%
1302   \expandafter\InCa@Shl#1!%
```

33

```
1303  \else
1304    \ifnum#2<10 %
1305      \InCa@Tim{#1}#2%
1306    \else
1307      \InCa@ProcessMul!#2!#1!%
1308    \fi
1309  \fi
1310 }
```

\InCa@Mul

```
1311 \def\InCa@ProcessMul#1!#2#3!#4!{%
1312  \ifx\InCa@Empty#3\InCa@Empty
1313    \expandafter\InCa@Add\number
1314    #10\expandafter\expandafter\expandafter!%
1315    \InCa@Tim{#4}#2!%
1316  \else
1317    \ifx\InCa@Empty#1\InCa@Empty
1318      \expandafter\expandafter\expandafter\InCa@ProcessMul
1319      \InCa@Tim{#4}#2!%
1320      #3!#4!%
1321    \else
1322      \expandafter\InCa@ProcessMul\number
1323      \expandafter\InCa@Add\number%
1324      #10\expandafter\expandafter\expandafter!%
1325      \InCa@Tim{#4}#2!!%
1326      #3!#4!%
1327    \fi
1328  \fi
1329 }
```

2.5.9 Sqr, Fac

\intcalcSqr

```
1330 \def\intcalcSqr#1{%
1331  \number\expandafter\InCa@Sqr\number#1! %
1332 }
```

\InCa@Sqr

```
1333 \def\InCa@Sqr#1#2!{%
1334  \ifx#1-%
1335    \InCa@Mul#2!#2!%
1336  \else
1337    \InCa@Mul#1#2!#1#2!%
1338  \fi
1339 }
```

\intcalcFac

```
1340 \def\intcalcFac#1{%
1341  \number\expandafter\InCa@Fac\number#1! %
1342 }
```

2.5.10 Pow

\intcalcPow

```
1343 \def\intcalcPow#1#2{%
1344  \number\expandafter\InCa@Pow
1345  \number\number#1\expandafter!%
1346  \number#2! %
1347 }
```

\InCa@Pow

```
1348 \def\InCa@Pow#1#2!#3#4!{%
1349   \ifcase#3#4 % power = 0
1350     1%
1351   \or % power = 1
1352     #1#2%
1353   \or % power = 2
1354     \ifx#1-%
1355       \InCa@Mul#2!#2!%
1356     \else
1357       \InCa@Mul#1#2!#1#2!%
1358     \fi
1359   \else
1360     \ifcase#1#2 % basis = 0, power <> 0
1361       0%
1362       \ifx#3-% power < 0
1363         0\IntCalcError:DivisionByZero%
1364       \fi
1365     \or
1366       1% basis = 1
1367     \else
1368       \ifnum#1#2=\m@ne % basis = -1
1369         \ifodd#3#4 %
1370           -%
1371         \fi
1372         1%
1373       \else % |basis| > 1
1374         \ifx#3-% power < 0
1375           0%
1376         \else % power > 2
1377           \ifx#1-% basis < 0
1378             \ifodd#3#4 %
1379               -%
1380             \fi
1381             \InCa@PowRec#2!#3#4!1!%
1382           \else
1383             \InCa@PowRec#1#2!#3#4!1!%
1384           \fi
1385         \fi
1386       \fi
1387     \fi
1388   \fi
1389 }
```

```
\InCa@PowRec        Pow(b, p) {
                      PowRec(b, p, 1)
                    }
                    PowRec(b, p, r) {
                     if p == 1 then
                       return r
                     else
                       ifodd p then
                         return PowRec(b*b, p div 2, r*b) % p div 2 = (p-1)/2
                       else
                         return PowRec(b*b, p div 2, r)
                       fi
                     fi
                    }
```

```
1390 \def\InCa@PowRec#1!#2!#3!{%
1391   \ifnum#2=\@ne
1392     \ifnum#1>#3 %
1393       \InCa@Mul#1!#3!%
1394     \else
1395       \InCa@Mul#3!#1!%
```

```
1396    \fi
1397  \else
1398    \expandafter\InCa@PowRec
1399    \number\InCa@Mul#1!#1!\expandafter!%
1400    \number\intcalcShr{#2}\expandafter!%
1401    \number
1402    \ifodd#2 %
1403      \ifnum#1>#3 %
1404        \InCa@Mul#1!#3!%
1405      \else
1406        \InCa@Mul#3!#1!%
1407      \fi
1408    \else
1409      #3%
1410    \fi
1411    \expandafter!%
1412  \fi
1413 }
```

2.5.11 Div

\intcalcDiv

```
1414 \def\intcalcDiv#1#2{%
1415  \number\expandafter\InCa@Div
1416  \number\number#1\expandafter!%
1417  \number#2! %
1418 }
```

\InCa@Div

```
1419 \def\InCa@Div#1!#2!{%
1420  \ifcase#2 %
1421    0\IntCalcError:DivisionByZero%
1422  \else
1423    \ifcase#1 %
1424      0%
1425    \else
1426      \expandafter\InCa@DivSwitch
1427      \number#1\expandafter!%
1428      \number#2!%
1429    \fi
1430  \fi
1431 }
```

\IntCalcDiv

```
1432 \def\InCa@Temp#1{%
1433  \def\IntCalcDiv##1!##2!{%
1434    \number
1435    \ifcase##2 %
1436      0\IntCalcError:DivisionByZero%
1437    \else
1438      \ifcase##1 %
1439        0%
1440      \else
1441        \InCa@@Div##1!##2!%
1442      \fi
1443    \fi
1444    #1%
1445  }%
1446 }
1447 \InCa@Temp{ }%
```

\InCa@DivSwitch   Decision table for \InCa@DivSwitch.

$x<0$	$y<0$	$+$	$\mathrm{Div}(-x,-y)$
	else	$-$	$\mathrm{Div}(-x,y)$
else	$y<0$	$-$	$\mathrm{Div}(x,-y)$
	else	$+$	$\mathrm{Div}(x,y)$

```
1448 \def\InCa@DivSwitch#1!#2!{%
1449  \ifnum#1<\z@
1450    \ifnum#2<\z@
1451      \expandafter\InCa@@Div\number-#1\expandafter!%
1452      \@gobble#2!%
1453    \else
1454      -%
1455      \expandafter\InCa@@Div\@gobble#1!#2!%
1456    \fi
1457  \else
1458    \ifnum#2<\z@
1459      -%
1460      \expandafter\InCa@@Div\number#1\expandafter!%
1461      \@gobble#2!%
1462    \else
1463      \InCa@@Div#1!#2!%
1464    \fi
1465  \fi
1466 }
```

\InCa@@Div

```
1467 \def\InCa@@Div#1!#2!{%
1468  \ifnum#1>#2 %
1469    \ifcase#2 % 0 already catched
1470 ?    \IntCalcError:ThisCannotHappen%
1471    \or % 1
1472      #1%
1473    \or % 2
1474      \InCa@Shr#1!%
1475    \else
1476      \InCa@DivStart!#1!#2!#2!%
1477    \fi
1478  \else
1479    \ifnum#1=#2 %
1480      1%
1481    \else
1482      0%
1483    \fi
1484  \fi
1485 }
```

\InCa@DivStart

```
1486 \def\InCa@DivStart#1!#2#3!#4#5{%
1487  \ifx#5!%
1488    \@ReturnAfterElseFi{%
1489      \InCa@DivStartI{#1#2}#3=!%
1490    }%
1491  \else
1492    \@ReturnAfterFi{%
1493      \InCa@DivStart{#1#2}!#3!#5%
1494    }%
1495  \fi
1496 }
```

\InCa@StartI

```
1497 \def\InCa@DivStartI#1!#2!{%
1498  \expandafter\InCa@DivStartII
```

```
1499   \number#2\expandafter\expandafter\expandafter!%
1500   \intcalcShl{#2}!%
1501   #1!%
1502 }
```

\InCa@StartII

```
1503 \def\InCa@DivStartII#1!#2!{%
1504   \expandafter\InCa@DivStartIII
1505   \number#1\expandafter!%
1506   \number#2\expandafter\expandafter\expandafter!%
1507   \intcalcShl{#2}!%
1508 }
```

\InCa@StartIII

```
1509 \def\InCa@DivStartIII#1!#2!#3!{%
1510   \expandafter\InCa@DivStartIV
1511   \number#1\expandafter!%
1512   \number#2\expandafter!%
1513   \number#3\expandafter!%
1514   \number\InCa@Add#3!#2!\expandafter\expandafter\expandafter!%
1515   \intcalcShl{#3}!%
1516 }
```

\InCa@StartIV

```
1517 \def\InCa@DivStartIV#1!#2!#3!#4!#5!#6!{%
1518   \InCa@ProcessDiv#6!#1!#2!#3!#4!#5!/%
1519 }
```

\InCa@ProcessDiv

```
1520 \def\InCa@ProcessDiv#1#2#3!#4!#5!#6!#7!#8!#9/{%
1521   #9%
1522   \ifnum#1<#4 % 0
1523     0%
1524     \ifx#2=%
1525     \else
1526       \InCa@ProcessDiv{#1#2}#3!#4!#5!#6!#7!#8!%
1527     \fi
1528   \else % 1-9
1529     \ifnum#1<#5 % 1
1530       1%
1531       \ifx#2=%
1532       \else
1533         \expandafter\InCa@ProcessDiv\expandafter{%
1534           \number\InCa@Sub#1!#4!%
1535           #2%
1536         }#3!#4!#5!#6!#7!#8!%
1537       \fi
1538     \else % 2-9
1539       \ifnum#1<#7 % 2 3 4 5
1540         \ifnum#1<#6 % 2 3
1541           \@ReturnAfterElseFi{%
1542             \expandafter\InCa@@ProcessDiv
1543             \number\InCa@Sub#1!#5!!%
1544             23%
1545           }%
1546         \else % 4 5
1547           \@ReturnAfterFi{%
1548             \expandafter\InCa@@ProcessDiv
1549             \number\InCa@Sub#1!#6!!%
1550             45%
1551           }%
1552         \fi
```

```
1553        #2#3!#4!#5!#6!#7!#8!%
1554      \else % 6 7 8 9
1555       \ifnum#1<#8 % 6 7
1556         \@ReturnAfterElseFi{%
1557           \expandafter\InCa@@ProcessDiv
1558           \number\InCa@Sub#1!#7!!%
1559           67%
1560         }%
1561       \else % 8 9
1562         \@ReturnAfterFi{%
1563           \expandafter\InCa@@ProcessDiv
1564           \number\InCa@Sub#1!#8!!%
1565           89%
1566         }%
1567       \fi
1568       #2#3!#4!#5!#6!#7!#8!%
1569     \fi
1570   \fi
1571 \fi
1572 \ifx#2=%
1573   \expandafter\@gobble
1574 \fi
1575 /%
1576 }
```

\InCa@@ProcessDiv

```
1577 \def\InCa@@ProcessDiv#1!#2#3#4#5!#6!{%
1578 \ifnum#1<#6 %
1579   #2%
1580   \@ReturnAfterElseFi{%
1581     \ifx#4=%
1582       \expandafter\InCa@CleanupIV
1583     \else
1584       \@ReturnAfterFi{%
1585         \InCa@ProcessDiv{#1#4}#5!#6!%
1586       }%
1587     \fi
1588   }%
1589 \else
1590   #3%
1591   \@ReturnAfterFi{%
1592     \ifx#4=%
1593       \expandafter\InCa@CleanupIV
1594     \else
1595       \@ReturnAfterFi{%
1596         \expandafter\InCa@ProcessDiv\expandafter{%
1597           \number\InCa@Sub#1!#6! %
1598           #4%
1599         }#5!#6!%
1600       }%
1601     \fi
1602   }%
1603 \fi
1604 }
```

\InCa@CleanupIV

```
1605 \def\InCa@CleanupIV#1!#2!#3!#4!{}
```

2.5.12 Mod

\intcalcMod

```
1606 \def\intcalcMod#1#2{%
```

39

```
1607  \number\expandafter\InCa@Mod
1608  \number\number#1\expandafter!%
1609  \number#2! %
1610 }
```

\intcalc@Mod Pseudocode/decision table for \intcalc@Mod.

$$
\begin{array}{lll}
\text{if} & y = 0 & \text{DivisionByZero} \\
\text{elsif} & y < 0 & -\operatorname{Mod}(-x, -y) \\
\text{elsif} & x = 0 & 0 \\
\text{elsif} & y = 1 & 0 \\
\text{elsif} & y = 2 & \text{ifodd}(x)\,?\,1:0 \\
\text{elsif} & x < 0 & z \leftarrow x - (x/y) * y; \quad (z < 0)\,?\,z + y:z \\
\text{else} & & x - (x/y) * y
\end{array}
$$

```
1611 \def\InCa@Mod#1!#2!{%
1612  \ifcase#2 %
1613    0\IntCalcError:DivisionByZero%
1614  \else
1615   \ifnum#2<\z@
1616     -%
1617     \expandafter\InCa@Mod
1618     \number-#1\expandafter!%
1619     \number-#2!%
1620    \else
1621     \ifcase#1 %
1622       0%
1623     \else
1624      \ifcase#2 % 0 already catched
1625 ?      \IntCalcError:ThisCannotHappen%
1626      \or % 1
1627        0%
1628      \or % 2
1629        \ifodd#1 1\else 0\fi
1630      \else
1631       \ifnum#1<\z@
1632         \expandafter\InCa@ModShift
1633         \number-%
1634          \expandafter\InCa@Sub
1635          \number\@gobble#1\expandafter!%
1636          \number\intcalcMul{#2}{%
1637            \expandafter\InCa@Div\@gobble#1!#2!%
1638          }!%
1639         !#2%
1640       \else
1641         \expandafter\InCa@Sub\number#1\expandafter!%
1642         \number\intcalcMul{#2}{\InCa@Div#1!#2!}!%
1643       \fi
1644      \fi
1645     \fi
1646    \fi
1647  \fi
1648 }
```

\IntCalcMod

```
1649 \def\InCa@Temp#1{%
1650  \def\IntCalcMod##1!##2!{%
1651   \number
1652   \ifcase##2 %
1653     0\IntCalcError:DivisionByZero%
1654   \else
1655    \ifcase##1 %
```

```
1656        0%
1657      \else
1658      \ifcase##2 % 0 already catched
1659 ?       \IntCalcError:ThisCannotHappen
1660      \or % 1
1661        0%
1662      \or % 2
1663        \ifodd ##1 1\else 0\fi
1664      \else
1665        \expandafter\InCa@Sub\number##1\expandafter!%
1666        \number\intcalcMul{##2}{\InCa@Div##1!##2!}!%
1667      \fi
1668      \fi
1669    \fi
1670    #1%
1671  }%
1672 }
1673 \InCa@Temp{ }%
```

\InCa@ModShift

```
1674 \def\InCa@ModShift#1!#2!{%
1675  \ifnum#1<\z@
1676    \expandafter\InCa@Sub\number#2\expandafter!%
1677    \@gobble#1!%
1678  \else
1679    #1%
1680  \fi
1681 }
```

2.5.13 Help macros

\InCa@Empty

```
1682 \def\InCa@Empty{}
```

\@gobble

```
1683 \expandafter\ifx\csname @gobble\endcsname\relax
1684  \long\def\@gobble#1{}%
1685 \fi
```

\@ReturnAfterFi

```
1686 \long\def\@ReturnAfterFi#1\fi{\fi#1}%
```

\@ReturnAfterElseFi

```
1687 \long\def\@ReturnAfterElseFi#1\else#2\fi{\fi#1}%
```

```
1688 \InCa@AtEnd%
```

```
1689 ⟨/package⟩
```

3   Test

3.1   Catcode checks for loading

```
1690 ⟨*test1⟩
```

```
1691 \catcode`\{=1 %
1692 \catcode`\}=2 %
1693 \catcode`\#=6 %
1694 \catcode`\@=11 %
1695 \expandafter\ifx\csname count@\endcsname\relax
1696  \countdef\count@=255 %
1697 \fi
```

```
1698 \expandafter\ifx\csname @gobble\endcsname\relax
1699   \long\def\@gobble#1{}%
1700 \fi
1701 \expandafter\ifx\csname @firstofone\endcsname\relax
1702   \long\def\@firstofone#1{#1}%
1703 \fi
1704 \expandafter\ifx\csname loop\endcsname\relax
1705   \expandafter\@firstofone
1706 \else
1707   \expandafter\@gobble
1708 \fi
1709 {%
1710   \def\loop#1\repeat{%
1711     \def\body{#1}%
1712     \iterate
1713   }%
1714   \def\iterate{%
1715     \body
1716       \let\next\iterate
1717     \else
1718       \let\next\relax
1719     \fi
1720     \next
1721   }%
1722   \let\repeat=\fi
1723 }%
1724 \def\RestoreCatcodes{}
1725 \count@=0 %
1726 \loop
1727   \edef\RestoreCatcodes{%
1728     \RestoreCatcodes
1729     \catcode\the\count@=\the\catcode\count@\relax
1730   }%
1731 \ifnum\count@<255 %
1732   \advance\count@ 1 %
1733 \repeat
1734
1735 \def\RangeCatcodeInvalid#1#2{%
1736   \count@=#1\relax
1737   \loop
1738     \catcode\count@=15 %
1739   \ifnum\count@<#2\relax
1740     \advance\count@ 1 %
1741   \repeat
1742 }
1743 \def\RangeCatcodeCheck#1#2#3{%
1744   \count@=#1\relax
1745   \loop
1746     \ifnum#3=\catcode\count@
1747     \else
1748       \errmessage{%
1749         Character \the\count@\space
1750         with wrong catcode \the\catcode\count@\space
1751         instead of \number#3%
1752       }%
1753     \fi
1754   \ifnum\count@<#2\relax
1755     \advance\count@ 1 %
1756   \repeat
1757 }
1758 \def\space{ }
1759 \expandafter\ifx\csname LoadCommand\endcsname\relax
```

```
1760  \def\LoadCommand{\input intcalc.sty\relax}%
1761 \fi
1762 \def\Test{%
1763   \RangeCatcodeInvalid{0}{47}%
1764   \RangeCatcodeInvalid{58}{64}%
1765   \RangeCatcodeInvalid{91}{96}%
1766   \RangeCatcodeInvalid{123}{255}%
1767   \catcode`\@=12 %
1768   \catcode`\\=0 %
1769   \catcode`\%=14 %
1770   \LoadCommand
1771   \RangeCatcodeCheck{0}{36}{15}%
1772   \RangeCatcodeCheck{37}{37}{14}%
1773   \RangeCatcodeCheck{38}{47}{15}%
1774   \RangeCatcodeCheck{48}{57}{12}%
1775   \RangeCatcodeCheck{58}{63}{15}%
1776   \RangeCatcodeCheck{64}{64}{12}%
1777   \RangeCatcodeCheck{65}{90}{11}%
1778   \RangeCatcodeCheck{91}{91}{15}%
1779   \RangeCatcodeCheck{92}{92}{0}%
1780   \RangeCatcodeCheck{93}{96}{15}%
1781   \RangeCatcodeCheck{97}{122}{11}%
1782   \RangeCatcodeCheck{123}{255}{15}%
1783   \RestoreCatcodes
1784 }
1785 \Test
1786 \csname @@end\endcsname
1787 \end
1788 ⟨/test1⟩
```

3.2 Macro tests

3.2.1 Preamble with test macro definitions

```
1789 ⟨*test2 j test4⟩
1790 \NeedsTeXFormat{LaTeX2e}
1791 \nofiles
1792 \documentclass{article}
1793 ⟨noetex⟩ \let\SavedNumexpr\numexpr
1794 ⟨noetex⟩ \let\numexpr\UNDEFINED
1795 \makeatletter
1796 \chardef\InCa@TestMode=1 %
1797 \makeatother
1798 \usepackage{intcalc}[2016/05/16]
1799 ⟨noetex⟩ \let\numexpr\SavedNumexpr
1800 \usepackage{qstest}
1801 \IncludeTests{*}
1802 \LogTests{log}{*}{*}
1803 ⟨/test2 j test4⟩
1804 ⟨*test2⟩
1805 \newcommand*{\TestSpaceAtEnd}[1]{%
1806 ⟨noetex⟩  \let\SavedNumexpr\numexpr
1807 ⟨noetex⟩  \let\numexpr\UNDEFINED
1808   \edef\resultA{#1}%
1809   \edef\resultB{#1 }%
1810 ⟨noetex⟩  \let\numexpr\SavedNumexpr
1811   \Expect*{\resultA\space}*{\resultB}%
1812 }
1813 \newcommand*{\TestResult}[2]{%
1814 ⟨noetex⟩  \let\SavedNumexpr\numexpr
1815 ⟨noetex⟩  \let\numexpr\UNDEFINED
1816   \edef\result{#1}%
1817 ⟨noetex⟩  \let\numexpr\SavedNumexpr
```

```
1818    \Expect*{\result}{#2}%
1819 }
1820 \newcommand*{\TestResultTwoExpansions}[2]{%
1821 〈*noetex〉
1822    \begingroup
1823      \let\numexpr\UNDEFINED
1824      \expandafter\expandafter\expandafter
1825    \endgroup
1826 〈/noetex〉
1827    \expandafter\expandafter\expandafter\Expect
1828    \expandafter\expandafter\expandafter{#1}{#2}%
1829 }
1830 \newcount\TestCount
1831 〈etex〉\newcommand*{\TestArg}[1]{\numexpr#1\relax}
1832 〈noetex〉\newcommand*{\TestArg}[1]{#1}
1833 \newcommand*{\TestTeXDivide}[2]{%
1834    \TestCount=\TestArg{#1}\relax
1835    \divide\TestCount by \TestArg{#2}\relax
1836    \Expect*{\intcalcDiv{#1}{#2}}*{\the\TestCount}%
1837 }
1838 \newcommand*{\Test}[2]{%
1839    \TestResult{#1}{#2}%
1840    \TestResultTwoExpansions{#1}{#2}%
1841    \TestSpaceAtEnd{#1}%
1842 }
1843 \newcommand*{\TestExch}[2]{\Test{#2}{#1}}
1844 \newcommand*{\TestInv}[2]{%
1845    \Test{\intcalcInv{#1}}{#2}%
1846 }
1847 \newcommand*{\TestNum}[2]{%
1848    \Test{\intcalcNum{#1}}{#2}%
1849 }
1850 \newcommand*{\TestAbs}[2]{%
1851    \Test{\intcalcAbs{#1}}{#2}%
1852 }
1853 \newcommand*{\TestSgn}[2]{%
1854    \Test{\intcalcSgn{#1}}{#2}%
1855 }
1856 \newcommand*{\TestMin}[3]{%
1857    \Test{\intcalcMin{#1}{#2}}{#3}%
1858 }
1859 \newcommand*{\TestMax}[3]{%
1860    \Test{\intcalcMax{#1}{#2}}{#3}%
1861 }
1862 \newcommand*{\TestCmp}[3]{%
1863    \Test{\intcalcCmp{#1}{#2}}{#3}%
1864 }
1865 \newcommand*{\TestInc}[2]{%
1866    \Test{\intcalcInc{#1}}{#2}%
1867    \ifnum\intcalcNum{#1}>-1 %
1868      \edef\x{%
1869        \noexpand\Test{%
1870          \noexpand\IntCalcInc\intcalcNum{#1}!%
1871        }{#2}%
1872      }%
1873      \x
1874    \fi
1875 }
1876 \newcommand*{\TestDec}[2]{%
1877    \Test{\intcalcDec{#1}}{#2}%
1878    \ifnum\intcalcNum{#1}>0 %
1879      \edef\x{%
```

```
1880     \noexpand\Test{%
1881       \noexpand\IntCalcDec\intcalcNum{#1}!%
1882     }{#2}%
1883   }%
1884   \x
1885  \fi
1886 }
1887 \newcommand*{\TestAdd}[3]{%
1888  \Test{\intcalcAdd{#1}{#2}}{#3}%
1889  \ifnum\intcalcNum{#1}>0 %
1890   \ifnum\intcalcNum{#2}> 0 %
1891    \ifnum\intcalcCmp{#1}{#2}>0 %
1892     \edef\x{%
1893       \noexpand\Test{%
1894         \noexpand\IntCalcAdd
1895         \intcalcNum{#1}!\intcalcNum{#2}!%
1896       }{#3}%
1897     }%
1898     \x
1899    \else
1900     \edef\x{%
1901       \noexpand\Test{%
1902         \noexpand\IntCalcAdd
1903         \intcalcNum{#2}!\intcalcNum{#1}!%
1904       }{#3}%
1905     }%
1906     \x
1907    \fi
1908   \fi
1909  \fi
1910 }
1911 \newcommand*{\TestSub}[3]{%
1912  \Test{\intcalcSub{#1}{#2}}{#3}%
1913  \ifnum\intcalcNum{#1}>0 %
1914   \ifnum\intcalcNum{#2}> 0 %
1915    \ifnum\intcalcCmp{#1}{#2}>0 %
1916     \edef\x{%
1917       \noexpand\Test{%
1918         \noexpand\IntCalcSub
1919         \intcalcNum{#1}!\intcalcNum{#2}!%
1920       }{#3}%
1921     }%
1922     \x
1923    \fi
1924   \fi
1925  \fi
1926 }
1927 \newcommand*{\TestShl}[2]{%
1928  \Test{\intcalcShl{#1}}{#2}%
1929  \edef\x{%
1930   \noexpand\Test{%
1931     \noexpand\IntCalcShl\intcalcAbs{#1}!%
1932   }{\intcalcAbs{#2}}%
1933  }%
1934  \x
1935 }
1936 \newcommand*{\TestShr}[2]{%
1937  \Test{\intcalcShr{#1}}{#2}%
1938  \edef\x{%
1939   \noexpand\Test{%
1940     \noexpand\IntCalcShr\intcalcAbs{#1}!%
1941   }{\intcalcAbs{#2}}%
```

```
1942  }%
1943  \x
1944 }
1945 \newcommand*{\TestMul}[3]{%
1946  \Test{\intcalcMul{#1}{#2}}{#3}%
1947  \edef\x{%
1948    \noexpand\Test{%
1949      \noexpand\IntCalcMul\intcalcAbs{#1}!\intcalcAbs{#2}!%
1950    }{\intcalcAbs{#3}}%
1951  }%
1952  \x
1953 }
1954 \newcommand*{\TestSqr}[2]{%
1955  \Test{\intcalcSqr{#1}}{#2}%
1956 }
1957 \newcommand*{\TestFac}[2]{%
1958  \expandafter\TestExch\expandafter{\the\numexpr#2}{\intcalcFac{#1}}%
1959 }
1960 \newcommand*{\TestPow}[3]{%
1961  \Test{\intcalcPow{#1}{#2}}{#3}%
1962 }
1963 \newcommand*{\TestDiv}[3]{%
1964  \Test{\intcalcDiv{#1}{#2}}{#3}%
1965  \TestTeXDivide{#1}{#2}%
1966  \edef\x{%
1967    \noexpand\Test{%
1968      \noexpand\IntCalcDiv\intcalcAbs{#1}!\intcalcAbs{#2}!%
1969    }{\intcalcAbs{#3}}%
1970  }%
1971 }
1972 \newcommand*{\TestMod}[3]{%
1973  \Test{\intcalcMod{#1}{#2}}{#3}%
1974  \ifcase\ifcase\intcalcSgn{#1} 0%
1975      \or
1976        \ifcase\intcalcSgn{#2} 1%
1977        \or 0%
1978        \else 1%
1979        \fi
1980      \else
1981        \ifcase\intcalcSgn{#2} 1%
1982        \or 1%
1983        \else 0%
1984        \fi
1985      \fi\relax
1986    \edef\x{%
1987      \noexpand\Test{%
1988        \noexpand\IntCalcMod
1989        \intcalcAbs{#1}!\intcalcAbs{#2}!%
1990      }{\intcalcAbs{#3}}%
1991    }%
1992    \x
1993  \fi
1994 }
1995 ⟨/test2⟩
```

3.2.2 Time

```
1996 ⟨*test2⟩
1997 \begingroup\expandafter\expandafter\expandafter\endgroup
1998 \expandafter\ifx\csname pdfresettimer\endcsname\relax
1999 \else
2000  \makeatletter
2001  \newcount\SummaryTime
2002  \newcount\TestTime
```

```
2003  \SummaryTime=\z@
2004  \newcommand*{\PrintTime}[2]{%
2005    \typeout{%
2006      [Time #1: \strip@pt\dimexpr\number#2sp\relax\space s]%
2007    }%
2008  }%
2009  \newcommand*{\StartTime}[1]{%
2010    \renewcommand*{\TimeDescription}{#1}%
2011    \pdfresettimer
2012  }%
2013  \newcommand*{\TimeDescription}{}%
2014  \newcommand*{\StopTime}{%
2015    \TestTime=\pdfelapsedtime
2016    \global\advance\SummaryTime\TestTime
2017    \PrintTime\TimeDescription\TestTime
2018  }%
2019  \let\saved@qstest\qstest
2020  \let\saved@endqstest\endqstest
2021  \def\qstest#1#2{%
2022    \saved@qstest{#1}{#2}%
2023    \StartTime{#1}%
2024  }%
2025  \def\endqstest{%
2026    \StopTime
2027    \saved@endqstest
2028  }%
2029  \AtEndDocument{%
2030    \PrintTime{summary}\SummaryTime
2031  }%
2032  \makeatother
2033 \fi
2034 ⟨/test2⟩
```

3.2.3 Test 4: additional mod/div operations

```
2035 ⟨*test4⟩
2036 \newcommand*{\TestDo}[2]{%
2037  \ifcase\numexpr#2\relax
2038  \else
2039    \edef\temp{\intcalcMod{#1}{#2}}%
2040    \Expect*{%
2041      \the\numexpr
2042      \intcalcMul{%
2043        \intcalcDiv{\intcalcAbs{#1}}{\intcalcAbs{#2}}%
2044      }{\intcalcAbs{#2}}%
2045      +\intcalcMod{\intcalcAbs{#1}}{\intcalcAbs{#2}}\relax
2046    }*{\the\numexpr\intcalcAbs{#1}\relax}%
2047  \fi
2048 }
2049 \newcommand*{\TestOne}[2]{%
2050  \TestDo{#1}{#1}%
2051 }
2052 \newcommand*{\TestTwo}[3]{%
2053  \TestDo{#1}{#2}%
2054  \TestDo{#2}{#1}%
2055 }
2056 \let\TestNum\TestOne
2057 \let\TestInv\TestOne
2058 \let\TestAbs\TestOne
2059 \let\TestSgn\TestOne
2060 \let\TestMin\TestTwo
2061 \let\TestMax\TestTwo
2062 \let\TestCmp\TestTwo
2063 \let\TestInc\TestOne
```

47

```
2064 \let\TestDec\TestOne
2065 \let\TestAdd\TestTwo
2066 \let\TestSub\TestTwo
2067 \let\TestShl\TestOne
2068 \let\TestShr\TestOne
2069 \let\TestMul\TestTwo
2070 \let\TestSqr\TestOne
2071 \def\TestFac#1#2{}
2072 \let\TestPow\TestTwo
2073 \let\TestDiv\TestTwo
2074 \let\TestMod\TestTwo
2075 ⟨/test4⟩
```

3.2.4 Test sets

```
2076 ⟨*test2 j test4⟩
2077 \makeatletter
2078
2079 \begin{qstest}{num}{num}%
2080   \TestNum{0}{0}%
2081   \TestNum{1}{1}%
2082   \TestNum{-1}{-1}%
2083   \TestNum{10}{10}%
2084   \TestNum{-10}{-10}%
2085   \TestNum{2147483647}{2147483647}%
2086   \TestNum{-2147483647}{-2147483647}%
2087   \TestNum{ 0 }{0}%
2088   \TestNum{ 1 }{1}%
2089   \TestNum{--1}{1}%
2090   \TestNum{ - + - + 4 }{4}%
2091   \TestNum{\z@}{0}%
2092   \TestNum{\@ne}{1}%
2093   \TestNum{\m@ne}{-1}%
2094 ⟨*etex⟩
2095   \TestNum{-10+30}{20}%
2096   \TestNum{10-30}{-20}%
2097 ⟨/etex⟩
2098 \end{qstest}
2099
2100 \begin{qstest}{inv}{inv}%
2101   \TestInv{0}{0}%
2102   \TestInv{1}{-1}%
2103   \TestInv{-1}{1}%
2104   \TestInv{10}{-10}%
2105   \TestInv{-10}{10}%
2106   \TestInv{2147483647}{-2147483647}%
2107   \TestInv{-2147483647}{2147483647}%
2108   \TestInv{ 0 }{0}%
2109   \TestInv{ 1 }{-1}%
2110   \TestInv{--1}{-1}%
2111   \TestInv{\z@}{0}%
2112   \TestInv{\@ne}{-1}%
2113   \TestInv{\m@ne}{1}%
2114 ⟨*etex⟩
2115   \TestInv{-10+30}{-20}%
2116   \TestInv{10-30}{20}%
2117 ⟨/etex⟩
2118 \end{qstest}
2119
2120 \begin{qstest}{abs}{abs}%
2121   \TestAbs{0}{0}%
2122   \TestAbs{1}{1}%
2123   \TestAbs{-1}{1}%
2124   \TestAbs{10}{10}%
```

```
2125  \TestAbs{-10}{10}%
2126  \TestAbs{2147483647}{2147483647}%
2127  \TestAbs{-2147483647}{2147483647}%
2128  \TestAbs{ 0 }{0}%
2129  \TestAbs{ 1 }{1}%
2130  \TestAbs{--1}{1}%
2131  \TestAbs{\z@}{0}%
2132  \TestAbs{\@ne}{1}%
2133  \TestAbs{\m@ne}{1}%
2134 ⟨*etex⟩
2135  \TestAbs{-10+30}{20}%
2136  \TestAbs{10-30}{20}%
2137 ⟨/etex⟩
2138 \end{qstest}
2139
2140 \begin{qstest}{sign}{sign}%
2141  \TestSgn{0}{0}%
2142  \TestSgn{1}{1}%
2143  \TestSgn{-1}{-1}%
2144  \TestSgn{10}{1}%
2145  \TestSgn{-10}{-1}%
2146  \TestSgn{2147483647}{1}%
2147  \TestSgn{-2147483647}{-1}%
2148  \TestSgn{ 0 }{0}%
2149  \TestSgn{ 2 }{1}%
2150  \TestSgn{ -2 }{-1}%
2151  \TestSgn{--2}{1}%
2152  \TestSgn{\z@}{0}%
2153  \TestSgn{\@ne}{1}%
2154  \TestSgn{\m@ne}{-1}%
2155 ⟨*etex⟩
2156  \TestSgn{-10+30}{1}%
2157  \TestSgn{10-30}{-1}%
2158 ⟨/etex⟩
2159 \end{qstest}
2160
2161 \begin{qstest}{min}{min}%
2162  \TestMin{0}{1}{0}%
2163  \TestMin{1}{0}{0}%
2164  \TestMin{-10}{-20}{-20}%
2165  \TestMin{ 1 }{ 2 }{1}%
2166  \TestMin{ 2 }{ 1 }{1}%
2167  \TestMin{1}{1}{1}%
2168  \TestMin{\z@}{\@ne}{0}%
2169  \TestMin{\@ne}{\m@ne}{-1}%
2170 ⟨*etex⟩
2171  \TestMin{1+2}{3+4}{3}%
2172 ⟨/etex⟩
2173 \end{qstest}
2174
2175 \begin{qstest}{max}{max}%
2176  \TestMax{0}{1}{1}%
2177  \TestMax{1}{0}{1}%
2178  \TestMax{-10}{-20}{-10}%
2179  \TestMax{ 1 }{ 2 }{2}%
2180  \TestMax{ 2 }{ 1 }{2}%
2181  \TestMax{1}{1}{1}%
2182  \TestMax{\z@}{\@ne}{1}%
2183  \TestMax{\@ne}{\m@ne}{1}%
2184 ⟨*etex⟩
2185  \TestMax{1+2}{3+4}{7}%
2186 ⟨/etex⟩
```

```
2187 \end{qstest}
2188
2189 \begin{qstest}{cmp}{cmp}%
2190   \TestCmp{0}{0}{0}%
2191   \TestCmp{-21}{17}{-1}%
2192   \TestCmp{3}{4}{-1}%
2193   \TestCmp{-10}{-10}{0}%
2194   \TestCmp{-10}{-11}{1}%
2195   \TestCmp{100}{5}{1}%
2196   \TestCmp{2147483647}{-2147483647}{1}%
2197   \TestCmp{-2147483647}{2147483647}{-1}%
2198   \TestCmp{2147483647}{2147483647}{0}%
2199   \TestCmp{\z@}{\@ne}{-1}%
2200   \TestCmp{\@ne}{\m@ne}{1}%
2201   \TestCmp{ 4 }{ 5 }{-1}%
2202   \TestCmp{ -3 }{ -7 }{1}%
2203 ⟨*etex⟩
2204   \TestCmp{1+2}{3+4}{-1}%
2205 ⟨/etex⟩
2206 \end{qstest}
2207
2208 \begin{qstest}{fac}{fac}
2209   \TestFac{0}{1}%
2210   \TestFac{1}{1}%
2211   \TestFac{2}{2}%
2212   \TestFac{3}{2*3}%
2213   \TestFac{4}{2*3*4}%
2214   \TestFac{5}{2*3*4*5}%
2215   \TestFac{6}{2*3*4*5*6}%
2216   \TestFac{7}{2*3*4*5*6*7}%
2217   \TestFac{8}{2*3*4*5*6*7*8}%
2218   \TestFac{9}{2*3*4*5*6*7*8*9}%
2219   \TestFac{10}{2*3*4*5*6*7*8*9*10}%
2220   \TestFac{11}{2*3*4*5*6*7*8*9*10*11}%
2221   \TestFac{12}{2*3*4*5*6*7*8*9*10*11*12}%
2222 \end{qstest}
2223
2224 \begin{qstest}{inc}{inc}%
2225   \TestInc{0}{1}%
2226   \TestInc{1}{2}%
2227   \TestInc{-1}{0}%
2228   \TestInc{10}{11}%
2229   \TestInc{-10}{-9}%
2230   \TestInc{999}{1000}%
2231   \TestInc{-1000}{-999}%
2232   \TestInc{129}{130}%
2233   \TestInc{2147483646}{2147483647}%
2234   \TestInc{-2147483647}{-2147483646}%
2235 \end{qstest}
2236
2237 \begin{qstest}{dec}{dec}%
2238   \TestDec{0}{-1}%
2239   \TestDec{1}{0}%
2240   \TestDec{-1}{-2}%
2241   \TestDec{10}{9}%
2242   \TestDec{-10}{-11}%
2243   \TestDec{1000}{999}%
2244   \TestDec{-999}{-1000}%
2245   \TestDec{130}{129}%
2246   \TestDec{2147483647}{2147483646}%
2247   \TestDec{-2147483646}{-2147483647}%
2248 \end{qstest}
```

```
2249
2250  \begin{qstest}{add}{add}%
2251  \TestAdd{0}{0}{0}%
2252  \TestAdd{1}{0}{1}%
2253  \TestAdd{0}{1}{1}%
2254  \TestAdd{1}{2}{3}%
2255  \TestAdd{-1}{-1}{-2}%
2256  \TestAdd{2147483646}{1}{2147483647}%
2257  \TestAdd{-2147483647}{2147483647}{0}%
2258  \TestAdd{20}{-5}{15}%
2259  \TestAdd{-4}{-1}{-5}%
2260  \TestAdd{-1}{-4}{-5}%
2261  \TestAdd{-4}{1}{-3}%
2262  \TestAdd{-1}{4}{3}%
2263  \TestAdd{4}{-1}{3}%
2264  \TestAdd{1}{-4}{-3}%
2265  \TestAdd{-4}{-1}{-5}%
2266  \TestAdd{-1}{-4}{-5}%
2267  \TestAdd{ -4 }{ -1 }{-5}%
2268  \TestAdd{ -1 }{ -4 }{-5}%
2269  \TestAdd{ -4 }{ 1 }{-3}%
2270  \TestAdd{ -1 }{ 4 }{3}%
2271  \TestAdd{ 4 }{ -1 }{3}%
2272  \TestAdd{ 1 }{ -4 }{-3}%
2273  \TestAdd{ -4 }{ -1 }{-5}%
2274  \TestAdd{ -1 }{ -4 }{-5}%
2275  \TestAdd{876543210}{111111111}{987654321}%
2276  \TestAdd{999999999}{2}{1000000001}%
2277 ⟨*etex⟩
2278  \TestAdd{100}{50+150}{300}%
2279  \TestAdd{2147483647}{10-2147483647}{10}%
2280 ⟨/etex⟩
2281  \end{qstest}
2282
2283  \begin{qstest}{sub}{sub}
2284  \TestSub{0}{0}{0}%
2285  \TestSub{1}{0}{1}%
2286  \TestSub{1}{2}{-1}%
2287  \TestSub{-1}{-1}{0}%
2288  \TestSub{2147483646}{-1}{2147483647}%
2289  \TestSub{-2147483647}{-2147483647}{0}%
2290  \TestSub{-4}{-1}{-3}%
2291  \TestSub{-1}{-4}{3}%
2292  \TestSub{-4}{1}{-5}%
2293  \TestSub{-1}{4}{-5}%
2294  \TestSub{4}{-1}{5}%
2295  \TestSub{1}{-4}{5}%
2296  \TestSub{-4}{-1}{-3}%
2297  \TestSub{-1}{-4}{3}%
2298  \TestSub{ -4 }{ -1 }{-3}%
2299  \TestSub{ -1 }{ -4 }{3}%
2300  \TestSub{ -4 }{ 1 }{-5}%
2301  \TestSub{ -1 }{ 4 }{-5}%
2302  \TestSub{ 4 }{ -1 }{5}%
2303  \TestSub{ 1 }{ -4 }{5}%
2304  \TestSub{ -4 }{ -1 }{-3}%
2305  \TestSub{ -1 }{ -4 }{3}%
2306  \TestSub{1000000000}{2}{999999998}%
2307  \TestSub{987654321}{111111111}{876543210}%
2308 ⟨*etex⟩
2309  \TestSub{100}{50+150}{-100}%
2310  \TestSub{2147483647}{-10+2147483647}{10}%
```

```
2311  ⟨/etex⟩
2312  \end{qstest}
2313
2314  \begin{qstest}{shl}{shl}
2315    \TestShl{0}{0}%
2316    \TestShl{1}{2}%
2317    \TestShl{5621}{11242}%
2318    \TestShl{1073741823}{2147483646}%
2319    \TestShl{-1}{-2}%
2320    \TestShl{-5621}{-11242}%
2321  \end{qstest}
2322
2323  \begin{qstest}{shr}{shr}
2324    \TestShr{0}{0}%
2325    \TestShr{1}{0}%
2326    \TestShr{2}{1}%
2327    \TestShr{3}{1}%
2328    \TestShr{4}{2}%
2329    \TestShr{5}{2}%
2330    \TestShr{6}{3}%
2331    \TestShr{7}{3}%
2332    \TestShr{8}{4}%
2333    \TestShr{9}{4}%
2334    \TestShr{10}{5}%
2335    \TestShr{11}{5}%
2336    \TestShr{12}{6}%
2337    \TestShr{13}{6}%
2338    \TestShr{14}{7}%
2339    \TestShr{15}{7}%
2340    \TestShr{16}{8}%
2341    \TestShr{17}{8}%
2342    \TestShr{18}{9}%
2343    \TestShr{19}{9}%
2344    \TestShr{20}{10}%
2345    \TestShr{21}{10}%
2346    \TestShr{22}{11}%
2347    \TestShr{11241}{5620}%
2348    \TestShr{73054202}{36527101}%
2349    \TestShr{2147483646}{1073741823}%
2350    \TestShr{-1}{0}%
2351    \TestShr{-2}{-1}%
2352    \TestShr{-3}{-1}%
2353    \TestShr{-11241}{-5620}%
2354  \end{qstest}
2355
2356  \begin{qstest}{mul}{mul}
2357    \TestMul{0}{0}{0}%
2358    \TestMul{1}{0}{0}%
2359    \TestMul{0}{1}{0}%
2360    \TestMul{1}{1}{1}%
2361    \TestMul{3}{1}{3}%
2362    \TestMul{1}{-3}{-3}%
2363    \TestMul{-4}{-5}{20}%
2364    \TestMul{3}{7}{21}%
2365    \TestMul{7}{3}{21}%
2366    \TestMul{3}{-7}{-21}%
2367    \TestMul{7}{-3}{-21}%
2368    \TestMul{-3}{7}{-21}%
2369    \TestMul{-7}{3}{-21}%
2370    \TestMul{-3}{-7}{21}%
2371    \TestMul{-7}{-3}{21}%
2372    \TestMul{12}{11}{132}%
```

```
2373  \TestMul{999}{333}{332667}%
2374  \TestMul{1000}{4321}{4321000}%
2375  \TestMul{12345}{173955}{2147474475}%
2376  \TestMul{1073741823}{2}{2147483646}%
2377  \TestMul{2}{1073741823}{2147483646}%
2378  \TestMul{-1073741823}{2}{-2147483646}%
2379  \TestMul{2}{-1073741823}{-2147483646}%
2380 ⟨*etex⟩
2381  \TestMul{2+3}{5+7}{60}%
2382  \TestMul{2147483647}{2147483647/2147483647}{2147483647}%
2383 ⟨/etex⟩
2384 \end{qstest}
2385
2386 \begin{qstest}{sqr}{sqr}
2387  \TestSqr{0}{0}%
2388  \TestSqr{1}{1}%
2389  \TestSqr{2}{4}%
2390  \TestSqr{3}{9}%
2391  \TestSqr{4}{16}%
2392  \TestSqr{9}{81}%
2393  \TestSqr{10}{100}%
2394  \TestSqr{46340}{2147395600}%
2395  \TestSqr{-1}{1}%
2396  \TestSqr{-2}{4}%
2397  \TestSqr{-46340}{2147395600}%
2398 \end{qstest}
2399
2400 \begin{qstest}{pow}{pow}
2401  \TestPow{-2}{0}{1}%
2402  \TestPow{-1}{0}{1}%
2403  \TestPow{0}{0}{1}%
2404  \TestPow{1}{0}{1}%
2405  \TestPow{2}{0}{1}%
2406  \TestPow{3}{0}{1}%
2407  \TestPow{-2}{1}{-2}%
2408  \TestPow{-1}{1}{-1}%
2409  \TestPow{1}{1}{1}%
2410  \TestPow{2}{1}{2}%
2411  \TestPow{3}{1}{3}%
2412  \TestPow{-2}{2}{4}%
2413  \TestPow{-1}{2}{1}%
2414  \TestPow{0}{2}{0}%
2415  \TestPow{1}{2}{1}%
2416  \TestPow{2}{2}{4}%
2417  \TestPow{3}{2}{9}%
2418  \TestPow{0}{1}{0}%
2419  \TestPow{1}{-2}{1}%
2420  \TestPow{1}{-1}{1}%
2421  \TestPow{-1}{-2}{1}%
2422  \TestPow{-1}{-1}{-1}%
2423  \TestPow{-1}{3}{-1}%
2424  \TestPow{-1}{4}{1}%
2425  \TestPow{-2}{-1}{0}%
2426  \TestPow{-2}{-2}{0}%
2427  \TestPow{2}{3}{8}%
2428  \TestPow{2}{4}{16}%
2429  \TestPow{2}{5}{32}%
2430  \TestPow{2}{6}{64}%
2431  \TestPow{2}{7}{128}%
2432  \TestPow{2}{8}{256}%
2433  \TestPow{2}{9}{512}%
2434  \TestPow{2}{10}{1024}%
```

```
2435  \TestPow{-2}{3}{-8}%
2436  \TestPow{-2}{4}{16}%
2437  \TestPow{-2}{5}{-32}%
2438  \TestPow{-2}{6}{64}%
2439  \TestPow{-2}{7}{-128}%
2440  \TestPow{-2}{8}{256}%
2441  \TestPow{-2}{9}{-512}%
2442  \TestPow{-2}{10}{1024}%
2443  \TestPow{3}{3}{27}%
2444  \TestPow{3}{4}{81}%
2445  \TestPow{3}{5}{243}%
2446  \TestPow{-3}{3}{-27}%
2447  \TestPow{-3}{4}{81}%
2448  \TestPow{-3}{5}{-243}%
2449  \TestPow{2}{30}{1073741824}%
2450  \TestPow{-3}{19}{-1162261467}%
2451  \TestPow{5}{13}{1220703125}%
2452  \TestPow{-7}{11}{-1977326743}%
2453 \end{qstest}
2454
2455 \begin{qstest}{div}{div}
2456  \TestDiv{1}{1}{1}%
2457  \TestDiv{2}{1}{2}%
2458  \TestDiv{-2}{1}{-2}%
2459  \TestDiv{2}{-1}{-2}%
2460  \TestDiv{-2}{-1}{2}%
2461  \TestDiv{15}{2}{7}%
2462  \TestDiv{-16}{2}{-8}%
2463  \TestDiv{1}{2}{0}%
2464  \TestDiv{1}{3}{0}%
2465  \TestDiv{2}{3}{0}%
2466  \TestDiv{-2}{3}{0}%
2467  \TestDiv{2}{-3}{0}%
2468  \TestDiv{-2}{-3}{0}%
2469  \TestDiv{13}{3}{4}%
2470  \TestDiv{-13}{-3}{4}%
2471  \TestDiv{-13}{3}{-4}%
2472  \TestDiv{-6}{5}{-1}%
2473  \TestDiv{-5}{5}{-1}%
2474  \TestDiv{-4}{5}{0}%
2475  \TestDiv{-3}{5}{0}%
2476  \TestDiv{-2}{5}{0}%
2477  \TestDiv{-1}{5}{0}%
2478  \TestDiv{0}{5}{0}%
2479  \TestDiv{1}{5}{0}%
2480  \TestDiv{2}{5}{0}%
2481  \TestDiv{3}{5}{0}%
2482  \TestDiv{4}{5}{0}%
2483  \TestDiv{5}{5}{1}%
2484  \TestDiv{6}{5}{1}%
2485  \TestDiv{-5}{4}{-1}%
2486  \TestDiv{-4}{4}{-1}%
2487  \TestDiv{-3}{4}{0}%
2488  \TestDiv{-2}{4}{0}%
2489  \TestDiv{-1}{4}{0}%
2490  \TestDiv{0}{4}{0}%
2491  \TestDiv{1}{4}{0}%
2492  \TestDiv{2}{4}{0}%
2493  \TestDiv{3}{4}{0}%
2494  \TestDiv{4}{4}{1}%
2495  \TestDiv{5}{4}{1}%
2496  \TestDiv{12345}{678}{18}%
```

```
2497  \TestDiv{32372}{5952}{5}%
2498  \TestDiv{284271294}{18162}{15651}%
2499  \TestDiv{217652429}{12561}{17327}%
2500  \TestDiv{462028434}{5439}{84947}%
2501  \TestDiv{2147483647}{1000}{2147483}%
2502  \TestDiv{2147483647}{-1000}{-2147483}%
2503  \TestDiv{-2147483647}{1000}{-2147483}%
2504  \TestDiv{-2147483647}{-1000}{2147483}%
2505 \end{qstest}
2506
2507 \begin{qstest}{mod}{mod}
2508  \TestMod{-6}{5}{4}%
2509  \TestMod{-5}{5}{0}%
2510  \TestMod{-4}{5}{1}%
2511  \TestMod{-3}{5}{2}%
2512  \TestMod{-2}{5}{3}%
2513  \TestMod{-1}{5}{4}%
2514  \TestMod{0}{5}{0}%
2515  \TestMod{1}{5}{1}%
2516  \TestMod{2}{5}{2}%
2517  \TestMod{3}{5}{3}%
2518  \TestMod{4}{5}{4}%
2519  \TestMod{5}{5}{0}%
2520  \TestMod{6}{5}{1}%
2521  \TestMod{-5}{4}{3}%
2522  \TestMod{-4}{4}{0}%
2523  \TestMod{-3}{4}{1}%
2524  \TestMod{-2}{4}{2}%
2525  \TestMod{-1}{4}{3}%
2526  \TestMod{0}{4}{0}%
2527  \TestMod{1}{4}{1}%
2528  \TestMod{2}{4}{2}%
2529  \TestMod{3}{4}{3}%
2530  \TestMod{4}{4}{0}%
2531  \TestMod{5}{4}{1}%
2532  \TestMod{-6}{-5}{-1}%
2533  \TestMod{-5}{-5}{0}%
2534  \TestMod{-4}{-5}{-4}%
2535  \TestMod{-3}{-5}{-3}%
2536  \TestMod{-2}{-5}{-2}%
2537  \TestMod{-1}{-5}{-1}%
2538  \TestMod{0}{-5}{0}%
2539  \TestMod{1}{-5}{-4}%
2540  \TestMod{2}{-5}{-3}%
2541  \TestMod{3}{-5}{-2}%
2542  \TestMod{4}{-5}{-1}%
2543  \TestMod{5}{-5}{0}%
2544  \TestMod{6}{-5}{-4}%
2545  \TestMod{-5}{-4}{-1}%
2546  \TestMod{-4}{-4}{0}%
2547  \TestMod{-3}{-4}{-3}%
2548  \TestMod{-2}{-4}{-2}%
2549  \TestMod{-1}{-4}{-1}%
2550  \TestMod{0}{-4}{0}%
2551  \TestMod{1}{-4}{-3}%
2552  \TestMod{2}{-4}{-2}%
2553  \TestMod{3}{-4}{-1}%
2554  \TestMod{4}{-4}{0}%
2555  \TestMod{5}{-4}{-3}%
2556  \TestMod{2147483647}{1000}{647}%
2557  \TestMod{2147483647}{-1000}{-353}%
2558  \TestMod{-2147483647}{1000}{353}%
```

```
2559  \TestMod{-2147483647}{-1000}{-647}%
2560  \TestMod{ 0 }{ 4 }{0}%
2561  \TestMod{ 1 }{ 4 }{1}%
2562  \TestMod{ -1 }{ 4 }{3}%
2563  \TestMod{ 0 }{ -4 }{0}%
2564  \TestMod{ 1 }{ -4 }{-3}%
2565  \TestMod{ -1 }{ -4 }{-1}%
2566 ⟨*etex⟩
2567  \TestMod{1+2}{1+3}{3}%
2568  \TestMod{1-2}{1+3}{3}%
2569  \TestMod{1-2}{1-4}{-1}%
2570  \TestMod{1+2}{1-4}{0}%
2571  \TestMod{1+2}{1-5}{-1}%
2572 ⟨/etex⟩
2573 \end{qstest}
2574 ⟨/test2 j test4⟩

2575 ⟨*test2⟩
2576 \newcommand*{\TestError}[2]{%
2577  \begingroup
2578    \expandafter\def\csname IntCalcError:#1\endcsname{}%
2579    \Expect*{#2}{0}%
2580    \expandafter\def\csname IntCalcError:#1\endcsname{ERROR}%
2581    \Expect*{#2}{0ERROR }%
2582  \endgroup
2583 }
2584 \begin{qstest}{error}{error}
2585  \TestError{FacNegative}{\intcalcFac{-1}}%
2586  \TestError{FacNegative}{\intcalcFac{-2147483647}}%
2587  \TestError{FacOverflow}{\intcalcFac{13}}%
2588  \TestError{FacOverflow}{\intcalcFac{2147483647}}%
2589  \TestError{DivisionByZero}{\intcalcPow{0}{-1}}%
2590  \TestError{DivisionByZero}{\intcalcDiv{1}{0}}%
2591  \TestError{DivisionByZero}{\intcalcMod{1}{0}}%
2592  \TestError{DivisionByZero}{\IntCalcDiv1!0!}%
2593  \TestError{DivisionByZero}{\IntCalcMod1!0!}%
2594 \end{qstest}
2595 ⟨/test2⟩

2596 ⟨*test2 j test4⟩
2597 \begin{document}
2598 \end{document}
2599 ⟨/test2 j test4⟩
```

4 Installation

4.1 Download

Package.   This package is available on CTAN[1]:

CTAN:macros/latex/contrib/oberdiek/intcalc.dtx The source file.

CTAN:macros/latex/contrib/oberdiek/intcalc.pdf Documentation.

Bundle.   All the packages of the bundle 'oberdiek' are also available in a TDS compliant ZIP archive. There the packages are already unpacked and the documentation files are generated. The files and directories obey the TDS standard.

CTAN:install/macros/latex/contrib/oberdiek.tds.zip

TDS refers to the standard "A Directory Structure for TeX Files" (**CTAN:tds/ tds.pdf**). Directories with `texmf` in their name are usually organized this way.

---

[1] http://ctan.org/pkg/intcalc

4.2 Bundle installation

Unpacking. Unpack the `oberdiek.tds.zip` in the TDS tree (also known as `texmf` tree) of your choice. Example (linux):

```
unzip oberdiek.tds.zip -d ~/texmf
```

Script installation. Check the directory `TDS:scripts/oberdiek/` for scripts that need further installation steps. Package **attachfile2** comes with the Perl script `pdfatfi.pl` that should be installed in such a way that it can be called as `pdfatfi`. Example (linux):

```
chmod +x scripts/oberdiek/pdfatfi.pl
cp scripts/oberdiek/pdfatfi.pl /usr/local/bin/
```

4.3 Package installation

Unpacking. The `.dtx` file is a self-extracting **docstrip** archive. The files are extracted by running the `.dtx` through plain TeX:

```
tex intcalc.dtx
```

TDS. Now the different files must be moved into the different directories in your installation TDS tree (also known as `texmf` tree):

```
intcalc.sty            → tex/generic/oberdiek/intcalc.sty
intcalc.pdf            → doc/latex/oberdiek/intcalc.pdf
test/intcalc-test1.tex → doc/latex/oberdiek/test/intcalc-test1.tex
test/intcalc-test2.tex → doc/latex/oberdiek/test/intcalc-test2.tex
test/intcalc-test3.tex → doc/latex/oberdiek/test/intcalc-test3.tex
test/intcalc-test4.tex → doc/latex/oberdiek/test/intcalc-test4.tex
intcalc.dtx            → source/latex/oberdiek/intcalc.dtx
```

If you have a `docstrip.cfg` that configures and enables **docstrip**'s TDS installing feature, then some files can already be in the right place, see the documentation of **docstrip**.

4.4 Refresh file name databases

If your TeX distribution (teTeX, mikTeX, …) relies on file name databases, you must refresh these. For example, teTeX users run `texhash` or `mktexlsr`.

4.5 Some details for the interested

Unpacking with LaTeX. The `.dtx` chooses its action depending on the format:

plain TeX: Run **docstrip** and extract the files.

LaTeX: Generate the documentation.

If you insist on using LaTeX for **docstrip** (really, **docstrip** does not need LaTeX), then inform the autodetect routine about your intention:

```
latex \let\install=y\input{intcalc.dtx}
```

Do not forget to quote the argument according to the demands of your shell.

Generating the documentation. You can use both the `.dtx` or the `.drv` to generate the documentation. The process can be configured by the configuration file `ltxdoc.cfg`. For instance, put this line into this file, if you want to have A4 as paper format:

```
\PassOptionsToClass{a4paper}{article}
```

An example follows how to generate the documentation with pdfLaTeX:

```
pdflatex intcalc.dtx
makeindex -s gind.ist intcalc.idx
pdflatex intcalc.dtx
makeindex -s gind.ist intcalc.idx
pdflatex intcalc.dtx
```

5 Catalogue

The following XML file can be used as source for the TeX Catalogue. The elements `caption` and `description` are imported from the original XML file from the Catalogue. The name of the XML file in the Catalogue is `intcalc.xml`.

```
2600 ⟨*catalogue⟩
2601 <?xml version='1.0' encoding='us-ascii'?>
2602 <!DOCTYPE entry SYSTEM 'catalogue.dtd'>
2603 <entry datestamp='$Date$' modifier='$Author$' id='intcalc'>
2604   <name>intcalc</name>
2605   <caption>Expandable arithmetic operations with integers.</caption>
2606   <authorref id='auth:oberdiek'/>
2607   <copyright owner='Heiko Oberdiek' year='2007'/>
2608   <license type='lppl1.3'/>
2609   <version number='1.2'/>
2610   <description>
2611     This package provides expandable arithmetic operations
2612     with integers, using the e-TeX extension <tt>\numexpr</tt> if it
2613     is available.
2614     <p/>
2615     The package is part of the <xref refid='oberdiek'>oberdiek</xref>
2616     bundle.
2617   </description>
2618   <documentation details='Package documentation'
2619      href='ctan:/macros/latex/contrib/oberdiek/intcalc.pdf'/>
2620   <ctan file='true' path='/macros/latex/contrib/oberdiek/intcalc.dtx'/>
2621   <miktex location='oberdiek'/>
2622   <texlive location='oberdiek'/>
2623   <install path='/macros/latex/contrib/oberdiek/oberdiek.tds.zip'/>
2624 </entry>
2625 ⟨/catalogue⟩
```

6 History

[2007/09/09 v1.0]

- First version.

[2007/09/27 v1.1]

- `\intcalcNum` added.

- `\intcalcShl` and `\intcalcShr` allow negative numbers. The sign is preserved.

- Reuse `\@gobble` instead of own macro `\IntCalc@Gobble`.

- Small fixes.

- Shorter internal prefix.

- Some programmer's interface.

[2016/05/16 v1.2]

- Documentation updates.

7 Index

Numbers written in italic refer to the page where the corresponding entry is described; numbers underlined refer to the code line of the definition; plain numbers refer to the code lines where the entry is used.

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