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CYALKIT-E02

Solar-Powered BLE Sensor Beacon Reference Design Kit Guide

Doc. No. 002-11317 Rev. *B

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Safety Information

Regulatory Compliance

The CYALKIT-E02 Solar-Powered Bluetooth Low Energy (BLE) Sensor Beacon Reference Design Kit (RDK) is intended for use as a development platform for hardware or software in a laboratory environment. The board is an open system design, which does not include a shielded enclosure. This may cause interference with other electrical or electronic devices in close proximity. In a domestic environment, this product may cause radio interference. In this case, the user may be required to take adequate preventive measures. Also, the board should not be used near any medical equipment or RF devices.

Attaching additional wiring to this product or modifying the product operation from the factory default may affect its performance and cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures should be taken.

The CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK as shipped from the factory has been verified to meet the requirements of CE as a Class A product.

The CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK contains electrostatic discharge (ESD) sensitive devices. Electrostatic charges readily accumulate on the human body and any equipment and can discharge without detection. Permanent damage may occur to devices subjected to high-energy discharges. Proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Store unused CYALKIT-E02 boards in the protective shipping package.

End of Life/Product Recycling

The end of life of this kit is five years after the date of manufacture mentioned on the back of the box. Contact your nearest recycler to discard the kit.

General Safety Instructions

ESD Protection

ESD can damage boards and their associated components. Cypress recommends that you perform procedures only at an ESD workstation. If one is not available, use appropriate ESD protection by wearing an antistatic wrist strap attached to chassis ground (any unpainted metal surface) on your board when handling parts.

Handling Boards

CYALKIT-E02 boards are sensitive to ESD. Hold the board only by its edges. After removing the board from its box, place it on a grounded, static-free surface. Use a conductive foam pad, if available. Do not slide the board over any surface.

1. Introduction

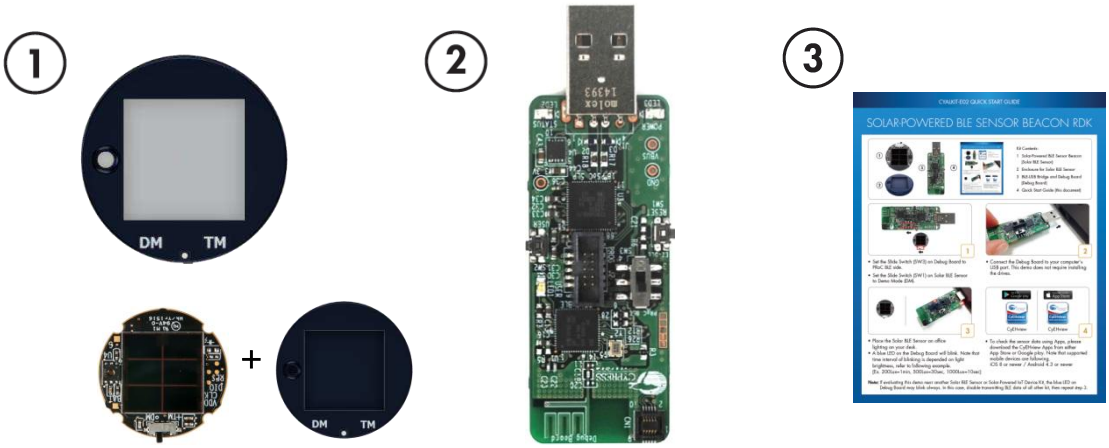
Thank you for your interest in the CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK. The Solar-Powered BLE Sensor Beacon RDK provides an easy-to-use platform for the development of a tiny solar-powered IoT device with BLE wireless connectivity. The RDK consists of a Solar BLE Sensor and a Debug Board. The Solar BLE Sensor is based on Cypress's energy harvesting power management IC (PMIC) S6AE103A and EZ-BLE products. The objective of this RDK is to provide a fully functional battery-less wireless sensor node (WSN). The Solar BLE Sensor will be enclosed in a casing to automatically transmit temperature and humidity sensor data in an office lighting environment. The Debug Board is based on Cypress's PRoC™ BLE and PSoC® 5LP products. It can be connected to a host (PC) that supports the Debug Board and on-chip debugging via a USB interface.

This kit guide explains how to set up and use the RDK. Be sure to read it before using the product. For questions, please consult with sales or support representatives.

Note: All information included in this document is current as of the date it was issued. Such information is subject to change without any prior notice. Please confirm the latest relevant information with the sales representative.

1.1 Kit Introduction

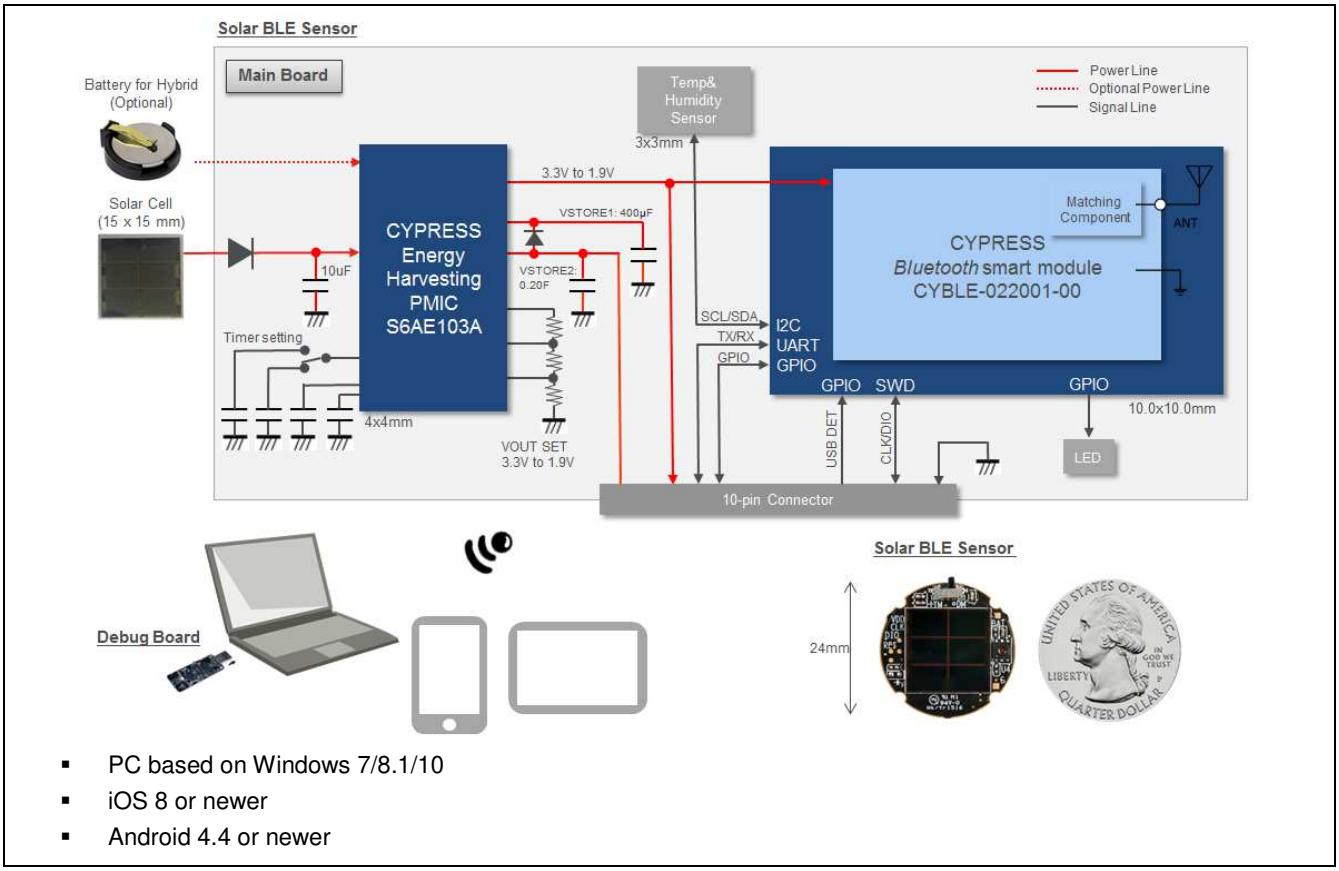
Figure 1-1. Kit Contents



1. Solar-Powered BLE Sensor Beacon (Solar BLE Sensor)
   - Board + Enclosure
2. BLE-USB Bridge and Debug Board (Debug Board)
3. Quick Start Guide

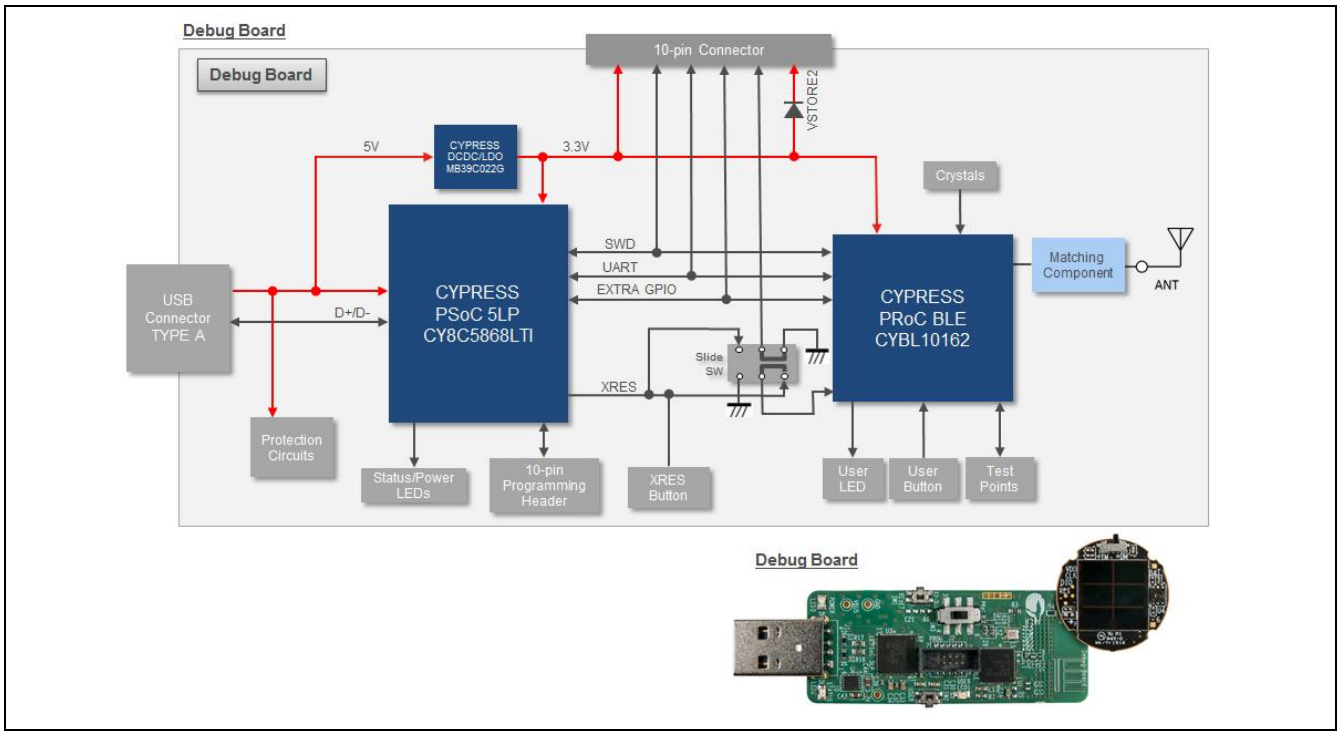
1.2 Block Diagrams

Figure 1-2. Block Diagram of Solar BLE Sensor



- PC based on Windows 7/8.1/10
- iOS 8 or newer
- Android 4.4 or newer

Figure 1-3. Block Diagram of Debug Board



1.3 Features

The Solar-Powered BLE Sensor Beacon RDK provides everything needed to develop a light-powered sensor node that transmits sensor data using Bluetooth Low Energy (BLE):

- Tiny solar-powered BLE sensor board (circle with 24-mm diameter, same size as a 25-cent coin)
- Operates using light energy harvested (>100 lux) by the included solar cell
- Supports BLE communication with a PC through the provided Debug Board that is preprogrammed with custom firmware for this kit
- Supports BLE communication with a mobile device (iOS 8 or newer / Android 4.4 or newer)
- Includes firmware that supports a BLE Beacon transmission with temperature and humidity data
- Energy harvesting PMIC S6AE103A that supports the following applications:
  - Demo mode, transmitting sensor data at 3- to 60-second intervals (without charging to a supercapacitor)
  - Timer mode, transmitting sensor data at 5-minute intervals while charging to the supercapacitor
  - Transmitting data at over 30 hours without ambient light (when mode is set to Timer mode and supercapacitor is fully charged)
- Solar BLE Sensor that can support the following:
  - Selection of mode using a slide switch (Demo or Timer mode)
  - Programming and debugging of the EZ-BLE module via the Debug Board
  - Parameter setting of the BLE Beacon via the Debug Board
  - Charging of surplus solar energy to a 0.2-F supercapacitor (Timer mode)
  - Charging of the supercapacitor via the Debug Board using USB bus power
  - Temperature and humidity digital sensor

- Expandable interface via 10-pin connector (GPIO)
- Test pads for power, ground, primary battery input, and SWD interface for programming

- Debug board that can support the following:
  - Debug board for receiving BLE data
  - Selecting the programming mode using a slide switch (EZ-BLE on Solar BLE Sensor or PRoC BLE on Debug Board)
  - Connector for Solar BLE Sensor (power, SWD, UART, USB detect, charging supercapacitor, and GPIO)
  - Connector for programming PSoC 5LP (KitProg)
  - Parameter setting of Solar BLE Sensor via USB-to-UART bridge on KitProg
  - Reset button for EZ-BLE and PRoC BLE
  - User button for PRoC BLE
  - LEDs for User, Status and USB power
  - Test pads for power, ground and expandable GPIO
- Includes reference schematic, BOM list, layout, and sample firmware for easy design
- Uses the following Cypress devices:
  - S6AE103A ultra-low-power energy harvesting PMIC
  - CYBLE-022001-00 EZ-BLE PRoC module
  - CYBL10162-56L PRoC BLE IC
  - CY8C5868L PSoC 5LP for KitProg
  - MB39C022G LDO

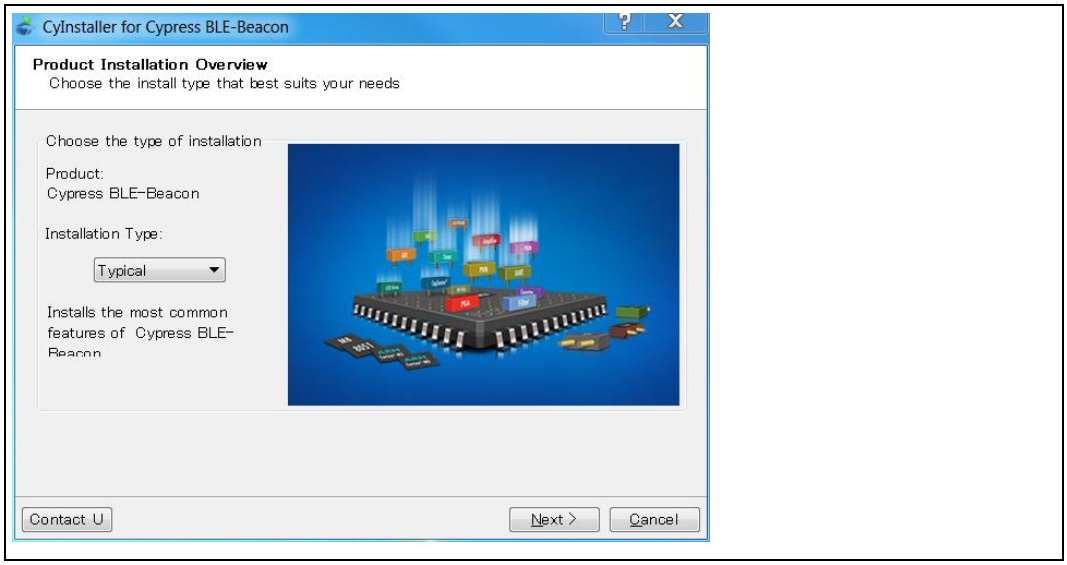
2. Software Installation

This section describes how to install the software.

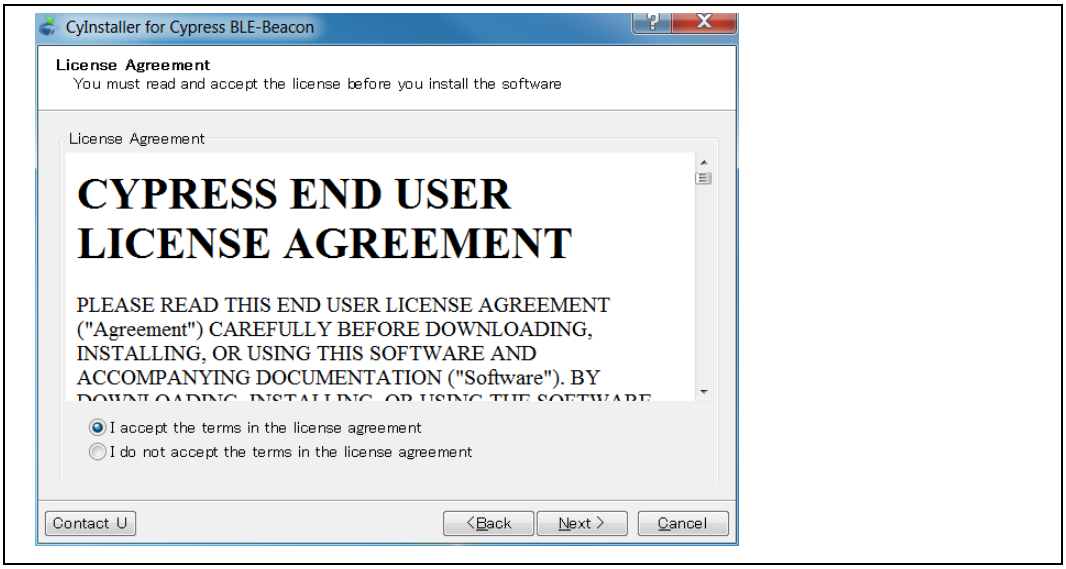
2.1 Install Cypress BLE-Beacon Software

Follow these steps to install the Cypress BLE-Beacon software:

1. Download and install the Cypress BLE-Beacon software from www.cypress.com/CypressBLE-Beacon-PC. The software is available in two different formats for download:
   - Cypress® BLE-Beacon™ PC: This executable file installs only the software contents, which include software files, and user documents. This package can be used if all the software prerequisites are installed on your computer.
   - Cypress® BLE-Beacon™ PC ISO (Create CD): This file is a complete package, stored in a CD-ROM image format that can be used to create a CD, or extract using ISO extraction programs, such as WinZip or WinRAR. This file includes all the required software and user documents.
2. Run Install Cypress BLE-Beacon to start the installation, as shown below.
3. Select the folder to install the Cypress BLE-Beacon–related files. Choose the directory and click **Next**.
4. The Cypress BLE-Beacon installer automatically installs the required software, if it is not present on your computer. The Setup installer directs you to download the required software from the Internet.
5. Choose the **Typical**/**Custom**/**Complete** installation type in the **Product Installation Overview** window. Click **Next** after you select the installation type.



6. Read the **Cypress End User License Agreement** and make a selection based on the terms of the license agreement. Click **Next** to continue the installation.



7. When the installation begins, a list of packages appears on the installation page. A green check mark appears next to each package after successful installation.
8. Click **Finish** to complete the Cypress BLE-Beacon installation.
9. Enter your contact information or select the **Continue Without Contact Information** check box. Click **Finish** to complete the Cypress BLE-Beacon installation.
10. After the installation is complete, the kit contents are available at the following location:

    <Install directory>\Cypress BLE-Beacon

    Default location (Example: Windows 7)

    - 64-bit: C:\Program Files (x86)\Cypress\Cypress BLE-Beacon
    - 32-bit: C:\Program Files\Cypress\Cypress BLE-Beacon

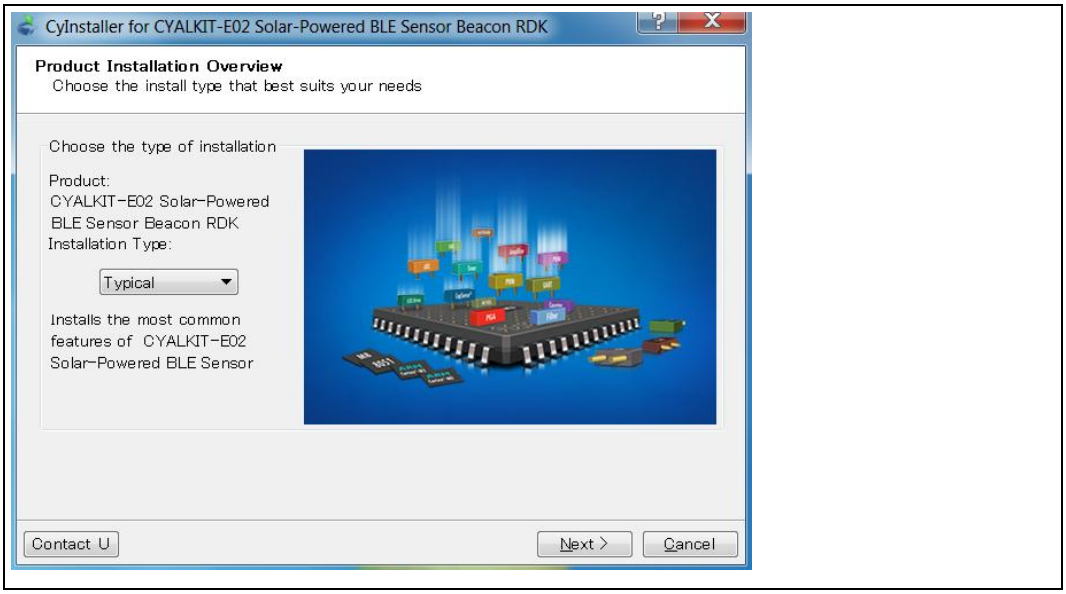
2.2 Install RDK Software

Follow these steps to install the CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK software:

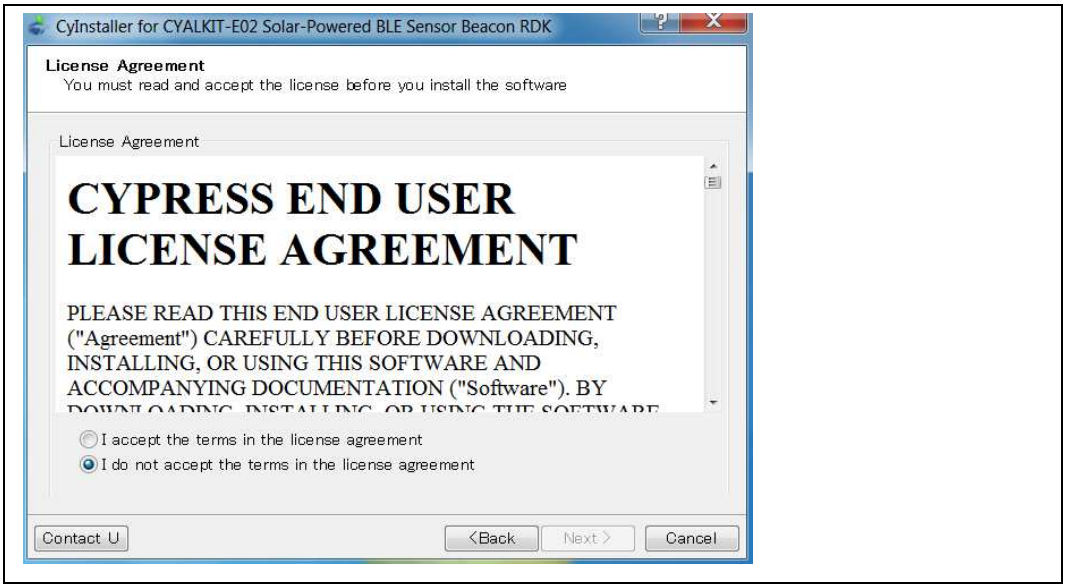
1. Download and install the CYALKIT-E02 software from www.cypress.com/CYALKIT-E02. The CYALKIT-E02 software is available in three different formats for download:

    - CYALKIT-E02 Complete Setup: This installation package contains the files related to the kit. However, it does not include the Windows Installer or Microsoft .NET framework packages. If these packages are not on your computer, the installer directs you to download and install them from the Internet.
    - CYALKIT-E02 Only Package: This executable file installs only the kit contents, which include code examples, hardware files, and user documents. This package can be used if all the software prerequisites are installed on your computer.
    - CYALKIT-E02 CD ISO: This file is a complete package, stored in a CD-ROM image format that can be used to create a CD, or extract using ISO extraction programs, such as WinZip or WinRAR. This file includes all the required software, utilities, drivers, hardware files, and user documents.

2. Run Install CYALKIT-E02 to start the installation, as shown below.
3. Select the folder to install the CYALKIT-E02-related files. Choose the directory and click **Next**.
4. The CYALKIT-E02 installer automatically installs the required software if it is not present on your computer. The CYALKIT-E02 Setup installer directs you to download the required software from the Internet.
5. Choose the **Typical**/**Custom**/**Complete** installation type in the **Product Installation Overview** window. Click **Next** after you select the installation type.



6. Read the **Cypress End User License Agreement** and make a selection based on the terms of the license agreement. Click **Next** to continue the installation.



7. When the installation begins, a list of packages appears on the installation page. A green check mark appears next to each package after successful installation.
8. Click **Finish** to complete the CYALKIT-E02 installation.
9. Enter your contact information or select the **Continue Without Contact Information** check box. Click **Finish** to complete the CYALKIT-E02 installation.
10. After the installation is complete, the kit contents are available at the following location:
    <Install directory>\CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK
    Default location (Example: Windows 7)
    - 64-bit: C:\Program Files (x86)\Cypress\CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK
    - 32-bit: C:\Program Files\Cypress\CYALKIT-E02 Solar-Powered BLE Sensor Beacon RDK

2.3 Uninstall Software

You can uninstall the Solar-Powered BLE Sensor Beacon RDK software and Cypress BLE-Beacon software using one of the following methods:

Example: Windows 7

- Go to Start > All Programs > Cypress > Cypress Update Manager; click the Uninstall button.
- Go to Start > Control Panel > Programs and Features. Select the Solar-Powered BLE Sensor Beacon RDK program from the list and click the Uninstall/Change button.

2.4 PSoC Creator™

PSoC Creator is a state-of-the-art, easy-to-use integrated design environment (IDE). It is a revolutionary hardware and software co-design environment, powered by a library of preverified and precharacterized PSoC Components. With PSoC Creator, you can:

- Drag and drop PSoC Components to build a schematic of your custom design
- Automatically place and route Components and configure GPIOs
- Develop and debug firmware using the included Component APIs

PSoC Creator also enables you to tap into an entire tool ecosystem with integrated compiler chains and production programmers for PSoC devices.

To develop firmware for the Solar-Powered BLE Sensor Beacon RDK, you must have PSoC Creator 3.3 SP2 or newer. Download the latest version from www.cypress.com/psoccreator.

For sample firmware information for this kit, refer to section Firmware Description.

3. Getting Started

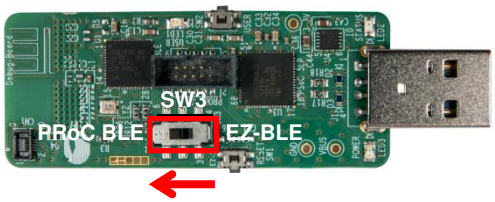
In this chapter, you will become familiar with the Solar-Powered BLE Sensor Beacon RDK by successfully establishing a BLE sensor beacon connection between the Solar BLE Sensor operating as a wireless sensor network (WSN), a PC with the Debug Board, and a mobile device with apps. This will also confirm that the Solar BLE Sensor, the Debug Board, your PC, and your mobile device are operating properly.

3.1 WSN Operation with PC

In this section, you will confirm that the Solar BLE Sensor is operating as a WSN by using the software provided on your PC to detect temperature and humidity changes.

3.1.1 USB Driver Installation of Debug Board

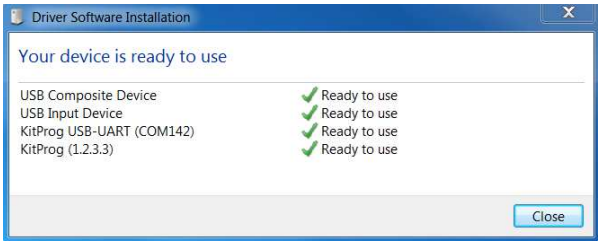
1. Set the slide switch (SW3) on the Debug Board to the PRoC BLE side. Refer to Slide Switch for Target Device Select for detailed information on each mode.



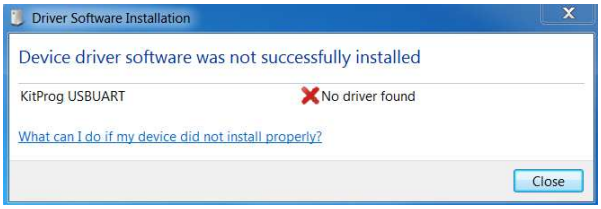
2. Plug the Debug Board into your computer's USB port.

3. The driver Installation starts automatically and the following message window will appear. Click the message window for the status.

4. Confirm that the device driver installation has successfully completed (all components are “Ready to use”). If the installation fails, do the installation manually using a file in the “USB drivers” folder. Refer to 3.1.2 USB Driver Installation Failed.



Completed
(Go to step 5)



Failed

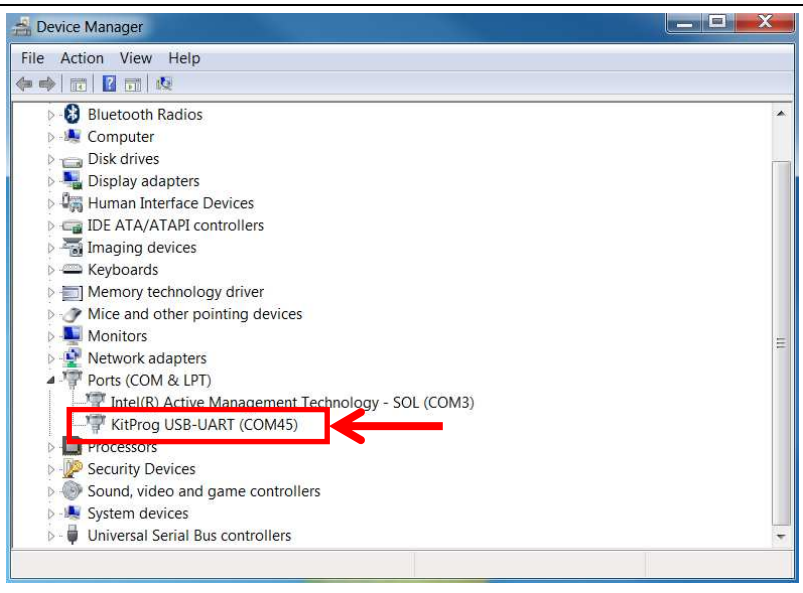
(Refer to USB Driver Installation Failed)

5. After successful device driver installation, confirm that a new COM port called “KitProg USB-UART” was added:

   Open the Device Manager:

   - Windows 7: **Start** > **Control Panel** > **Device Manager**
   - Windows 8/8.1/10: Right-click the Start button and select **Device Manager**.

   B. Under **Ports (COM & LPT),** confirm that a COM port called “KitProg USB-UART” was added. Note the COM number (COMxx).

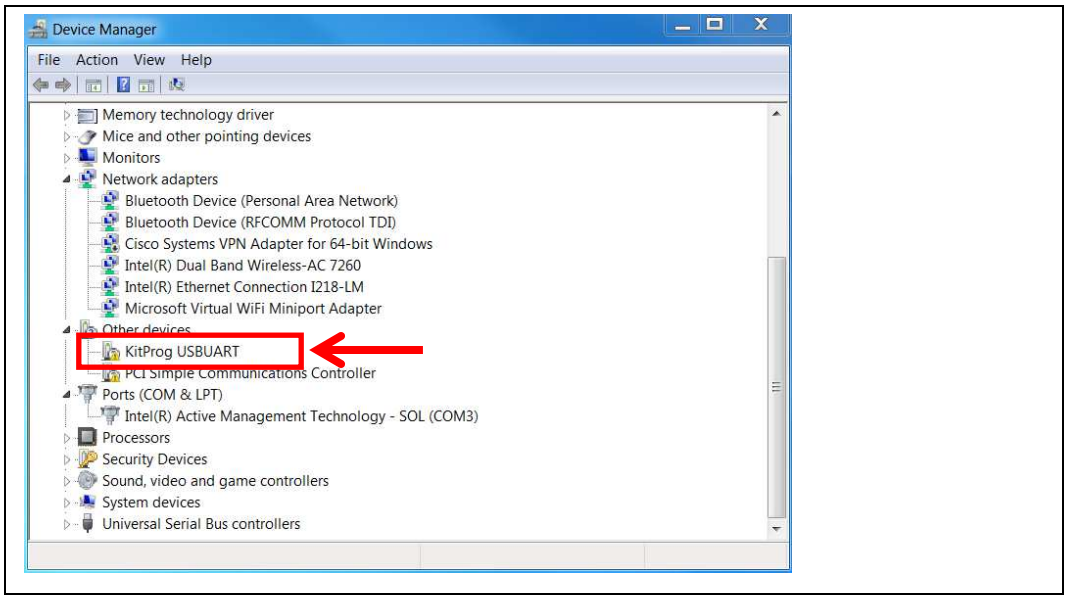


6. Continue as described in 3.1.3 Establishing BLE Connection.

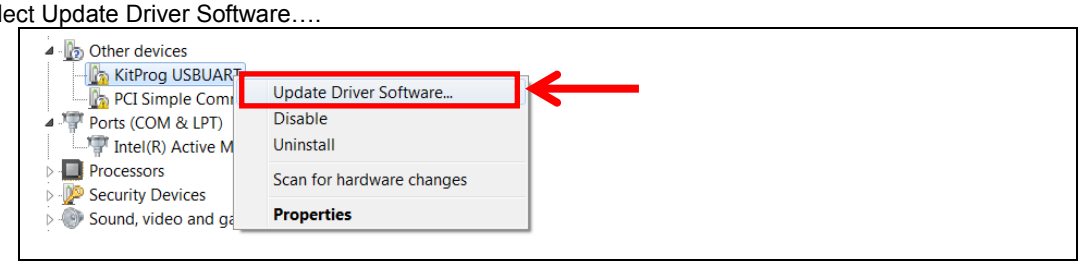
3.1.2 USB Driver Installation Failed

If the device driver installation fails, confirm that an unconfigured KitProg USB-UART appears in the **Device Manager**:

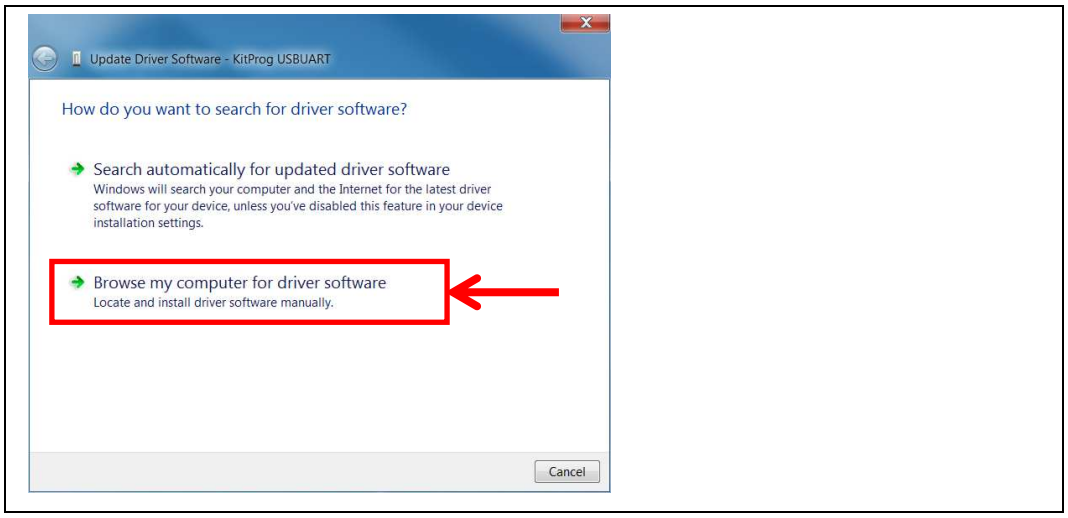
1. Open the **Device Manager**:
   - Windows 7: Start > Control Panel > Device Manager
   - Windows 8/8.1/10: Right-click the Start button and select Device Manager.
2. Under **Other devices**, confirm that KitProg USB-UART appears with no associated COM port.



3. Update the USB driver software or the unconfigured “KitProg USB-UART.”
   A. Click the right mouse button on “KitProg USB-UART.”
   B. Select Update Driver Software….



4. Select **Browse my computer for driver software**.



5. Search for the USB driver in the PSoC Programmer folder.

   Default location (Example: Windows 7)

   - 64-bit: *C:\Program Files (x86)\Cypress\Programmer\drivers*
   - 32-bit: *C:\Program Files\Cypress\Programmer\drivers*

   If there is no folder for PSoC Programmer, please download and install it from PSoC Programmer page. The recommend version is 3.24 or later.

   A. Select the **Include subfolders** box.

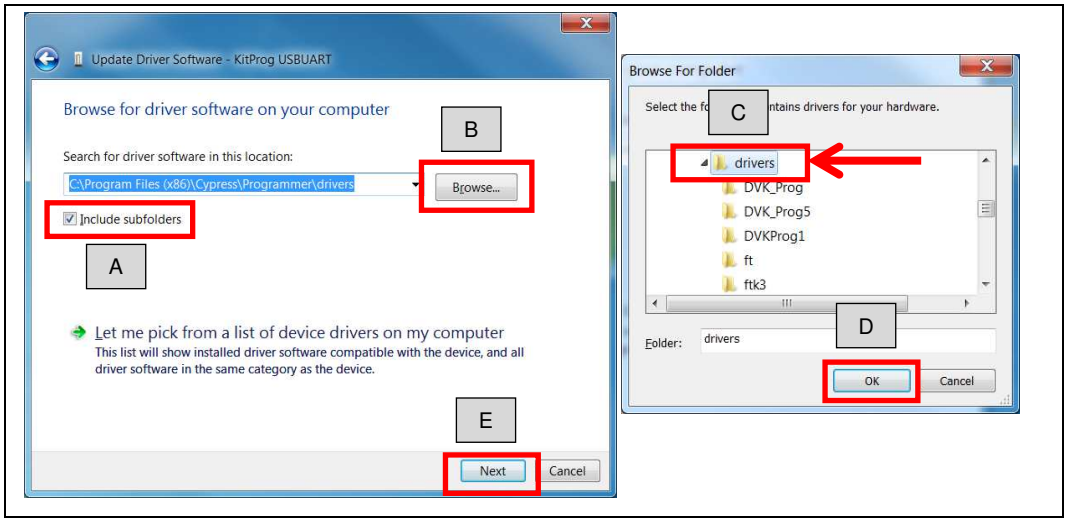
   B. Click the **Browse…** button.

   C. Select the "drivers" folder of PSoC Programmer:

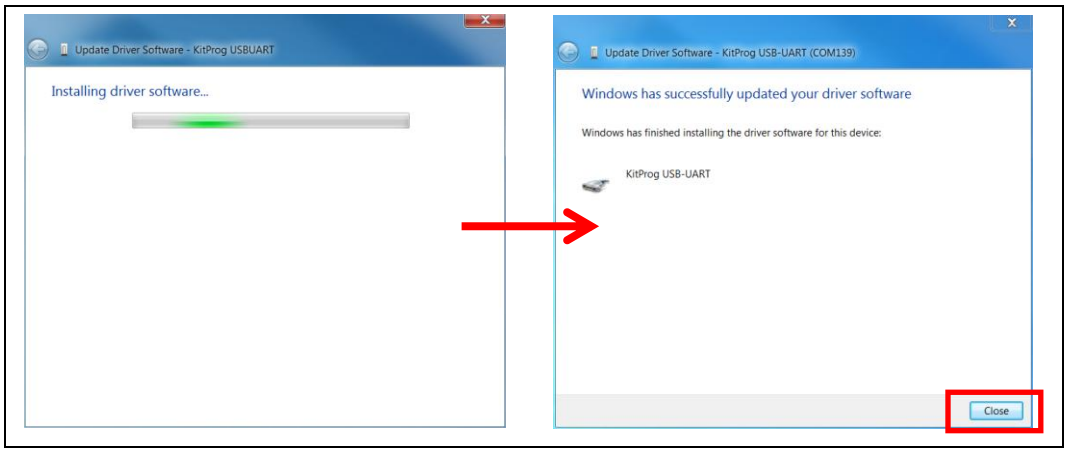
      <Install directory>\Programmer\drivers

   D. Click the **OK** button.

   E. Click the **Next** button.



6. Start installing the USB driver. Click the **Close** button when the KitProg USB-UART driver installation finishes.

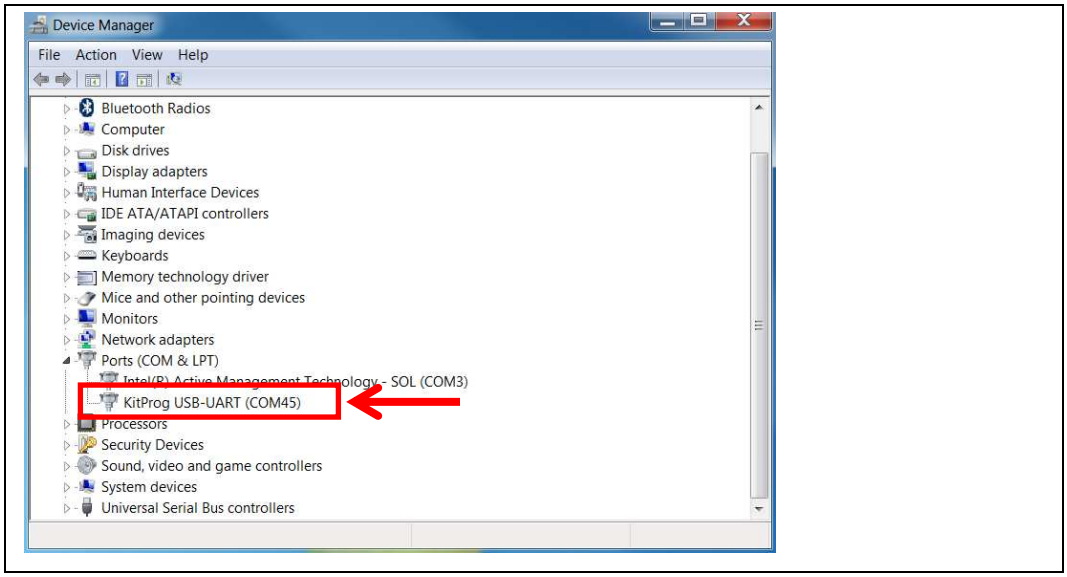


7. After successful device driver installation, confirm that a new COM port called “KitProg USB-UART” was added:

   A. Open the **Device Manager**.

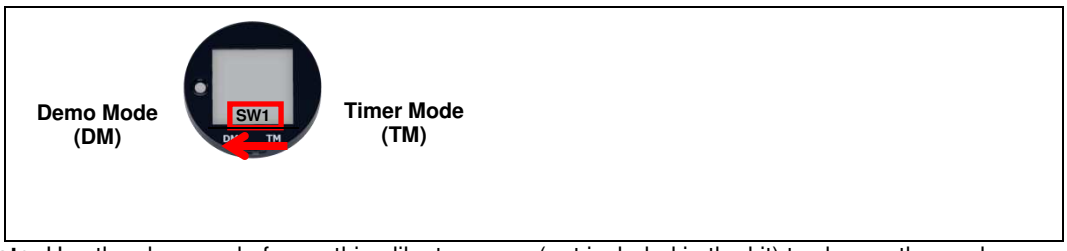
   B. Under **Ports (COM & LPT),** confirm that a COM port called “KitProg USB-UART” was added.

   Note the COM number (COMxx).



3.1.3 Establishing BLE Connection

1. Set the slide switch (SW1) on the Solar BLE Sensor to Demo mode (DM). Refer to 5.1.4.1 Waveform of Demo Mode and Timer Mode for detailed information on each mode.



Note: Use the sharp end of something like tweezers (not included in the kit) to change the mode.

2. Place the Solar BLE Sensor under an office light. The firmware to operate the Solar BLE Sensor as a BLE sensor beacon is preloaded from the factory. After placing the Solar BLE Sensor under a suitable light (refer to Table 3-1. Light Level Versus Time Interval), it will automatically power up and begin transmitting.

Table 3-1. Light Level Versus Time Interval

Typical Light Level	Environment	Time Interval of Sensor[1]
~1 lx	Moonlight	Does not work
100 lx~200 lx	Under street lighting	50 s ~
200 lx~400 lx	At museum	30 s ~ 50 s
400 lx~500 lx	Office lighting	15 s ~ 30 s
1000 lx ~	Shopping mall, rainy day	3 s ~ 15 s

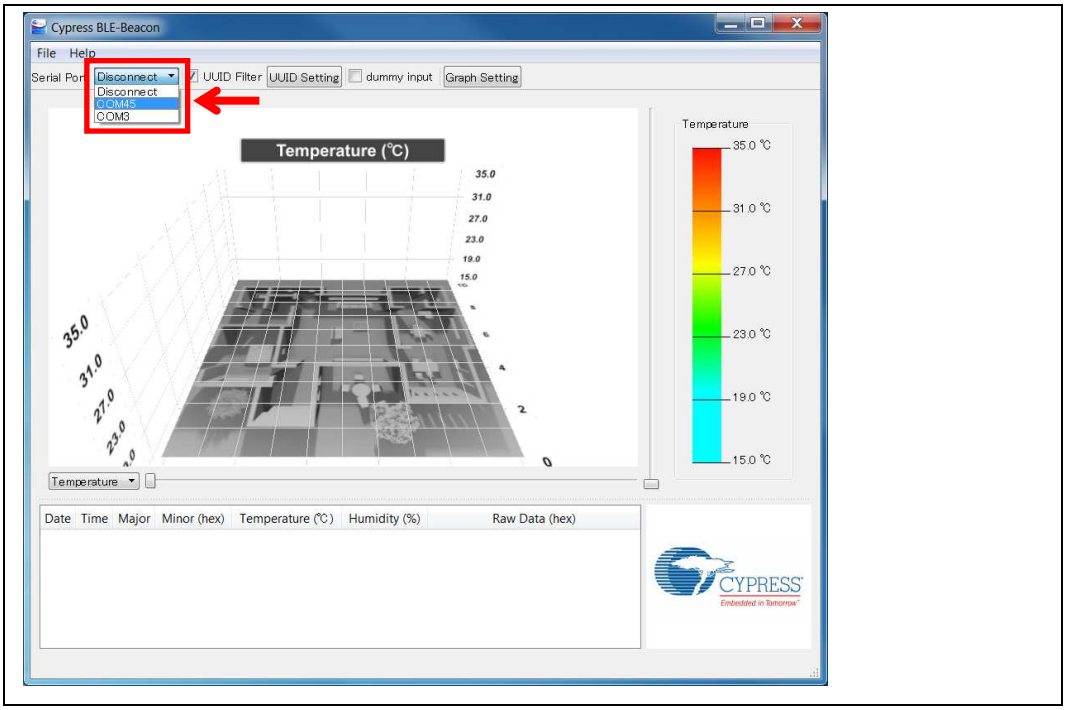
[1]The time interval of the sensor is three seconds in all light levels when the supercapacitor on the Solar BLE Sensor is fully charged.

3. Plug the Debug Board into your computer's USB port.

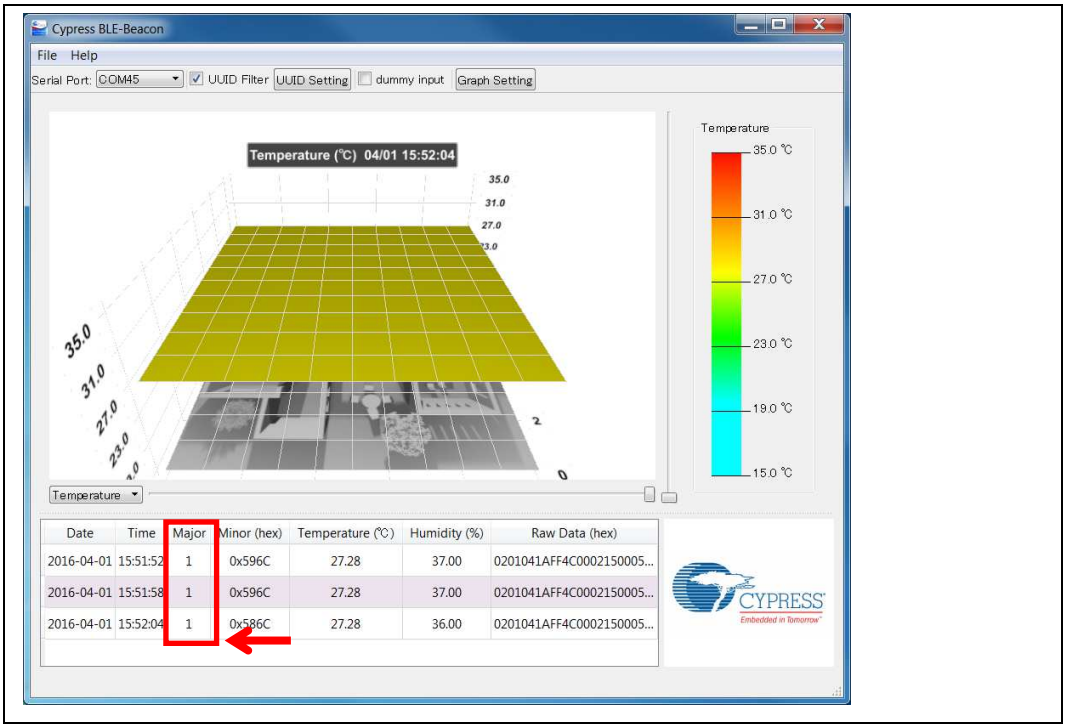
4. Run *CypressBLE-Beacon.exe*, which is in the Windows application used to view the data received from the Solar BLE Sensor. It is located in the Software folder that you installed earlier:

   <Install directory>\Cypress BLE-Beacon\EXE

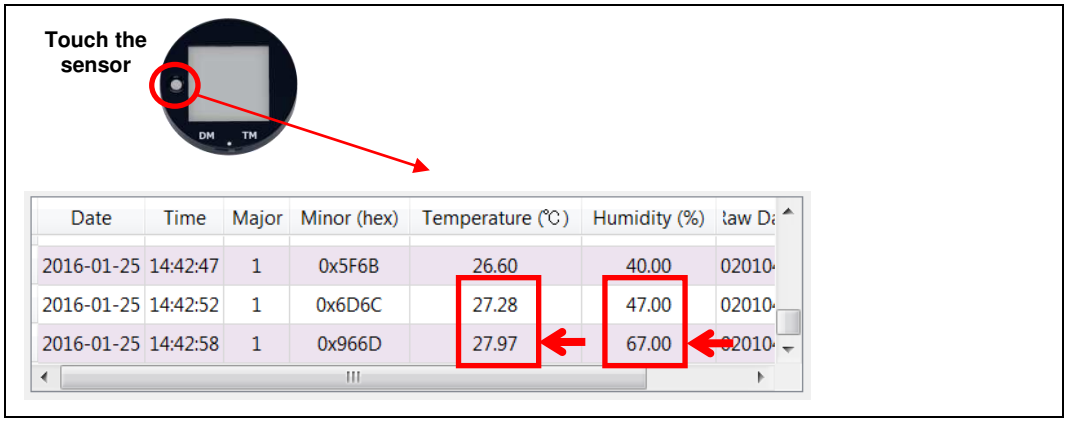
   A Cypress BLE-Beacon window will appear. Select COMxx in the **Serial Port** drop-down menu, where COMxx corresponds to the port that was confirmed in step 5 of 3.1.1 USB Driver Installation of Debug Board.



5. Find the **Major** number (initial value is 0x0001) of the Solar BLE Sensor in the Cypress BLE-Beacon software. Refer to 3.3 Configuring Solar BLE Sensor to change the **Major** number.



6. Confirm that the WSN is operating by placing your finger on the sensor on the Solar BLE Sensor. Placing your finger raises the temperature and humidity from the indoor environment condition. You should see a corresponding change in temperature or humidity on your PC. When touching the board, be careful of static electricity.



Refer to Cypress BLE-Beacon PC User Guide for detailed information.

3.2 WSN Operation with Mobile Device

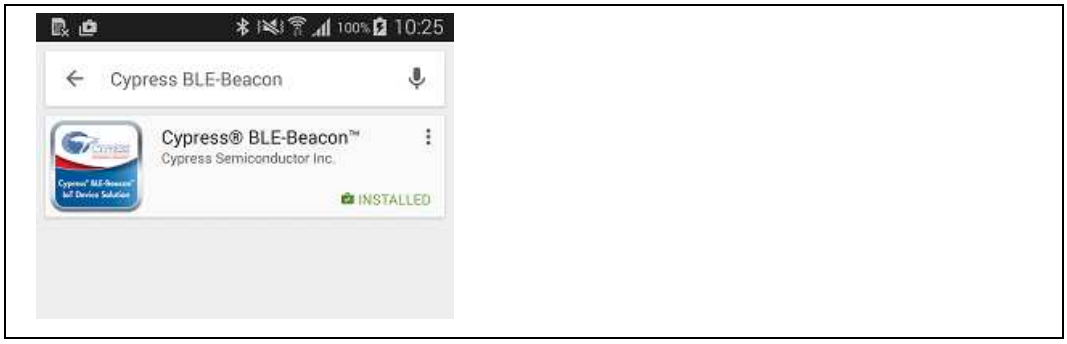
In this section, you will confirm that the Solar BLE Sensor is operating as a WSN by using the apps on your mobile device to detect temperature and humidity changes.

3.2.1 Mobile Apps Installation

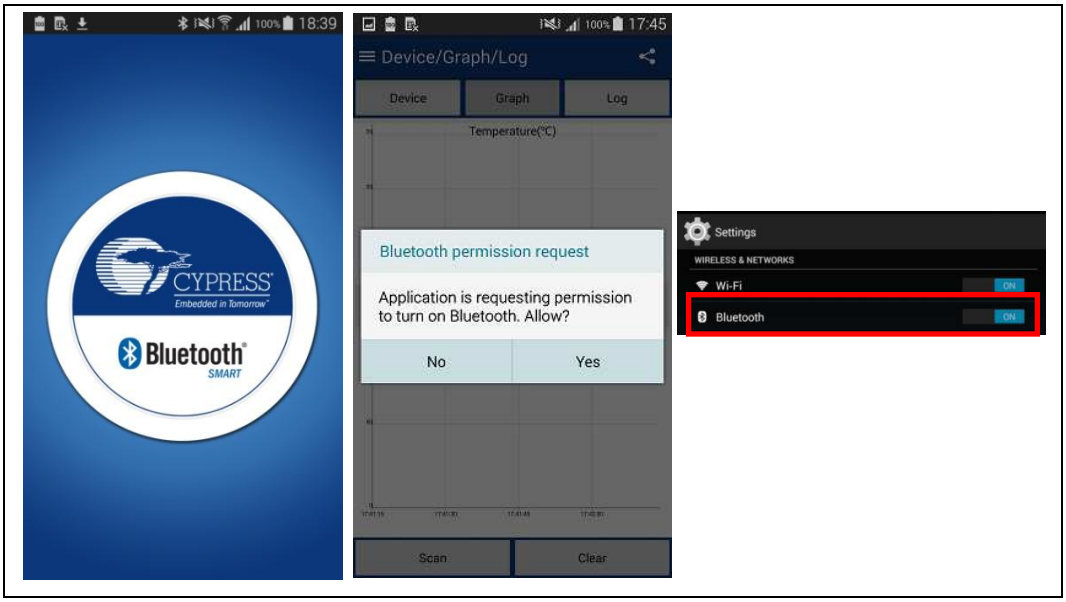
The Cypress BLE-Beacon app is available on Google Play and in the Apple Store for free. To install the app, follow these instructions.

3.2.1.1 Installing the Android App

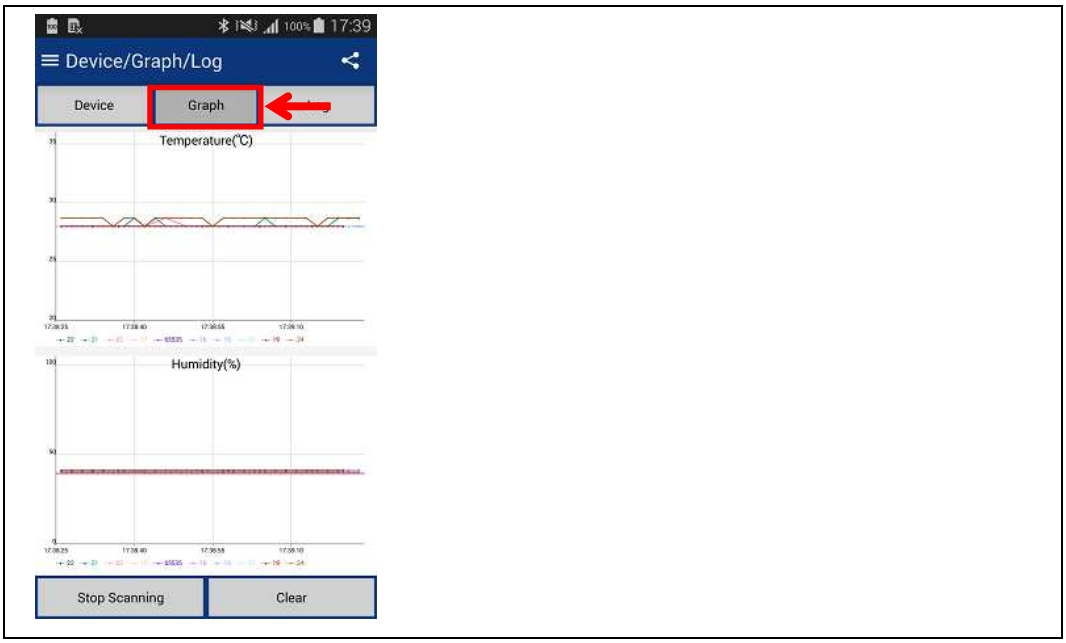
1. Open Google Play and search for “Cypress BLE-Beacon”.



2. Select the Cypress BLE-Beacon (BLE-Beacon) app. On the subsequent screen, click the **Install** button to proceed with installation.
3. When presented with the app permission dialog, click **Accept** to continue.
4. When the installation is complete, the BLE-Beacon app can be launched from the App Drawer.
5. Place the Solar BLE Sensor under an office light. Refer to step 2 of 3.1.3 Establishing BLE Connection.
6. Launch the BLE-Beacon app. A splash screen is displayed for a few seconds before the app displays the **Device List** screen. If Bluetooth is turned OFF in the Android device, Android OS will prompt you to turn ON Bluetooth.



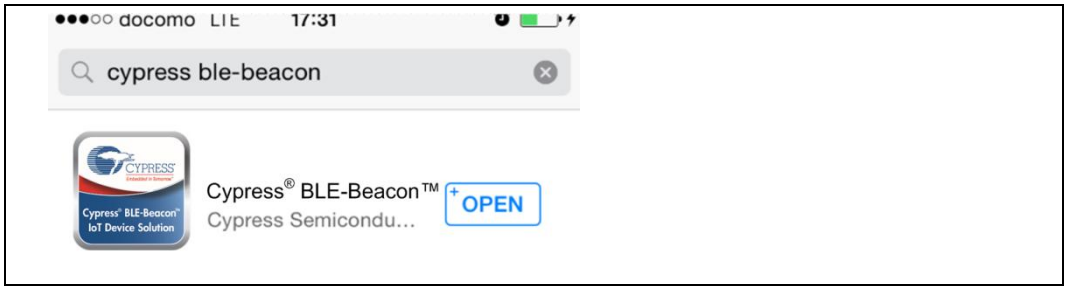
7. The BLE-Beacon app performs device discovery by default when the app is opened. Select the mode as Graph to display the sensor data.



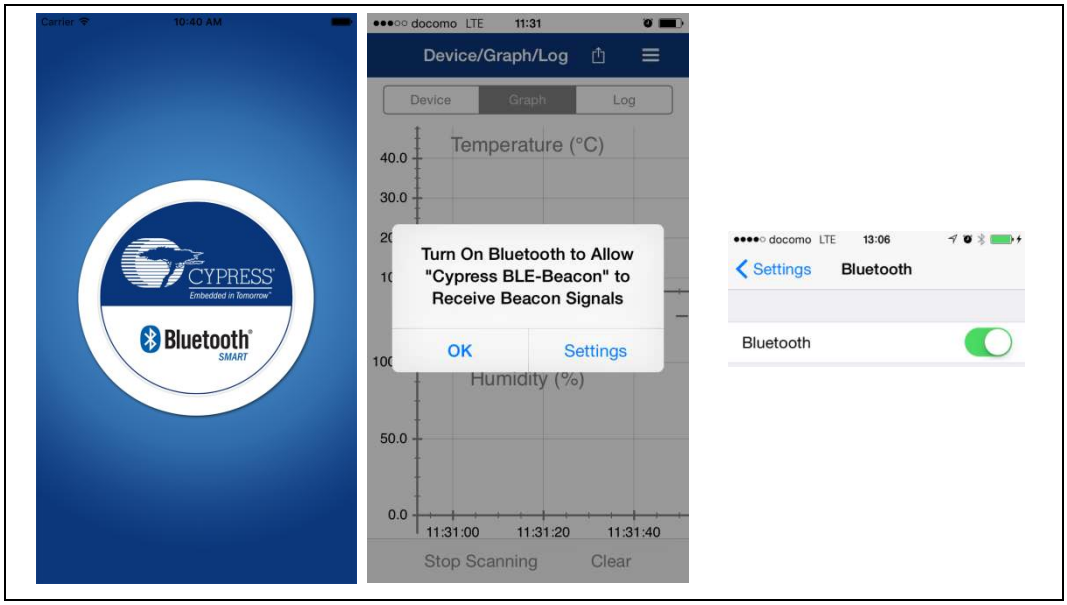
Refer to Cypress BLE-Beacon Android App User Guide for detailed information.

3.2.1.2 Installing the iOS App

1. Open the App Store and search for “Cypress BLE-Beacon.”

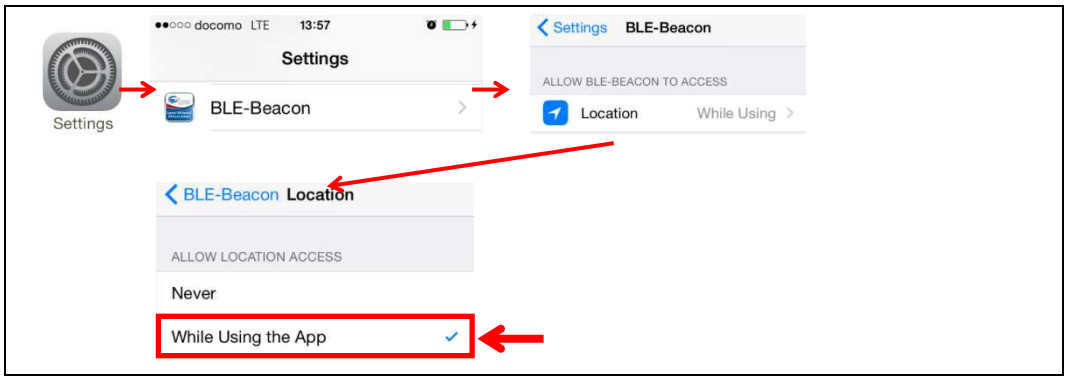


2. Select the Cypress BLE-Beacon (BLE-Beacon) app, and proceed to install the app on your iOS device.
3. Place the Solar BLE Sensor under an office light. Refer to step 2 of 3.1.3 Establishing BLE Connection.
4. Launch the BLE-Beacon app. A splash screen is displayed for a few seconds before the app displays the **Device List** screen. If Bluetooth is turned OFF in the iOS device, iOS will display a message box to turn ON Bluetooth with the **Settings** and **OK** buttons. Click the **Settings** button to turn ON Bluetooth on the **Settings** screen. Clicking the **OK** button will display the message “Please turn Bluetooth ON,” which requires the standard iOS procedure to turn ON Bluetooth.



5. The BLE-Beacon app performs device discovery by default when the app is opened. Select the mode as **Graph** to display the sensor data.

Note that if the sensor data has not appeared on the BLE-Beacon of iOS, you need to confirm that the **Location** setting is set to **While Using the App** (iOS: **Home screen** > **Settings** > **BLE-Beacon** > **Location**).



Refer to Cypress BLE-Beacon iOS App User Guide for detailed information.