TYPE 728: MULTIPLE POWER LEVEL LIGHTS

General Description

This component is intended to model one of many control strategies for reduced energy usage lighting. It takes two control signals and is only ON if both control signals are ON. In a typical application, one of the control signals might be connected to the occupancy of the a room, while the other is connected to a daylight level sensor. The model also features an automatic delayed shut off as would be appropriate to model lighting connected to a motion sensor. When one of the two control signals drops to zero, the lights stay on (and continue to draw power and create a heat gain in the space) for a user settable amount of time. Finally, users may specify the number of power levels at which the lighting may be operated. Both power draw and heat gain are correspondingly stepped back.

Nomenclature

Q_{lights}	-	Heat gain from lights [kJ/h]
W	-	Total light wattage [W]
F_{sa}	-	Special allowance factor [-]

Detailed Description

At the heart of Type728 is the equation given by ASHRAE [1] to compute heat gain from lights as shown in Equation 728.1.

$$Q_{lights} = 3.6 * W * F_{sa} \qquad \text{(Eq. 728.1)}$$

In which 3.6 is simply the conversion factor between W and kJ/h. The factor F_{sa} is included by ASHRAE to account for lighting fixtures that are designed so that not all of the heat that they generate enters the conditioned space. In cases where the special allowance factor is greater than unity, the additional heat gain is primarily due to ballast losses.

The model reports the total power draw of the fixture based on the specified fixture wattage parameter (W in Equation 1). In addition to reporting the total heat gain, the model reports the convective and radiative components of the heat gain based on a split specified by the user among the parameters, and reports heat to space and heat to return, also based upon a user specified split. If the fixture is installed in such a way that all of the heat generated enters conditioned space, it suffices to set the value of parameter 7 to 1. This feature would allow a user to model a situation in which the ceiling space above the lamp is being used as a return plenum. The heat not entering the conditioned space could be instead added to the return air stream.

The complexities of this light fixture model lie in its control strategy. It is set up to have two independent control signals and to only be ON if both of those control signals are ON. If the first of the two signals switches to OFF, the lights will stay on for the amount of time specified in the second parameter. The control signal can, of course be generated by whatever desired combination of TRNSYS components and/or equations the user may have. However, one of its uses would be in modeling a light fixture that is integrated with a motion sensor. The first control signal might be connected to the occupancy of the room. As soon as someone enters the room, the lights come on (provided that the second control signal is also set to ON). When the last person leaves the room, the lights stay on for a

user designated period of time (say 5 minutes) and then shut off. The model keeps track of when the first control signal switches OFF and computes the amount of additional power that is drawn by the lamp and the amount of heat that is generated by the lamp before it too switches OFF.

The second control signal is not affected by the parameter 2 delay. As soon as the second control signal switches OFF, the lights switch OFF as well. Again, this control signal can be generated by anything but may often be connected to a daylight level sensor in the room. As long as enough daylight falls on the sensor, the lights will remain OFF. As soon as the daylight level drops below a certain set point, the lights would turn back ON provided that the first control signal is also set to ON.

The model contains other “energy efficiency” feature. The lights may be operated at varying power levels. The user sets the first parameter to the number of discrete power levels at which the light may be operated. By default this Type is set up to allow as many as 10 light/power levels. To modify that limit, it suffices to change the value of NPMAX in the file Type728.for, recompile the component and relink the appropriate TRNSYS dll. After setting parameter 1 to the number of levels, the final n parameters are set to the appropriate fractional power levels. The model assumes that the fixture’s heat gain varies linearly with power level such that at 50% light power, it generates 50% of the heat predicted by Equation 1. The third input to the model is then the power level at which the lights are currently being operated. If the lights are turned OFF, they will come back on (when controlled to do so) at the last set power level.

References

[1] ASHRAE Handbook of Fundamentals, 2001. chapter 29