Connected Lighting Platform
Getting Started Guide

Attention: The Connected Lighting Platform is powered by AC Mains, and exposed to high voltage. Only trained personnel should manipulate and operate on the system. Ensure that all boards are properly connected before powering, and that power is off before disconnecting any boards. Do not attempt re-connecting any of these boards while under operation. During operation, some surfaces may become hot; the LED board can dissipate up to 55 watts. Use appropriate heat sink. The Lighting Platform is delivered with high luminous LEDs boards. Before any operation, use suitable Personal Protective Equipment (PPE) to protect the eyes. Failure to comply with appropriate safety precautions may result in personal injury or death, or equipment damage.

1. Overview

The Connected Lighting Platform is a modular kit for developing a complete industrial lighting solution with power supply, LED driving system and Bluetooth® Low Energy connectivity through the *RSL10 Sense and Control* mobile app.
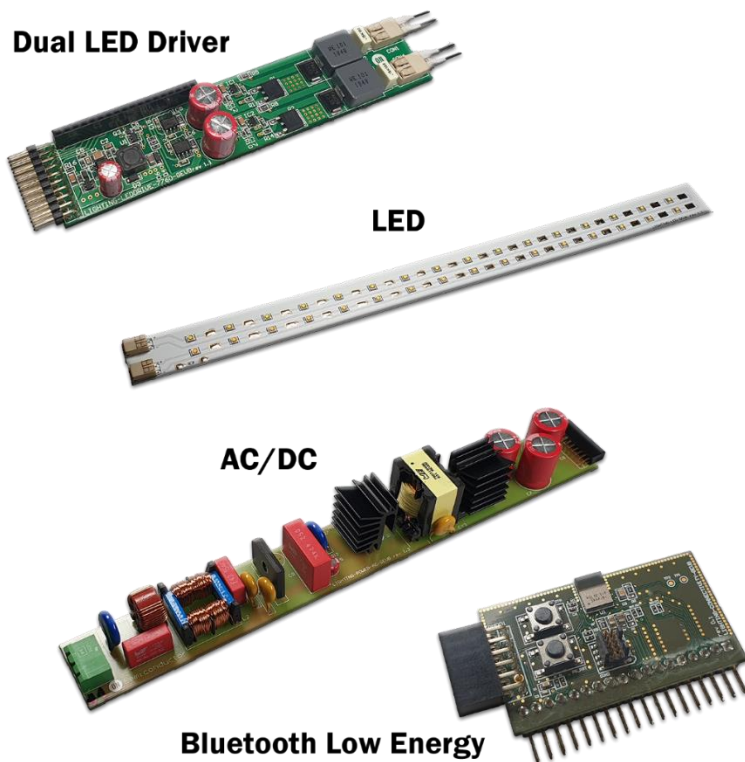

Figure 1. Connected Lighting Platform

The following modules are available as part of the platform (LIGHTING-1-GEVK):

- Dual LED driver
- AC/DC power supply
- Bluetooth Low Energy connectivity
- LED

For high-power connectivity, an IEEE 802.3bt compliant Power-Over-Ethernet (PoE) board is available separately.

Features

- High-power lighting features
    - Up to 2 Strings of 16 LEDs (7000 Lumen)
    - Dual independent LED Channel
    - White balance control (12-bit Dimmer from 0 to Max)
- Multiple connectivity options
    - Bluetooth® Low Energy
    - Power Over Ethernet (PoE)
- Compliant with multiple industry standards
- High efficiency power conversion (>90% at full load)

2.   Prerequisites

Hardware
- Connected Lighting Platform (LIGHTING-1-GEVK)
- J-link Ultra+ Debug Probe
- AC power cord with (example here)

If Using the PoE Power Module
- Power Over Ethernet Power Module (LIGHTING-POWER-POE-GEVB)
- PoE Power Injector (Phihong POE90U-1BT PSE)

Supporting Platforms (Optional)
- Energy Harvesting Bluetooth Low Energy Switch (if using the Energy Harvesting sample application)
- RSL10 USB Dongle

Software
- Bluetooth® IoT Development Kit CMSIS Pack (01.11.02 or higher)
- ON Semiconductor IDE Installer
- RSL10 Software Package
- RSL10 Software Apps Package
- RSL10 Getting Started Guide
- Connected Lighting Platform FOTA Firmware (Optional)

If using the RSL10 USB Dongle

- RSL10 BLE Explorer

Mobile Apps

- RSL10 Sense and Control (IoS®, Google Play™)
- RSL10 FOTA (IoS, Google Play)

3. Hardware Set-up

3.1 Setting up the Connected Lighting Platform Modules

1. Connect the Bluetooth Low Energy connectivity module to the LED driver module as shown in **Figure 2** below.
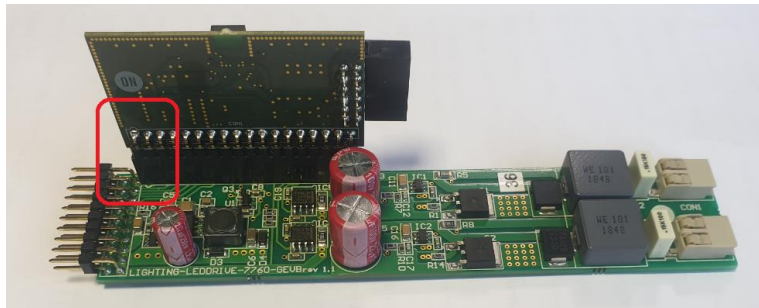

Figure 2. Connecting the Bluetooth Low Energy Connectivity Module to the LED driver module

2. Connect the remaining modules as depicted in **Figure 3.**

Figure 3. Connecting the Connected Lighting Platform Modules

3.1.1. Powering the Platform using the AC/DC Module

Using an AC power cable, connect the phase, neutral and PE according to **Figure 4.**

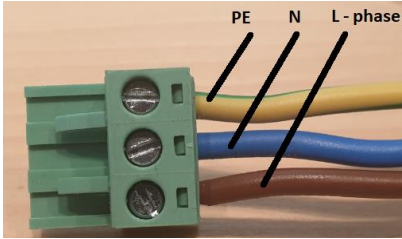**NOTE: Ensure that all modules are connected properly before powering the platform.**

Figure 4. AC/DC Power Cord Wiring to AC Connector

3.1.2. Powering using the PoE Power Board

Connect OUT of the **Phihong POE90U-1BT PSE** power injector to the input connector of the PoE module.

Figure 5. Lighting Platform Hardware Setup with PoE power supply

4. Software Development Kit (SDK)

4.1 Overview

The RSL10 firmware runs on FreeRTOS™ operation system, included as part of the CMSIS SDK release, with detailed description of the code and services used in the threads. This section is intended as an overview of the software tools provided with the Connected Lighting Platform. **For full details, refer to the readme embedded in the CMSIS-Pack.**

The Connected Lighting Platform utilizes the following Bluetooth® Low Energy services:

- **Light Control Service**, used by connected peer devices to read and change state of kits LED strings.
- **Telemetry Service,** exposes variables measured by the platform to peer devices. This includes current flowing through each LED driver and system voltage.
- **PoE Power Delivery Service***, peer device can retrieve information about PoE imposed power limits on the device that were negotiated between the PoE injector and platform.

*If using the PoE module

4.2 Prerequisite Software

In addition to the software listed in Section 2. Prerequisites, ensure the following items are installed on your PC.

1. *64-bit version of Java*
2. *J-Link Version 6.32i or later*
3. *Arm CMSIS pack 5.5.1 or higher*
4. *FreeRTOS version 10.2.0 or higher**

*If designing code using FreeRTOS

4.3 Bluetooth Low Energy Services

4.3.1 Light Control Service

This service exposes a Dimmable Light characteristic for each available LED string. The value of this characteristic directly relates to the duty cycle that will be applied to the corresponding LED channel. By default, the allowed duty cycle range is from 0 (0%) up to 4000 (100%). When multiple LED channels are present, the characteristic will always have a Characteristic Presentation Format descriptor that reports channel number in its description value, starting from 1 (first) up to the number of channels (second in this case).

If the platform is powered by PoE, there might be an imposed additional duty cycle limit so that the sum of all channel currents does not exceed capability of used PoE injector. Refer to Section **4.2.3 PoE Powered Device Service** for additional information.

4.3.2 Telemetry Service

The Telemetry service is used to report various system variables measured by the Lighting Kit. This includes currents flowing through LED channels and system voltage.

4.3.3 PoE Powered Device Service

The PoE Powered Device service provides information on the power levels for both the Powered Device and Power Supply Equipment.

4.3.3.1 PD Class Characteristic

The PD Class Characteristic reports the power level of Powered Device (Lighting Platform). The PD power level class will always be 8, which requests 70 Watts from the PSE to power both LED strings at full power.

4.3.3.1 PSE Class Characteristic

The PSE Assigned PD Class characteristic will change depending on the PoE injector. This is the device class assigned to the Lighting Platform during negotiation between injector and the PoE controller. If the assigned power level is lower than requested, additional duty cycle limits will be applied to the LED strings. Duty limits will be applied to the sum of all channel duty cycles for different PoE power level classes.

4.2.3.1   PSE PD Class Override

The *PSE PD Class Override* characteristic allows the peer device to disable the power limits described above. This feature is available when using the 2-pair 802.3at injectors that can provide more than 71 W of power. Write 1 to this characteristic to disable any power limiting or 0 to apply limits.

4.4 Importing the CMSIS-Pack

For complete information about importing the CMSIS-Pack into the ON Semiconductor IDE Installer, refer to the Bluetooth IoT Development Kit Getting Started Guide (EVBUM2589).

4.5 Sample Applications
4.5.1 Importing Sample Applications

After installing the Bluetooth IoT Development Kit CMSIS-Pack, you can access a number of sample applications in the Examples Menu shown in Figure 6.
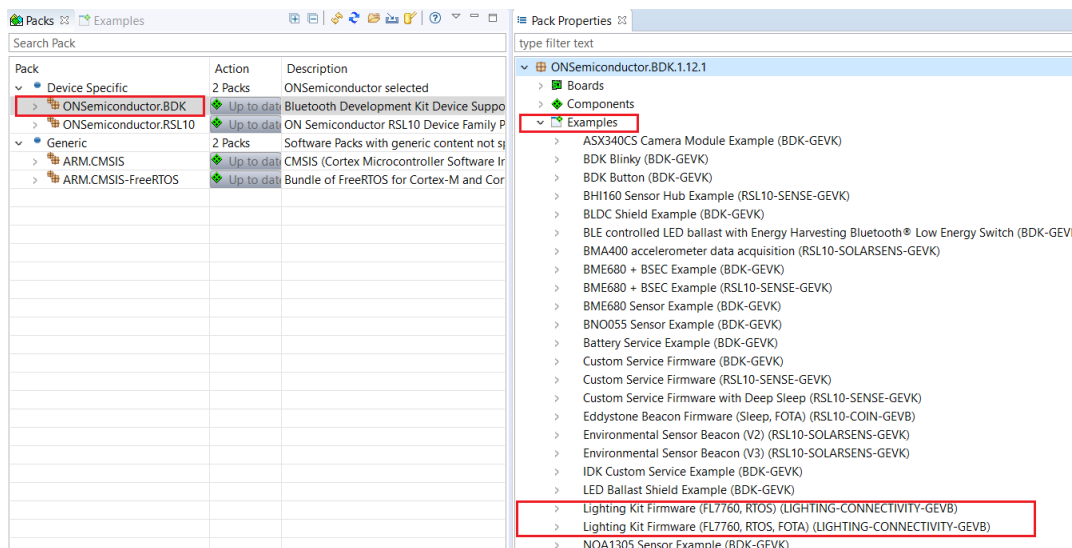

Figure 6. FreeRTOS-based Sample Applications Supported by the Lighting Platform

All applications can be imported into the IDE workspace by right clicking and selecting **Copy**.

Figure 7. Copying Sample Applications into the IDE Workspace

After copying the sample code, you can access all detailed information about the RTOS software in the provided **Readme**. The document also provides descriptions of Bluetooth Low Energy services, file structures, and special features (E.g., RTOS aware debugging).
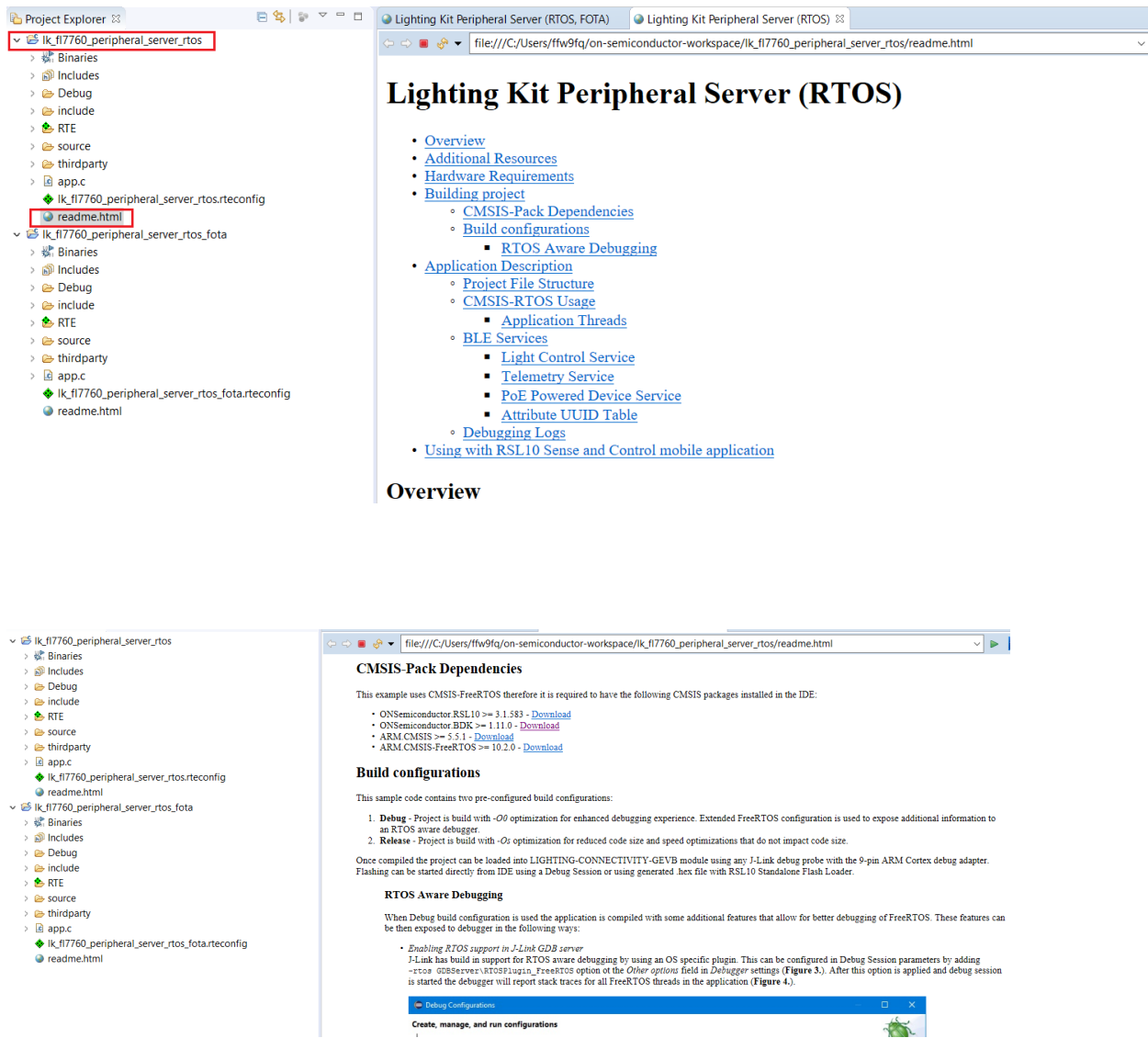

Figure 8. Lighting Platform Readme

4.5.2 Energy Harvesting Bluetooth Low Energy Switch

4.5.2.1 Overview

The brightness of the Lighting Platform can be controlled by the Energy Harvesting Bluetooth Low Energy Switch (BLE-SWITCH001-GEVB). The sample application can be loaded to the RSL10 using the IDE or through the RSL10 FOTA app. This section is intended to provide an overview of the Energy Harvesting sample application for the Connected Lighting Platform. For full information, refer to the **Readme**.
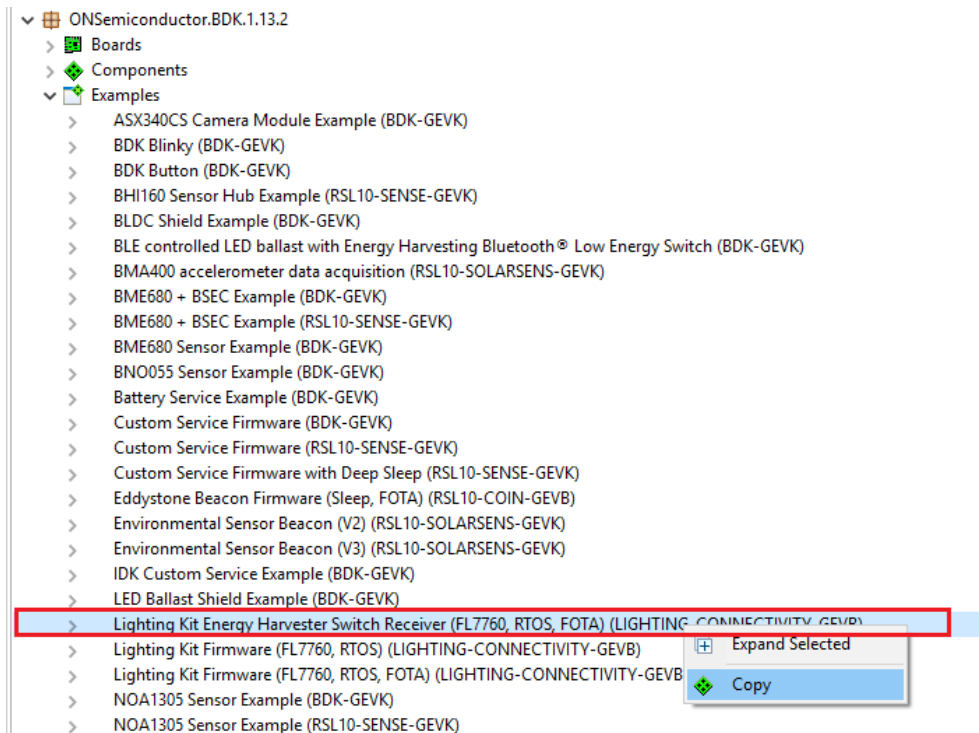

Figure 9. Energy Harvesting Switch Sample Application

After pairing the switch, the brightness can be increased by pressing and holding the switch. Once the switch is released, or a maximal value of the PWM duty cycle is achieved, the current light intensity is maintained. When the switch is pressed again while the light is on, the brightness can be decreased by pressing and holding the switch. The brightness decreasing can be stopped by releasing the switch, or by achieving the PWM duty cycle with zero value.
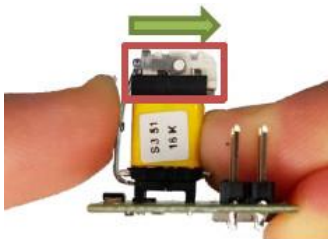
Figure 10. Pressing the Energy Harvesting Bluetooth Low Energy Switch

Note: Ensure the plastic piece on top of the yellow generator can move freely in the direction of the actuation or the switch will not work correctly.

4.5.2.2.   Pairing the Energy Harvesting Bluetooth Low Energy Switch

In order to use the switch to control the LEDs on the Lighting Platform, you will first need to pair the Switch. After the successful pairing, any paired switch- up to a maximum of 10- can be used to control the LED dimming.

To add or remove switches, the receiving system needs to be in a Pairing Mode. To enter the Pairing mode, press the PB_FOTA button on the Connectivity Module for more than 3 seconds. The button is located next to PMOD1 connector and above the PB_RST button (Figure 12.).
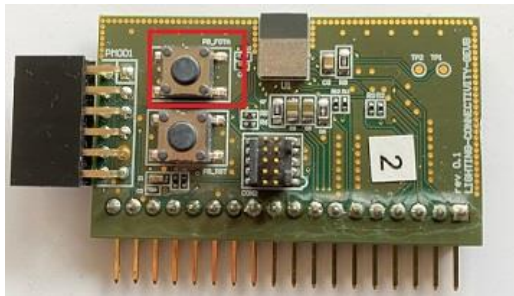

Figure 12. PB-FOTA Button on the Connectivity Module

Once the receiving system is in the Pairing Mode, the switch that should be added needs to be pressed. If the pairing was successful, the Lighting Platform can now be controlled by this switch.

4.5.2.3.   Un-pairing the Energy Harvesting Bluetooth Low Energy Switch

To clear the list of associated switches, the system needs to be in the Pairing mode. While the Pairing mode is active, press the PB_FOTA button for more than 3 seconds. Then the list of paired switches was successfully cleared.

Now all switches are un-paired and up to 10 new switches can be paired as described above.

4.5.2.4.   Exiting Pairing Mode

If you want to exit the Pairing mode without adding or removing a switch, press the PB_FOTA button for a short time (<3s). The application will then return to the Normal Mode.

5. Mobile Apps

5.1 RSL10 Sense and Control

The RSL10 Sense and Control application enables monitoring and control of various peripherals connected to RSL10-based platforms. Available on IoS and Google Play, the app allows you to set and view light intensity, step of shift and current and voltage values of the Connected Lighting Platform.

5.1.1 Using the RSL10 Sense and Control App

After downloading and opening the app, a pairing message will prompt you to connect to the Lighting Platform over Bluetooth Low Energy.

1. Display measured LED channel currents and system voltage telemetry data.
2. Independently set PWM duty
3. Cycle of each LED channel.
4. Adjust PWM duty slider behavior by rounding values with given step and enable setting of both channels at the same time with single slider.
5. When powered by PoE, display information about negotiated power limits between PoE controller and PSE.
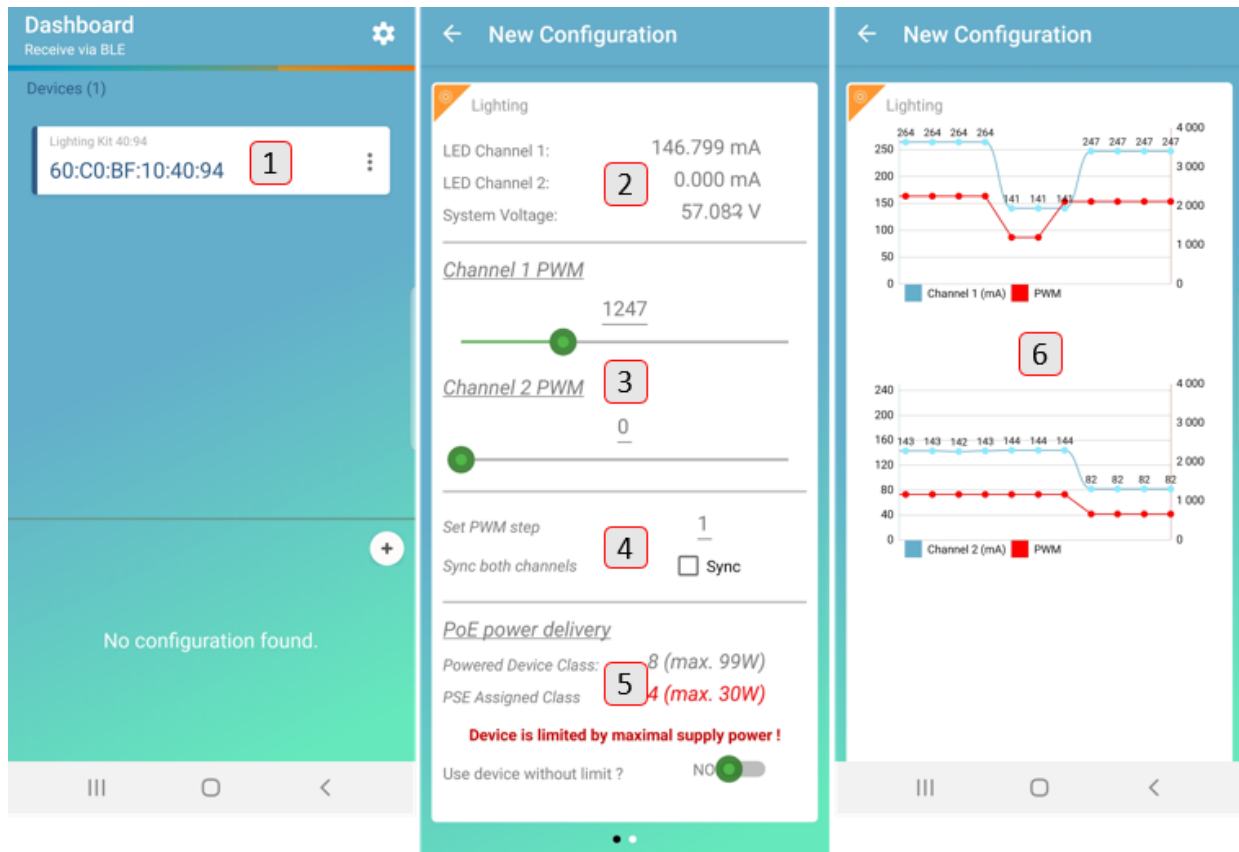6. Swipe right to show graphs with past PWM settings and LED channel currents.

Figure 13. RSL10 Sense and Control User Interface (Android™)

5.1.2   Lighting Control

The Lighting Platform features two stripes of LED with different light colors. Using the RSL10 Sense and Control app, the LEDs can be controlled individually or synchronized. There are two seek bars to adjust the PWM (light intensity) for each stripe. The Lighting Platform's PWM range is 4000 steps. The **Sync** box enables the synchronized control of the two stripes.
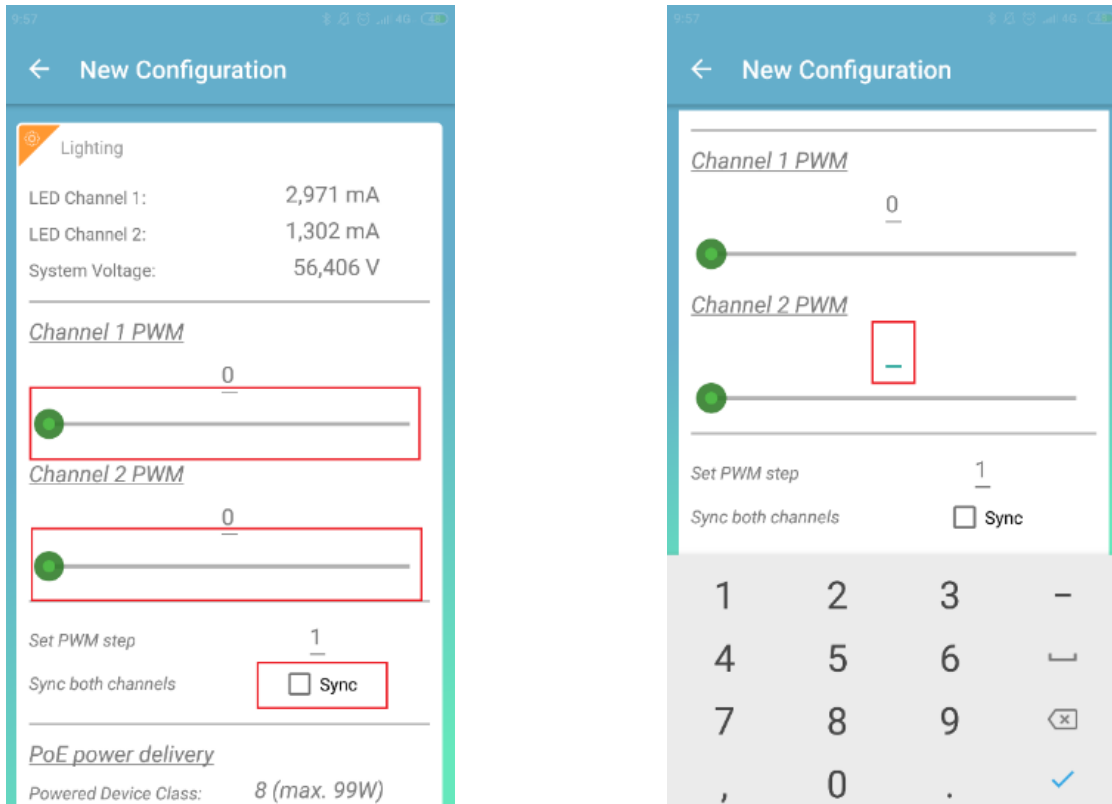

Figure 14. RSL10 Sense and Control App Panel

Another option to adjust PWM (light intensity) is to type the desired value in the window over the particular seek bar. Select the value window over the seek bar, and enter the value what you want to set. Confirm by selecting **OK**.

5.1.2.1   Setting the PWM Step

The PWM step or step of shift seek bar is value, which determines the difference between the two following steps on the progress bar. The PWM step is automatically set to 1 This can be changed by selecting the current step, and entering a new value.

5.1.2.2   Current and Voltage Values

The LED strip operating current and system voltage values are displayed at the top of the app screen. These values are updated regularly to match the current PWM (Light Intensity) setting. Currents and

PWM values are listed in plots. The first plot corresponds to the first LED channel; the bottom plot to the second LED channel.
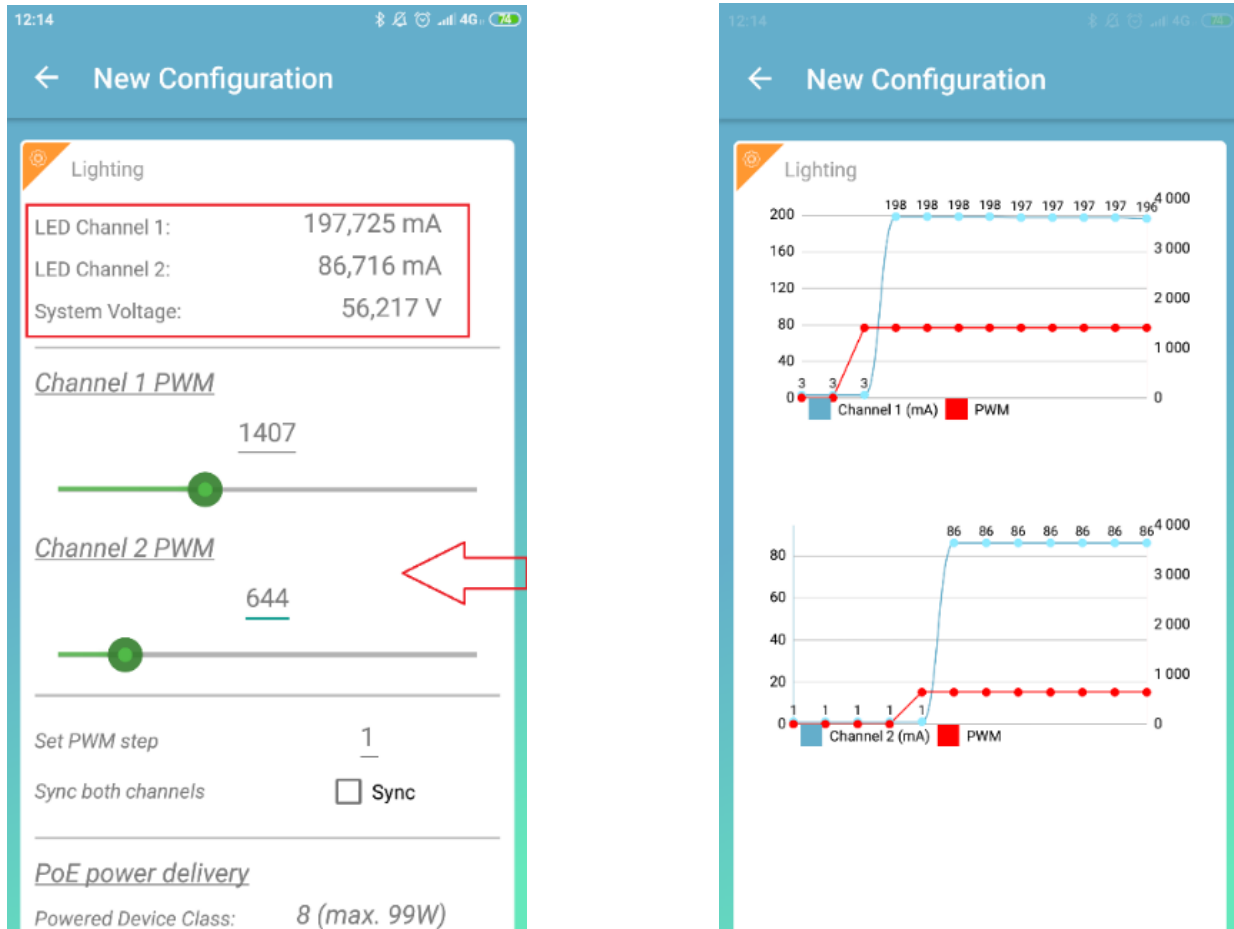

Figure 15. RSL10 Sense and Control App Telemetry Panel

5.1.3 Power Supply

5.1.3.1 AC/DC

The RSL10 Sense and Control App does not provide any limitation configuration as the AC/DC is compatible with the AC mains voltage range.

5.1.3.2 Power Over Ethernet

If powering the connected Lighting Platform via PoE, the platform detects the type of power supply and sends a notification to the mobile app. Power limits, required power class of the Powered Device (PD and Power Supply Equipment (PSE) are displayed at the bottom of the screen, as shown in **Figure 16.**

 If the power supply is of a lower class than required (Class 8, 90 W), the Lighting Platform will reduce power of light, causing the PWM range to be limited. For example, if power supply class is 4 (max. 30W), the maximum PWM range for both LED channels will be only 3600 steps. You can override this limit by switching the "Use Device without Limit" option to **Yes**.
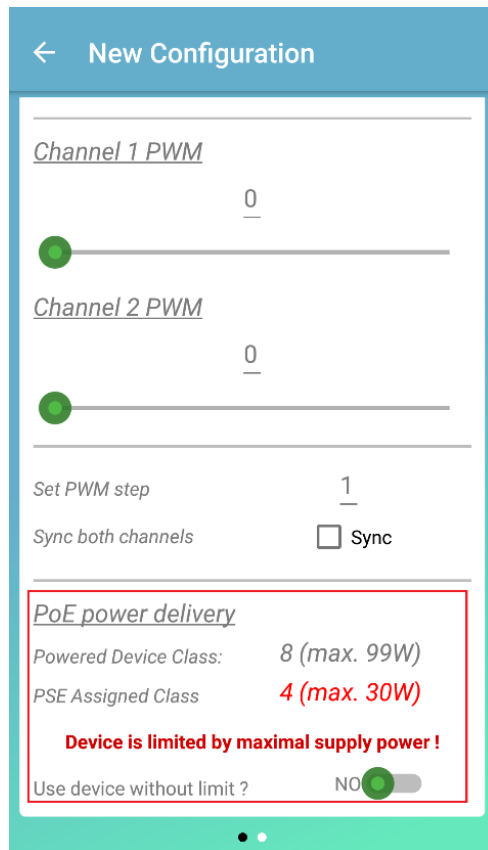

Figure 16. Power Limits Alert

5.2 RSL10 FOTA Mobile App

The RSL10 FOTA mobile app enables Firmware-Over-The-Air (FOTA) updates for the Connected Lighting Platform and other RSL10-based platforms. After downloading the RSL10 FOTA App, the firmware of the Connected Lighting Platform can be conveniently updated with a wireless connection. Firmware updates can also be sent using the RSL10 USB Dongle.

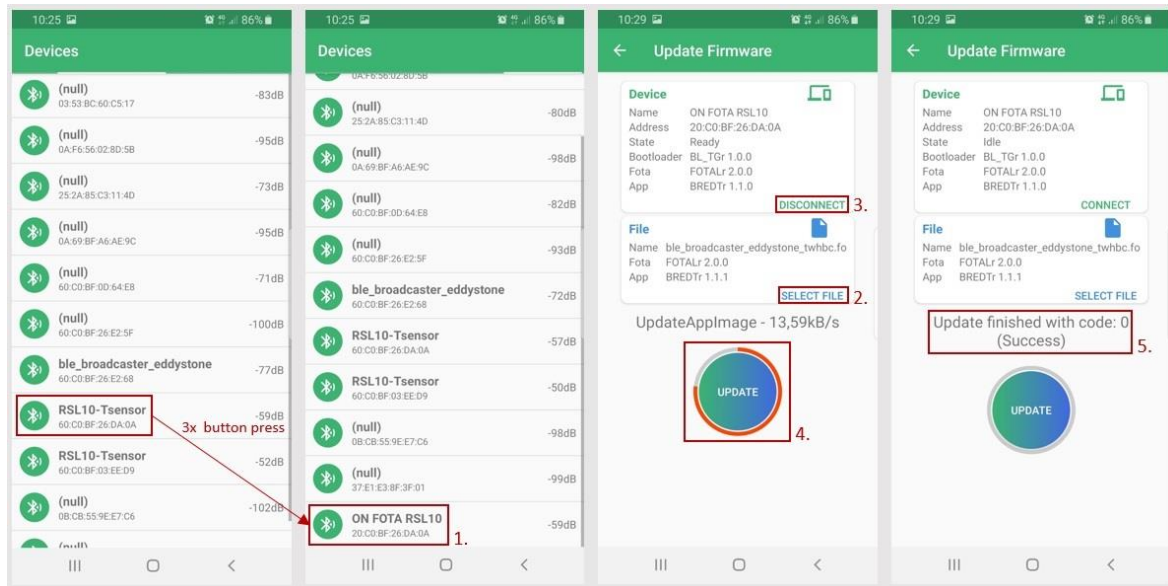### 5.2.1   Using the RSL10 FOTA Mobile App

Figure 17. Firmware Update Process using the *RSL10 FOTA* App

1. Download the Connected Lighting Platform FOTA Firmware or create your own firmware image to be deployed via FOTA.
2. Transfer the lk_fl7760_peripheral_server_rtos_fota.fota file (contained in the package) into any directory in your mobile device. Among others means, you can use a data enabled USB cable for that purpose.
3. Open the RSL10 FOTA application on your phone.
4. Switch the target board into DFU Mode by quickly pressing the button 3 times. Successful transition to DFU Mode will be indicated by the green LED on the board flashing green for 0.5 seconds.
5. Find the device you want to update in the list of scanned devices in RSL10 FOTA app.
6. (optional) Press the PB_FOTA button on the connectivity module with RSL10. The kit will then appear in the app with the name ON FOTA RSL10
7. Connect directly to the platform without pressing the button. In this case, the board will be named Lighting Kit xx:xx where xx:xx are two bytes from its MAC address.
8. Click on it to go to firmware update screen and in File section click SELECT FILE and select the copied lk_fl7760_peripheral_server_rtos_fota.fota.

9. Click on CONNECT to connect to target device. This will display the firmware version on the device and the FOTA image.
10. Click the UPDATE button to start the DFU process and wait until completion once the SUCCESS message will pop up on the App.

Note: Connected Lighting Platform hardware with LOT:SK19450001 will not support FOTA off-the-shelf. In order to enable the functionality, the suitable firmware needs to be flashed as described in two Sample Applications (Section 4.5) of the CMSIS-Pack.

- Lighting Kit Energy Harvester Switch Receiver (FL7760, RTOS, FOTA)
- Lighting kit firmware (FL7760, RTOS, FOTA)

5.2.2 FOTA Updates using RSL10 USB Dongle

Firmware Over the Air updates can also be sent to target devices using the RSL10 USB Dongle. In addition to the RSL10 USB Dongle, you will need to install the RSL10 USB Dongle BLE Explorer file and the **Fota.console.exe** utility from the *RSL10 Software Utility Apps* package. More details can be provided in the Readme file of the Connected Lighting Platform CMSIS Pack.

1. Build project
2. Copy generated lk_fl7760_peripheral_server_rtos_fota.fota file into the directory where you unpacked the FOTA PC Application.
3. Connect RSL10 USB Dongle to PC and use the *RSL10 Bluetooth Low Energy Explorer* application to find you COM port number of the USB dongle. The Explorer can also be used to verify functionality of the dongle by scanning for BLE devices. Close the app afterwards.
4. Open terminal in the folder with Fota.Console.exe and the Fota image.
5. Enter the following command with replaced COM port number:

Fota.Console.exe /COM=COM14 /IN=lk_fl7760_peripheral_server_rtos_fota.fota

The dongle will immediately start scanning for a device called ON FOTA RSL10.

Alternatively, the device can be updated without switching to DFU mode using the push button on the dongle. In this case, an additional command line parameter specifying the name or address of target board has to be provided on the command line. The Fota.Console.exe /HELP command can be used to list all options. Fota.Console.exe /COM=COM14 /IN=lk_fl7760_peripheral_server_rtos_fota.fota /ADDR=60:C0:12:34:56

6. Press the PB_FOTA button on the target board to switch to DFU mode. The update process will start automatically as soon as the console application scans the board in DFU mode.
7. Wait for update to finish.

Figure 19. FOTA Updates using the the FOTA PC Application and RSL10 USB Dongle