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S6SAE101A00SA1002

Solar-Powered Internet of Things (IoT) Device Kit User Guide

Document No. 002-00297 Rev. **

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Preface

This manual explains how to use the evaluation board. Be sure to read this manual before using the product. For this product, please consult with sales representatives or support representatives.

Handling and Use

Handling and use of this product and notes regarding its safe use are described in the manuals.

Follow the instructions in the manuals to use this product.

Keep this manual at hand so that you can refer to it anytime during use of this product.

Notice on This Document

All information included in this document is current as of the date it is issued. Such information is subject to change without any prior notice.

Please confirm the latest relevant information with the sales representatives.

Caution of the Products Described in This Document

The following precautions apply to the product described in this manual.

⚠**WARNING**	Indicates a potentially hazardous situation which could result in death or serious injury and/or a fault in the user's system if the product is not used correctly.

Electric shock, Damage	Before performing any operation described in this manual, turn off all the power supplies to the system. Performing such an operation with the power on may cause an electric shock or device fault.
Electric shock, Damage	Once the product has been turned on, do not touch any metal part of it. Doing so may cause an electric shock or device fault.

⚠ **CAUTION**	Indicates the presence of a hazard that may cause a minor or moderate injury, damages to this product or devices connected to it, or may cause the loss of software resources and other properties such as data, if the device is not used appropriately.

Cuts, Damage	Before moving the product, be sure to turn off all the power supplies and unplug the cables. Watch your step when carrying the product. Do not use the product in an unstable location such as a place exposed to strong vibration or a sloping surface. Doing so may cause the product to fall, resulting in an injury or fault.
Cuts	The product contains sharp edges that are left unavoidably exposed, such as jumper plugs. Handle the product with due care not to get injured with such pointed parts.
Damage	Do not place anything on the product or expose the product to physical shocks. Do not carry the product after the power has been turned on. Doing so may cause a malfunction due to overloading or shock.
Damage	Since the product contains many electronic components, keep it away from direct sunlight, high temperature, and high humidity to prevent condensation. Do not use or store the product where it is exposed to much dust or a strong magnetic or electric field for an extended period of time. Inappropriate operating or storage environments may cause a fault.
Damage	Use the product within the ranges given in the specifications. Operation over the specified ranges may cause a fault.
Damage	To prevent electrostatic breakdown, do not let your finger or other object come into contact with the metal parts of any of the connectors. Before handling the product, touch a metal object (such as a door knob) to discharge any static electricity from your body.
Damage	When turning the power on or off, follow the relevant procedure as described in this document. Before turning the power on, in particular, be sure to finish making all the required connections. Furthermore, be sure to configure and use the product by following the instructions given in this document. Using the product incorrectly or inappropriately may cause a fault.
Damage	Because the product has no casing, it is recommended that it be stored in the original packaging. Transporting the product may cause a damage or fault. Therefore, keep the packaging materials and use them when re-shipping the product.

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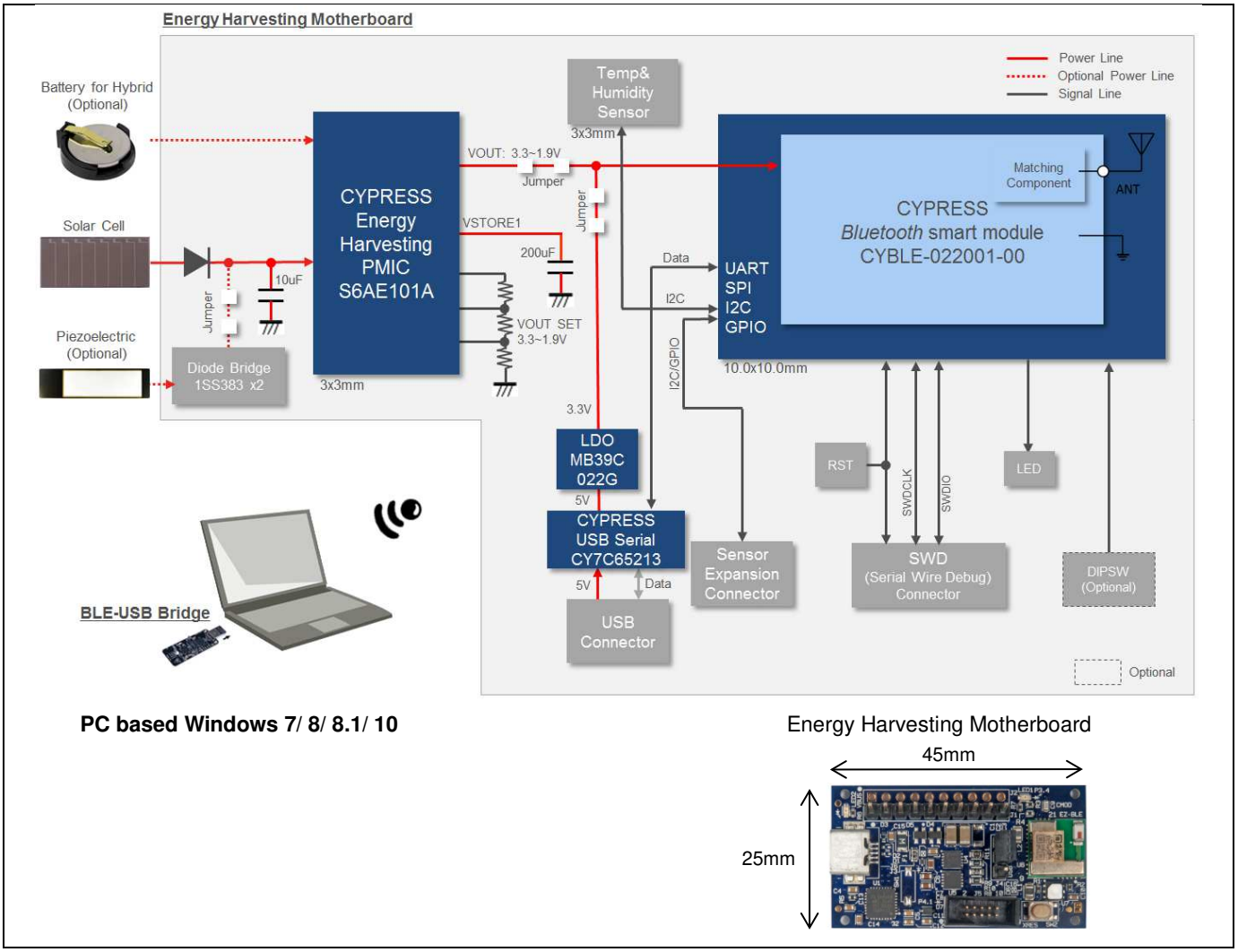
Tables

1. Description

The Solar-Powered IoT Device Kit provides an easy-to-use platform for the development of a solar-powered IoT device with BLE wireless connectivity. It includes the S6AE101A Energy Harvesting Power Management IC (PMIC) device, which is ideal for solar- or light-powered Energy Harvesting Systems (EHS) since it only consumes 250nA. The S6AE101A also supports a hybrid EHS that uses a solar cell Energy Harvesting Device (EHD) along with a coin cell battery, and an optional vibration EHD with external diode bridge. The output voltage from the S6AE101A is configurable from 1.1V to 5.2V, supporting a broad range of device components for an IoT device. Also included in the kit is Cypress' EZ-BLE™ PRoC™ Module (CYBLE-022001-00), a fully integrated Bluetooth Low Energy (BLE) module solution that offers high flexibility for a wide variety of IoT device uses. A USB port is provided by Cypress' USB-UART LP Bridge Controller device (CY7C65213).

Figure 1-1 Block Diagram of Development Kit



2. Features

The Solar Powered IoT Device Kit provides everything needed to develop a light-powered sensor node that transmits sensor data using BLE:

- Operates using light (>200 lux) energy harvested by the included solar cell
  - Supports the use of a vibration Energy Harvesting Device with an external diode bridge (not included)
  - Also supports the use of a coin cell battery (optional, not supplied)
- Supports BLE communication with a PC through the provided BLE-USB Bridge that is pre-programmed with custom firmware for this kit
- Includes firmware that supports the following applications:
  - Bluetooth Low Energy (BLE) Beacon, transmitting data at 1.5 sec intervals with ambient light as low as 200 lx
  - Wireless Sensor Node (WSN), transmitting data at 6 sec intervals with ambient light as low as 200 lx
- Includes an expandable terminal on the Motherboard that can support the following:
  - Reset button for EZ-BLE Module
  - JTAG header to debug EZ-BLE Module
  - Expandable sensor interface (I^2C/UART/SPI/GPIO)
  - DIP switch for future expansion (Not mounted)
  - LEDs for USB power and status
- Includes reference schematic, BOM list, and layout data for easy design
- Uses the following Cypress Devices:
  - S6AE101A ultra low power Energy Harvesting PMIC
  - CYBLE-022001-00 EZ-BLE PRoC Module
  - CY7C65213 USB-UART LP Bridge Controller
  - MB39C022G LDO

3. Applications

- Battery-less wireless sensor node (WSN)
- IoT device that monitors various sensors
- BLE Beacon
- Wearable device
- Building Energy Management System (BEMS)
- Home Energy Management System (HEMS)
- Factory Energy Management System (FEMS)
- Wireless lighting control
- Wireless HVAC sensor
- Security system

4. Kit Introduction

4.1 Contents

1. Energy Harvesting Motherboard
2. BLE-USB Bridge
3. Solar Module (Panasonic AM-1801)
4. Two jumper wires
5. 220 µF Capacitor and 10Ω Resistor[1]
6. USB Standard-A to Mini-B cable
7. Quick Start Guide

[1] The 220 µF capacitor is an additional output capacitor. The 10Ω resistor is for current measurement. Refer to "11.2 How to Use Extra Components" for detailed information.

5. Software Installation

5.1 Install Software

Follow these steps to install the S6SAE101A00SA1002 Solar-Powered IoT Device Kit software:

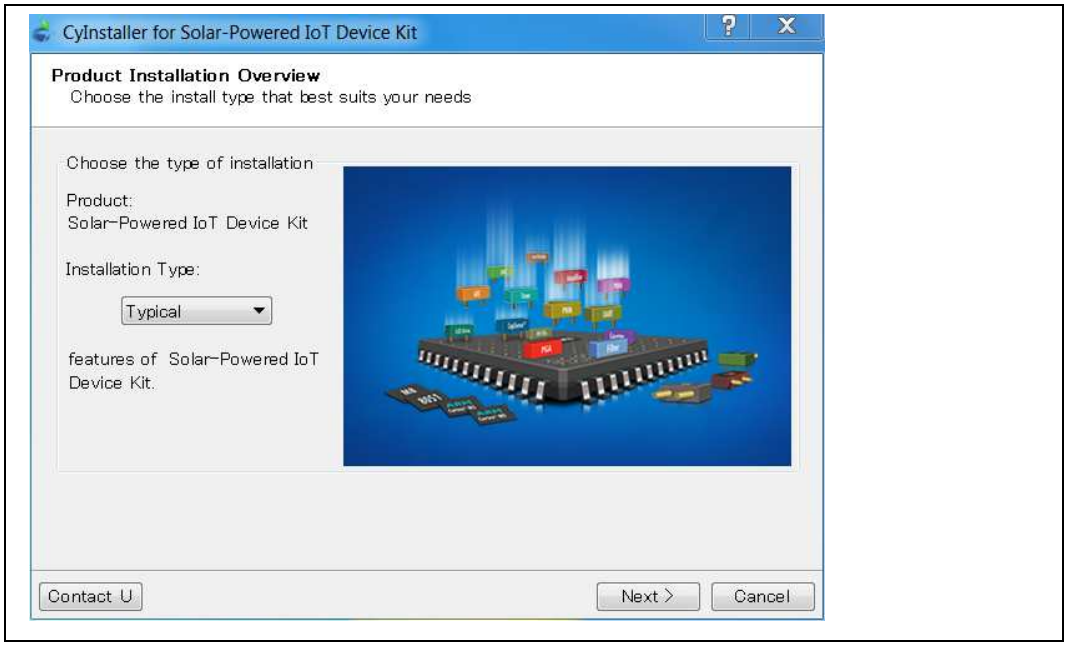
1. Download and install the Solar-Powered IoT Device Kit software from www.cypress.com/energy-harvesting.
   The Solar-Powered IoT Device Kit software is available in two different formats for download:
   a. Solar-Powered IoT Device Kit Complete Setup: This installation package contains the files related 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.
   b. Solar-Powered IoT Device Kit 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.
   c. Solar-Powered IoT Device Kit 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 Solar-Powered IoT Device Kit to start the installation, as shown below.

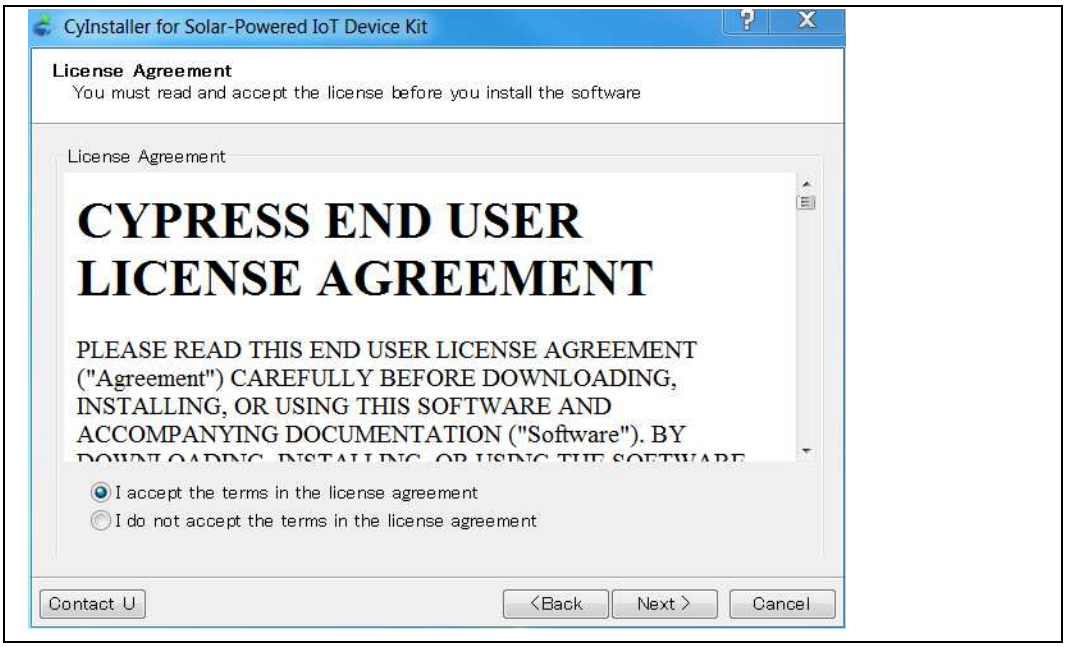
3. Select the folder to install the Solar-Powered IoT Device Kit-related files. Choose the directory and click Next.

4. The Solar-Powered IoT Device Kit ISO installer automatically installs the required software, if it is not present on your computer. The Solar-Powered IoT Device Kit 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 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 Solar-Powered IoT Device Kit installation.

9. Enter your contact information or select the Continue Without Contact Information check box. Click Finish to complete the Solar-Powered IoT Device Kit installation.

10. After the installation is complete, the kit contents are available at the following location:
<Install directory>\ Solar-Powered IoT Device Kit
Default location (Example. Windows 7):
64-bit: C:\Program Files (x86)\Cypress\ Solar-Powered IoT Device Kit
32-bit: C:\Program Files\Cypress\ Solar-Powered IoT Device Kit

5.2 Uninstall Software

You can uninstall the Solar-Powered IoT Device Kit 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 IoT Device Kit program from the list and click the Uninstall/Change button.

5.3 PSoC Creator™

PSoC Creator[1] 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.

PSoC Creator 3.2 SP1 or newer: Download the latest version from www.cypress.com/psoccreator.

For sample firmware information for this kit, refer to "8. Example Project".

[1] To develop firmware for the Solar-Powered IoT Device Kit, require PSoC Creator 3.2 SP1 or newer.

6. Getting Started

You will become familiar with the different components of the Solar-Powered IoT Device Kit by successfully establishing a BLE Beacon connection between the Energy Harvesting Motherboard operating as a WSN, and a PC with the BLE-USB Bridge. This will also confirm that the Motherboard, BLE-USB Bridge, and your PC are operating properly.

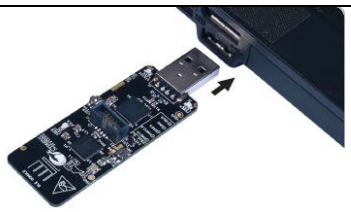
6.1 Solar-Powered BLE Beacon Operation

You will confirm that the Motherboard and BLE-USB Bridge are properly operating by establishing a BLE connection. The Motherboard contains all of the components of the WSN which are: the energy harvesting PMIC S6AE101A; capacitors for energy storage; an EZ-BLE PRoC Module for transmitting data; and an I^2C temperature and humidity sensor. A USB to serial device is also included on the Motherboard to allow the user to configure parameters such as the ID into the EZ-BLE module from a PC application. The Motherboard comes with pre-loaded firmware to operate as a BLE Beacon. By connecting the Solar Module to the Motherboard and exposing it to ambient light, it will power up and begin transmitting.

The BLE-USB Bridge is pre-configured to look for the transmission from the Motherboard operating as a BLE Beacon. By installing the BLE-USB Bridge on a Windows PC and using the provided software, you will be able to detect the Motherboard, and determine the distance between the Motherboard and the PC using BLE.

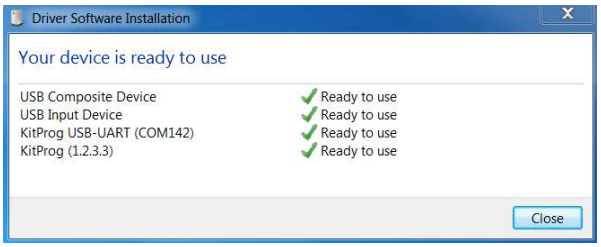
6.1.1 USB Driver Installation of the BLE-USB Bridge

1. Plug in the BLE-USB Bridge into your computer's USB port.



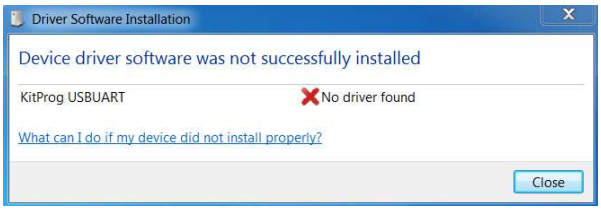
2. The driver Installation starts automatically and the following message window will appear. Click the message window for status.

3. Confirm that the device driver installation has successfully completed (all components will be "Ready to use"). If the installation fails, do installation manually using a file in the "USB drivers" folder. Refer to "6.1.2 USB Driver Installation failed" below.



Completed

(Next to step4)



Failed

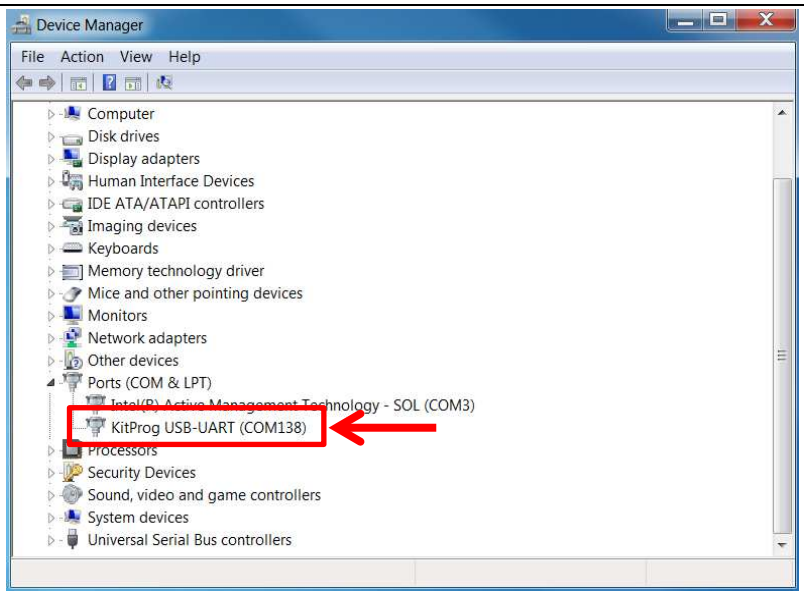
(Refer to "6.1.2 USB Driver Installation failed")

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

   a. Open the Device Manager:

Windows 7	Start Menu > Control Panel > Device Manager
Windows 8/8.1/10	Right Click Start Button > Device Manager

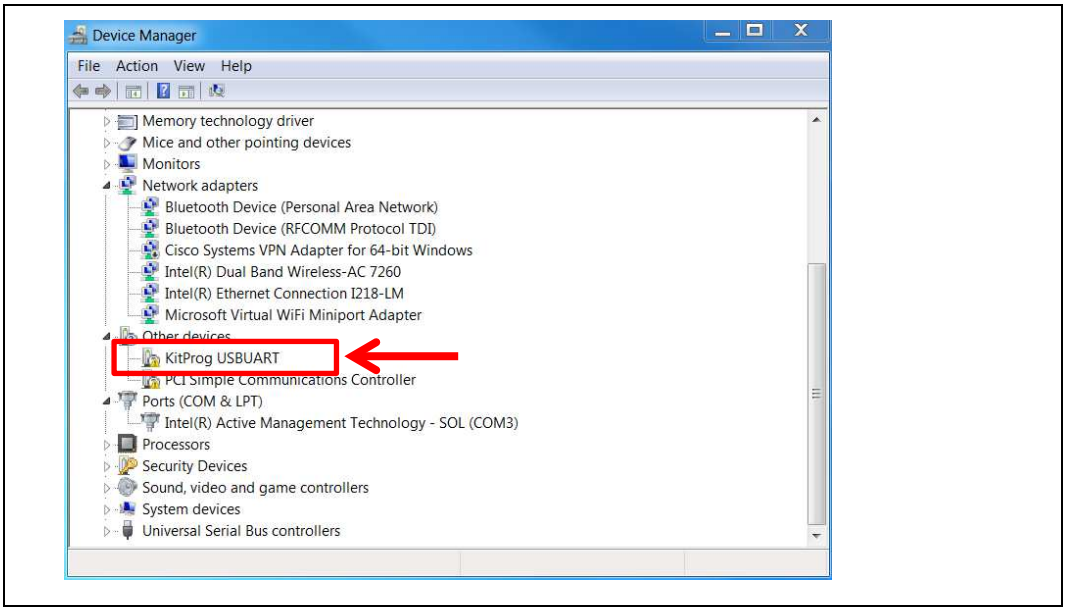
   b. Under Ports (COM & LPT), confirm that a COM port called KitProg USB-UART was added. Note the COM number (COMxx).



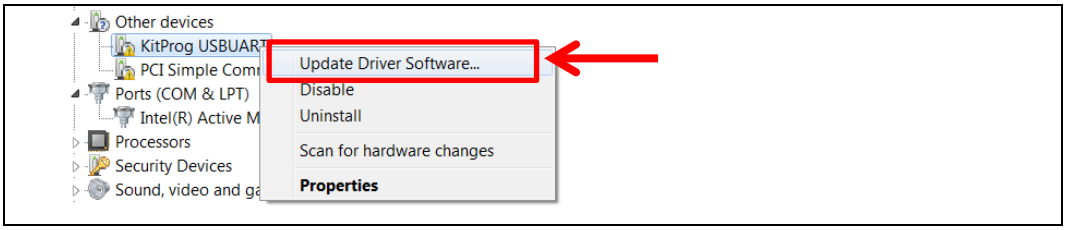
5. Skip the "5.1.2 USB Driver Installation failed", continue with the "6.1.3 USB Driver Installation for the Motherboard".

6.1.2 USB Driver Installation failed

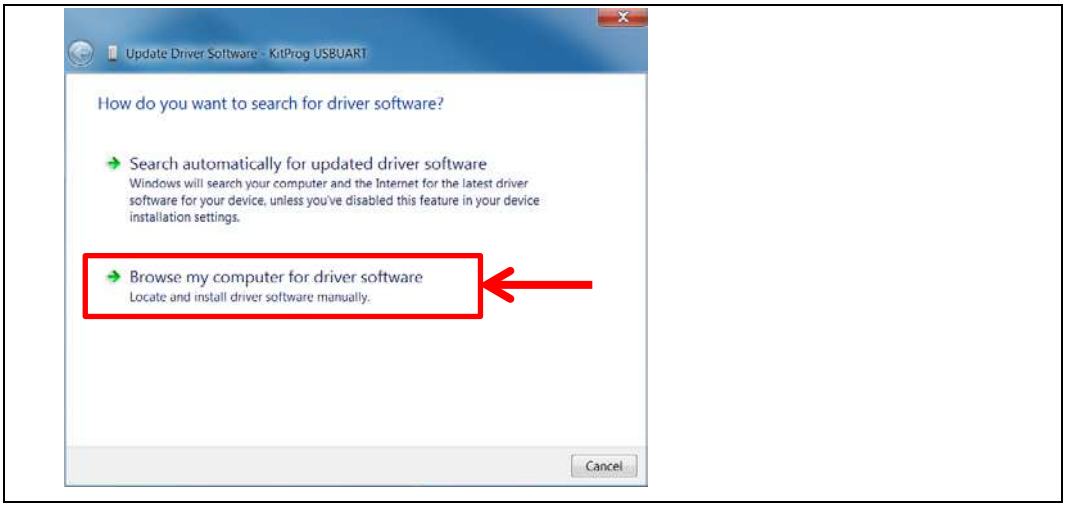
1. If the device driver installation fails, confirm that an unconfigured KitProg USB-UART appears in the device manager:
   a. Open the Device Manager:
      Windows 7 Start Menu > Control Panel > Device Manager
      Windows 8/8.1/10 Right Click Start Button > Device Manager
   b. Under Other devices, confirm that KitProg USB-UART appears with no associated COM port.



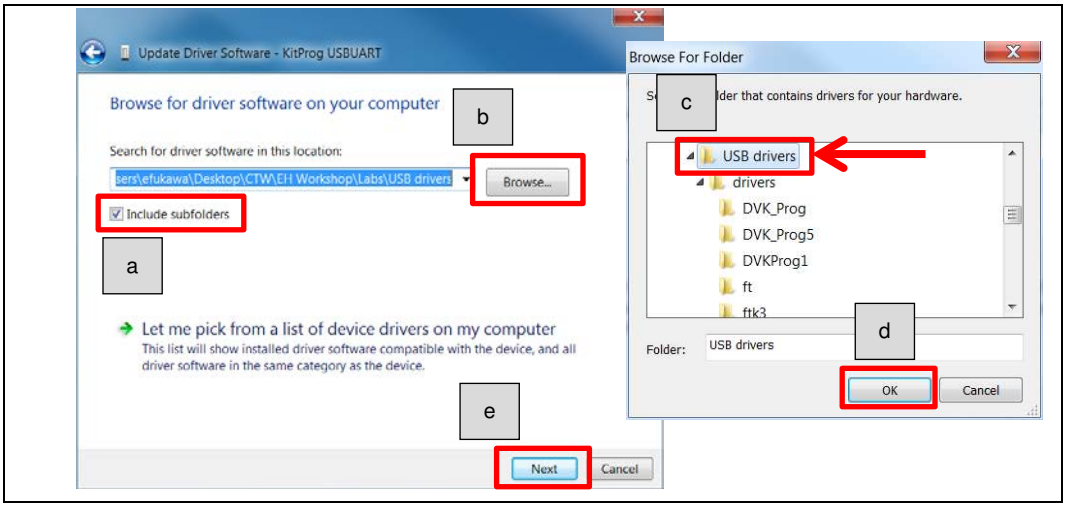
2. Update the USB driver software or the unconfigured KitProg USB-UART.
   a. Click the right mouse button on KitProg USB-UART
   b. Select Update Driver Software…



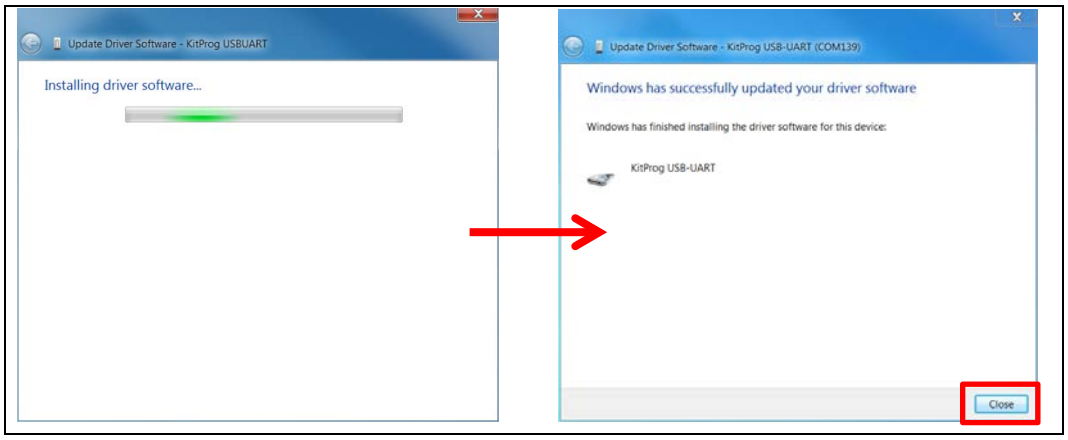
3. Select “Browse my computer for driver software”.



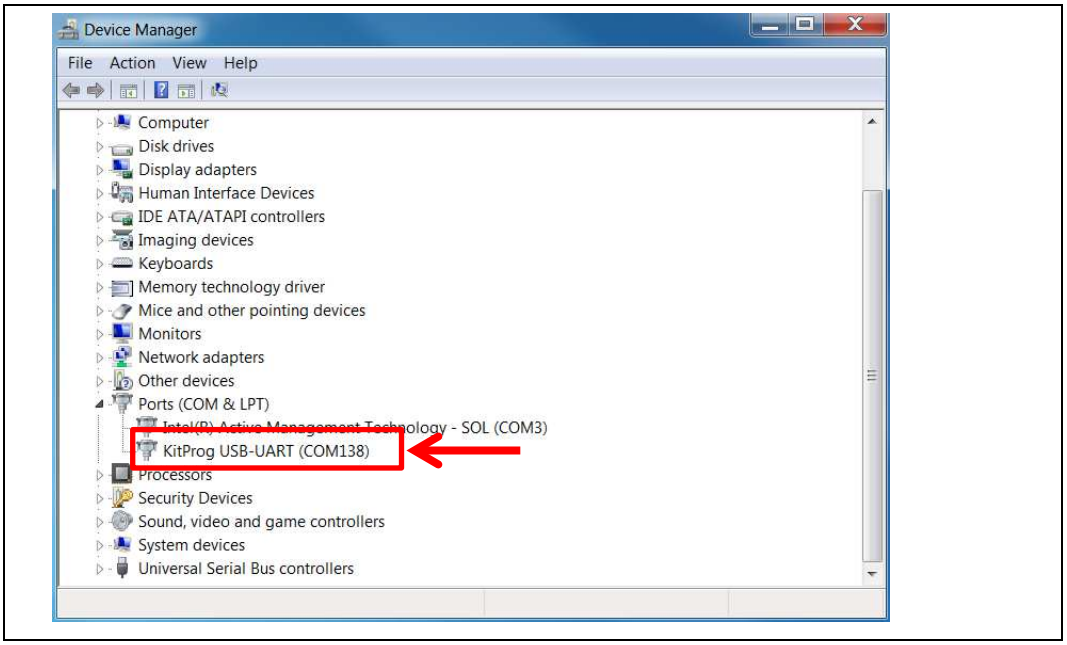
4. Search for USB driver in the Lab files.
   a. Check the “Include subfolders” box
   b. Push the “Browse my computer for driver software” button
   c. Select the “USB drivers” folder in the kit files
      <Install directory>/Solar-Powered IoT Device Kit/1.0/USB drivers
   d. Push the “OK” button
   e. Push the “Next” button



5. Start installing USB driver. Push the “Close” button when the driver installation of the KitProg USB-UART finishes.

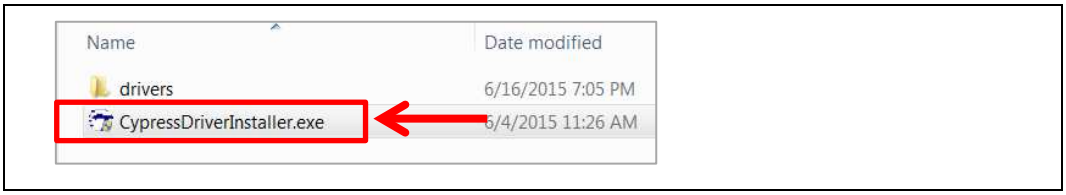


6. After successful device driver installation, confirm that a new COM port called KitProg USB-UART was added:
   a. Open the Device Manager.
   b. Under Ports (COM & LPT), confirm that a COM port called KitProg USB-UART was added. Note the COM number (COMxx).

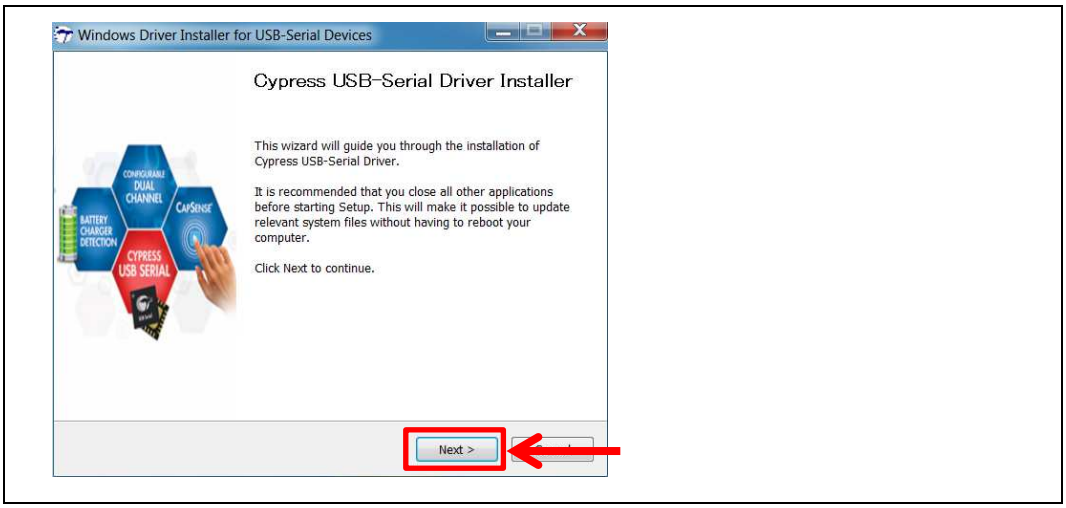


6.1.3 USB Driver Installation for the Motherboard

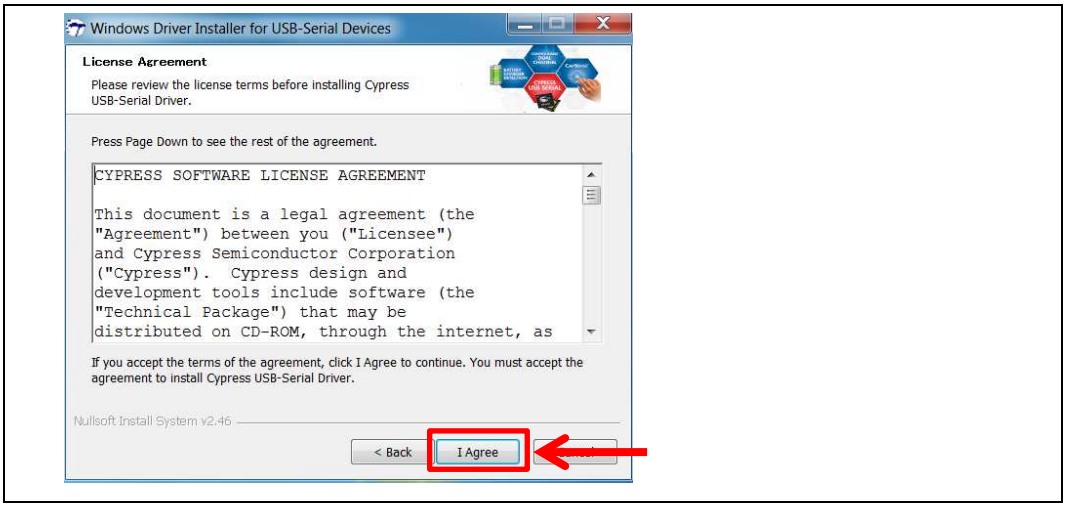
1. Run CypressDriverInstaller.exe, which is the installer for the USB serial device on the Motherboard. <Install directory>/Solar-Powered IoT Device Kit/1.0/USB drivers



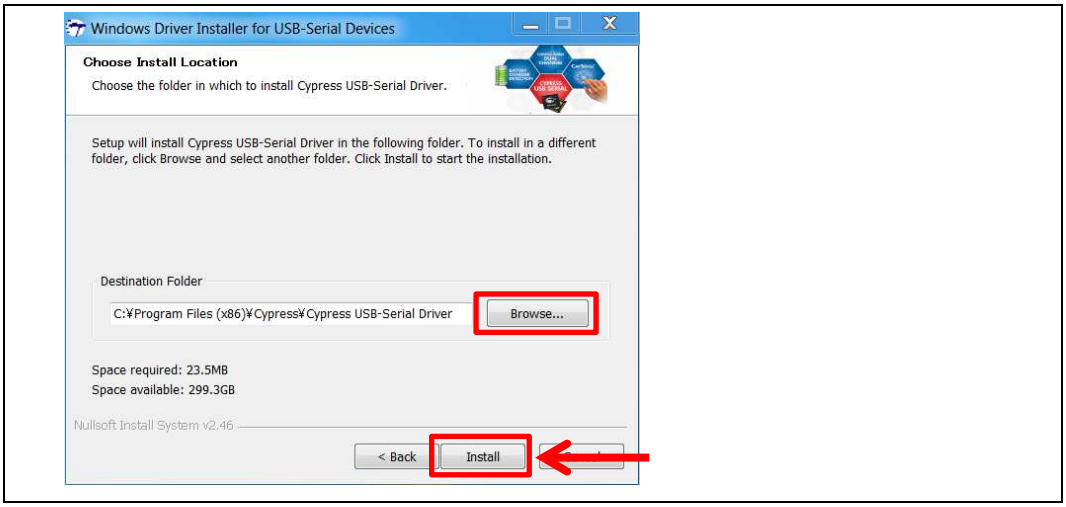
2. Push the “Next >” button.



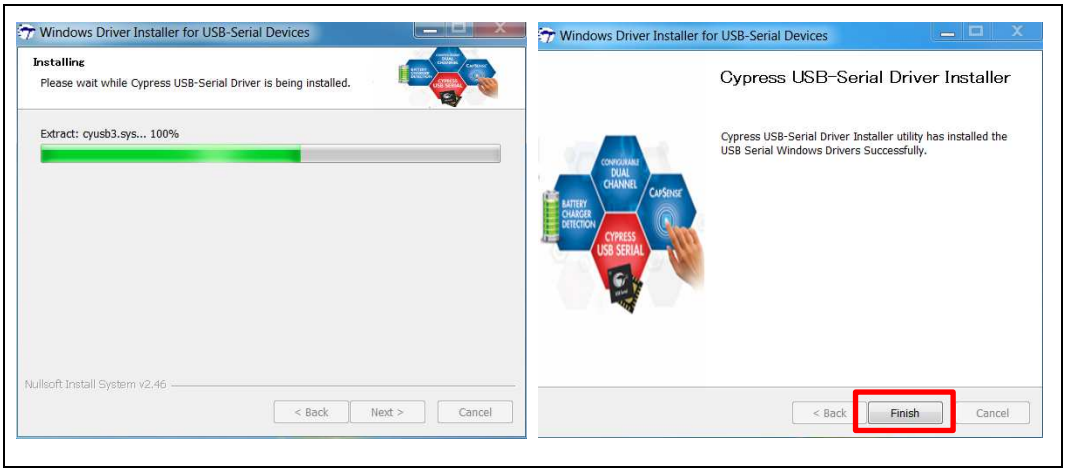
3. Push the “I Agree” button.



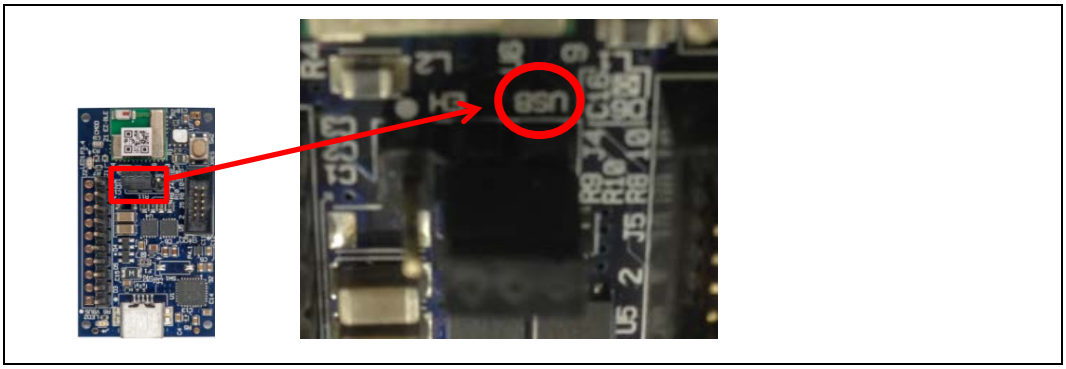
4. Push the “Install” button. Use the “Browse…” button if you want to change the Destination Folder.



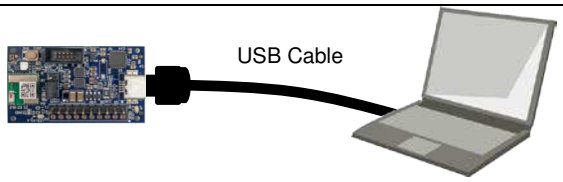
5. Push the “Finish” button when the driver installation for the Motherboard finishes.



6. Configure the Motherboard to receive power from the USB port. Change jumper J4 to "USB" from "EH".

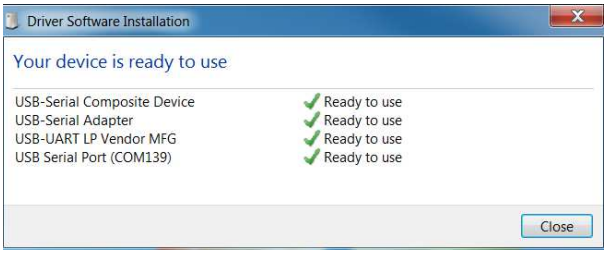


7. Connect the Motherboard to your computer using a USB cable.



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

9. Confirm that the device driver installation has successfully completed (all components will be "Ready to use").

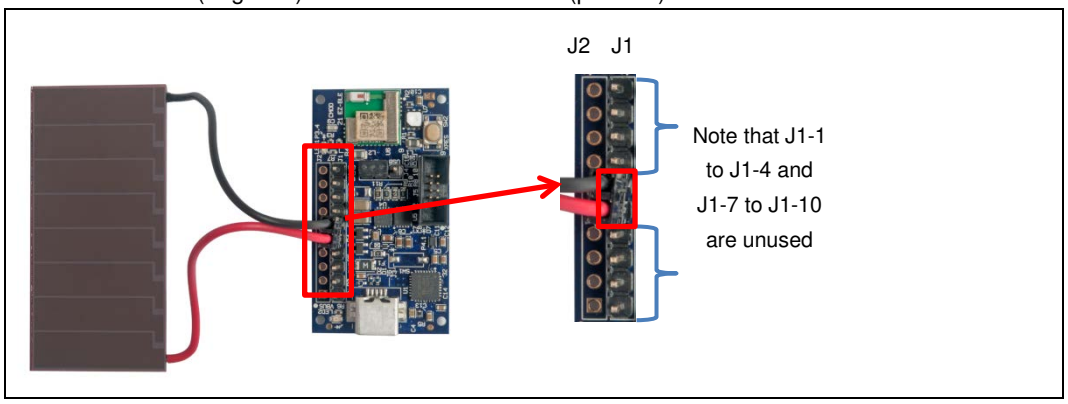


10. After successful device driver installation, confirm that a new COM port called USB Serial Port was added:
    a. Open the Device Manager.
    b. Under Ports (COM & LPT), confirm that a COM port called KitProg USB-UART was added. Note the COM number (COMxx).

11. Finally, disconnect the USB cable, then reset the jumper J4 set in step 6 back to "EH" from "USB" to supply power from the Solar Module.

6.1.4 Establishing BLE Connection

1. Connect the Solar Module (AM-1801, included in the kit) to the Energy Harvesting Motherboard. Plug the black wire (negative) to J1-6 and the red wire (positive) to J1-5 as shown below.



2. Place the Motherboard with Solar Module under an office light. The firmware to operate the Motherboard as a BLE Beacon is pre-loaded from the factory. After attaching the Solar Module and placing the Motherboard under a suitable light level (Refer to Table 5-1), it will automatically power up and begin transmitting.

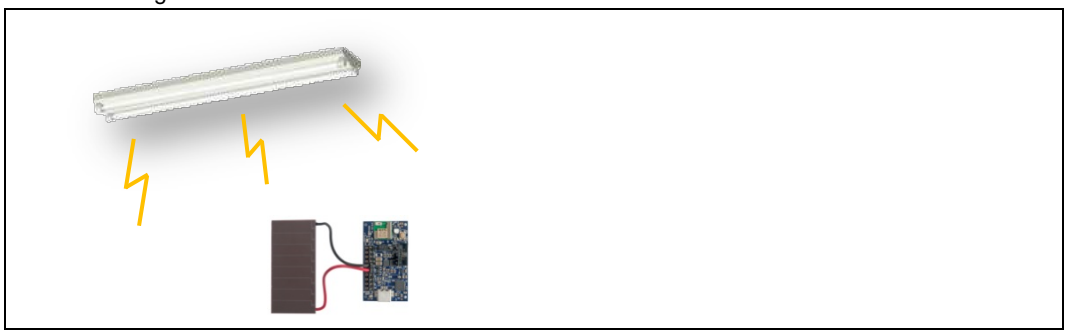


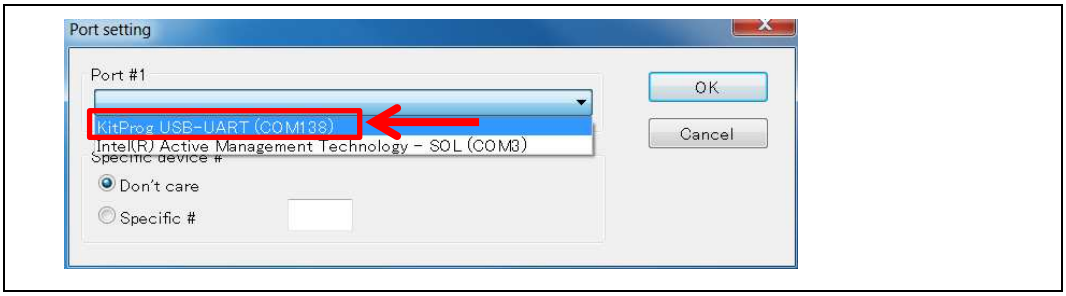
Table 6-1 Light level vs Time Interval

Typical Light Level	Environment	Time Interval of Beacon[1]
~1 lx	Moonlight	Does not work
50 lx~100 lx	Under street lighting	Does not work
200 lx~400 lx	At Museum	1.0 sec ~ 5.0 sec
400 lx~500 lx	Office lighting	0.6 sec ~ 1.0 sec
1000 lx	Shopping mall, Rainy day	0.4 sec ~ 0.6 sec

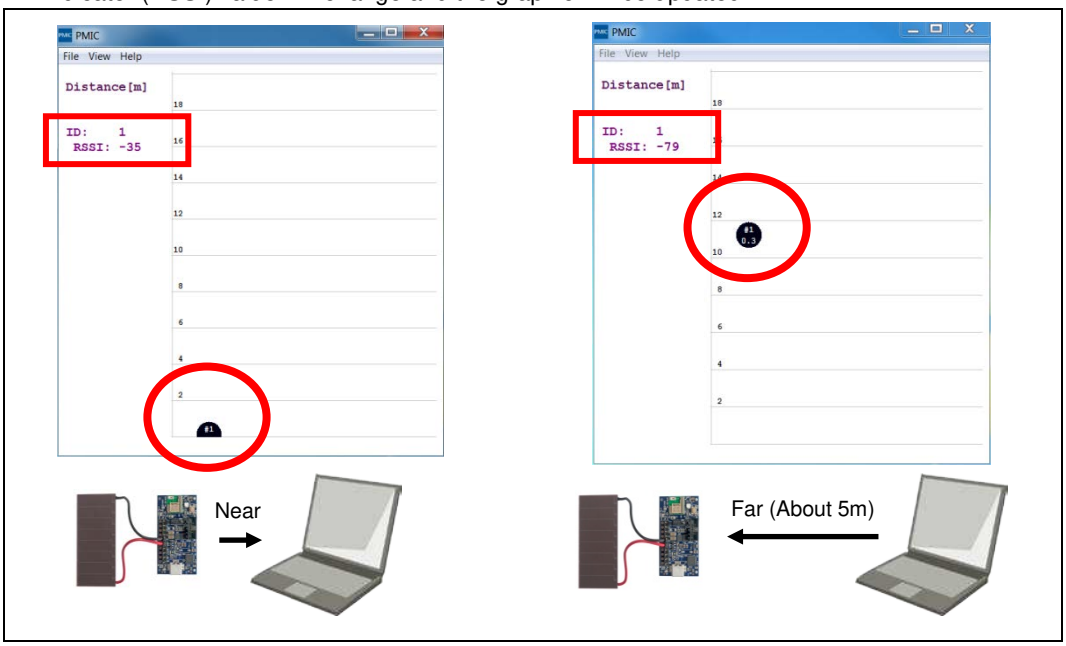
[1] The initial setting of time interval is set 1.5 sec. You need to configure an "ITRVL" command to change time interval. Refer to "6.3 Serial Command List".

3. Plug in the BLE-USB Bridge into your computer's USB port.

4. Run PMIC.exe, which is in the Windows application used to view data received from the Motherboard. It is located in the PMIC Software folder that you installed earlier
   <Install directory>/Solar-Powered IoT Device Kit/1.0/PMIC Software
   A dialog box will appear. Select KitProg USB-UART (COMxx) in the drop down menu under Port #1, where COMxx corresponds to the port that was confirmed in step 5. Leave the Specific Device # to "Don't care". Push the "OK" button.



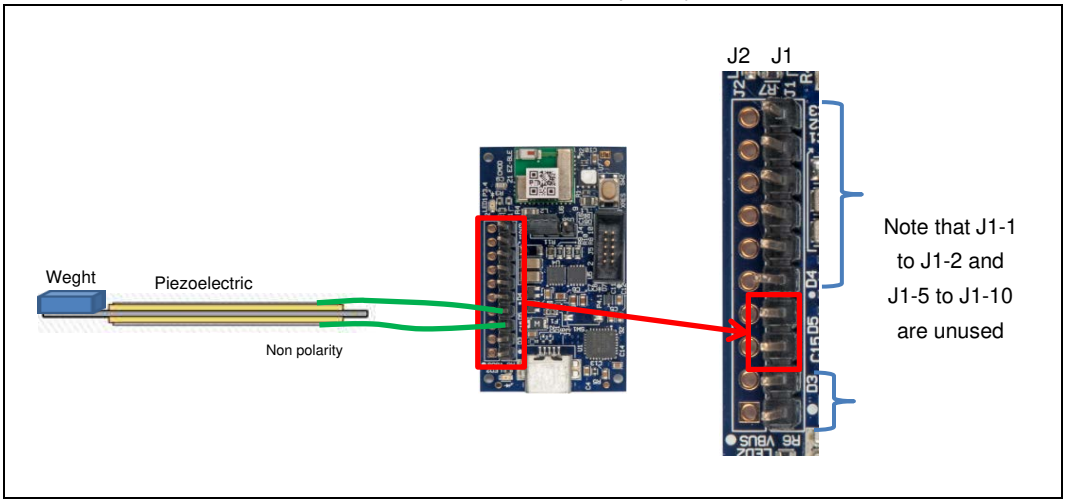
5. Find your MAJOR number (Refer to "6.3 Serial Command List") of the Motherboard on the PMIC Software. Then move the Motherboard further away from your computer. The Received Signal Strength Indicator (RSSI) value will change and the graphic will be updated.



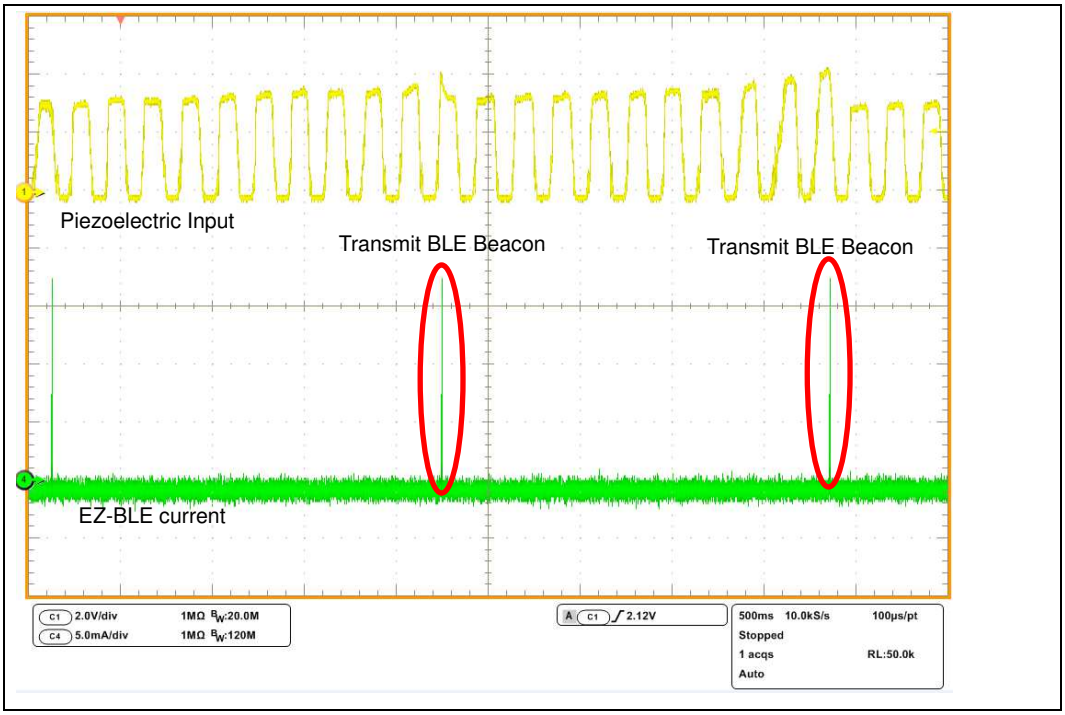
6.1.5 Vibration Energies Connection (Optional)

The Energy Harvesting Motherboard supports receiving AC voltage from piezoelectric or electro-magnetic Energy Harvesting Devices (EHDs) that harvest vibration energy. To confirm this operation, a piezoelectric or electro-magnetic EHD is required (not supplied with Kit).

1. Connect the piezoelectric or electro-magnetic EHD to the Motherboard. Plug the wires from the EHD to J1-3 and J1-4 as shown below. Note that there is no polarity.



2. Move the EHD to generate vibration energy.
3. Follow steps 3-5 of "6.1.4 Establishing BLE Connection" to confirm that the Energy Harvesting Motherboard is operating. Following is sample waveform for the operation of vibration energies. If the Motherboard is not operating, you may have to increase the vibration energy. Refer to the documentation for the EHD being used.



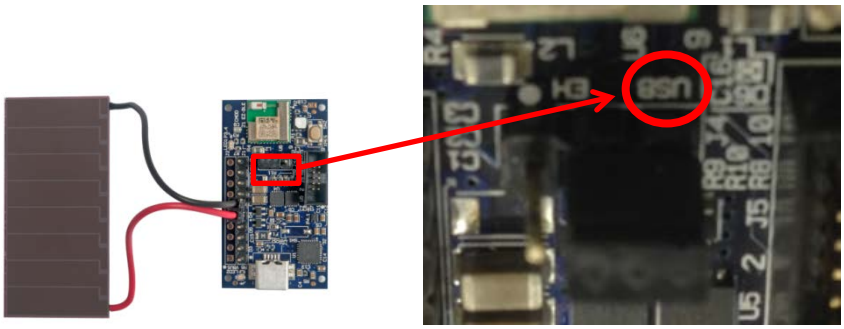
6.2 Solar-Powered Wireless Sensor Node (WSN) with BLE Beacon

You will configure the Motherboard as a WSN by turning on the temperature and humidity sensor. You will do this using a serial USB connection from your PC to send configuration commands to the Motherboard.

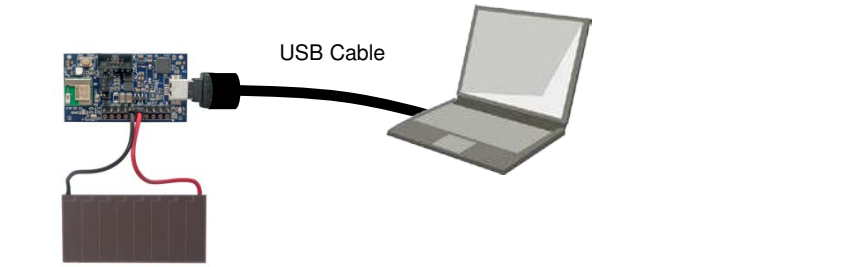
Finally, you will confirm that the Motherboard is operating as a WSN by using the provided software on your PC to detect temperature and humidity changes.

6.2.1 Configuring the Motherboard as a WSN

1. Configure the Motherboard to receive power from the USB port by changing jumper J4 to "USB" from "EH".



2. Connect the Energy Harvesting Motherboard to your computer using a USB cable.



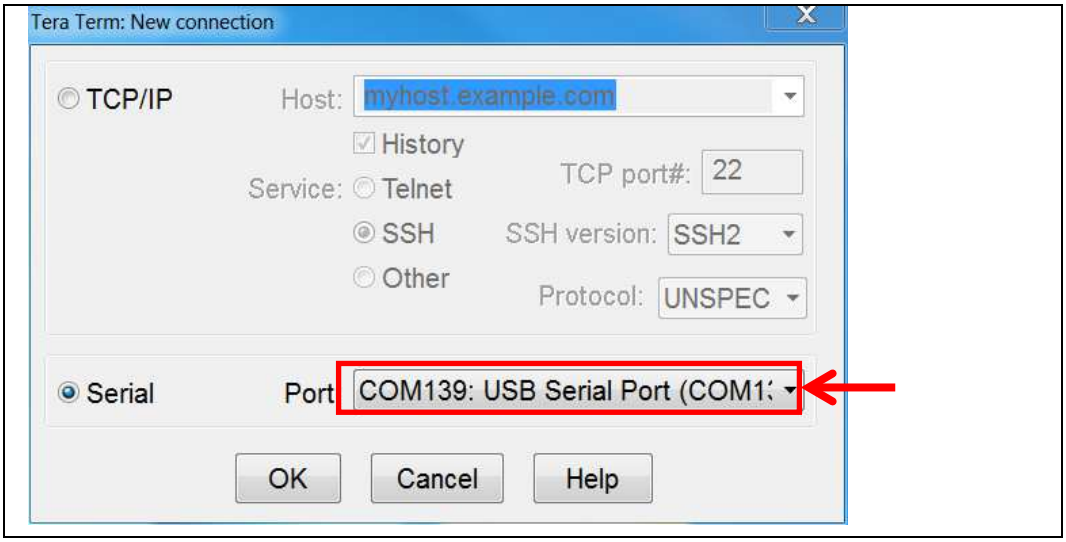
3. Confirm that a COM port (USB Serial Port) was added in the Windows Device Manager:
   a. Open the Device Manager:
   b. Under Ports (COM & LPT), confirm that a USB Serial Port was added. Note the COM number (COMxxx).

4. Install Tera Term from the following location:
   <Install directory>/Solar-Powered IoT Device Kit/1.0/PMIC Software/teraterm

5. After installed, run Tera Term:

Windows 7	Start Menu > All Programs > Tera Term
Windows 8/8.1	Ctrl + Tab keys > All Apps > Tera Term
Windows 10	Start Button > All Apps > Tera Term

6. In "Tera Term: File > New Connection" window, click Serial and select "COMxxx: USB Serial Port(COMxxx)", click OK.



7. Configure Terminal setting (Setup > Terminal) as shown below, click OK.
   Receive: AUTO
   Transmit: CR+LF
   Local echo: Check
   Other settings: Default