MODULE *ExperimentControl*

Specification of a system to control an experiment to characterize a material based on a curve of heating response. The material is put in a compartment with a resistance attached and a power supply to send voltage to resistance to heat the material. When it reachs a *High* value, the material is freezed having a *Low* temperature as a parameter to reverse again to heating phase. Then, when *High* temperature is reached, it is frezeed again and then reaching *Low* temperature, the experiment halts.

EXTENDS *Integers*

VARIABLES *delta*, *freeze*, *pc*, *power*, *temperature*, *phase*

CONSTANTS *High*, *Low*, *Delta*

$$
\begin{aligned}
\mathit{Invariant} \triangleq\ & \land\ \mathit{pc} \in \{\text{“HEAT”},\ \text{“FREEZE”},\ \text{“DONE”}\} \\
& \land\ \mathit{power} \in \{\text{“ON”},\ \text{“OFF”}\} \\
& \land\ \mathit{freeze} \in \{\text{“YES”},\ \text{“NO”}\} \\
& \land\ \mathit{temperature} \in \mathit{Int} \\
& \land\ \mathit{phase} \in \{1,\ 2,\ 3,\ 4\} \\
& \land\ \mathit{Low} < \mathit{High}
\end{aligned}
$$

$$
\begin{aligned}
\mathit{Init} \triangleq\ & \land\ \mathit{pc} = \text{“HEAT”} \\
& \land\ \mathit{power} = \text{“ON”} \\
& \land\ \mathit{freeze} = \text{“NO”} \\
& \land\ \mathit{temperature} = \mathit{Low} \\
& \land\ \mathit{phase} = 1 \\
& \land\ \mathit{delta}\ = \mathit{Delta}
\end{aligned}
$$

$$
\begin{aligned}
\mathit{Heat} \triangleq\ & \land\ \mathit{pc} = \text{“HEAT”} \\
& \land\ \text{IF}\ \mathit{temperature} \geq \mathit{High}\ \text{THEN}\ \land\ \mathit{freeze}' = \text{“YES”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \mathit{power}' = \text{“OFF”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \mathit{pc}' = \text{“FREEZE”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \mathit{phase}' = \mathit{phase} + 1 \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \text{UNCHANGED}\ \langle \mathit{delta},\ \mathit{temperature} \rangle \\
& \qquad\qquad\qquad\qquad\qquad\ \text{ELSE}\ \land\ \mathit{temperature}' = \mathit{temperature} + \mathit{delta} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \text{UNCHANGED}\ \langle \mathit{delta},\ \mathit{power},\ \mathit{freeze},\ \mathit{pc},\ \mathit{phase} \rangle
\end{aligned}
$$

$$
\begin{aligned}
\mathit{Freeze} \triangleq\ & \land\ \mathit{pc} = \text{“FREEZE”} \\
& \land\ \text{IF}\ \mathit{temperature} \leq \mathit{Low}\ \text{THEN}\ \land\ \mathit{freeze}' = \text{“NO”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \text{IF}\ \mathit{phase} \neq 4\ \text{THEN}\ \land\ \mathit{power}' = \text{“ON”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \mathit{pc}' = \text{“HEAT”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \mathit{phase}' = \mathit{phase} + 1 \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\ \text{ELSE}\ \land\ \mathit{power}' = \text{“OFF”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \mathit{pc}' = \text{“DONE”} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \text{UNCHANGED}\ \mathit{phase} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \text{UNCHANGED}\ \langle \mathit{delta},\ \mathit{temperature} \rangle \\
& \qquad\qquad\qquad\qquad\qquad\ \text{ELSE}\ \land\ \mathit{temperature}' = \mathit{temperature} - \mathit{delta} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\ \land\ \text{UNCHANGED}\ \langle \mathit{delta},\ \mathit{power},\ \mathit{freeze},\ \mathit{pc},\ \mathit{phase} \rangle
\end{aligned}
$$

$$\mathit{Next} \triangleq \mathit{Heat} \lor \mathit{Freeze}$$

$$vars \triangleq \langle delta, freeze, pc, power, temperature, phase \rangle$$

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