TYPE 671: N-STAGE DIFFERENTIAL CONTROLLER IN HEATING

General Description

An N-stage differential controller is modeled to output N ON/OFF control functions that can be used to control a heating system having a N-stage heat source.

The controller commands a first stage control signal at low input values, a second stage control signal at lower input values, a third stage control signal at even lower input values etc. through the n^{th} defined level.

The user has the option to enable or disable the output control functions for levels lower than the critical control function. For example if the model decides that the third stage signal should be ON, the user has the option of then deciding whether stage 1 and stage 2 should be ON or OFF.

Nomenclature

$SetPt\|_t$	[ºC] [1]	The set controller set point at the current time step.
$SetPt\|_{t-1}$	[ºC] [1]	The controller set point at the previous time step.
γ	[0..1]	The controller state (1 if the controller is ON, 0 if the controller is OFF
ΔT_{db}	[ºC] [1]	The controller dead band.
$\gamma_{SetBack}$	[0..1]	The control signal for the controller set back option.
$\Delta T_{SetBack}$	[ºC] [1]	The temperature difference the that the controller will be set back when the setback function is enabled.

[1.] While "temperature" notation is used throughout this model and documentation, any consistent set of variables may be used in model to simulate different types of ON/OFF controllers.

Detailed Description

While "temperature" notation is used throughout this model and documentation, any consistent set of variables may be used in model to simulate different types of ON/OFF controllers. A number of features are included with the model.

Set Back Controls
In many applications, the desired set point condition may depend on the time of day or the day of the week. This variation of the set points are modeled in Type671 using an optional set back control function (INPUT 2) and set back difference (PARAMETER 4).

Hysteresis
Hysteresis effects can be included in the model by supplying the dead band difference ΔT_{db} (PARAMETER 5). A single value of ΔT_{db}, is applied to all N output control functions.

PARAMETER 2, NSTK, sets the number of oscillations permitted within a time step before the output state of the controller is stuck. It is recommended that NSTK be chosen carefully. An odd value of NSTK may cause the controller to oscillate during successive time steps while an even value of NSTK may cause the output control function to stay ON or OFF longer than it should. For a discussion of

controller stability problems, see Section 4.4 of Volume 1 (the red binder) of the TRNSYS documentation set.

The ON/OFF set points for any given stage are determined as shown in equation 671.1.

$$SetPt\big|_t = SetPt\big|_{t-1} - (1-\gamma)\frac{\Delta T_{db}}{2} + \gamma\frac{\Delta T_{db}}{2} - \gamma_{SetBack} * \Delta T_{SetBack} \quad \text{(Eq. 671.1)}$$

If hysteresis effects are not desired, ΔT_{db} is set to zero. If set back option is not desired then both $\gamma_{SetBack}$ and $\Delta T_{SetBack}$ are set to zero.

Care should be taken when choosing deadbands and set points. Deadbands that are greater than the temperature difference between the setpoints will cause controller convergence problems.

Example

Type671 is used in an example that can be found in:
" ..\trnsys16\TESS Models\Studio Projects\Controllers Library\Lots of Controllers.tpf"