Multiple-zone Daylighting Control Sequences of Operation

Understanding the capabilities of Digital Lighting Management (DLM) photosensors, and how to configure the sensors for the desired control strategy is one key to successful daylighting controls projects. This bulletin describes typical sequences of operation for different LMLS-500 operating modes, and explains how to change zone and sensor parameters to modify the sequence of operation.

Please note that all DLM jobs with LMLS photosensors must be submitted to WattStopper Project Management for review and approval.

Sequences of operation

Until an LMLS-500 is configured, it will not control the lighting. Once the photosensor is configured, daylighting control layers on top of the sequence of operation that has been established for a given room (e.g. Plug n’ Go configuration for manual-on; auto-on to 50%; or on to previous level, when personal controls are included). The LMLS-500 may be configured to hold off daylighting loads to maximize energy savings (see page 8). See examples of daylighting control sequences of operation for switching, multi-level control and continuous dimming on the following pages.

Photosensor features and applications

The LMLS-500 is a multi-zone, open loop photosensor, characterized by the following attributes:

- Measures daylight level only
- Requires manual entry of target illuminance levels for calibration
- Features simplified commissioning
- Can automatically switch or dim up to three zones of lighting
- Ideal for single or multi-zone toplighting applications with skylights or clerestories, or multi-zone sidelighting applications

Plug n’ Go and Push n’ Learn

The LMLS-500 does not participate in Plug n’ Go, and Push n’ Learn is not used to assign loads for daylighting control. Daylighting loads are assigned to an LMLS-500 using an LMCT-100 Wireless Configuration Tool after other DLM components have been configured.

Photosensor configuration using LMCT-100

In addition to load binding, the LMCT-100 is used to set up LMLS-500 photosensors to control one to three zones, utilize the desired control strategy (switching, bi-level, tri-level, dimming) for each zone, and to adjust photosensor parameters. It is also used to configure the LMLS-500 and initiate calibration. Detailed information about setup options appears at the end of this bulletin, beginning on page 6, and in the LMLS-500 installation instructions.
Multiple-zone Daylighting Control Sequences of Operation

Example 1: LMLS-500 Multi-zone Switching Control

- Manual-ON (Loads 1, 2 & 3), Automatic-OFF
- Three Daylight Zones, 1 Load per Zone

For this example, all loads were configured for Manual-ON operation using Push n’ Learn. When an occupant turns a load assigned to daylight control ON, the photosensor takes control of that load.

If the photosensor determines that the light level in one or more of the daylight zones has exceeded the Off Setpoint for more than 10 minutes (Off Time Delay), it will turn the lights in those zones OFF.

If the photosensor later determines that the light level in one or more of the zones has fallen below the On Setpoint for more than 20 seconds (On Time Delay), it will turn the lights back ON.

The On and Off Setpoints for each zone must be defined during calibration.

The occupant can turn the lights OFF and ON with the switch at any time. Turning the lights ON after the photosensor has turned them OFF in response to daylight (permitted by Allow Override setting of “Yes”) overrides photosensor control of the selected loads for 2 hours (Override Time). Turning one or more loads OFF disables photosensor control for those loads.

When the room is vacated, the occupancy sensor turns all lights OFF and disables photosensor control. The entire sequence starts over the next time someone enters the area.

See pages 6-8 for more details on photosensor settings.

<table>
<thead>
<tr>
<th>LMCT-100 Menu</th>
<th>Menu option</th>
<th>Default Setting</th>
<th>Application Setting</th>
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</thead>
<tbody>
<tr>
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<td>Number of Zones</td>
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<td>Operating Mode (for each zone)</td>
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<td>Load Assignment</td>
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<td>Load 1 Daylight - yes, Zone 1</td>
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<td></td>
<td>Load 2 Daylight - no</td>
<td>Load 2 Daylight - yes, Zone 2</td>
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<tr>
<td></td>
<td></td>
<td>Load 3 Daylight - no</td>
<td>Load 3 Daylight - yes, Zone 3</td>
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<tr>
<td>Calibration (pg. 7)</td>
<td>Calibration for each Zone</td>
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<td>fc per calibration</td>
</tr>
<tr>
<td>Zone Settings (pg. 7)</td>
<td>On Setpoint</td>
<td>n/a</td>
<td>fc per calibration</td>
</tr>
<tr>
<td></td>
<td>Off Setpoint</td>
<td>n/a</td>
<td>fc per calibration</td>
</tr>
<tr>
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<td>On Time Delay</td>
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<tr>
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<td>Off Time Delay</td>
<td>10 minutes</td>
<td>10 minutes (default)</td>
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<tr>
<td>Advanced Settings (pg. 8)</td>
<td>Allow Override</td>
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<td>Yes</td>
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<tr>
<td></td>
<td>Override Time</td>
<td>Infinity</td>
<td>2 hours</td>
</tr>
<tr>
<td></td>
<td>Hold Off</td>
<td>No</td>
<td>No (default)</td>
</tr>
</tbody>
</table>
Multiple-zone Daylighting Control Sequences of Operation

**Example 2: LMLS-500 Multi-zone Bi-level Control**

- **Auto-ON (1 & 3), Manual-ON (2 & 4), Auto-OFF**
- **Two Daylight Zones, 2 Loads per Zone**

This room is configured for Auto-On to 50% [Plug n’ Go]. The photosensor is set up to hold daylight loads off (Hold Off setting “Yes”) unless it determines there is less light than the value of the On Setpoint in one or more zones.

When the occupancy sensor detects that someone has entered the room, Loads 1 (Zone 1 Med) and 3 (Zone 2 Med) will only turn ON if needed. And, because Allow Override is “No,” an occupant can only switch a Max level load (2 or 4) ON if the zone light level remains below the On Setpoint.

Once the lighting is on, the photosensor will switch lights from Max to Med or from Med to OFF in any zone where the level exceeds the Off Setpoint for more than 10 minutes (Off Time Delay). It will restore a higher light level if a zone is below the On Setpoint for more than 20 seconds.

An occupant can use the switch to select a lower light level, or turn lights OFF, but can only switch lighting ON when the zone light level is below the On Setpoint.

When the room is vacated the occupancy sensor automatically turns all lights OFF. The entire sequence starts over the next time someone enters the area.

*See pages 6-8 for more details on photosensor settings.*

<table>
<thead>
<tr>
<th>LMCT-100 Menu</th>
<th>Menu option</th>
<th>Default Setting</th>
<th>Application Setting</th>
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</thead>
<tbody>
<tr>
<td>Zone Setup</td>
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<td>Load Assignment</td>
<td>Load 1 Daylight - no</td>
<td>Load 1 Daylight - yes, Zone 1 On When - Med &amp; Max</td>
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<tr>
<td></td>
<td>Load 2 Daylight - no</td>
<td>Load 2 Daylight - yes, Zone 1 On When - Max</td>
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<tr>
<td></td>
<td>Load 3 Daylight - no</td>
<td>Load 3 Daylight - yes, Zone 2 On When - Med &amp; Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load 4 Daylight - no</td>
<td>Load 4 Daylight - yes, Zone 2 On When - Max</td>
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<td>Calibration</td>
<td>Calibration for each Zone</td>
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<td>Enter light level for each zone</td>
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<tr>
<td>Zone Settings</td>
<td>On Setpoint</td>
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<tr>
<td></td>
<td>Off Setpoint</td>
<td>n/a</td>
<td>fc per calibration</td>
</tr>
<tr>
<td></td>
<td>On Time Delay</td>
<td>20 seconds</td>
<td>20 seconds [default]</td>
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<tr>
<td></td>
<td>Off Time Delay</td>
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<td>10 minutes [default]</td>
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<tr>
<td>Advanced Settings</td>
<td>Allow Override</td>
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<td>No [default]</td>
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<td></td>
<td>Override Time</td>
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<td>Infinity [default]</td>
</tr>
<tr>
<td></td>
<td>Hold Off</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Multiple-zone Daylighting Control Sequences of Operation

**Example 3: LMLS-500 Multi-zone Tri-level Control**

- **Auto-ON (1 & 3), Manual-ON (2 & 4), Auto-OFF**
- **Two Daylight Zones, 2 Loads per Zone**

This room is configured for Auto-On to 33%. The photosensor is set to hold daylight loads off [Hold Off setting “Yes”] in each zone unless it determines there is less light than the value of the On Setpoint.

When the occupancy sensor detects that someone has entered the room, Loads 1 and 3 will only turn ON if needed. If the zone levels are still below the On Setpoint the occupant can turn Loads 2 and 4 ON without overriding the sensor.

When enabled, photosensor control will reduce the lighting level in any zone that remains above the Off Setpoint for more than 10 minutes (Off Time Delay). If the light level falls below the On Setpoint for more than 20 seconds (On Time Delay), the photosensor will restore a higher level.

The occupant can switch lighting above the level permitted by the photosensor, overriding control of selected loads (Allow Override “Yes”). The occupant can also select a lower level, and this does not override the photosensor.

When the room is vacated, the occupancy sensor automatically turns all lights OFF. The entire sequence starts over the next time someone enters the area.

**See pages 6-8 for more details on photosensor settings.**

<table>
<thead>
<tr>
<th>LMLS-500 Settings for Multi-zone Tri-level Control, Example 3</th>
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<td><strong>LMCT-100 Menu</strong></td>
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<td>Number of Zones</td>
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<tr>
<td>Operating Mode (for each zone)</td>
</tr>
<tr>
<td>Load Assignment</td>
</tr>
<tr>
<td>Load 1 Daylight - no</td>
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<tr>
<td>Load 2 Daylight - no</td>
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<tr>
<td>Load 3 Daylight - no</td>
</tr>
<tr>
<td>Load 4 Daylight - no</td>
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<tr>
<td>Calibration (pg. 7)</td>
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<td>Calibration for each Zone</td>
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<tr>
<td>Zone Settings (pg. 7)</td>
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<tr>
<td>On Setpoint</td>
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<td>Off Setpoint</td>
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<tr>
<td>On Time Delay</td>
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<td>Off Time Delay</td>
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<tr>
<td>Advanced Settings (pg. 8)</td>
</tr>
<tr>
<td>Allow Override</td>
</tr>
<tr>
<td>Override Time</td>
</tr>
<tr>
<td>Hold Off</td>
</tr>
</tbody>
</table>

**Diagram:**

- LMLS-500 Open Loop Photosensor
- Occupancy Sensor
- 100 Series Room Controller
- Line Voltage
- Loads
Multiple-zone Daylighting Control Sequences of Operation

Example 4: LMLS-500 Multi-zone Dimming Control

- **Auto-ON (Loads 1, 2 & 3), Automatic-OFF**
- **Three Daylight Zones, 1 Load per Zone**

For this example, all loads are configured for Auto-ON. When the occupancy sensor detects motion, all the daylighting loads turn ON to their last non-zero levels. After 3 seconds, the photosensor will adjust the loads to reach the setpoint level for each zone. The setpoints are established by calibration.

If a zone is too dark, the photosensor will raise the lighting level at the Ramp Up rate. If a zone is too bright, the photosensor will dim the lighting at the Ramp Down rate. If the lighting reaches its minimum level, and the light level exceeds the Day Setpoint level for more than 10 minutes (Cut Off Delay), the photosensor will switch the load(s) OFF.

An occupant can manually increase the light levels, overriding daylighting control for selected loads [Allow Override “Yes.”]. An Override Time of 2 hours is permitted.

The Scenes Stop DL option has been set to “Yes,” so that if an occupant selects a scene that includes daylighting loads, daylighting control of those loads is suspended. The photosensor will resume control of the loads when the scene level, or the level of any load in the zone is changed.

When the room is vacated, the occupancy sensor turns all lights OFF and disables photosensor control. The sequence starts over the next time someone enters the area.

See pages 6-8 for more details on photosensor settings.

### LMLS-500 Settings for Multi-zone Dimming Control, Example 1

<table>
<thead>
<tr>
<th>LMCT-100 Menu</th>
<th>Menu option</th>
<th>Default Setting</th>
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<td>Zone Setup</td>
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<td>Load Assignment</td>
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<td></td>
<td>Load 2 Daylight - no</td>
<td>Load 2 Daylight - yes, Zone 2</td>
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<td></td>
<td>Load 3 Daylight - no</td>
<td>Load 3 Daylight - yes, Zone 3</td>
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<td>Calibration</td>
<td>Calibration</td>
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<td>Enter light level for each zone</td>
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<tr>
<td>Zone Settings</td>
<td>Setpoint</td>
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<td>fc per calibration</td>
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<td></td>
<td>Ramp Up</td>
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<td>20%/second [default]</td>
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<tr>
<td></td>
<td>Ramp Down</td>
<td>2%/second</td>
<td>2%/second [default]</td>
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<tr>
<td></td>
<td>Cut Off Delay</td>
<td>Never</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Advanced Settings</td>
<td>Allow Override</td>
<td>No</td>
<td>Yes</td>
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<td>Override Time</td>
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<td></td>
<td>Hold Off</td>
<td>No</td>
<td>No [default]</td>
</tr>
<tr>
<td></td>
<td>Scenes Stop DL</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Multiple-zone Daylighting Control Sequences of Operation

LMCT-100 Daylighting Menus and Menu Options

The following sections describe LMLS-500 configuration options, and illustrate the LMCT-100 main daylighting menu selections you will use to set up each sensor for the desired sequence of operation. Refer to the LMLS-500 installation instructions for additional information.

Zone Setup

Begin the setup process by selecting a specific LMLS photosensor to configure. The Zone Setup options establish number of zones, the operating mode for each daylighting zone and the load binding. Each photosensor must be configured individually.

Use the Zone Setup menu to establish the number of zones and operating modes for the selected photosensor.

**Number of Zones**

1, 2 or 3

**Operation of Zones**

Zone 1
Zone 2
Zone 3

Select Switched, Bi-Level, Tri-Level or Dimmed for each zone

Additional setting for Bi- and Tri-Level. Assigns each load to an ON or OFF state when the sensor switches lighting to different levels – Low, Medium (bi-level only), High (tri-level only) or Maximum.

```
“Med & Max” means that the load will be ON for both 50% and 100% levels.
```

```
“Max” means that the load will be ON only for 100% level.
```

```
“Low & Max” means that the load will be ON for both 33% and 100% levels.
```

```
“Hi & Max” means that the load will be ON for both 67% and 100% levels.
```

**Load Assignment**

All Loads

Once you have selected the operating mode for each zone, you will be prompted to assign specific loads to daylighting control. Load assignment is analogous to binding.

**Daylight Load: Yes**

Zone #

- **On When Bi-Level**
  - Med & Max (50%)
  - Max (50%)

- **Tri-Level**
  - Low & Max (33%)
  - Hi & Max (67%)

**Daylight Load: No**

Once you have selected the operating mode for each zone, you will be prompted to assign specific loads to daylighting control. Load assignment is analogous to binding.

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Multiple-zone Daylighting Control Sequences of Operation

**Topic:** DLM Operation with LMLS-500 Photosensor, v2.xx  **Issue:** # TB186  **Date:** March 15, 2012

**Calibration**

Calibration establishes a relationship between workplane illuminance and the light level measured by the sensor. The LMLS-500 is calibrated manually. As part of the calibration process, the sensor establishes application-appropriate setpoints based on the illuminance levels detected at the photosensor. See the LMLS-500 instructions for additional information.

**Zone Settings**

Use the Zone Settings menus to establish setpoints and control parameters for each daylighting zone that was configured during zone setup. The menu options are dependent on the operating mode for each zone (switching, bi-level, tri-level or dimming). Both the switching and dimming options are illustrated below.

**Zone Settings for Switched, Bi-Level and Tri-Level**

- **On Setpoint:** Established by calibration, or selected footcandle setting
  - Target illuminance below which daylighting load will turn ON.
- **Off Setpoint:** Established by calibration, or selected footcandle setting
  - Target illuminance above which daylighting load will turn OFF.
- **On Time Delay:** Range: 1 to 60 seconds (Default: 20 sec.)
  - Amount of time sensor must detect footcandle level below ON setpoint before lights turn ON.
- **Off Time Delay:** Range: 3 to 30 minutes (Default: 10 min.)
  - Amount of time sensor must detect footcandle level above OFF setpoint before lights turn OFF.

**Zone Settings for Dimmed**

- **Setpoint:** Established by calibration, or setting from 5 to 200 fc
  - Desired light level at task surface.
- **Ramp Up:** Range: 1% - 100% per second (Default: 20%)
  - Rate at which light level increases.
- **Ramp Down:** Range: 1% - 100% per second (Default: 2%)
  - Rate at which light level decreases.
- **Cut Off Delay:** Never, or 1 to 30 minutes (Default: Never)
  - Amount of time the controlled lighting will remain at the minimum level before switching OFF. “Never” prevents lights from switching OFF automatically due to high daylight levels.
Multiple-zone Daylighting Control Sequences of Operation

**Advanced Settings**

Complete the LMLS-500 setup by using the Advanced Settings menu options to establish control parameters for the photosensor [applicable to all zones]. These powerful options help customize the daylighting sequence of operation for each sensor on each project.

**Control Mode**

The final menu option is Control Mode. Options include Normal (default), Test, Demo and Disable. Test Mode shortens time delays and speeds ramp rates to allow quick verification of operation. Demo Mode is precalibrated for sales demonstrations. Disable is useful for troubleshooting.

**Project Support**

Please remember that all DLM jobs with LMLS photosensors must be submitted to WattStopper Project Management for review and approval.

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**Light Level:**

Read-only display of the current light level at the photocell.

**Allow Override:**

Permits or prevents manual override.

**Override Time:**

Establishes time delay after override action before photosensor control resumes.

**Hold Off:**

Establishes photosensor priority.

**Ignore After Hours:**

Establishes response to after hours scheduling.

**Scenes Stop Daylighting:**

Used when application includes lighting scenes.

**Calibration Data Display:**

DR and EL for Z1, Z2 and Z3

---

Switch can only adjust load(s) to a level below, or equal to, the level permitted by the photosensor.

Switch can raise the level of selected load(s) above the level permitted by the photosensor.

Time period limits how long a manual action (if allowed) will override photosensor control. “Infinite” allows manual override to continue until the load is turned OFF (by any means).

Photosensor does not take control of a load until it is turned ON via switch, occupancy sensor or scheduling.

Photosensor will prevent loads from turning ON if light level is above the target illuminance (see Setpoints).

When a scene is selected, the photosensor may adjust daylighting loads (in response to daylight) below the levels established by the scene, but will not exceed those levels unless the scene is changed manually, or until the next cycle of occupancy.

When a scene is selected, daylighting control for any load included in a scene is suspended until the level of that load is modified.

Daylighting control continues for all loads regardless of normal/after hours status.

Read-only display of levels established during calibration for all zones:
- **DR** (daylight ratio) shows the daylight contribution measured at both the photocell and at the task level in the zone.
- **EL** (electric light) shows the light maximum level contribution of the electric lighting in the zone.