

MODULE *appex1_3*

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EXTENDS *Naturals*, *TLC*
 CONSTANTS *Places*, *N*, *Q*, *B*
 VARIABLES *M*

t1 \triangleq

$\wedge M["p2"] \geq 1 \wedge M["pi"] \geq 1$
 $\wedge M' = [[[M \text{ EXCEPT } !["p1"] = 1]$
 $\quad \text{EXCEPT } !["pi"] = @ - 1]$
 $\quad \text{EXCEPT } !["p2"] = @ - 1]$

t2 \triangleq

$\wedge M["p1"] \geq 1 \wedge M["p5"] < B$
 $\wedge M' = [[[M \text{ EXCEPT } !["p1"] = @ - 1]$
 $\quad \text{EXCEPT } !["p5"] = M["p5"] + 1]$
 $\quad \text{EXCEPT } !["p2"] = 1]$

t3 \triangleq

$\wedge M["p5"] \geq 1 \wedge M["p4"] \geq 1$
 $\wedge M' = [[[M \text{ EXCEPT } !["p3"] = @ + 1]$
 $\quad \text{EXCEPT } !["p5"] = @ - 1]$
 $\quad \text{EXCEPT } !["p4"] = @ - 1]$

t4 \triangleq

$\wedge M["p3"] \geq 1 \wedge M["po"] < Q$
 $\wedge M' = [[[M \text{ EXCEPT } !["p3"] = M["p3"] - 1]$
 $\quad \text{EXCEPT } !["po"] = M["po"] + 1]$
 $\quad \text{EXCEPT } !["p4"] = M["p4"] + 1]$

Init1 \triangleq $M = [p \in \text{Places} \mapsto \text{IF } p \in \{"p4", "p2"\} \text{ THEN } 1 \text{ ELSE }$
 $\quad \text{IF } p = "pi" \text{ THEN } N \text{ ELSE } 0]$

Init \triangleq *Init1*

Next \triangleq *t1* \vee *t2* \vee *t3* \vee *t4* \vee *M'* $= M$

TypeInvariant \triangleq $\forall p \in \text{Places} : M[p] \geq 0$

Inv1 \triangleq $M["pi"] + M["p5"] + M["po"] + M["p1"] + M["p3"] = N$

Inv2 \triangleq $M["po"] \leq Q$

$$QInv4 \triangleq M["\text{pi}"] + M["\text{p5}"] + M["\text{po}"] + M["\text{p2}"] + M["\text{p4}"] = N + 2$$

$$Inv5 \triangleq M["\text{p3}"] + M["\text{p4}"] + M["\text{p1}"] + M["\text{p2}"] = 2$$

$$Inv3 \triangleq M["\text{p3}"] = 0$$

$$Inv6 \triangleq M["\text{p1}"] + M["\text{p2}"] = 1$$

$$Question \triangleq M["\text{po}"] \neq N$$

$$Safety1 \triangleq M["\text{p2}"] \leq 1 \wedge M["\text{p2}"] \geq 0$$

$$Check \triangleq Inv6$$

$$safe \triangleq Inv3$$