# TYPE 727: CONTINUALLY STEPPED LIGHT FIXTURES

## 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. One of the two control signals is digital, the other an analog value between 0 and 1. The light supplied by the fixture (and its corresponding heat gain) are stepped linearly with the value of the analog control signal. In a typical application, the digital control signals might be connected to the occupancy of the a room, while the analog signal 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 the digital control signal 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.

## Nomenclature

| | | |
|---|---|---|
| $Q_{lights}$ | - | Heat gain from lights [kJ/h] |
| W | - | Total light wattage [W] |
| CTRL | - | Lighting control function [0..1] |
| $F_{sa}$ | - | Special allowance factor [-] |

## Detailed Description

At the heart of Type727 is the equation given by ASHRAE [1] to compute heat gain from lights as shown in Equation 727.1.

$$Q_{lights} = 3.6 * W * CTRL * F_{sa} \qquad \text{(Eq. 727.1)}$$

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 value of CTRL may vary between 0 and 1. If a control signal of greater than 1 is seen by the model, the value is limited to 1 and a warning is printed to the list file.

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 features. It is set up to have two independent control signals, one of which is digital (0 or 1) and the other of which is analog. The light fixture is only ON ON if both of those control signals have values greater than 0. If the digital signal

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 digital 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 analog control signal is also greater than 0). 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 digital 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 analog control signal is not affected by the parameter 2 delay. As soon as it 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. Because the lighting power level is determined by the value of this analog control signal, the lights will be dimmed according to the amount of available daylight.

## References

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