TYPE 658: HUMIDISTAT

General Description

This ON/OFF differential device is most often used to control the operation of a humidifier based on the temperatures and relative humidities of the zone and inlet air ventilation stream. The humidistat generates a control function which can have a value of 1 or 0. The value of the control signal is set as a function of the difference between a set point relative humidity and the relative humidity of the zone air, compared with two dead band relative humidity differences. The new value of the control function also depends upon the value of the input control function at the previous time step. The controller is normally used with the input control signal connected to the output control signal, providing a hysteresis effect. However, control signals from different components may be used as the input control signal for this component if a more detailed form of hysteresis is desired.

Nomenclature

$RH_{SetPoint}$	%	The relative humidity set point for the humidistat. In other words, the target zone relative humidity.
$T_{AirInlet}$	C	The temperature of air sensed by the controller.
A	-	The multiplier used to calculate the relative humidity set point from the inlet air temperature.
B	-	The constant used to calculate the relative humidity set point from the inlet air temperature.

Detailed Description

In this model, the relative humidity set point is a linear function of the inlet air temperature as shown in equation 1:

$$RH_{SetPoint} = A * T_{AirInlet} + B \qquad \text{(Eq. 658.1)}$$

Where "A" is the relative humidity set point multiplier (parameter 6) and "B" is the relative humidity set point constant (parameter 5). For safety considerations, a high limit cut-out is included with this controller. Regardless of the dead band conditions, the control function will be set to zero if the high limit condition is exceeded.

The overall control strategy is as follows. If the input control signal was ON at the previous time step (in other words humidification was being called for at the last time) then the signal remains ON as long as the difference between the relative humidity set point and the zone relative humidity is greater than the lower relative humidity dead band. Otherwise, the control signal switches OFF.

If the input control signal was OFF at previous time step, then the signal switches ON if the difference between the relative humidity set point and the zone relative humidity is greater than the upper relative humidity dead band. Otherwise, the control signal stays OFF.

As stated previously, the signal switches OFF regardless of the dead band conditions if the high limit cutout is activated. The control strategy is depicted graphically in Figure 1.

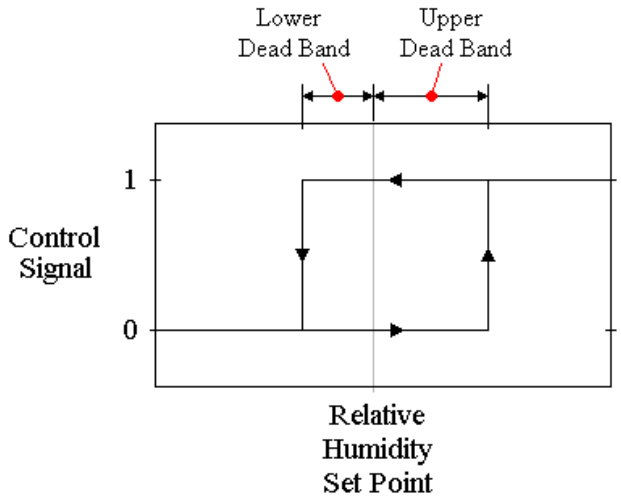


Figure 1: Humidistat Control Strategy

When the difference between the relative humidity set point and the zone relative humidity nears the upper or lower dead band in the normal mode of operation, the control signal may sometimes oscillate between ON and OFF for successive iterations at a given time step. This happens because the relative humidity set point and the relative humidity of the zone change slightly at each iteration, alternately satisfying and not satisfying the conditions for switching the controller. The value of parameter 1 in this model is the number of oscillations of the control signal that are permitted in the time step before the component "sticks" the output signal at one value so that the calculations at this time step may be solved. It is recommended that the value of this first parameter be set to an odd number to avoid biasing short-term results.

The problem of control strategies, controller sticking, and hysteresis in simulation is discussed in considerable detail in sections 3.3.4, 3.4.2, and 4.4 of Volume 1 (the red binder) of the TRNSYS documentation set.

Example

Type658 is used in an example that can be found in:
" ..\trnsys16\TESS Models\Studio Projects\Controllers Library\Lots of Controllers.tpf"

References

[1] Beckman, W.A., J.W. Thornton,, S. Long, and B.D. Wood, *"Control Problems in Solar Domestic Hot Water Systems"*, Proceedings of the American Solar Energy Society, Solar 93 Conference, Washington D.C., 1993

[2] Duffie, J.A. and W.A. Beckman, Solar Engineering of Thermal Processes, Wiley Interscience, New York, 1980