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LEiF Lighting Control

Application Note

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1. Overview

LEiF provides a complete and flexible wireless lighting control solution based on the qualified Bluetooth mesh networking technology.

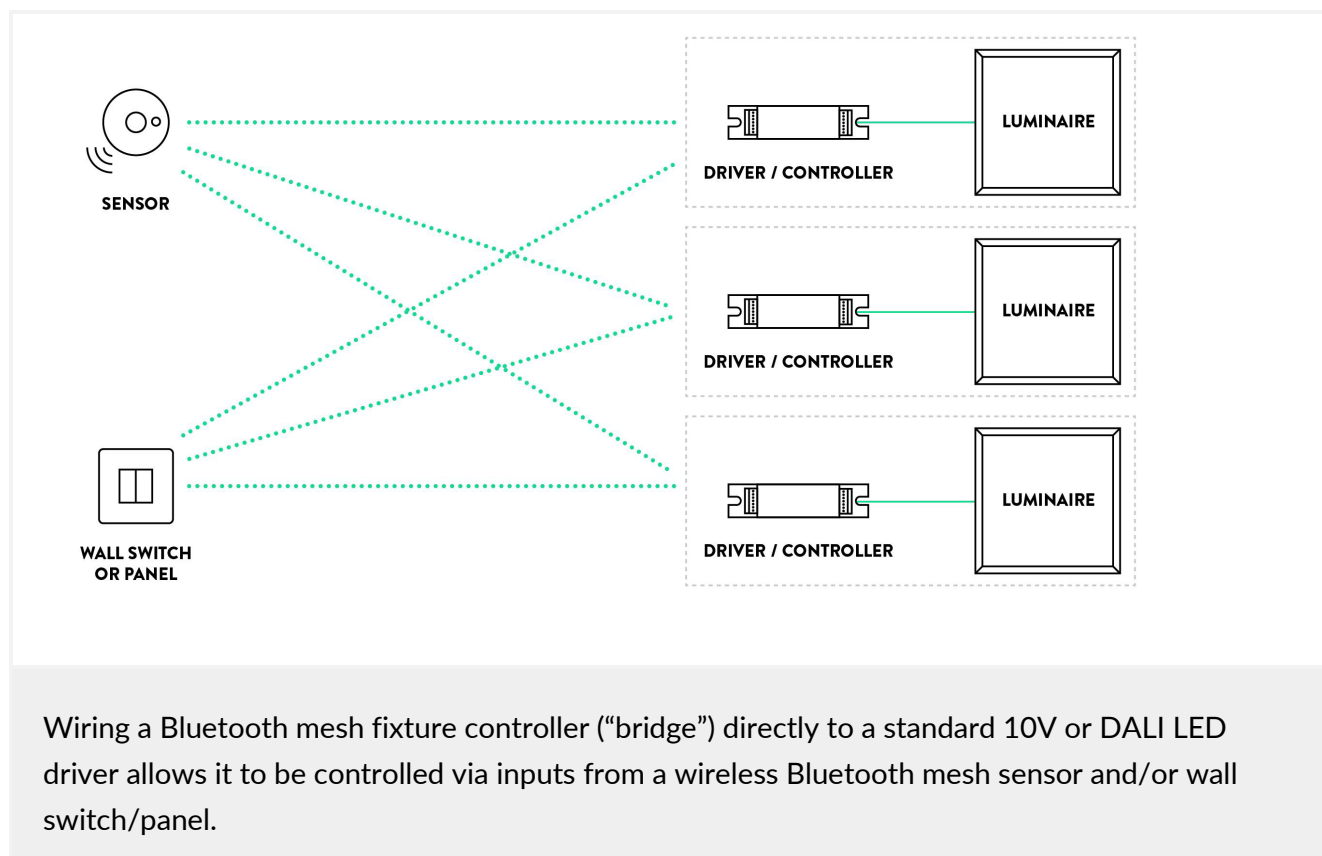
As part of our intelligent lighting platform, we provide a set of dedicated software tools for commissioning and managing connected lighting installations. The LEiF Commissioning has been designed to support advanced lighting control strategies, including occupancy sensing and daylight harvesting. Both are proven methods of reducing energy consumption, and for this reason are often mandated by building energy codes, such as California's Title 24.

To enable maximum flexibility, we support a number of lighting control strategies for non-residential spaces. These include manual control, occupancy and vacancy sensing, daylight harvesting, scenes, etc.

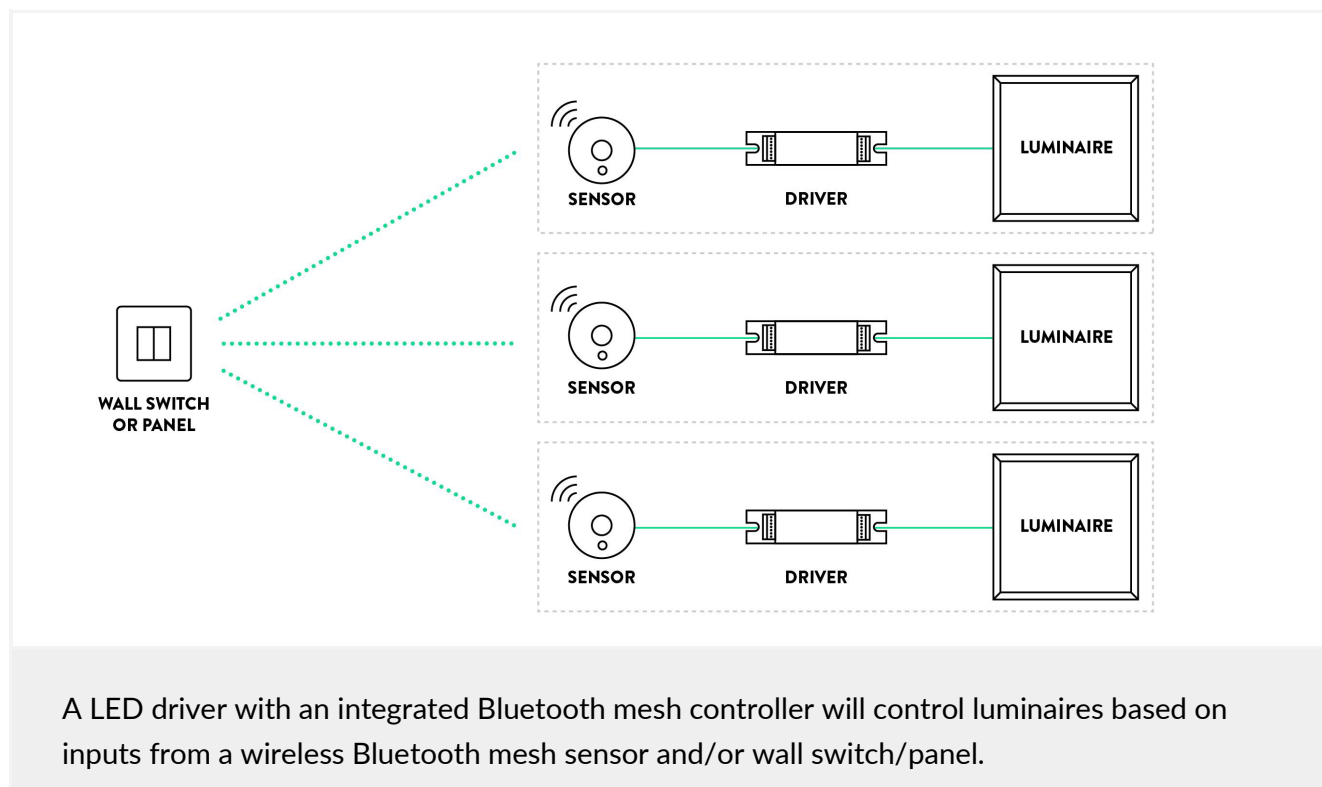
2. Integration within a Lighting System

There are three basic options for integrating Bluetooth mesh lighting control into a lighting system.

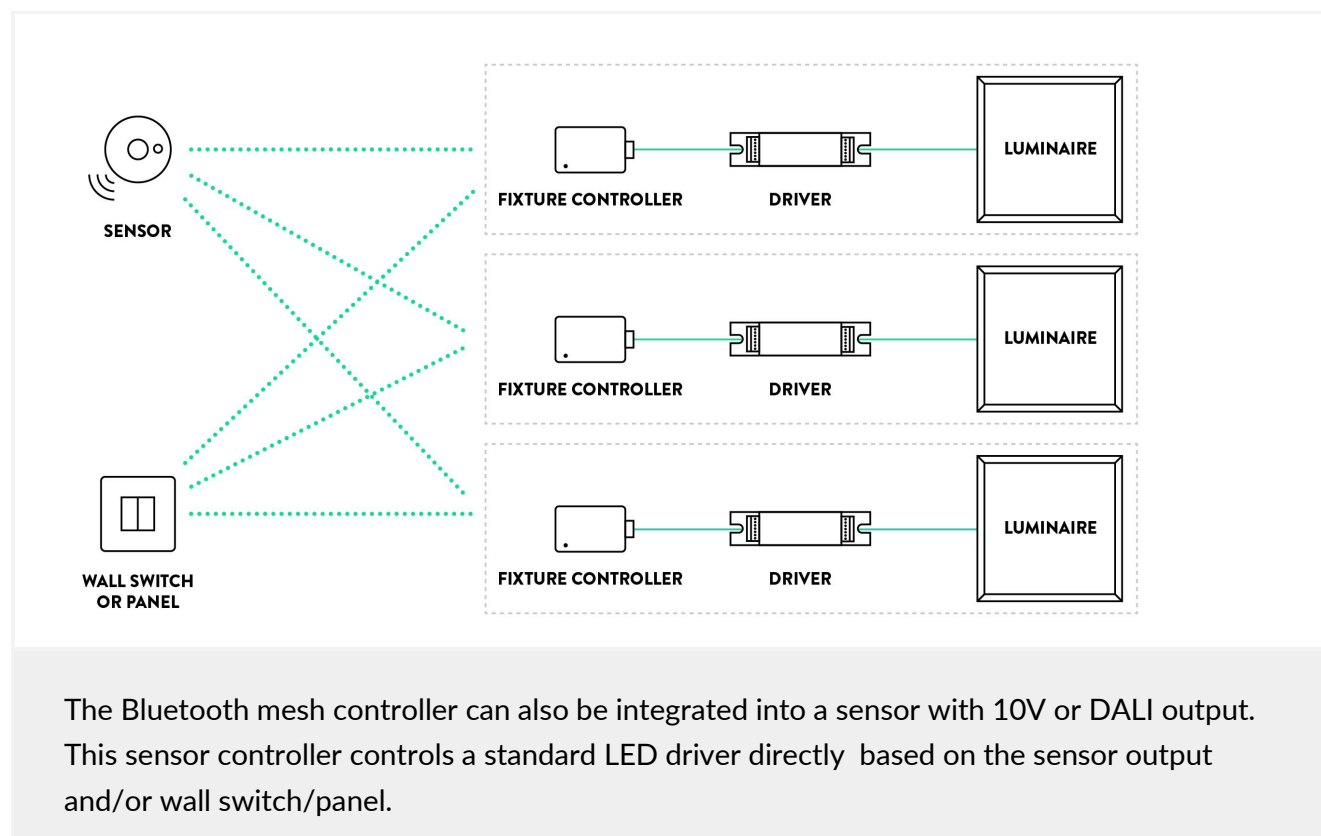
2.1 Fixture Controller



2.2 Driver



2.3 Sensor controller



3. System Architecture and Control Features

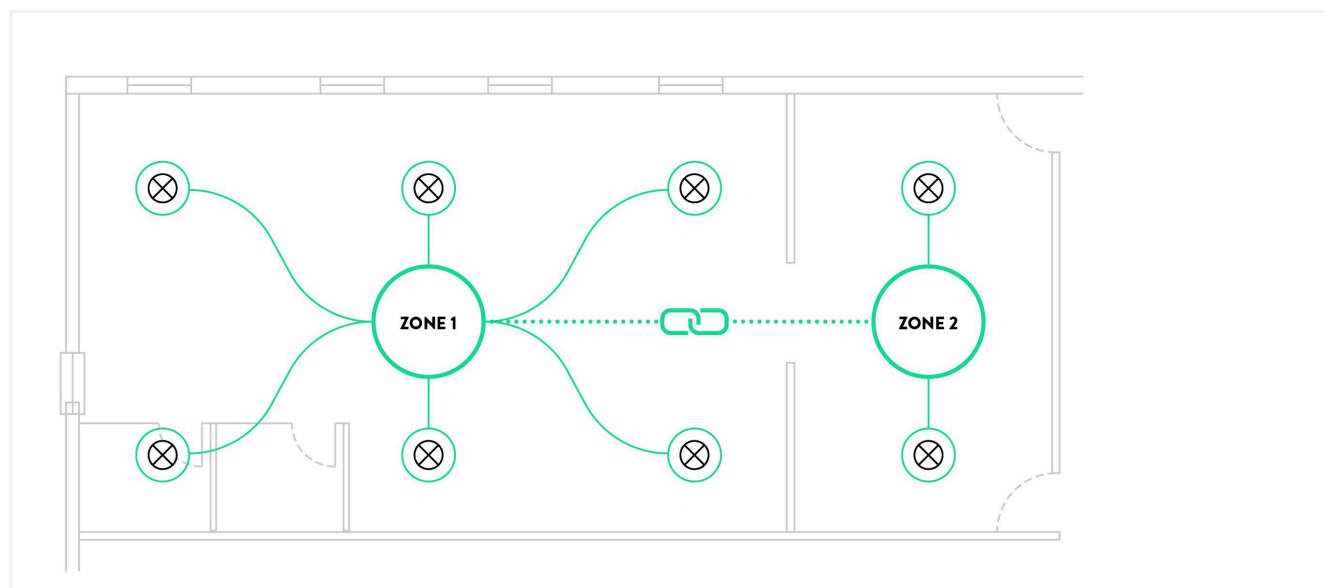
All commissioning of lighting control is carried out using the **LEiF Commissioning** tool which consists of a web and mobile app.

In the **web app**, users can precisely plan the entire project before visiting the site. This involves uploading floor plans, mapping individual zones on the floor plans, and specifying the behavior of the lighting system by assigning one of the predefined control profiles to each of the zones.

Once the planning stage is complete, the **mobile app** needs to be used on-site to carry out the implementation stage and finalize the commissioning process. The mobile app connects with individual network nodes and implements configuration settings specified earlier in the web app. Once implemented, the settings of each device are stored in the device itself, allowing it to operate autonomously as part of a network with no central controller.

This fully decentralized architecture removes communication bottlenecks and eliminates single points of failure. It doesn't require central controllers, since it puts a software controller into each luminaire. The software controller allows luminaires to exercise any of the lighting control features listed below.

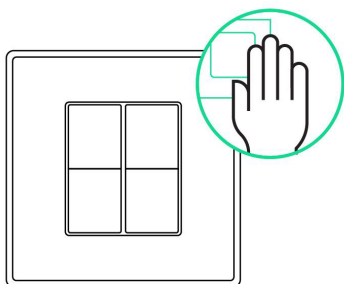
3.1 Lighting Zones (Grouping)



The LEiF Commissioning organizes devices (i.e. fixtures, sensors or switches) into zones. A zone is a group of devices that exercise the same lighting control scenario. Within a single zone, devices of the same type behave in exactly the same way. This means that any user-defined triggering events or light level outputs apply to all fixtures within a given zone, any user-defined switch behavior applies to all switches within a given zone, etc.

A room can consist of one or multiple zones, e.g. separate daylight or smaller occupancy zones in order to achieve higher energy savings.

3.2 Manual Control

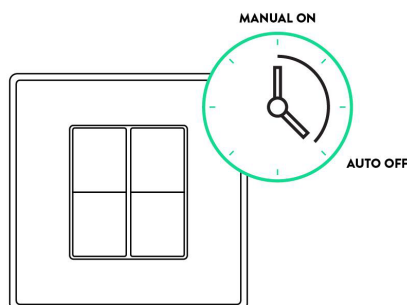


Sivair Commissioning supports manual control including on/off, scenes, dimming and adjusting color temperature. If manual controls have been used to override automatic control, it may be restored manually or automatically when a given zone is vacant after manual override timeout.

Switches are primarily used to control the luminaires within the zones they are assigned to. However, the zone linking feature (look below: **3.9. Zone Linking**) also allows a single wall switch to control multiple zones at the same time.

Required: Bluetooth mesh manual controls, e.g. wall switch, wall panel or EnOcean self-powered switch for Bluetooth systems

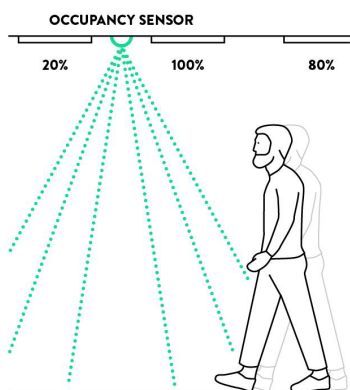
3.3 Timer Switch Control



All lights within a zone can be switched off automatically after a certain time from switching on manually. Manual controls can be used again to restart the timer.

Required: Manual controls

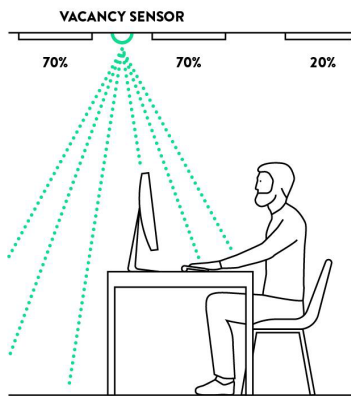
3.4 Occupancy Sensing



Lights are automatically switched on to a defined light level by occupancy sensors and dimmed or switched off automatically when the zone is vacant. Once occupancy is detected, they return to the defined light level.

Required: Motion or occupancy sensor

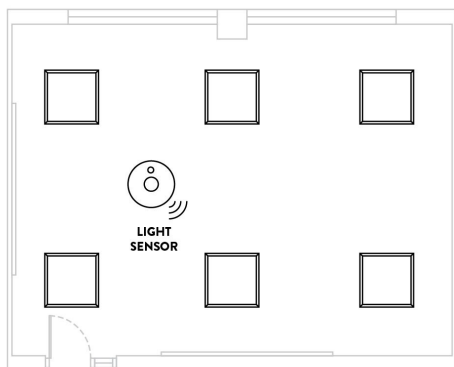
3.5 Vacancy Sensing



To maximize the energy savings light may be switched on manually using a wall switch and dimmed or switched off automatically when a given zone is vacant.

Required: Motion or occupancy sensor

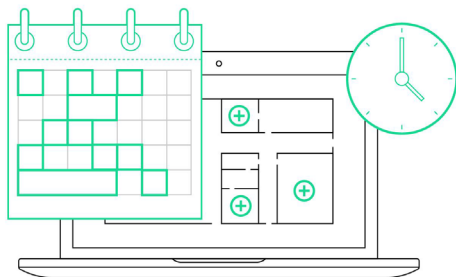
3.6 Daylight Control (Per Zone)



The light level of the luminaires in the zone is adjusted automatically in accordance to the availability of the daylight measured by a single light sensor added to that zone to maintain the desired light level (lux).

Required: Light sensor or sensor controller

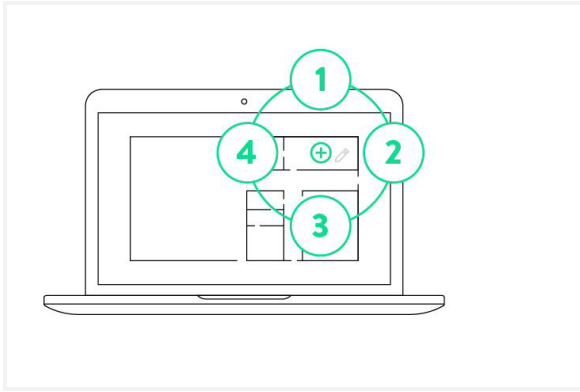
3.7 Scheduling



Light control settings may be adjusted automatically based on time of the day and day of the week.

Required: LEiF gateway and internet connection.

3.8 Scenes



LEiF provides up to 4 user defined settings for a group of luminaires to suit multiple activities in a space and allow for the recall of these settings via a switch or Scheduling.

Required: Manual control or Scheduling.

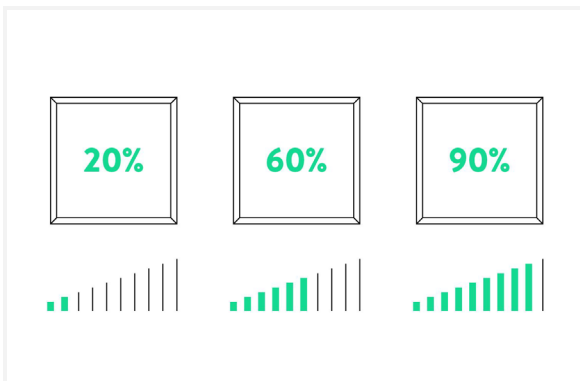
3.9 Zone Linking



Zones can be linked together to provide occupancy or manual control to other zones. Applications could include linking neighboring daylight zones to achieve simultaneous occupancy control over the whole space or linking a conference room with the corridor so that occupants do not have to step out into a dark corridor.

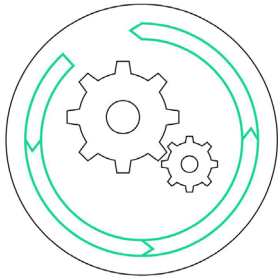
Required: Manual control or Occupancy/Vacancy sensing.

3.10 High-end and Low-end Trim



LEiF gives the ability to adjust the maximum and minimum light level to which light can be adjusted.

3.11 On Power Up Behavior



After a power failure, the luminaires can be configured to one of the following scenarios: keep light off, restore to last state or adjust to predefined level.

3.12 Photocell



Lighting control depending on the level of ambient light and occupancy.

Required: Light sensor or sensor controller

3.13 Plug Load Control



Automatic plug load control can be added to every lighting control scenario supported by LEiF Commissioning. With relay-based operation, it ensures full synchronization¹ between the plug loads and the luminaires. Depending on the lighting control strategies applied, plug load control can be based e.g. on luminaires' scheduled operation, sensor-triggered operation, or manual switch control.

Required: Power relays

¹ The relay is open when the luminaire output equals zero and closed when the output is greater than zero

4. Control Scenarios

In LEiF Commissioning, light control is defined in control scenarios that can be managed using the LEiF web app and implemented by the LEiF mobile app. LEiF provides several ready-to-use scenarios. Each of them comes with certain predefined settings that may be customized to meet specific project requirements.

Lighting control scenarios

Manual control

The simplest lighting control in which all lights in a given space can be switched on to a defined level, switched off or dimmed only manually using a wall switch. Two custom scenes are available with a wall switch. There's no automatic control as no sensors are used.

Required: manual controls

Vacancy sensing

All luminaires are switched on manually to a defined level with a wall switch and dimmed or switched off automatically when no motion is detected in a zone for a given time. Two custom scenes and dimming is available with a wall switch. Manual override may timeout after defined time and restore default settings.

Required: manual controls, occupancy sensor

Vacancy sensing with daylight harvesting

The light is switched on manually with a wall switch to a minimum level and adjusted automatically in accordance with the availability of the daylight measured by a single light sensor added to that zone to maintain the desired light level(lux). Light is dimmed or switched off automatically when no motion is detected in a zone for a given time. Two custom scenes and dimming is available with a wall switch. Manual override may timeout after defined time and restore

defaultsettings

Required: manual controls, occupancy sensor, light sensor

Occupancy sensing

All luminaires are automatically switched on to a defined light level when motion is detected and dimmed or switched off when no motion is detected for a given time. Two custom scenes and dimming is available with a wall switch. Manual override may timeout after defined time and restore default settings.

Required: occupancy sensor

Occupancy sensing with daylight harvesting

All luminaires are automatically switched on to a minimum level by an occupancy sensor. Light level adjust automatically in accordance with the availability of the daylight measured by a single light sensor added to that zone to maintain the desired light level (lux). Light is dimmed or switched off automatically when no motion is detected in a zone for a given time. Two custom scenes and dimming is available with a wall switch. Manual override may timeout after defined time and restore default settings.

Required: occupancy sensor, light sensor

Multiple scenes

A set of 4 definable scenes with various control types to choose from. You can change the defined scene for all luminaires automatically or manually. You can also use the switch to manually dim or brighten all luminaires. Such a manual override lasts till the next scene event.

Required: manual controls or scheduling

Central control

The light is controlled by a central controller.

Required: light controller

5. Applications

5.1 CONFERENCE ROOM WITH DAYLIGHT

A conference room with up to 2 daylight zones (recommended ~4 lights per zone), each with an independent light sensor. Light is switched on manually and switched off automatically when the space is vacant.



Components

Bluetooth mesh controlled light fixtures
 Bluetooth mesh light & occupancy sensors
 EnOcean Bluetooth wall switch

Light control features

- Vacancy sensing
- Daylight harvesting
- High-end Trim/Tuning
- Manual control
- Scenes
- Zone linking

SEQUENCE OF OPERATION

Space is occupied	Manual control	Space is vacant
<p>Light does not automatically turn on when someone enters the space and must be switched on manually with a wall switch.</p> <p>General lighting level is automatically adjusted to the level of daylight in order to maintain the predefined lightness in the space (e.g. 250 lux).</p>	<p>Light can be manually switched off. An occupant can select one of two custom scenes to set the desired light levels for all luminaires. The maximum light level is set to 80%.</p>	<p>Light automatically turns off after 20 minutes and returns to the automatic mode after all people exit the room.</p>

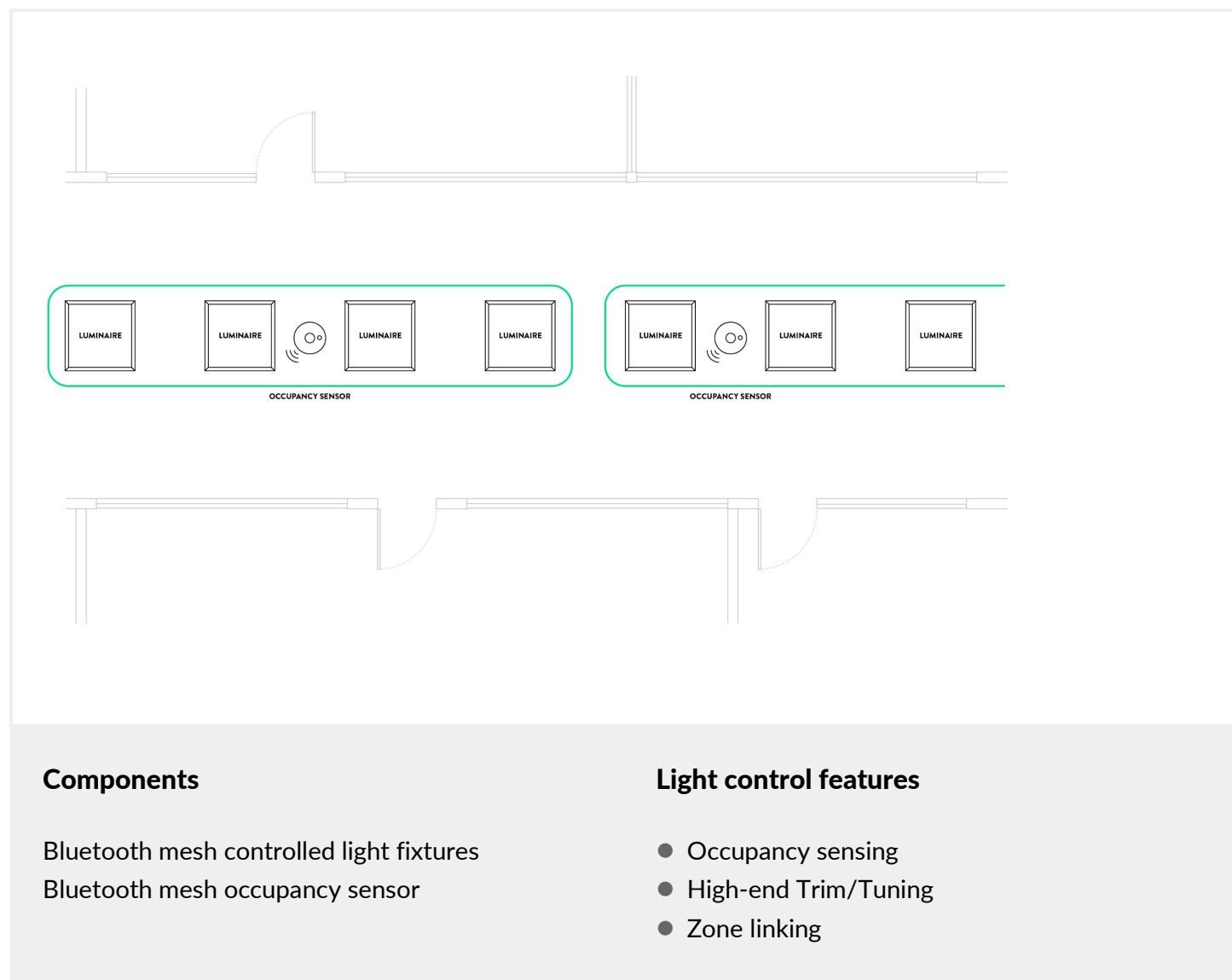
SCENARIO SETTINGS

Scenario type	Manual On / Auto Off with Daylight harvesting
Occupied	Fade time: 1s , Light level: 300 lux , Min: 10% , Timeout: 10 min
Prolong	Fade time: 10s , Light level: 30 lux , Min: 1% , Timeout: 5 min
Vacant	Fade time: 10s , Light level: Off
Low and high end trim	Min: 0% , Max: 80%
Manual override timeout	On: 10 min
Scenes	<p>Scene A: "Full On" - All lights switched on to maximum level²</p> <p>Scene B: "Projection" - Lights closest to the screen switched off, mid-room lights: 10% and the ones at the end of the room: 20%.</p>
Zone linking	All daylight zones linked together: each switch and occupancy control triggers light in all daylight zones.

² Maximum is limited by high-end trimming to 80% in this scenario.

5.2 EGRESS CORRIDOR WITHOUT DAYLIGHT

Corridor composed of multiple zones (recommended ~4-6 lights per zone) each with an independent occupancy sensor. The whole corridor's light level is low. Occupancy triggers light in the neighbouring zones. No manual control.



SEQUENCE OF OPERATION

Space is occupied

Light level in the occupied and neighbouring spaces is automatically adjusted to maximum 80%.

Space is vacant

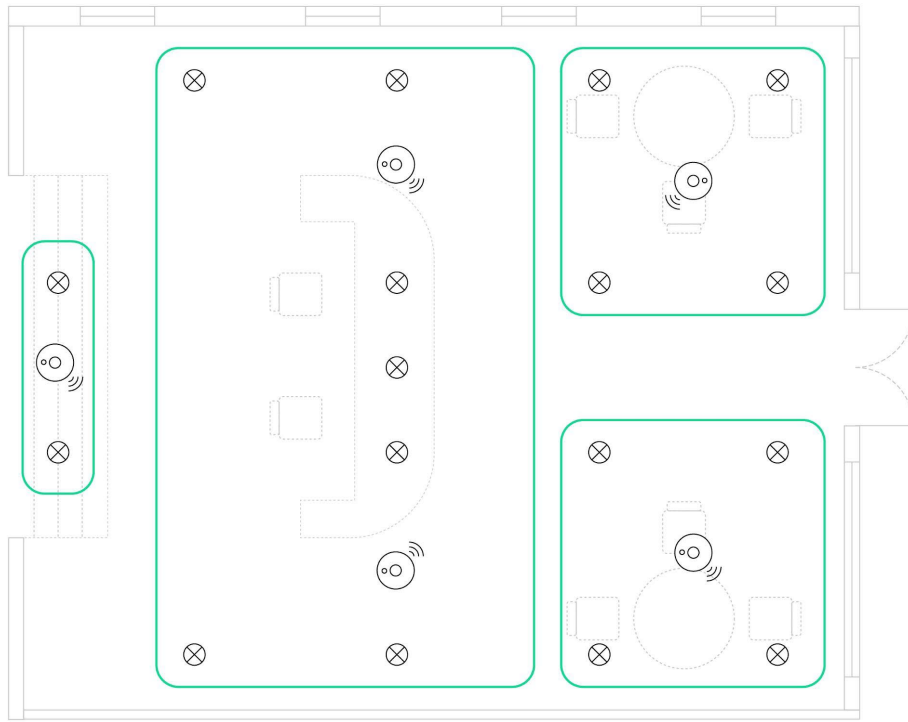
Light level is automatically set to minimum 10% after 10 minutes.

Scenario settings

Scenario	Auto On / Off
Occupied	Fade time: 1s , Light level: 80% , Timeout: 10 min
Prolonged	-
Standby	Fade time: 10s , Light level: 10%
Light level range	Min: 0% , Max: 80%
Manual override timeout	Off
Scenes	-
Zone linking	Neighbouring zones linked together

5.3 ATRIUM / LOBBY

The space is composed of multiple lights in the single or multiple zones, each with an independent daylight sensor. During building operating hours when the space is vacant the light is maintained at the minimum level to make the space inviting and suggesting business hours. After closing the building, the light is switched off.



Components

Bluetooth mesh controlled light fixtures
Bluetooth mesh daylight sensor

Light control features

- Daylight harvesting
- High-end Trim/Tuning
- Scheduling
- Manual control
- Scenes

SEQUENCE OF OPERATION

Scheduling

Every workday at 6am Scene 2 “Operating hours” with minimum level at 10% or 50 lux is triggered enabling occupancy sensing with daylight harvesting.

Every workday at 8pm Scene 1 “Off” is triggered switching the light off and disabling occupancy sensing.

Space is occupied

Automatic: When a person enters the room during operating hours the light level is automatically adjusted to maintain 300 lux with minimum 10% in the space. After hours the light is off.

Manual: Light in the whole space can be manually switched off or dimmed. The maximum light level is set to 80% Scene “Maintenance” can be selected for the whole space with all lights on to the maximum light level for the time required for cleaning. .

Space is vacant

Light is automatically set to minimum light level 50 lux and no less than 10%.

Scenario settings

Scenario type

Multiple scene

Light level range

Off

Scene 1

“Off”, Light level: **0%**

Scene 2

“Operating hours”, Occupancy sensing, Daylight harvesting

Occupied

Fade **1s**, Light level: **300 lux**, Minimum: **10%**, Timeout: **15 min**

Vacant

Fade: **10s**, Light level: **50 lux**, Minimum: **10%**

Scene 3

“Maintenance”, Light level: **100%**

Scheduling

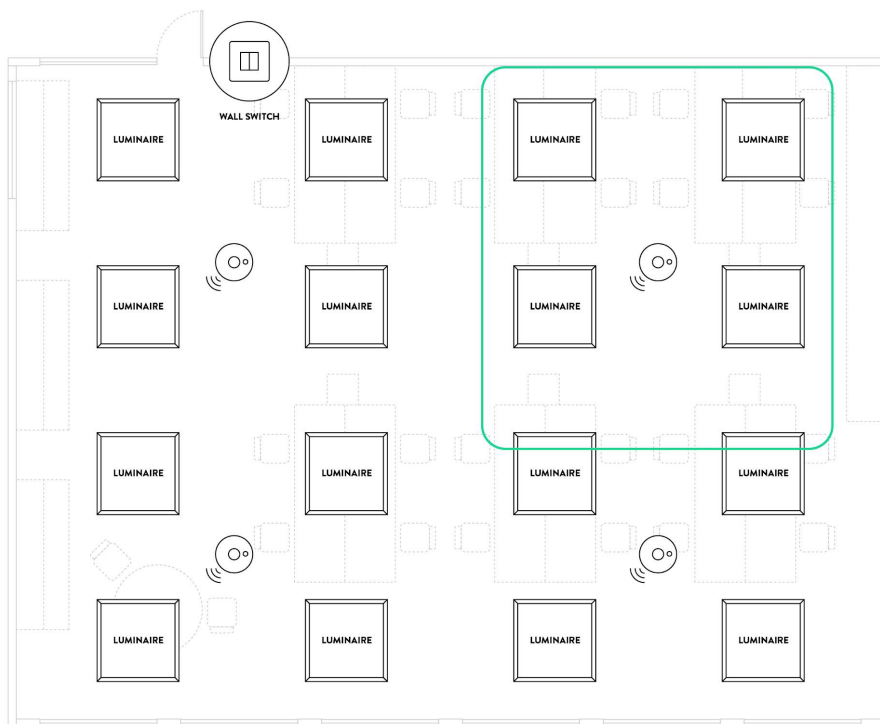
Every workday at 6 am triggering the Scene 2 “Operating hours” and every workday and at 8pm the Scene 1 “Off”.

Zone linking

All zones linked together.

5.4 OPEN SPACE WITH DAYLIGHT

Office open space composed of multiple zones (recommended ~4-6 lights per zone) each with independent occupancy and light sensor. Occupancy triggers light in the neighbouring zones. Single wall switch for the whole space. Optionally each zone can be equipped with a separate manual control.

**Components**

Bluetooth mesh controlled light fixtures
 Bluetooth mesh occupancy and light sensors
 EnOcean wall switch

Light control features

- Occupancy sensing
- Daylight harvesting
- High-end Trim/Tuning
- Manual control
- Zone linking
- Scenes

SEQUENCE OF OPERATION

Space is occupied

Light in occupied and neighbouring zones is automatically switched on when someone enters the zone.

General lighting light level is automatically adjusted in response to daylight available to maintain 250 lux in the space. Light is switched off in the unoccupied zones after 20 minutes.

Manual control

Light in the whole space can be manually switched off. Scene "Maintenance" can be selected for the whole space to switch all lights on to the maximum light level for the time required for cleaning. Manual override will timeout after 10 minutes when the space is vacant.

The maximum light level is set to 80%.

Space is vacant

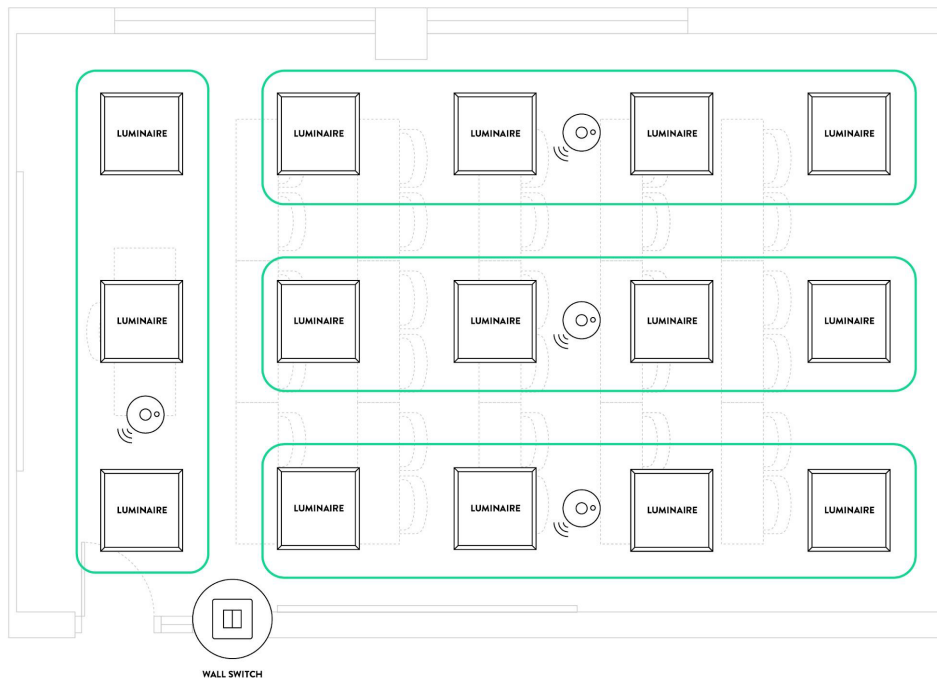
Light automatically turns off in each zone after 20 minutes after all people exit.

Scenario settings

Scenario type	Occupancy sensing with daylight harvesting
Occupied	Fade time: 1s , Light level: 300 lux , Timeout: 10 min
Prolonged	Fade time: 10s , Light level: 30 lux , Timeout: 10 min
Vacant	Fade time: 10s , Light level: Off
Light level range	Min: 0% , Max: 80%
Manual override timeout	On: 10 minutes
Scenes	Scene A: "Maintenance" - All lights switched on to maximum level
Zone linking	Neighbouring zones linked together.

5.5 CLASSROOM

Classroom composed of three daylight zones (recommended ~4-6 lights per zone) each with independent occupancy and light sensor. Occupancy triggers light in the whole space. Single wall switch for the whole space at the teachers station with manual on/off, dimming and scenes control. Optionally: separate zone for whiteboard lights.



Components

Bluetooth mesh controlled light fixtures
 Bluetooth mesh occupancy and light sensors
 EnOcean wall switch

Light control features

- Occupancy sensing
- Daylight harvesting
- High-end Trim/Tuning
- Manual control
- Zone linking
- Scenes

SEQUENCE OF OPERATION

Space is occupied

Light in the space is switched on automatically to the level when someone enters the classroom.

General lighting light level is automatically adjusted in response to daylight available to maintain 300 lux in the space.

Manual control

Light in the whole space can be manually switched off. Dedicated scenes "Presentation" and "Test"

can be selected for the whole space. The maximum light level is set to 80%.

Space is vacant

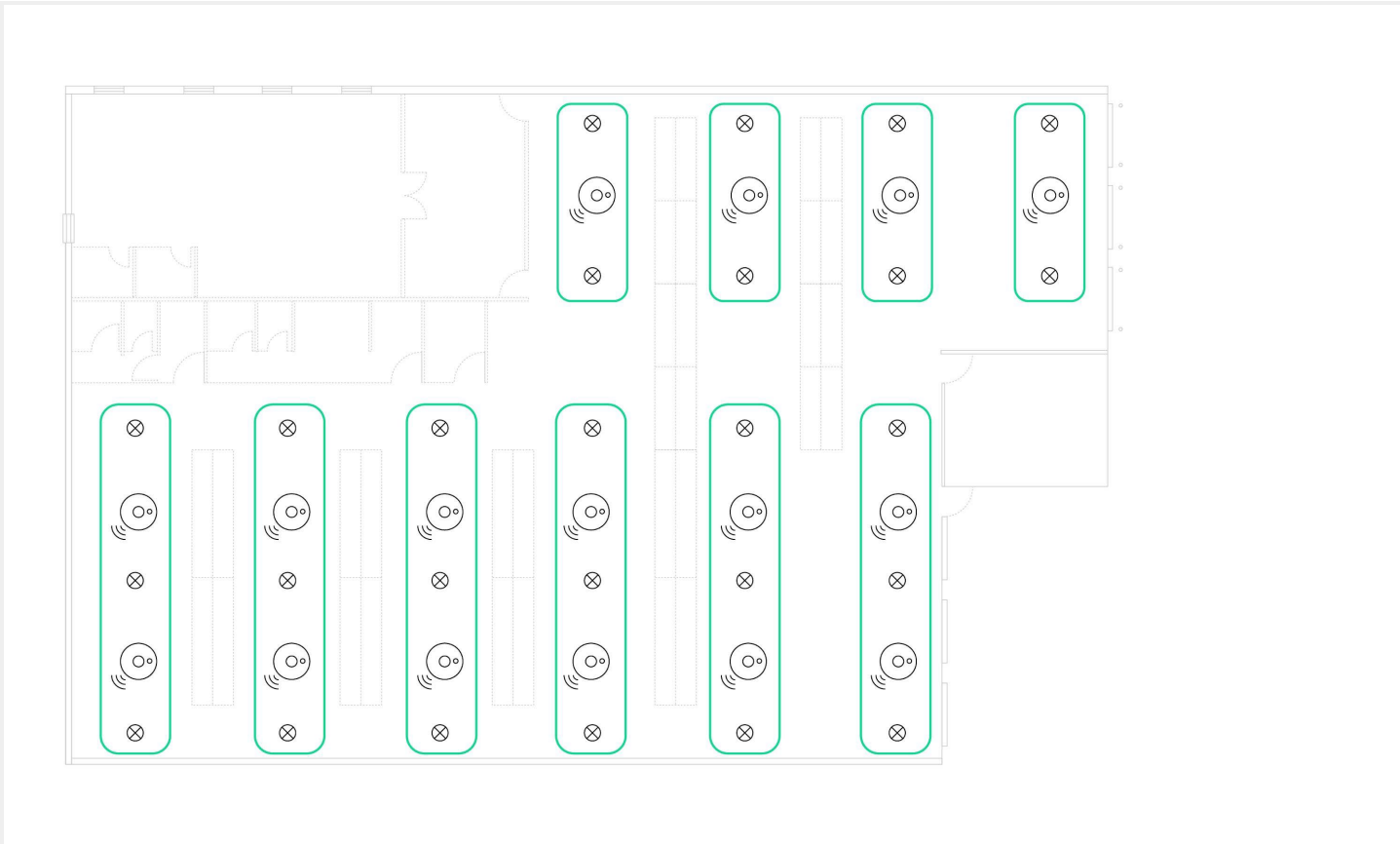
Light automatically turns off after 20 minutes after all people exit.

Scenario settings

Scenario type	Auto On / Off with daylight harvesting
Occupied	Fade time: 1s , Light level: 300 lux , Timeout: 15 min
Prolonged	Fade time: 10s , Light level: 30 lux , Timeout: 5 min
Vacant	Fade time: 10s , Light level: Off
Light level range	Min: 0% , Max: 80%
Manual override timeout	On: 10 minutes
Scenes	<p>Scene A: "AV Presentation" - Lights closest to the whiteboard/screen switched off, mid-room lights: 5% and the ones at the end of the room: 10%.</p> <p>Scene B: "Test" - All lights set to 50% for the time of low activity, e.g. writing or test.</p>
Zone linking	All zones linked together.

5.6 WAREHOUSE

A warehouse with several storage aisles each with around 28 high-bay fixtures equipped with a Bluetooth mesh enabled. Each aisle is divided into several zones with ~1-3 fixtures. Occupancy triggers light in the occupied zone and neighbouring zones.



Components

Bluetooth mesh occupancy and light sensor controllers

Light control features

- Occupancy sensing
- Daylight harvesting
- High-end Trim/Tuning
- Zone linking

SEQUENCE OF OPERATION

Space is occupied	Space is vacant
Light in the occupied and neighboring zones is switched on automatically to the level of 80% when someone enters the aisle.	Light is automatically switched off in a zone after 15 minutes after the person leaves it.

Scenario settings	
Scenario	Occupancy sensing
Occupied	Fade time: 1s, Light level: 80%, Timeout: 10 min
Prolonged	Fade time: 10s, Light level: 10%, Timeout: 5 min
Vacant	Fade time: 10s, Light level:Off
Light level range	Min: 0%, Max: 80%
Manual override timeout	--
Scenes	--
Zone linking	Neighboring zones linked together.

5.7 PARKING LOT

Components	Light control features
Bluetooth mesh occupancy and light sensors	<ul style="list-style-type: none">● Occupancy sensing● High-end Trim/Tuning

SEQUENCE OF OPERATION

Night

The light is switched ON to 30% at dusk (when the light level reported by the light sensor falls below 35 lux).

The light level during the night is raised to full output when occupancy is detected and dims back to 30% after 25 minutes.

Day

The light is switched OFF at dawn (when the light level reported by the light sensor exceeds 70 lux)

Scenario settings

Scenario type	Photocell
Night	Starts below 35 lux, Light level: 30%, Occupancy 100%
Day	Starts above 70 lux, Light level: 0%
Fade time	1 sec
Occupancy timeout	25min
Manual override timeout	On: 1 hrs
Low/high-end trim	Min: 0%, Max: 100%
Zone linking	All zones linked together.

5.8 PARKING ENTRANCE/EXIT**Components**

Light sensor controllers

Light control features

- Daylight harvesting

SEQUENCE OF OPERATION

Night

The light is switched OFF during the night (when the light level reported by the light sensor falls below 35 lux).

Day

The light is ON to 100% during the day (when the light level reported by the light sensor exceeds 70 lux).

Scenario settings

Scenario type	Photocell
Night	Starts below 35 lux, Light level: 0%
Day	Starts above 70 lux, Light level: 70%
Fade time	1 sec
Occupancy timeout	-
Manual override timeout	Off
Low/high-end trim	Min: 0%, Max: 100%
Zone linking	All zones linked together.

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