MODULE *Therac25*

EXTENDS *Naturals*

VARIABLES *count*, *pc*, *target*, *photon*

CONSTANT *Intensity*, *Time*, *Mode*

X ray intensity is set to a constant 25 *MeV*

$$XRayIntensity \triangleq 25$$

In "Electron" mode the electron beam intensity in lesser than the current in "XRay" mode.

$$\begin{aligned} TypeInvariant \triangleq\ & \land\ Time \in Nat \land Time \neq 0 \\ & \land\ Mode \in \{\text{"Electron"}, \text{"XRay"}, \text{"Done"}\} \\ & \land\ Intensity \leq XRayIntensity \end{aligned}$$

The "count" variable is decreased at each step and it stops when it is zeroed. In the "XRay" mode, the target must be placed in the path of the beam to act as a filter and collimator. Int the "Electron" mode, the target is not needed due the low 'lightning' intensity.

$$\begin{aligned} Init \triangleq\ & \land\ count = Time \\ & \land\ pc = Mode \\ & \land\ \text{IF } pc = \text{"XRay"} \text{ THEN } \land\ photon = XRayIntensity \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ target\ = \text{"On"} \\ & \qquad\qquad\qquad\quad \text{ELSE } \land\ photon = Intensity \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ target\ = \text{"Off"} \end{aligned}$$

Electron mode

$$\begin{aligned} Treat1 \triangleq\ & \land\ pc = \text{"Electron"} \\ & \land\ target = \text{"Off"} \\ & \land\ \text{IF } count = 0 \text{ THEN } \land\ pc' = \text{"Done"} \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ photon' = 0 \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ \text{UNCHANGED } \langle target \rangle \\ & \qquad\qquad\qquad\quad \text{ELSE } \land\ count' = count - 1 \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ \text{UNCHANGED } \langle pc, photon, target \rangle \end{aligned}$$

XRay mode

$$\begin{aligned} Treat2 \triangleq\ & \land\ pc = \text{"XRay"} \\ & \land\ target = \text{"On"} \quad \text{Confirm that the target is activated.} \\ & \land\ \text{IF } count = 0 \text{ THEN } \land\ pc' = \text{"Done"} \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ photon' = 0 \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ target' = \text{"Off"} \\ & \qquad\qquad\qquad\quad \text{ELSE } \land\ count' = count - 1 \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ \text{UNCHANGED } \langle pc, photon, target \rangle \end{aligned}$$

$$Next \triangleq Treat1 \lor Treat2$$

$$vars \triangleq \langle count, pc, target, photon \rangle$$

$$Spec \triangleq Init \land \Box[Next]_{\langle vars \rangle}$$