Daylighting Control – Overview

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1. Overview

The purpose of this document is to answer some frequently asked questions about Sensor Switch's Daylighting Control Products. The information in this document generally applies to both Standard Products and nLight Products.

All of Sensor Switch's Daylighting Control Products contain a microcontroller and either a photocell or a photodiode. The microcontroller, amongst other things, allows the product to obtain and remember information about the lights it is controlling. The use of the photocell versus a photodiode should have no effect on the product functionality.

1.1. Light Measurements

Each Daylight Control Product measures the light level either by looking down through the lens or up out of the back of the product. The light level is measured in foot candles. A foot candle meter is often used to determine the amount of foot candles present at a specific point. A foot candle meter placed next to a sensor and oriented in the same way should roughly result in the same value that the sensor is measuring. This is not exact and various factors can effect this, especially the fact that foot candle meters generally have a wider field of view than the sensors.

1.2. Thresholds

Each Daylighting Control Product will have a set number of foot candles it will try to keep its foot candle measurement above. The specific threshold a given product will maintain is a result of the combination of the Set Point and the Sunlight Discount Factor. Keep in mind that the light level will be maintained at the sensor and not necessarily at the work surface. When active, On/Off Daylighting Control products will be comparing their foot candle measurement to one of two thresholds. If the light the sensor is controlling is off, then the sensor will compare its foot candle measurement to its Set Point multiplied by its Sunlight Discount Factor. If the foot candle measurement ever goes beneath this threshold the sensor will start its countdown to turn the lights on.

If the light the sensor is controlling is on, then the sensor will compare its foot candle measurement to its Set Point multiplied by its Sunlight Discount Factor plus the measured artificial contribution of the lights it is controlling and a safety factor. If the foot candle measurement ever goes above this threshold the sensor will start its countdown to turn the lights off. The measured artificial contribution of the lights it is controlling must be included to ensure when the lights are switched off that the underlying threshold is maintained. Otherwise the lights could cycle on and off going above and below the threshold forever. The measured artificial contribution of the lights and the safety factor are sometimes referred to as the Deadband.

1.2.1. Artificial Measurement

To prevent cycling the sensor must measure the artificial contribution of the lights it is controlling. The sensor will try to measure this value during its normal functioning by measuring the foot candle level before and after it turns the lights on or off. The sensor must measure the artificial contribution at least twice to confirm that it is correct and not skewed by something

else changing the light level in the space. The end result of the artificial measurement process is that the lights may cycle on and off a few times when the sensor is first installed until it acquires the correct artificial measurement.

The Auto Set Point will also automatically acquire the artificial measurement, so if an Auto Set Point is performed the lights should not cycle to acquire the artificial.

1.3. Sunlight Discount Factor

The Sunlight Discount Factor was introduced to compensate for the fact that in most installations the sensor will measure the effect of the artificial lights differently than the effect of sunlight on the work surface. Ideally, all of the light measured by the sensor will be light that is reflected off of the work surface and up at the sensor. This would result in a constant ratio between the light measured at the work surface and the light measured at the sensor. Often the sensor also measures sunlight which does not bounce off the work surface but instead comes from bouncing off other surfaces. The result is that the ratio of the artificial light hitting the work surface to the artificial light measured at the sensor is different than the ratio of the sunlight hitting the work surface to the sunlight measured at the sensor. This ratio is always higher for sunlight in that it takes a larger change in sunlight than artificial at the sensor to result in the same change at the work surface.

To compensate for this effect the part of the light measurement which results from sunlight is divided by the Sunlight Discount Factor. This is possible since the artificial contribution is known. For On/Off Daylighting Control Products it can be shown that this is mathematically equivalent to multiplying the Set Point by the Sunlight Discount Factor. This is also true for Automatic Dimming Control products when the lights are off or at full bright. When the Automatic Dimming Control products are actively dimming this simplification is not possible and the effective threshold will vary along with the dimming level.

By default the Sunlight Discount Factor is set to 4 and the Set Point is set to 5 foot candles. It has been found in most cases that these settings result in adequate Daylighting Control performance. In certain cases it may make sense to adjust these factors and directions for doing so are included as an Application Note with each product.

1.4. Auto Set Point

The auto set point is a function of the Daylighting Control Sensors which allows the Set Point to be selected automatically based on the contribution the artificial lights. It does this by cycling the lights on and off and measuring the foot candle reading before and after. If the reading is over 4 foot candles it will then set the Set Point as this value. If it is below 4 foot candles it will cycle the lights a maximum of 4 times and if the reading is still below 4 foot candles it will set the Set Point to 4 foot candles. The auto set point does not affect the sunlight discount factor. The theory behind the auto set point is based on the idea that if the space is designed correctly such that there is adequate work surface light when there is no sunlight. Therefore maintaining the light level at the level the artificial contributes should maintain adequate work surface illumination.

1.5. Transition Delays

When the light measurement crosses the active threshold a time delay occurs before the state of the lights actually changes. This prevents the lights from cycling on and off quickly in response to changing sunlight (clouds). During this period the led will flash rapidly. On/Off Daylighting Control Sensors contain a feature called Cloud Detection. This feature will automatically increase the transition time until the light goes off if the sensor detects wide swings in the foot candle readings that could cause cycling. The off transition time starts at 5 minutes and can reach a maximum of 25 minutes.

2. Application Information

2.1. Determining Daylighting Settings with a Foot Candle Meter

If a customer has a foot candle meter and wishes to use it to determine their daylighting settings they can do so by following these steps:

- ❑ Measure the foot candle reading on the work surface.
- ❑ Measure the foot candle reading at the sensor with the foot candle meter pointing down if the sensor has a downward facing photocell.
- ❑ Calculate the ratio between these two numbers: $Ratio = \frac{FC_{sensor}}{FC_{workspace}}$
- ❑ Choose the desired foot candle reading at the work surface.
- ❑ Multiply the desired foot candle reading by the ratio to get the effective set point.
- ❑ Choose a Sunlight Discount Factor and Set Point that when multiplied together will result in a number close to the effective set point. If the sensor contains dimming the Sunlight Discount Factor should be chosen to reflect the characteristics of the room.

Notes: Depending on the time of day the measurements are taken you may get different results for the ratio. Ideally the ratio should be taken when there is sufficient sunlight such that the lights could be turned off and still satisfy the desired foot candle number at the work surface.

3. Frequently Asked Questions

3.1. Do I have to wait until a sunny day to run the Auto Set Point?

No, the Auto Set Point cycles the lights on and off and measures the difference between the two measurements. As a result any other sources of light will have no effect on the result.

3.2. How should Daylighting Control Sensors be placed so as not to interfere with each other?

Any light which a sensor can see which it is not controlling is interpreted by the sensor as sunlight. As a result if a sensor can see the lights that another sensor is controlling it is possible that the two will start “fighting” and cause both of them to cycle on and off or dim up and down continuously. It is recommended that wherever possible a single Dual Zone sensor should be used instead of two separate sensors. If two sensors must be used then they should be at least 15 feet away from the lights that the other sensor is controlling. The minimum required

distance may change depending on the height of the ceiling, the flooring type, and other factors.

3.3. Where should Daylighting Control Sensors be placed?

As outlined in the Daylighting Control Application Note:

- According to occupancy sensor placement rules (applicable for combination units only).
- Outside the direct cone of light from indirect fixtures.
- As close to the fixture being controlled as possible.
- Between 6 and 15 feet from window.
- Above the least illuminated space in work areas.
- Away from spaces exposed to direct beam sunlight.
- Away from lighting that it is not controlling.

Following these guidelines as closely as possible will:

- Improve the close loop operation of the sensor.
- Result in better Auto Set-Point selection.
- Allow for greater dynamic range of dimming (-ADC option only).

3.4. How does the "Duo Mode" work in non-dimming DZ sensors?

The Duo Mode is designed for "stepped dimming" of two sets of lights within one fixture. The sensor will cycle through the different combinations of the lights depending on the ambient sunlight. If the two lights being controlled contribute equally there will be three stages, if they are different there will be four stages. The stages are as follows going from low sunlight to high sunlight:

- Both on.
- Brightest On, Dimmest Off.
- Brightest Off, Dimmest On.
- Both Off.

The sensor will determine through its operation the contribution of each of the lights and adjust its behavior accordingly. The Duo Mode should not be used in open loop applications as the lights will quickly pass through any intermediate stages.

3.5. How does the "Dual Zone Mode" work in non-dimming DZ sensors?

The Dual Zone Mode allows the control of two sets of lights with full On/Off operation with separate set points for each set of lights. The second set point is defined as a percentage offset of the first set point.

3.6. How does daylighting control work in 2P-P sensors?

The daylighting control is strictly inhibit only in 2P-P sensors. This means that if appropriate sunlight is available and the lights are currently off due to no occupancy then the lights will be inhibited from coming on when occupancy is present. As soon as appropriate sunlight is not available the lights will come on. The set point is independently settable for each set of lights.

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3.7. How do dimming DZ sensors work?

Dimming DZ sensors allow one set of lights to be controlled in closed loop mode and a second set of lights to follow the first set of lights with a voltage offset. This voltage offset is set in function #17 as the Second Zone Offset Voltage. If the Dimming DZ sensor has On/Off capability it will turn the first set of lights off completely if appropriate sunlight is available. It will then turn the second set of lights off if the second zone's off point is satisfied. Function #18 allows the selection of the Second Zone Offpoint as a percentage offset from the first zone's set point.

3.8. How does the Blink Back Set-Point function work?

When function #4 option #5 is selected the set point will be "blinked back" to the user. The set point is blinked back in two digits separated by a pause. The first digit is the ten's digit and the second digit is the one's digit. This will be followed by a longer pause and then the set point will be blinked back again twice more for a total of three times. Zero is represented by a rapid flash and other digits are represented by the corresponding number of blinks. For example the set point 5 foot candles would result in the following (zero in the tens digit and 5 in the ones digit):

rapid flash – pause – 5 blinks – long pause –
rapid flash – pause – 5 blinks – long pause –
rapid flash – pause – 5 blinks – long pause –

