Application Note

BRTSYS_AN_090

Smart Lighting

Version 1.1

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1 Introduction

BRTSys' PanL Smart Living (PSL) platform unifies disparate smart home/office automation solutions into a single seamless ecosystem. It enables streamlined access to a wide range of smart living functionalities, delivering enhanced convenience, efficiency, and control across various environments, including residential, hospitality, and commercial spaces.

This application note outlines the use of PSL for controlling lighting devices and details the configuration of features such as scenes and events to maintain consistent ambient lighting within spaces. The lighting standards, protocols, and ecosystems supported by PSL include:

- Dimmable, Colour and Tuneable White Lighting
- Protocols: Zigbee, DMX, DALI, 0-10V, RF433, IR
- 3RD Party Lighting Systems: Philips Hue, Lutron, Aqara, Tuya etc.

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2 Lighting Automation Modes

This section describes the four available lighting automation modes, which stabilize light brightness based on ambient (lux) sensor data.

2.1 Threshold On/Off

Description: Lights are either **ON** or **OFF**, based on a single ambient-light threshold.

How it works: One sensor, typically facing the window, monitors ambient light. - Lights turn **ON** when measured lux is below the threshold, and **OFF** when above.

Best for: Corridors, storage rooms, or other non-critical zones.

Trade-offs: Simple and energy-efficient, but abrupt with no dimming control.

2.2 Hysteresis (Stepped Dimming)

Description: Prevents frequent switching by using **upper** and **lower thresholds** for smoother transitions.

How it works: A single window-facing sensor monitors lux. Light turns **ON at full brightness** below the lower threshold, **Dims** (e.g.: 50% brightness) when lux is between the lower and upper thresholds and **OFF** above the upper threshold.

Best for: Office edges or perimeter zones with moderate daylight fluctuations.

Trade-offs: Smoother than On/Off mode but not fully adaptive; requires careful threshold tuning.

2.3 Dynamic Daylight Harvesting (Closed-Loop)

Description: Continuously adjusts light output to maintain a **target lux** at the workplace.

How it works: A single wall-mounted sensor near the desk measures ambient light. The controller modulates the luminaire in real time to maintain the desired lux, automatically adapting to changing daylight.

Best for: Workstations, cubicles, or small zones where consistent task lighting is critical.

Trade-offs: Most accurate and adaptive among all modes; sensor placement must be carefully planned (avoid direct desk placement), and no calibration is required after initial installation.

2.4 Static Daylight Harvesting (Pre-Computed Profiles)

Description: Uses **pre-defined thresholds and control curves** instead of continuous feedback.

How it works:

1. **Calibration/Profiling:** Desk-level sensors are temporarily installed to measure lux under different daylight and shading conditions, including night-time step-dimming. **BRTSys** processes the data to determine optimal thresholds and create events, which are then applied to the PanL Hub.
2. **Actual Setup:** Only ceiling and window sensors are needed to apply the pre-computed rules.

Best for: Spaces with predictable daylight behaviour, where runtime simplicity is desired.

Trade-offs: Easier to operate after setup; less accurate than Dynamic mode; requires initial calibration using desk sensors.

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Mode	Sensors Required	Accuracy & Comfort	Runtime Complexity	Calibration Needed	Best Use Case
On/Off	1 (window)	Low	Very Low	Minimal	Corridors, storage areas
Hysteresis	1 (window)	Moderate	Low	Threshold tuning	Perimeter zones
Dynamic (Closed-Loop)	1 wall-mounted near desk	**High (most accurate)**	Moderate	None (self-adjusting)	Workstations, task lighting
Static (pre-computed)	Desk sensors (calibration only) → Ceiling + window (runtime)	Moderate (approximate)	Low at runtime	**High (profiling required)**	Predictable daylight environments

Table 1 - Quick Comparison

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3 PanL Network

The following diagram depicts the PanL network diagram required for this configuration:

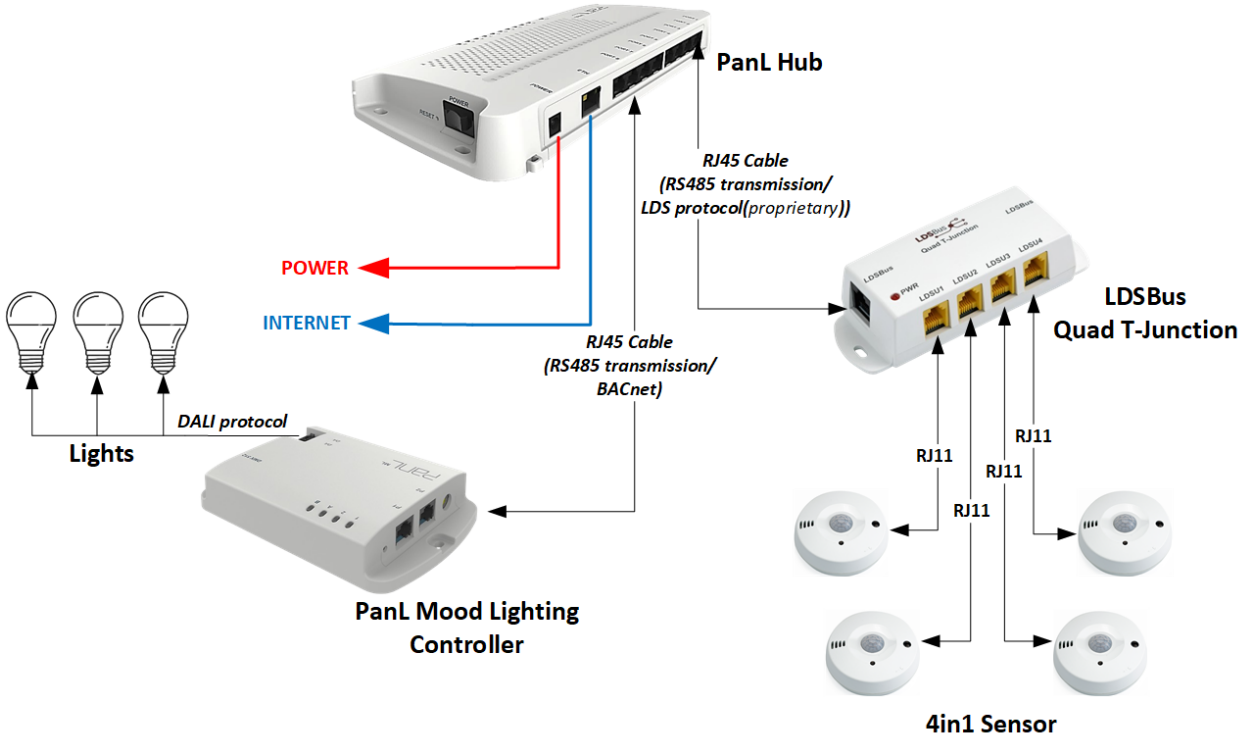

Figure 1 – PanL Network Diagram

- PanL Hub – A PanL Hub facilitates the integration of a diverse range of devices using wired protocols (such as BACNet, DALI, DMX, LDS, and Modbus) or wireless protocols (such as Wi-Fi, ZigBee, and RF433) to use with the PSL ecosystem.
- LDSBus Quad T-Junction – A Quad T-Junction connects multiple devices to the PanL Hub. It serves as a data and power interface between the LDSBus host and the LDSBus devices.
- 4in1 Sensor – The 4in1 sensor includes an ambient light sensor that is used to measure light levels
- PanL Mood Lighting Controller – The PanL Mood Lighting Controller supports DALI and DMX protocols to manage lighting functions including dimming and on/off switching

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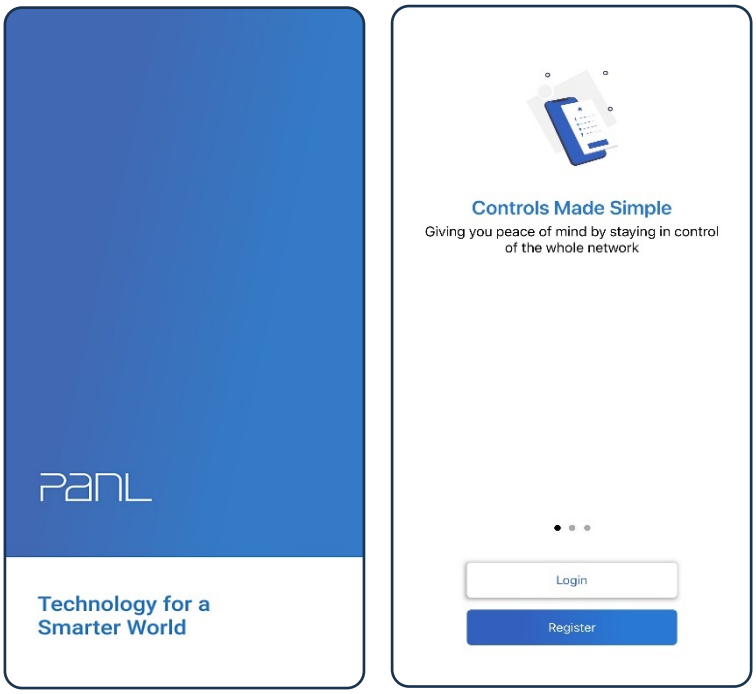
4 Software



Before logging into the PanL Smart Living (PSL) app, the user must first create a PanL network, set it up, and configure all devices. For detailed instructions on creating a PanL network and adding devices, refer to PSL User Guide – System Installation.

Once the network and devices are ready, the user should log in to their PSL account and navigate to the *More* page.

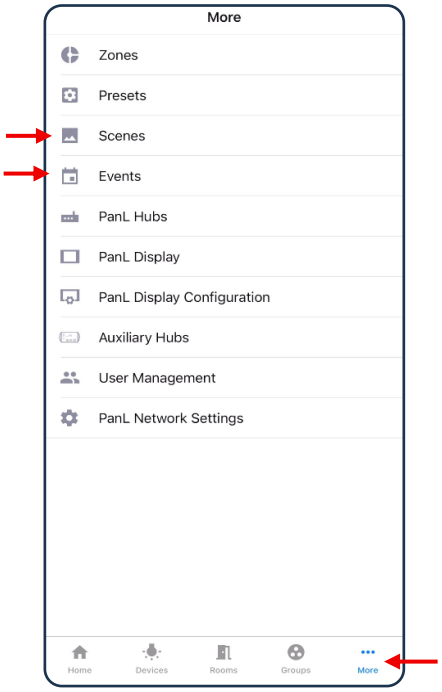


Figure 2 - PSL App: More Page

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The two main features of the PSL app that will be utilized are the creation and use of **Scenes** and **Events** (Refer Figure 2). A scene is a package of actions grouped together to execute sequentially, while an event can be configured to automatically trigger devices, scenes etc.

For the rest of this application note, we will be using the Event and Scene features of the mobile app. Detailed examples of event and scene creation can be found in Appendix C – Event/Scene Creation Example.

The PanL Smart Living app is available for download on iOS from the App Store and on Android from the Google Play Store.

For more information about how to navigate and use the PanL Smart Living app, refer to the following user guides:

- PSL User Guide – iOS Mobile App
- PSL User Guide – Android Mobile App

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5 Lighting Controls

The following sections explain the implementation of different lighting modes using events and scenes.

Note: Lighting level threshold values are provided for illustration only and should be based on the deployment requirements.

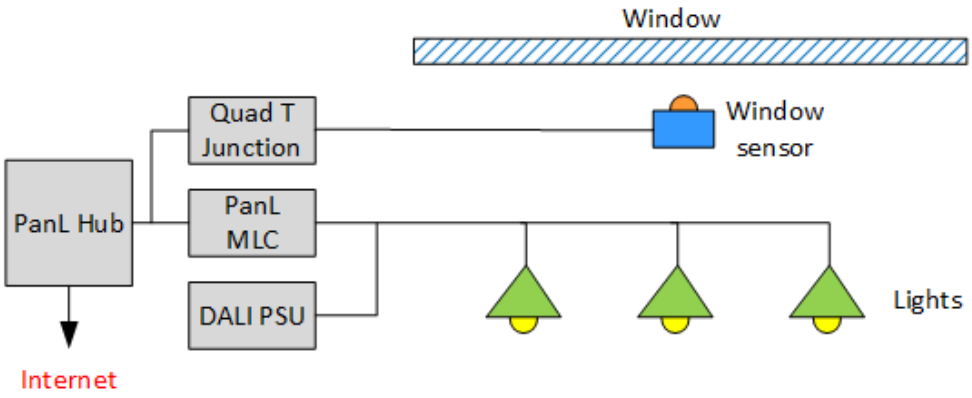
5.1 On/Off Control

In this mode, the sensor continuously measures the Ambient Light Sensor (ALS) value.

- When the reading falls below 500 Lux (indicating low outdoor brightness) during the operating hours, the lights turn ON.
- When the reading rises above 500 Lux (indicating sufficient daylight) during the operating hours, the lights turn OFF.

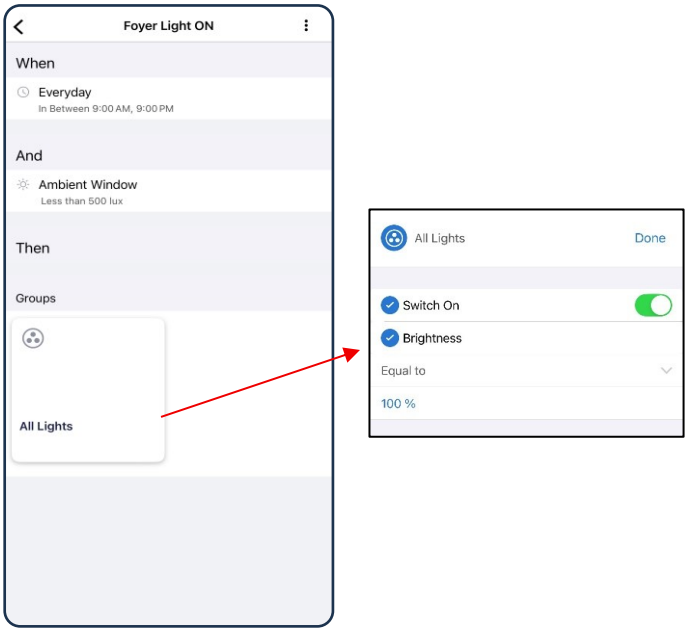
Setup:

- A single light sensor is used and points to the window



To execute this using the PSL mobile application, two advanced events must be configured; one to turn the lights ON and one to turn them OFF.

Event 1: Turn ON the lights group when both conditions are met - the ambient sensor reading falls below 500 Lux, and the store is within operating hours.



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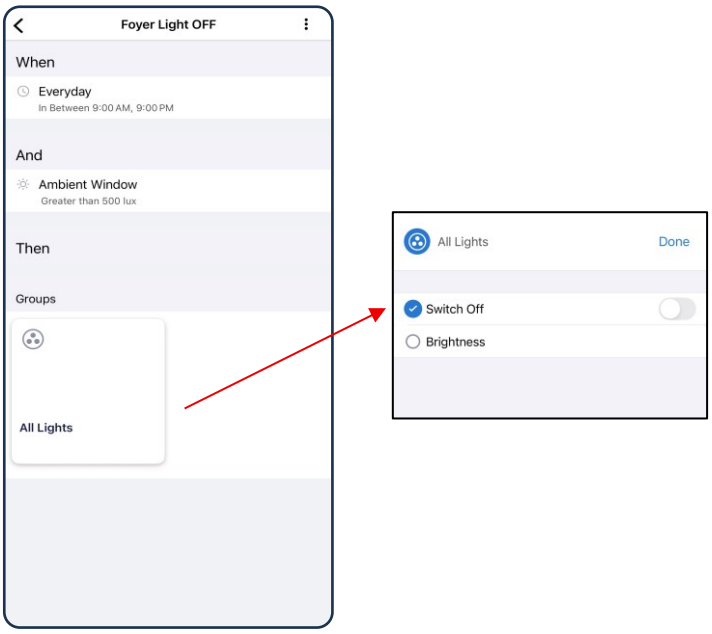
<u>Event 2</u>: Turn OFF the lights group when both conditions are met - the ambient sensor reading exceeds 500 Lux, and the store is within operating hours.



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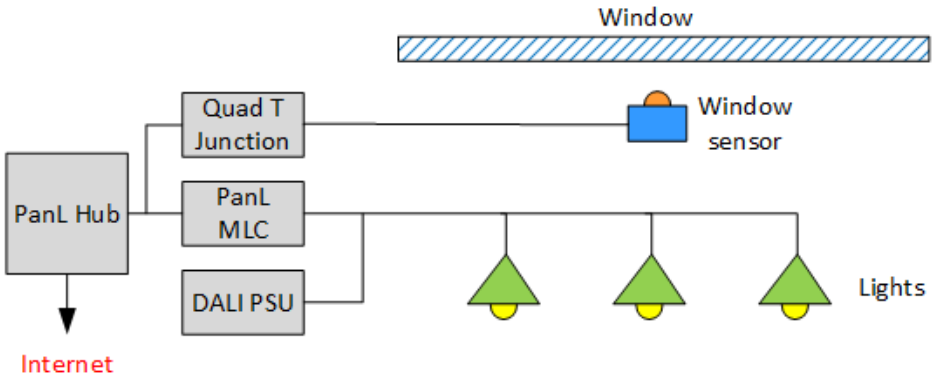
5.2 Hysteresis mode

In this mode we configure two thresholds - 200 and 500 lux. This acts as a subtle buffer to ON/OFF transitions, allowing lighting to adjust only when a significant change occurs.

Pre-requisites:

- A single light sensor is used and points to the window

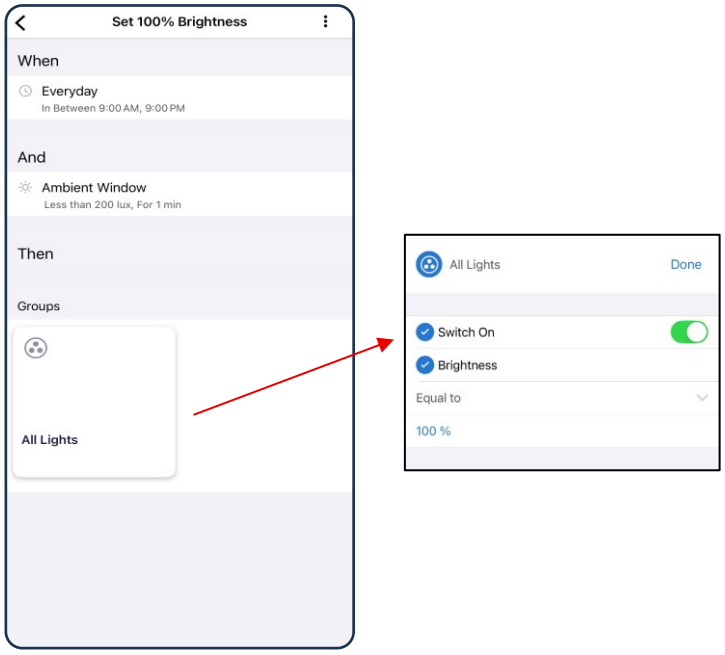


To execute this using the PSL mobile application, we will create 3 events as below:

- Event 1 - If ambient sensor falls below 200 Lux for at least 1 minute during the operating hours, set the brightness to 100%.
- Event 2 - If ambient sensor is between 200 Lux and 500 Lux for at least 1 minute during the operating hours, set the brightness to 50%.
- Event 3 - If ambient sensor above 500 Lux for at least 1 minute during the operating hours, turn off the lights.

Since there is a huge brightness adjustment between different conditions, the event should be triggered if the condition is met for some time, e.g: 1 or 2 minutes.

Event 1: If the ambient sensor reading falls below 200 Lux for 1 minute and within operating hours, set the brightness to 100%.



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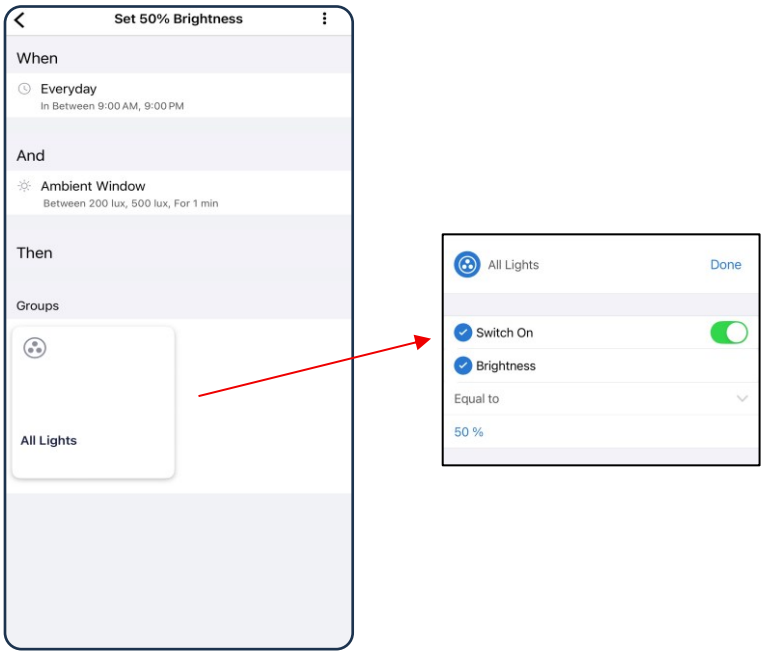
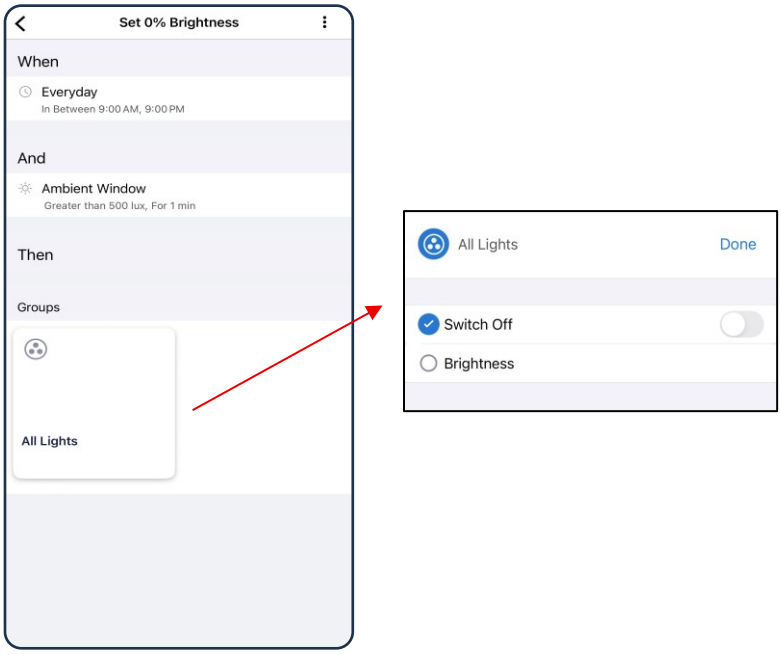
Event 2: If the ambient sensor reading is between 200 and 500 Lux for 1 minute and within operating hours, set the brightness to 50%.



Event 3: If the ambient sensor reading rises above 500 Lux for 1 minute and within operating hours, turn off the light.



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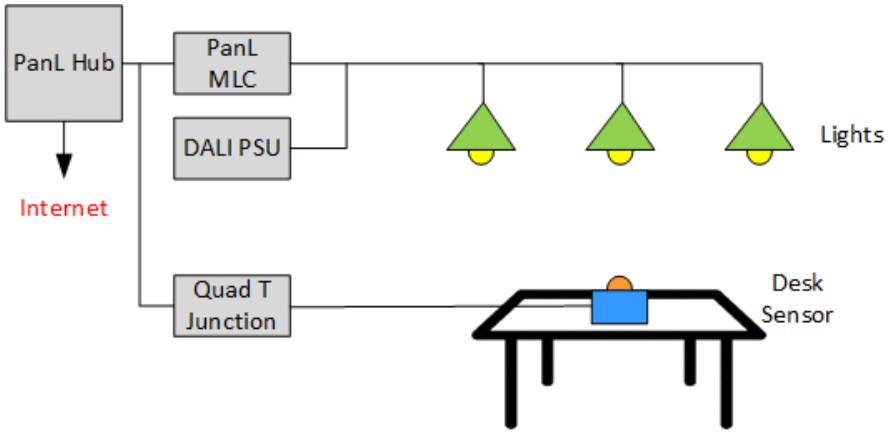
5.3 Dynamic Daylight Harvesting Mode

In this mode, the user defines a target Lux level for the desired lighting environment. The ALS readings from each sensor are continuously monitored, and the connected lights are adjusted (increase, decrease) to maintain the target level, ensuring consistent comfort and visual quality.

Pre-requisites:

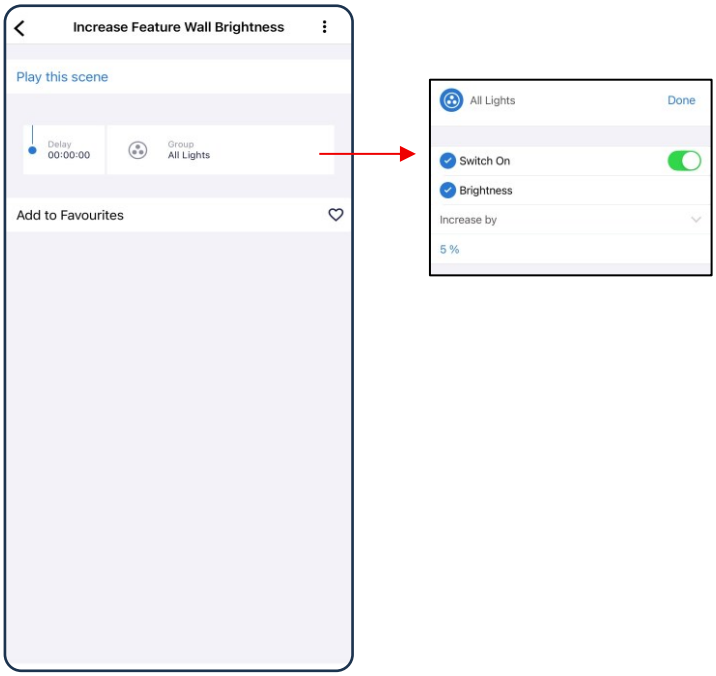
- The sensor is positioned at the centre of the desk, facing upward toward the lights



The following steps outline how to achieve dynamic daylight harvesting mode using the PSL app:

- Scene 1: Increase light brightness by 5%
- Scene 2: Decrease light brightness by 5%
- Event 1: When the ALS detects less than 395 Lux and within store operating hours, activate scene 1 (increase brightness by 5%)
- Event 2: When the ALS detects more than 405 Lux and within store operating hours, activate scene 2 (decrease brightness by 5%)

Scene 1: Increase Brightness by 5%



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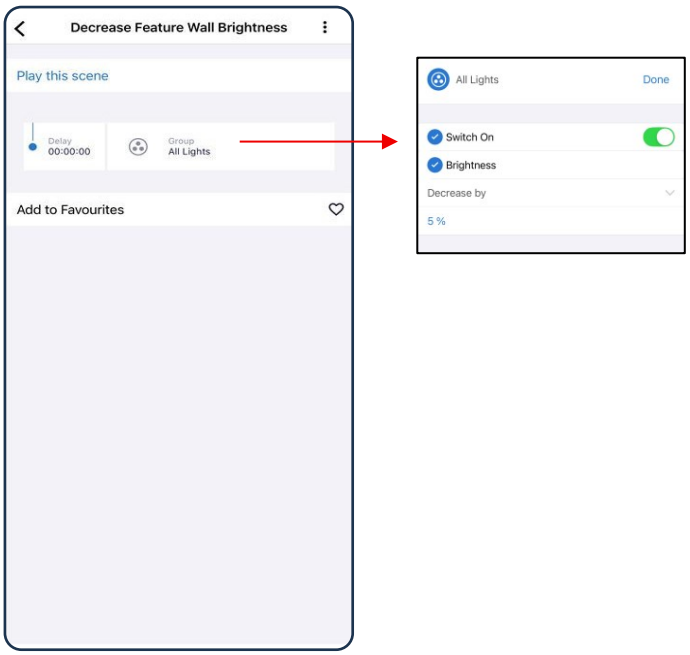
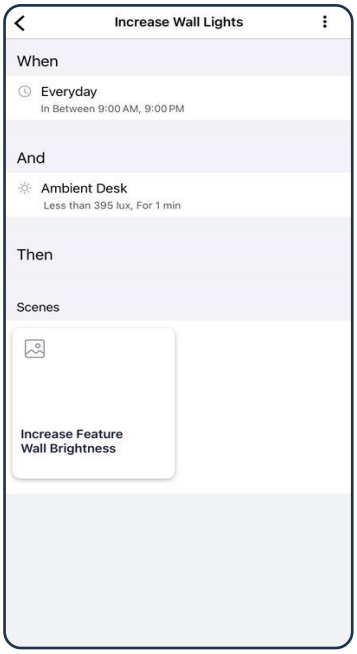
Scene 2: Decrease Brightness by 5%



Event 1: When the ALS detects a brightness level below 395 Lux during operating hours, call scene 1 (increase brightness by 5%)



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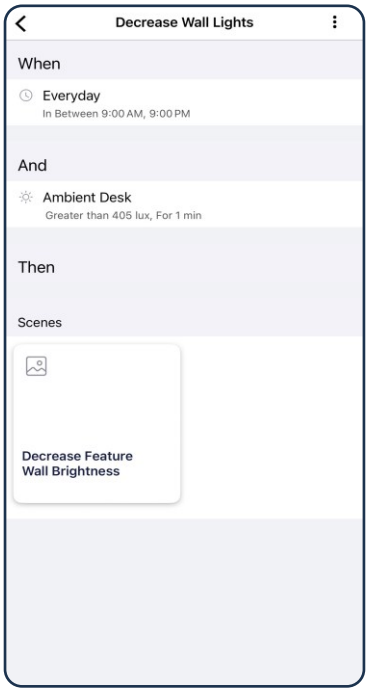
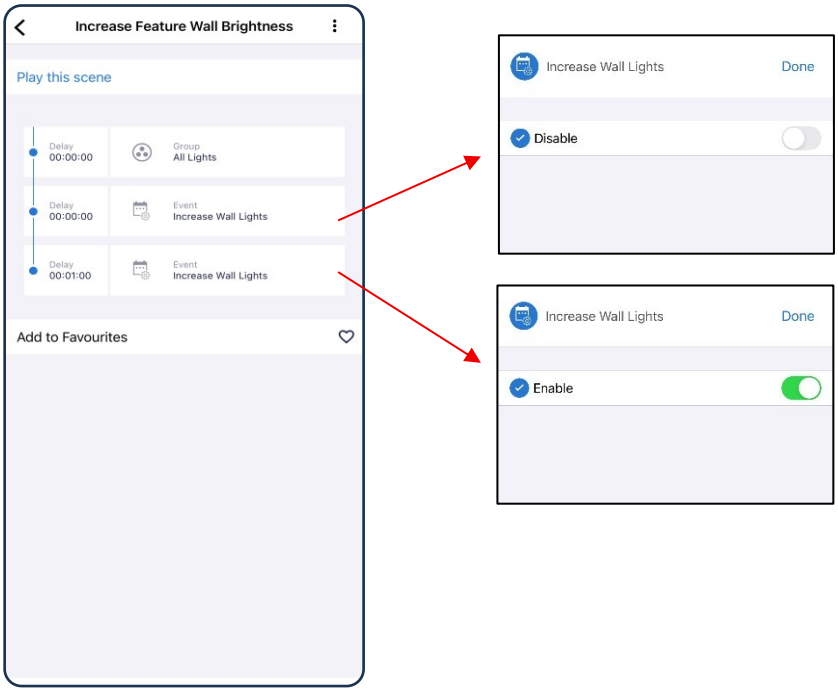
Event 2: When the ALS detects a brightness level more than 405 Lux during operating hours, call scene 2 (decrease brightness by 5%)



Note: Events are designed so that once a condition is met, they will not trigger again until the condition is reset and occurs again. To ensure proper triggering, scene 1 and 2 should be updated to add a step to disable and enable Event 1 and 2 respectively with a 1-minute delay between them as shown below.

Scene 1:



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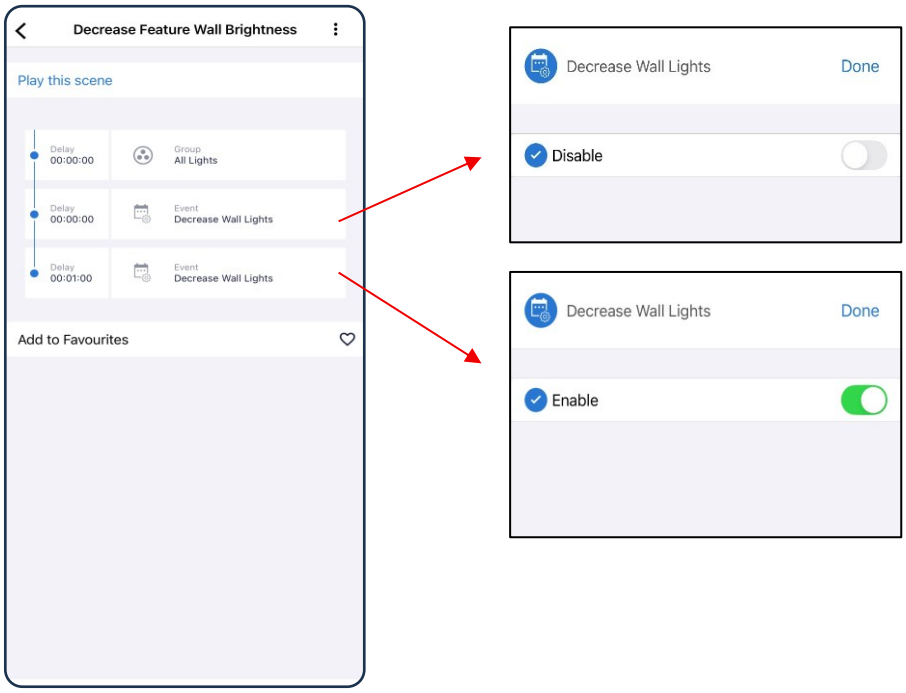
Scene 2:



By combining desk-mounted and ceiling-mounted ambient sensors with smart lighting, the PSL app automatically adjusts brightness based on real-time indoor light levels, ensuring a consistently comfortable and visually pleasing environment.

Note: The Dynamic Daylight Harvesting Mode provides the highest accuracy; however, it must be placed on a surface such as a desk, where movement around it may cause interference. A practical workaround is to mount the sensor on a wall and angle it toward the ceiling.

If using the Dynamic Daylight Harvesting Mode is not feasible, the Static Daylight Harvesting Mode serves as the next most reliable option.

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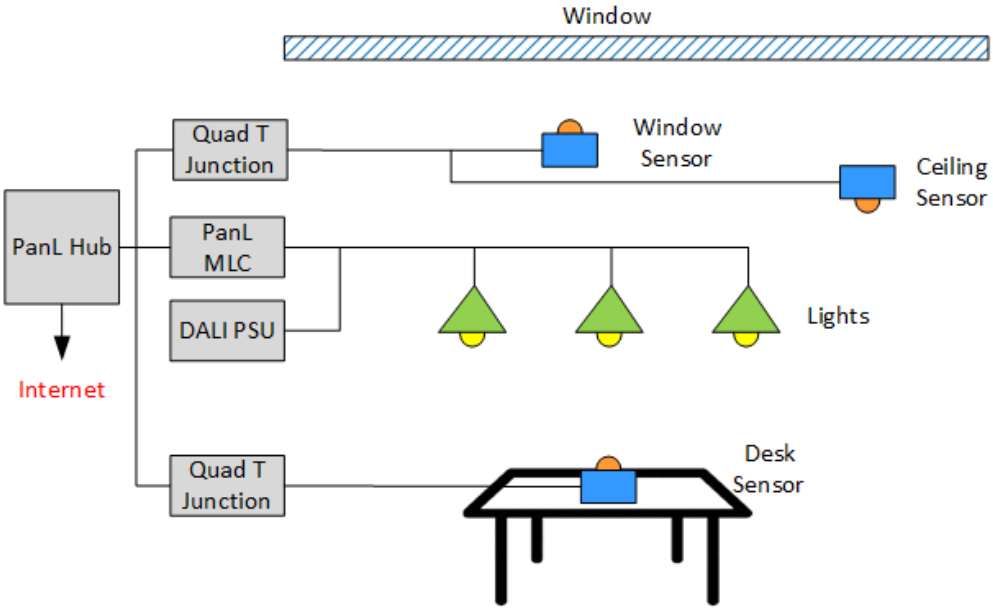
5.4 Static Daylight Harvesting Mode

This method relies on a calibration process to determine the optimal thresholds that will later be applied in the actual setup. Once applied, they enable the PSL app to automatically adjust lighting levels, ensuring consistent lighting.

For example, in a room with large windows, the calibration process will capture how sunlight varies from morning to afternoon with curtains fully open and closed. Based on this data, the PSL app can apply the right thresholds to provide ambient room lighting at all times.

Pre-requisites:
Before actual setup, a calibration process must be carried out using three sensors: one placed on the desk, one on the ceiling, and one oriented toward the window.

a. **Calibration Setup** – Three sensors are installed: one on the desk, one on the ceiling, and one oriented toward the window.



The user must capture the calibration data by running the script provided by BRTSys on a PC which is on the same network as the PanL Hub.
This script should be run continuously for at least one day, during which the setup records brightness levels from the sensors under varying conditions (for example, one day with curtains/blinds fully closed and one day fully open).

Follow the steps below to capture the calibration dataset:

1. Download script.zip folder and extract the files. Ensure users have the following installed on their PCs:

   - Python 3.10
   - Pipenv

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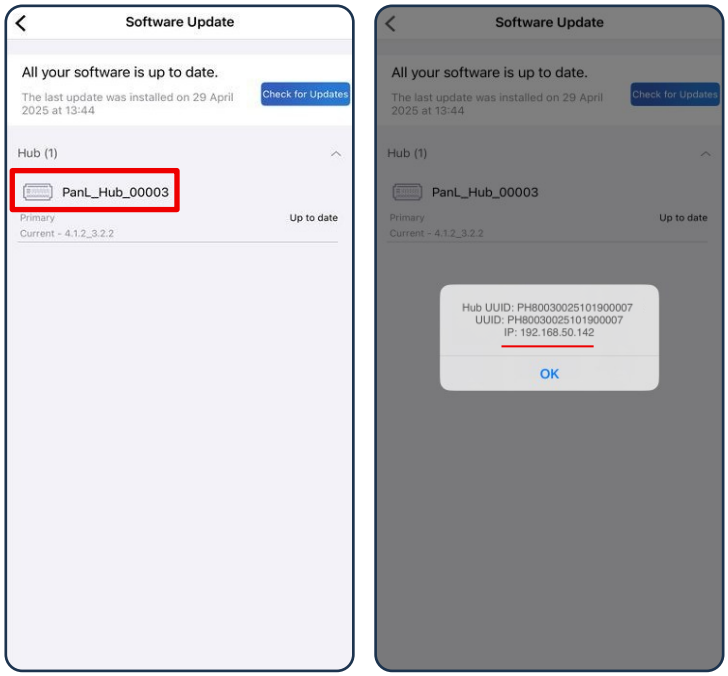
2. Open *config.json* file and update the following:

   - Primary PanL Hub IP

   In the PanL Smart Living mobile app navigate to **More** page.
   Click on **PanL Networking Settings** -> **Software Update** to find the list of Hubs. Find the primary PanL Hub and click on it to view the Hub IP.



   - Collected Devices

     These are the light and sensor devices added to the PSL app. Device names reflect their configuration within the app, e.g., Hue Lamp 1, Living Room Lights, etc.

3. Using the Command Prompt, navigate to the script folder and run the following commands:
   - pipenv install<CR>
   - pipenv shell<CR>
   - python collect_data.py<CR>

```
C:\Users\Downloads\baseline_script 1\script>python collect_data.py
Configuration loaded: {'primary_ip': '192.168.50.142', 'collected_devices': ['0-10V Dimmer', '0-10V Dimmer', '0-10V Dimm
er', '0-10V Dimmer', 'Ambient'], 'interval': 60}
Collecting data for: 0-10V Dimmer
Collecting data for: 0-10V Dimmer
Collecting data for: 0-10V Dimmer
Collecting data for: 0-10V Dimmer
Collecting data for: Ambient
['20250901_151544', 34, 34, 34, 34, 303.89999389648844]
Waiting... 0 out of 60 seconds
Waiting... 10 out of 60 seconds
Waiting... 20 out of 60 seconds
Waiting... 30 out of 60 seconds
```

4. The script will collect the data from PanL Hub and create a csv file called *data_<timestamp>.csv*. The following is an example of the .csv file:

timestamp	Hue Lamp 1	Hue Lamp 2	Hue Lamp 3	Hue Lamp 4	Light Dimmer	Ambient
20250821_142949	100	100	100	100	100	84.09999847
20250821_143000	95	100	98	88	100	82.86877898

Note: When capturing calibration data for multiple scenarios (e.g., curtain fully open or closed) over a period of time, the user must record the timestamp of each scenario change to ensure data consistency.

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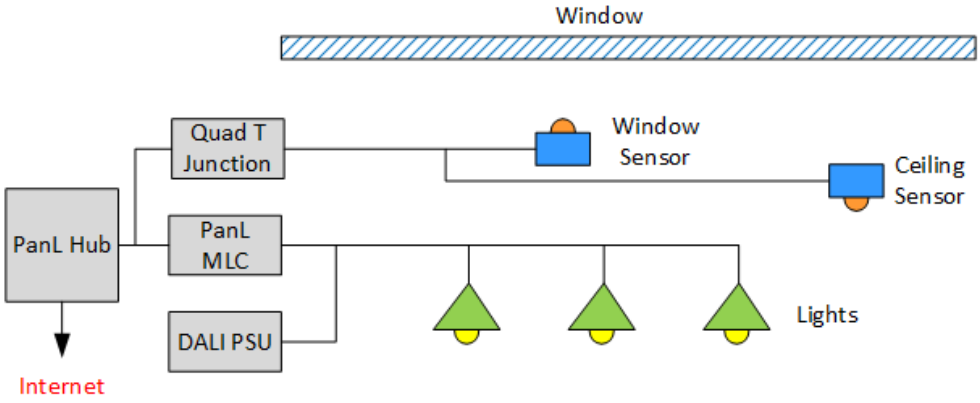
5. Once calibration is complete, the collected data (exported as a `.csv` files) should be sent to BRTSys.

6. Based on the data in the .csv file, BRTSys will assist in creating the events required for controlling the lights based on the actual setup shown below.

b. **Actual Setup** - Two sensors are installed, one on the ceiling, and one oriented toward the window. The desk sensor used during calibration setup is removed and these 2 sensors will regulate the ambient lighting inside the room.



This method maintains consistent brightness throughout the day and night, based on the specific conditions of each location.

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6 Contact Information

Refer to https://brtsys.com/contact-us/ for contact information.

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Appendix A – References

Document References

PanL Hub Datasheet

Ambient Sensor Datasheet

PanL Mood Lighting DALI/DMX 512 Controller Datasheet

PanL Mood Lighting DALI/DMX 512 Controller Application Note

Acronyms and Abbreviations

Terms	Description
ALS	Ambient Light Sensor

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Figure 2 - PSL App: More Page 7

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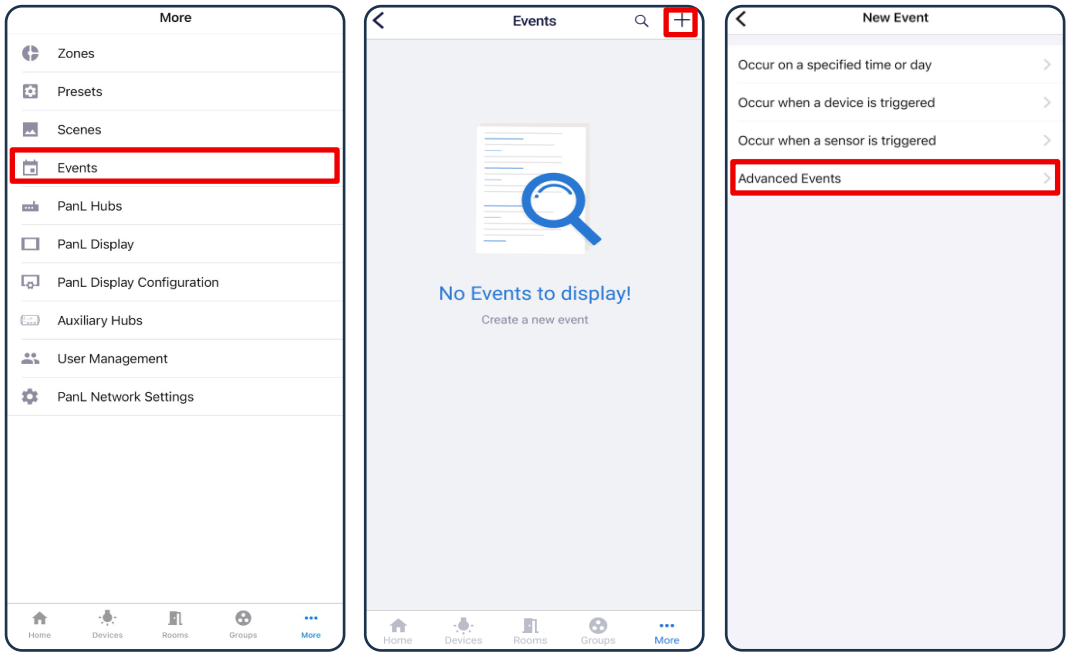
Appendix C – Event/Scene Creation Example

The following sections explain how to create events and scenes using the PanL Smart Living app on iOS.

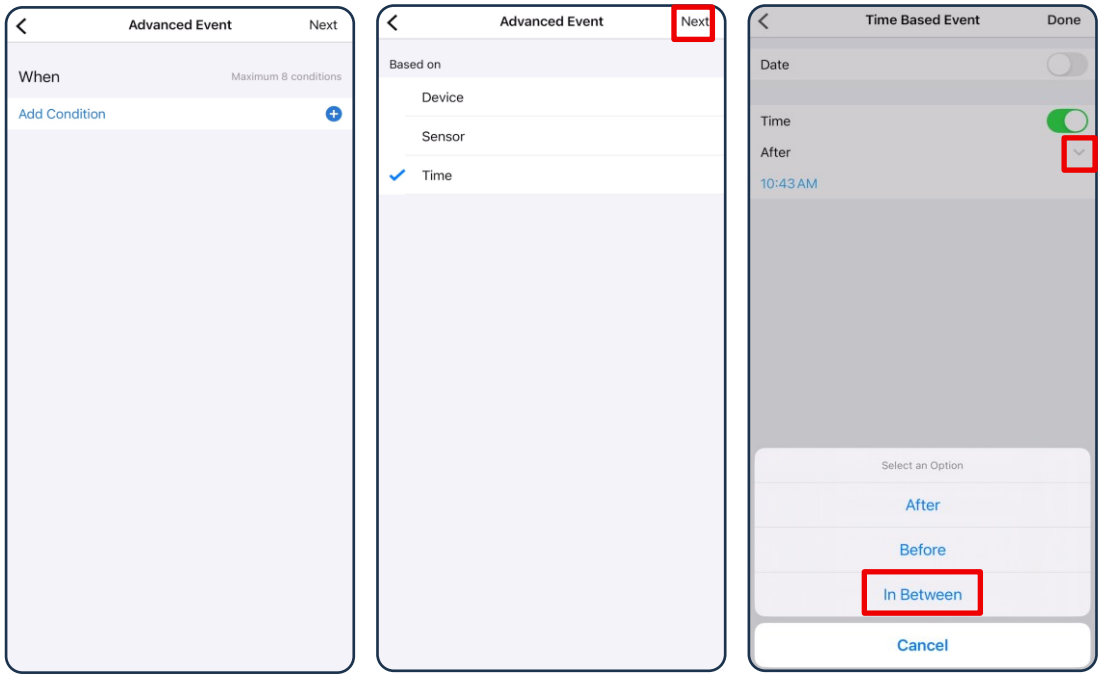
Event Creation - Example

The screenshots below show an example of setting up an event that turns a group of lights ON when the time is between 9:00 AM and 9:00 PM and the sensor reading falls below 500 Lux.

a. Select **[+]** to create a new event. Tap on Advanced Events.



b. Add Condition 1 – When selecting the *Time* event, open the dropdown menu and choose 'In Between' to set the time range from 9:00 AM to 9:00 PM.



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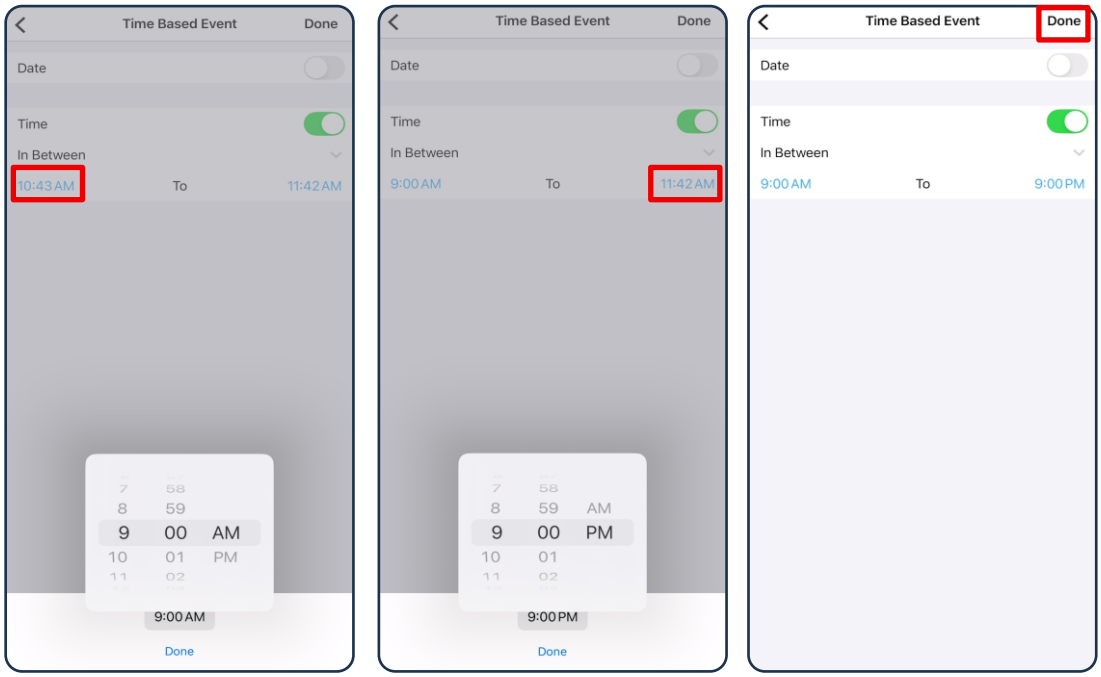
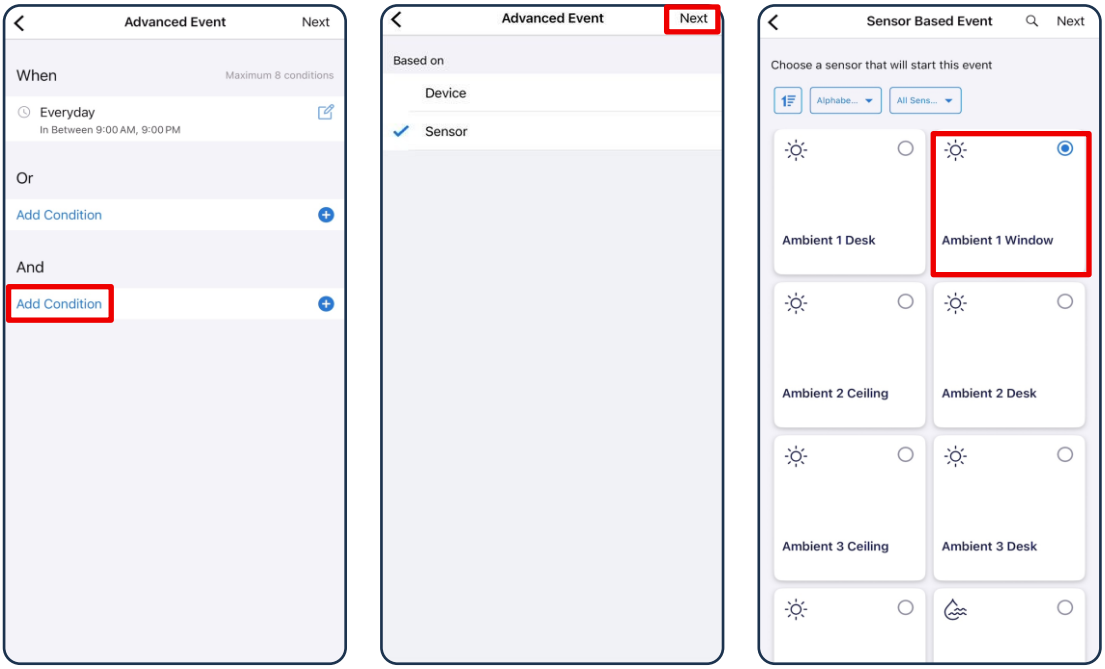


c. Add Condition 2 – Add an "And" condition (i.e. both conditions have to be met for the event action to be triggered). On selecting *Sensor* based event, select the required ambient sensor, click to open the drop down for condition and choose "Less than" and set a value for checking, in this case 500 Lux.



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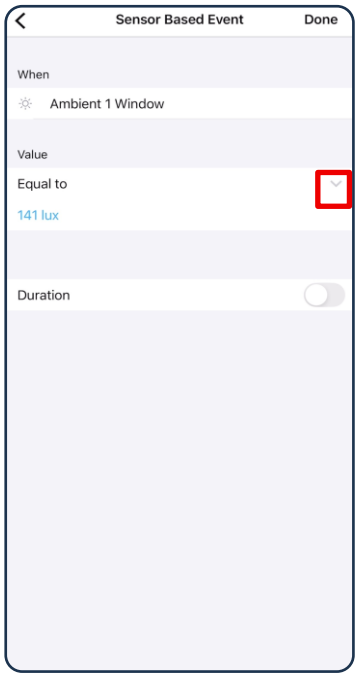

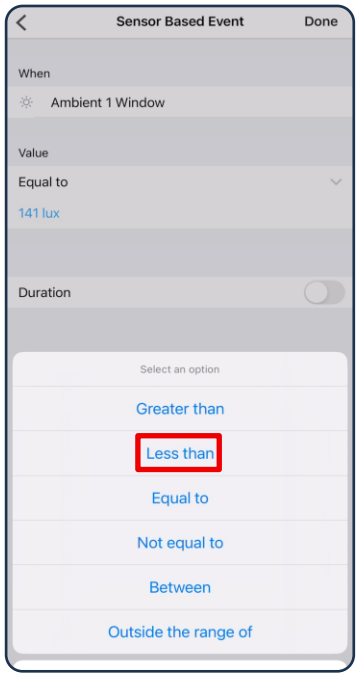

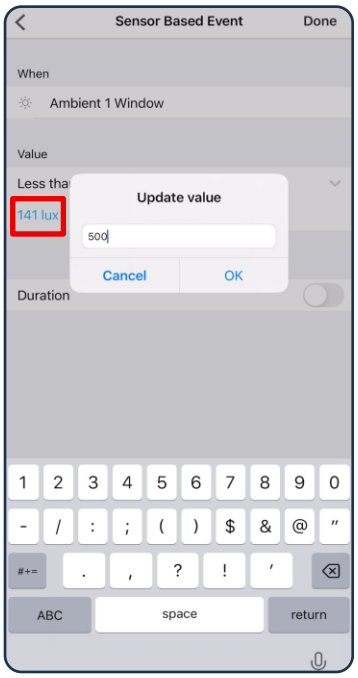

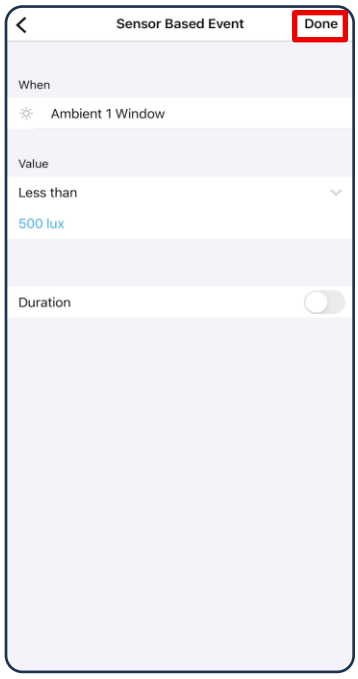

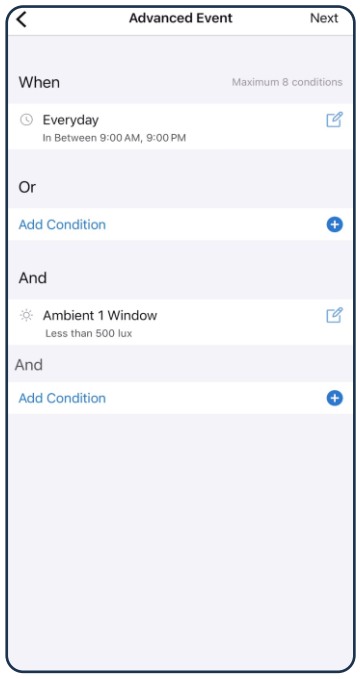

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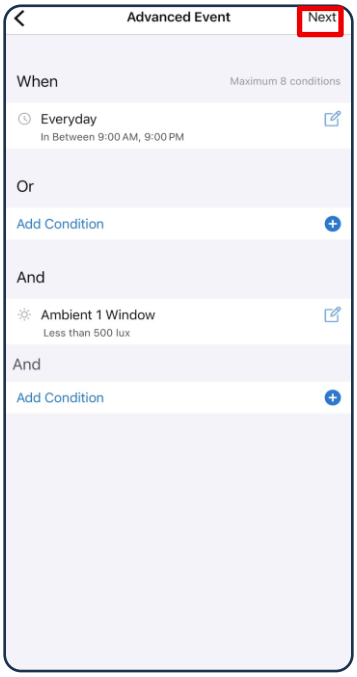
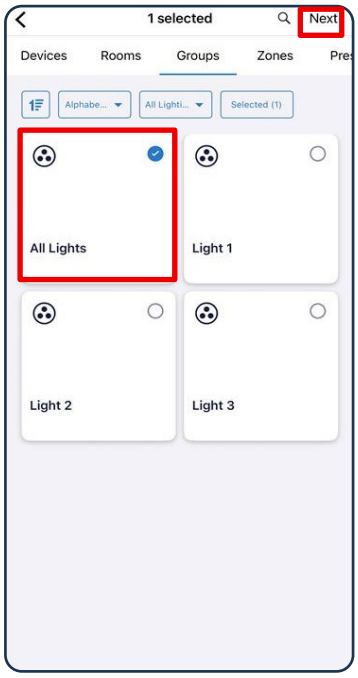
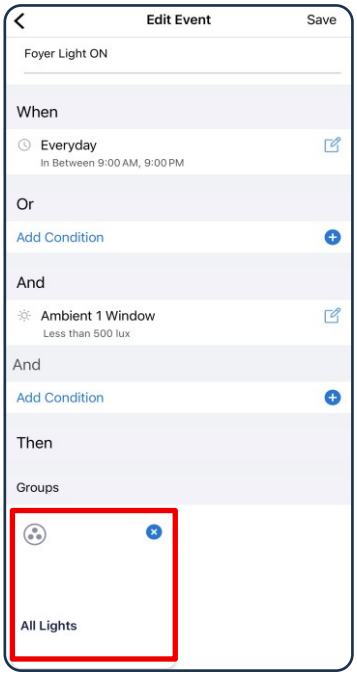
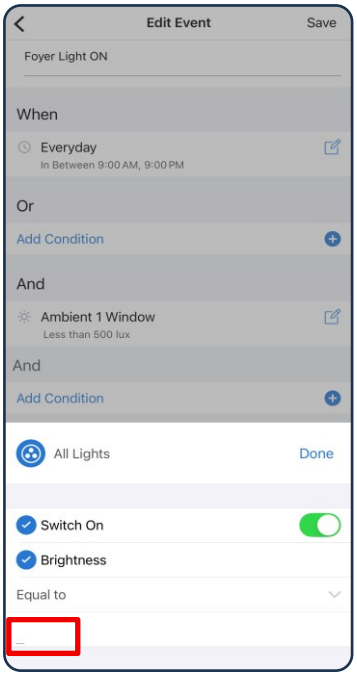
d. Add Action – To configure the event action, select the light group to be controlled. Tap the group to set the desired brightness level, then save the event. The created event can be enabled/disabled using the toggle button.

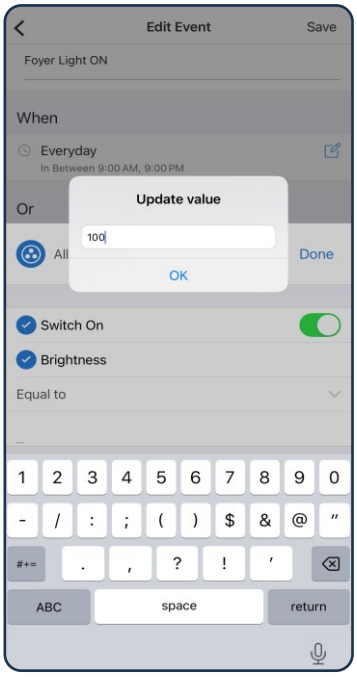


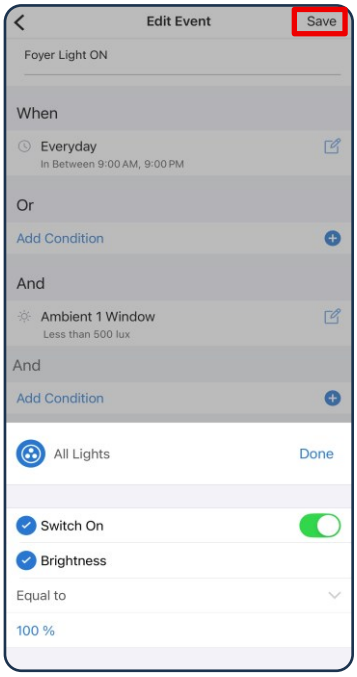




Brightness and colour (if supported) of the light devices can be customised by the user.







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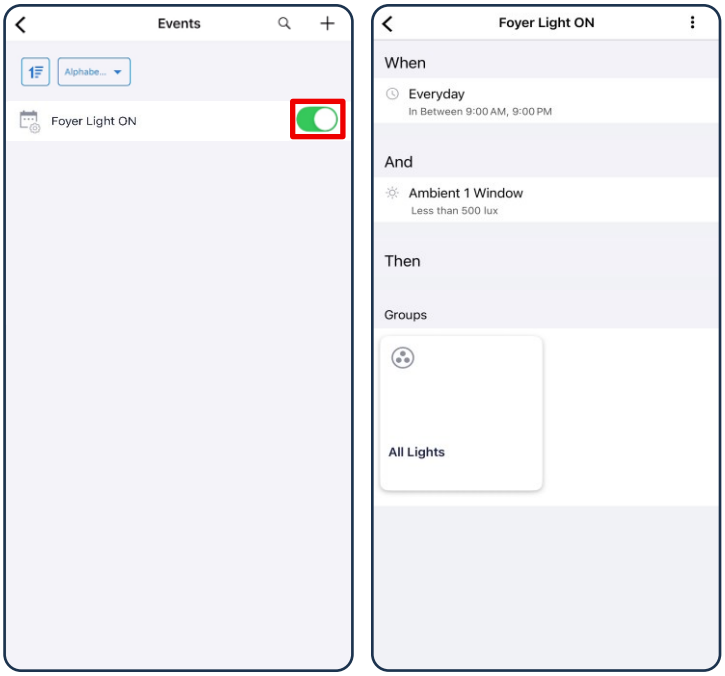
The user can enable the event by switching on the toggle button. Once enabled, the system will automatically monitor the sensor readings and operating hours, and adjust the lights based on the configured conditions.



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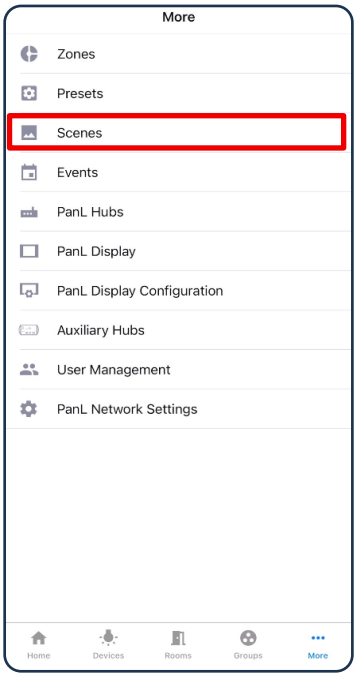
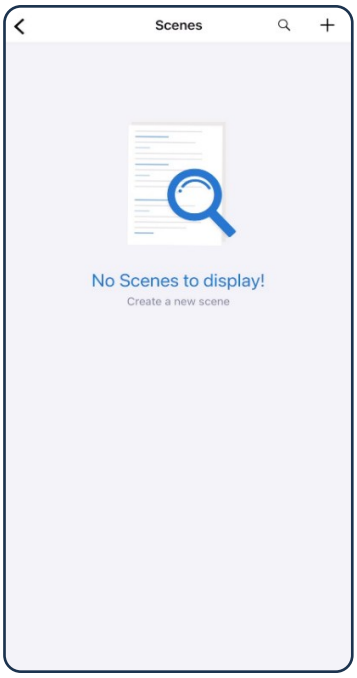
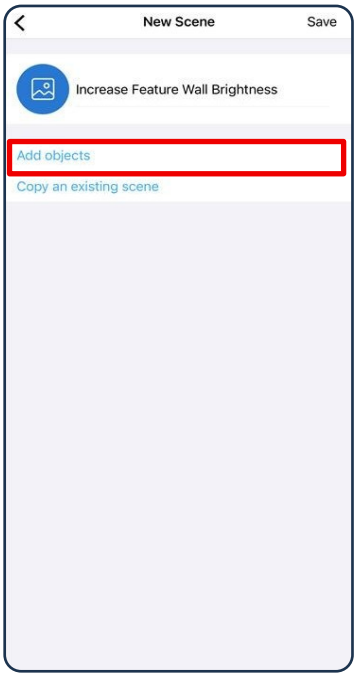
Scene Creation – Example

The screenshots below illustrate how to create a scene that raises the brightness of a light group by 5%.

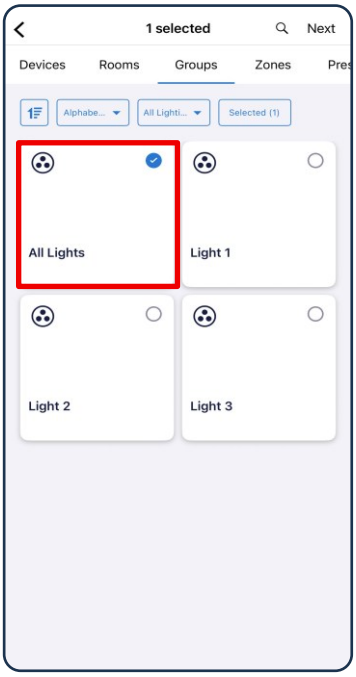
a. Click **[+]** to create a new scene and enter a name. Add a name for the scene and tap **[Add objects]** to include the items to be controlled by the scene.

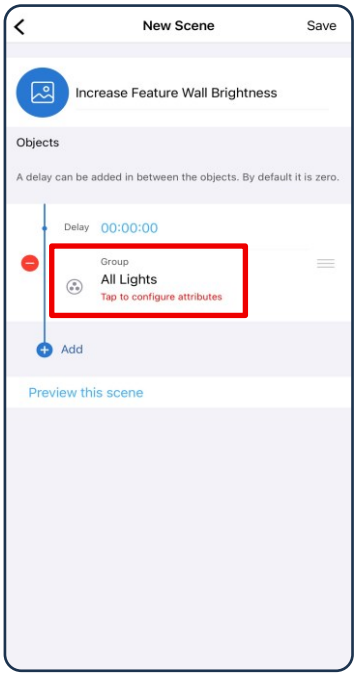


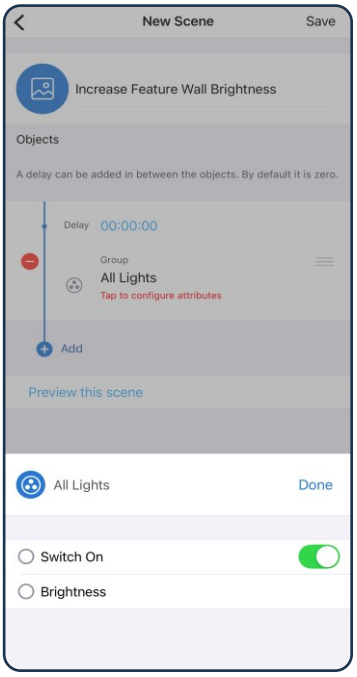




b. Select the lights group and click **[Next]**. Tap on the lights group to view its attributes.







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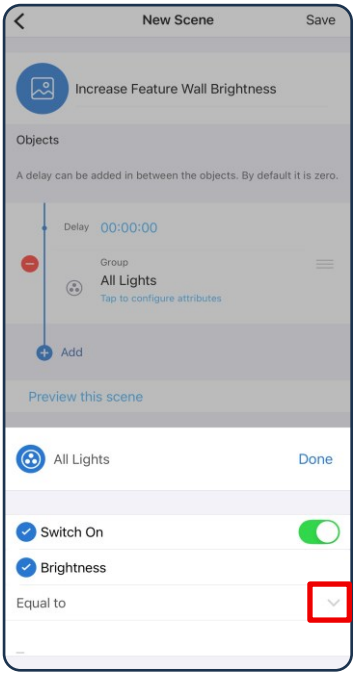
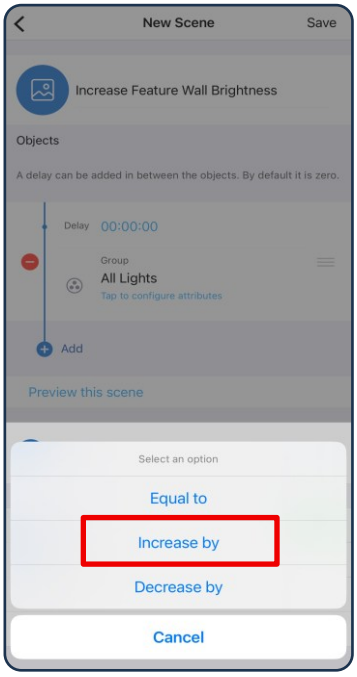
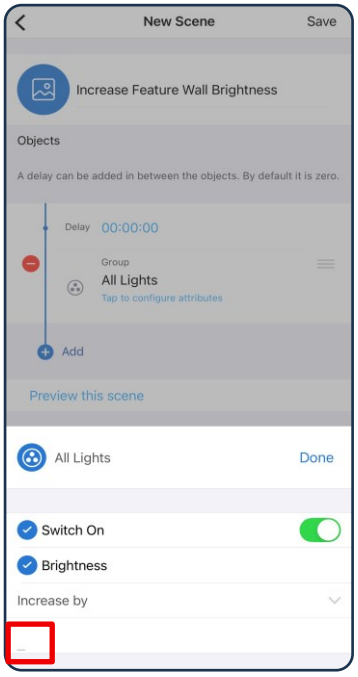
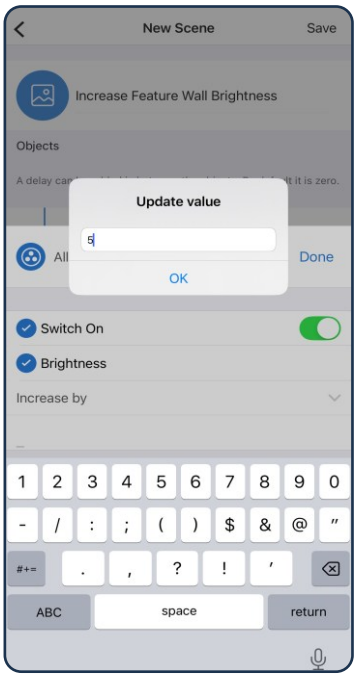
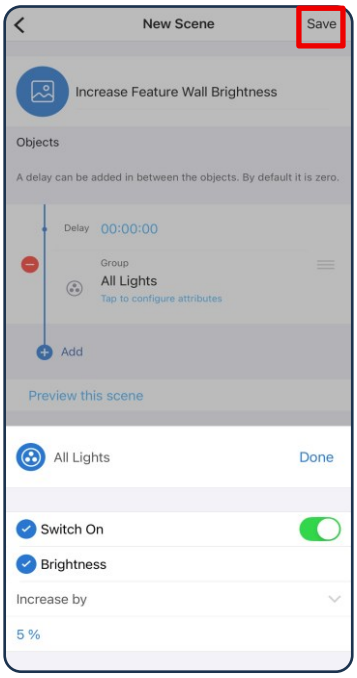
c. Tap the dropdown to change the condition to "Increase by". Set value to 5%.

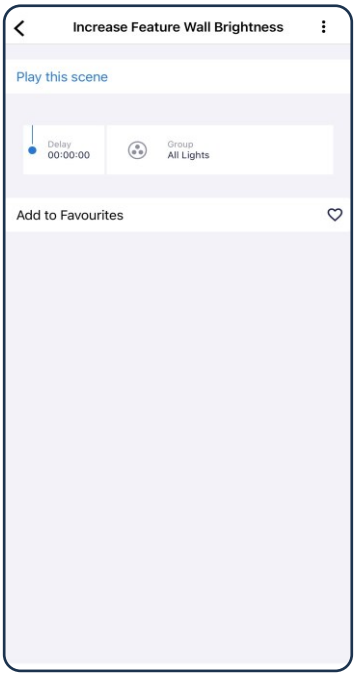












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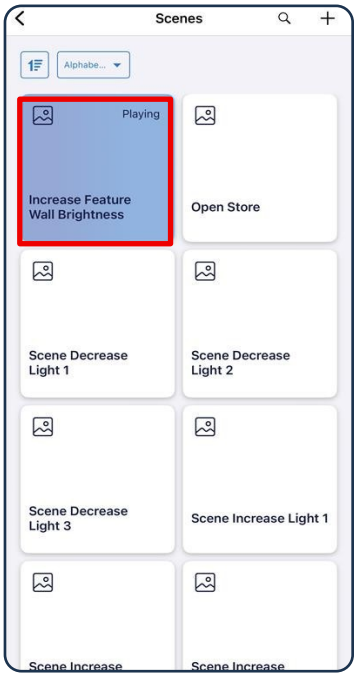
- Click the scene to play it. When triggered by an event, the scene increases the brightness of the light group by 5%.



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Appendix D – Revision History

Document Title: BRTSYS_AN_090 Smart Lighting

Document Reference No.: BRTSYS_000217

Clearance No.: BRTSYS#136

Product Page: http://brtsys.com/

Document Feedback: Send Feedback

Revision	Changes	Date
1.0	Initial Release	19-09-2025
1.1	Minor update	24-09-2025

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