UM1752
User manual

Software GUI user guide for STEVAL-ISV021V1, STEVAL-IDS002V1 and STEVAL-IDS003V1 evaluation boards

Introduction

This document describes the software graphic user interface designed to test the key features of the SPV1050 ultra low power energy harvester and battery charger device. It can be downloaded directly from www.st.com and supports the following demonstration kit and evaluation boards:

Table 1. Evaluation products supported by the software

Order code	Description
STEVAL-ISV021V1	Energy harvesting demonstration kit based on SPV1050
STEVAL-IDS002V1	Autonomous wireless multi-sensor node powered by PV cells and based on SPV1050 (SPIDEr@ST™)
STEVAL-IDS003V1	Autonomous wireless multi-sensor node powered by thermoelectric generator and based on SPV1050 (SPIDEr@ST™)

The evaluation boards and power monitoring board (PMB) pictures are shown in *Figure 1*, *Figure 2*, *Figure 3* and *Figure 4*. Please refer to the related application notes for further details. The dedicated software GUI displays in a very user-friendly way the SPV1050 features and system performances to let users test the device in the real operating working condition. The PMB has to be connected to the above mentioned boards in order to provide the electrical specification of energy harvesting sources (PV module or TEG) and the power extracted from it, the battery operating voltage and current, the conversion efficiency, the MPPT accuracy, the environmental irradiance or temperature, and the overall system power budget. The next section describes the hardware setup and software configuration to perform measures and tests.

Contents

1 Evaluation board photos

Figure 1. STEVAL-IDS002V1 (SPIDEr@ST™ with PV module): top and bottom

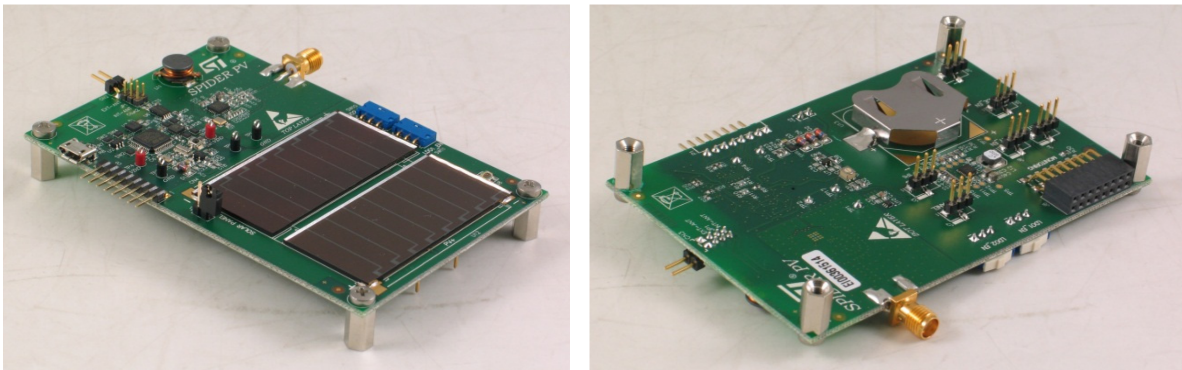


Figure 2. STEVAL-IDS003V1 (SPIDEr@ST™ with TEG): top and bottom

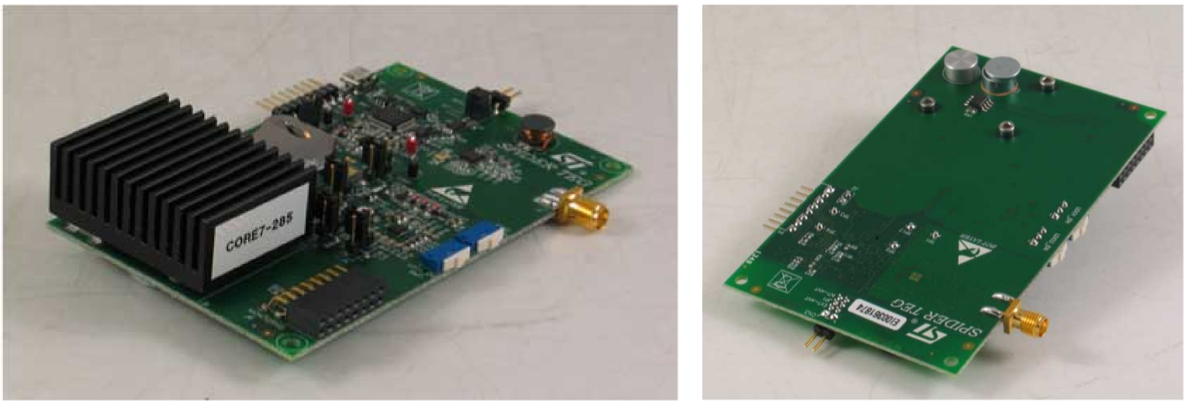


Figure 3. STEVAL-ISV021V1 (Energy harvesting module): top and bottom

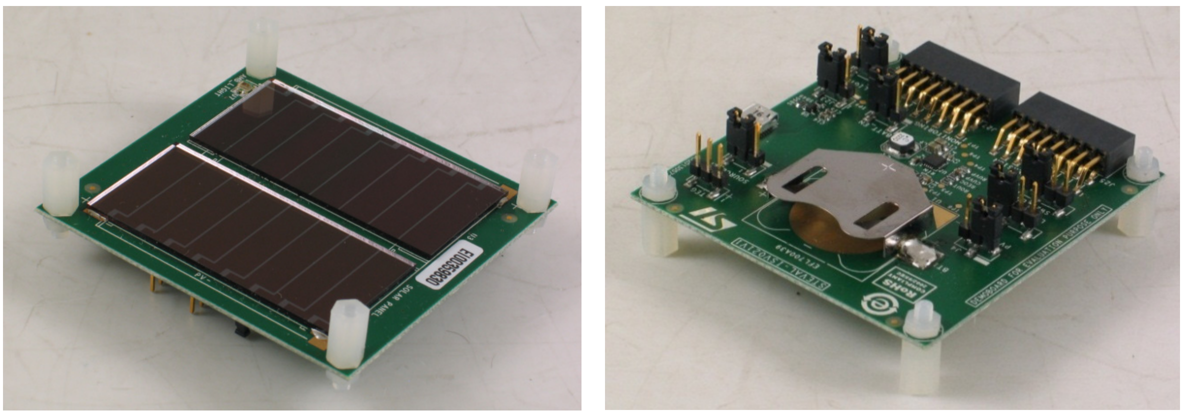
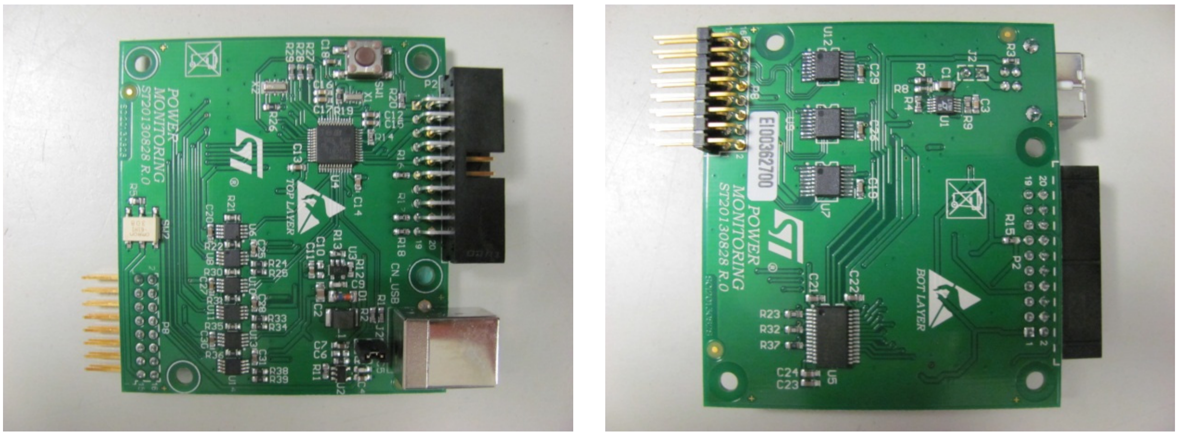


Figure 4. Power Monitoring Board (PMB): top and bottom

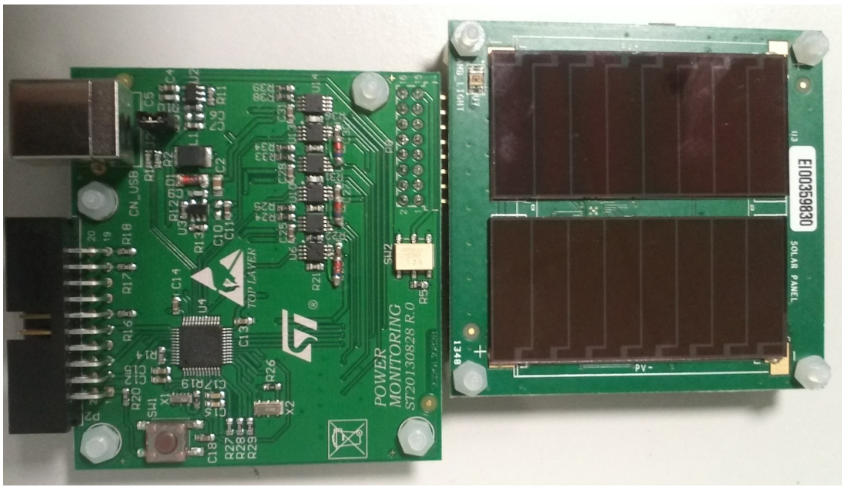


2 Hardware Setup

2.1 STEVAL-ISV021V1

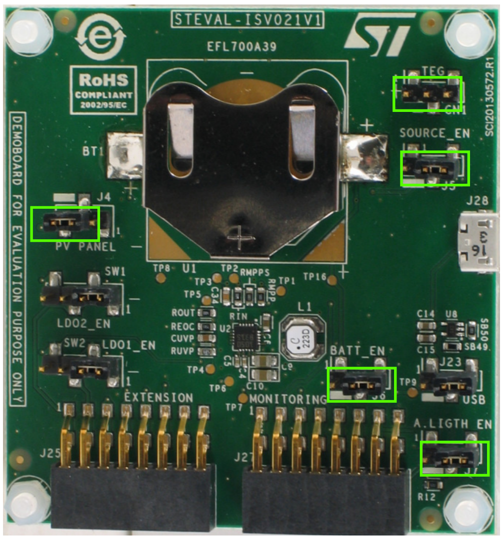
Connect the PMB through the USB cable to the PC first and then connect the STEVAL-ISV021V1 to it as shown in *Figure 5*. It's strongly recommended to not connect the PMB to the STEVAL-ISV021V1 if it is not yet powered by the USB cable as its current draining could damage the battery on the board.

Figure 5. STEVAL-ISV021V1 and PMB connection



Check jumper position on bottom side of the STEVAL-ISV021V1. In order to supply the system by the on board PV panel, close pins 2-3 of J4 and leave open CN1. When the STEVAL-ISV021V1 is connected to PMB, the jumpers J5, J6 and J7 must be positioned on the right (close pins 2-3), as shown in *Figure 6*.

Figure 6. Jumpers positioning on bottom side of STEVAL-ISV021V1



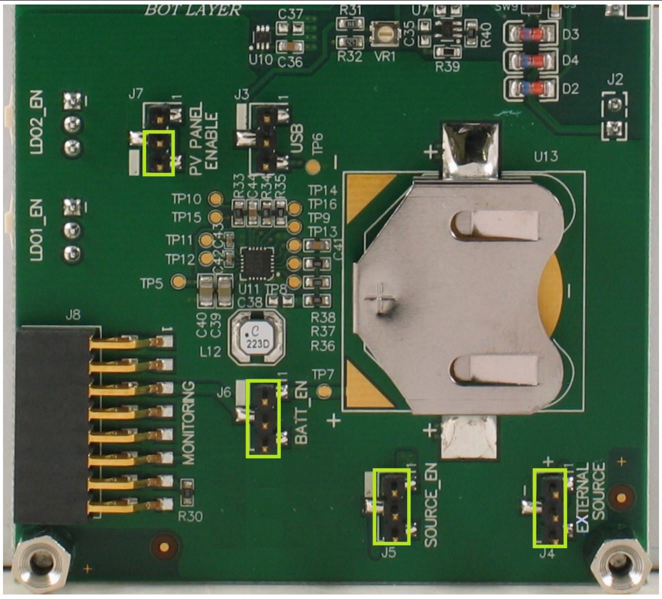
2.2 STEVAL-IDS002V1

Connect the PMB through the USB cable to the PC first and then connect the STEVAL-IDS002V1 to it as shown in *Figure 7*. It's strongly recommended to not connect the PMB to the STEVAL-IDS002V1 if it is not yet powered by the USB cable as its current draining could damage the battery on the board.

Figure 7. STEVAL-IDS002V1 and PMB connection

Check jumper position on bottom side of the STEVAL-IDS002V1. In order to supply the system by the on board PV panel, close pins 2-3 of J7 and leave J4 open. When STEVAL-IDS002V1 is connected to PMB, the jumpers J5 and J6 must be left open, as shown in *Figure 8*.

Figure 8. Jumpers positioning on bottom side of STEVAL-IDS002V1



2.3 STEVAL-IDS003V1

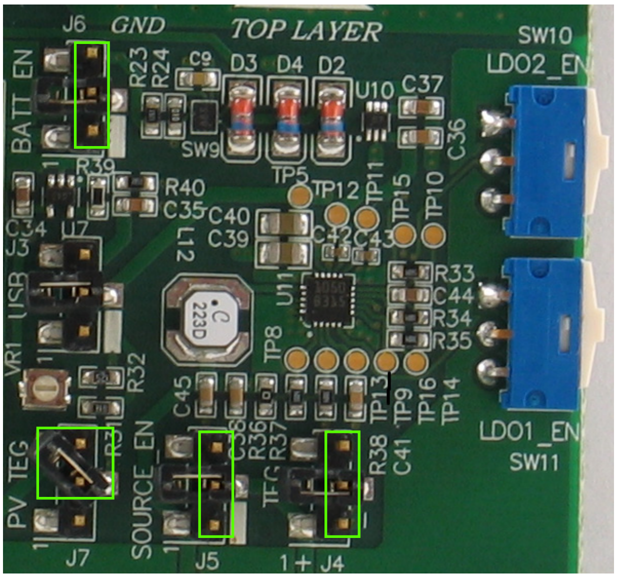
Connect the PMB through the USB cable to the PC first and then connect the STEVAL-IDS003V1 to it as shown in *Figure 9*.

It's strongly recommended to not connect the PMB to the STEVAL-IDS002V1 if it is not yet powered by the USB cable as its current draining could damage the battery on the board.

Figure 9. STEVAL-IDS003V1 and PMB connection

Check jumper position on top side of the STEVAL-IDS003V1. In order to supply the system by the on board TEG, close pins 2-3 of J7 and leave J4 open. When the STEVAL-IDS003V1 is connected to the PMB, the jumpers J5 and J6 must be left open, as shown in *Figure 10*.

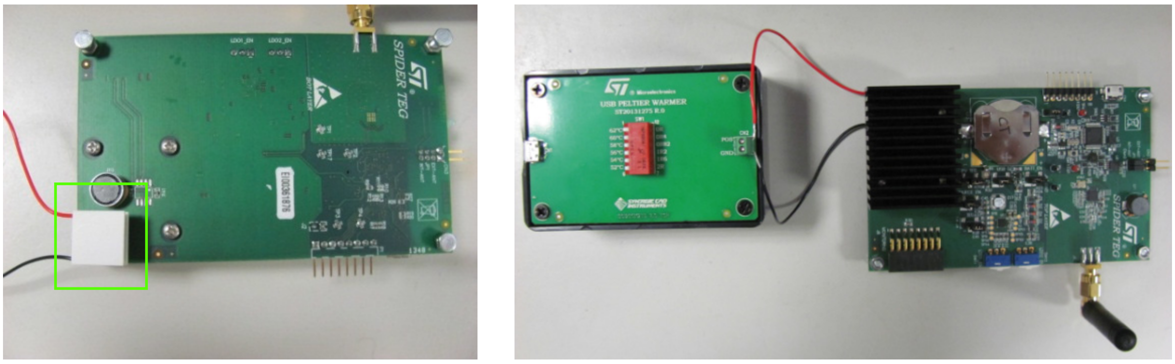
Figure 10. Jumpers positioning on top side of STEVAL-IDS003V1



2.4 Heater board

The TEG mounted on the STEVAL-IDS003V1 board provides an easy access to the cold or hot plate to create a gradient temperature across the two TEG plates. In fact, the second one is generally at ambient temperature. In order to heat up the exposed surface of the TEG, the Peltier cell based heating module can be used. The module is not included in the box, but it represents a very immediate tool to quickly warm up the accessible plate of TEG. It is supplied through its USB cable which has to be connected to a PC. Make sure that the Peltier cell surface is in contact with the TEG surface located on the bottom side of the STEVAL-IDS003V1 to guarantee the maximum heat transfer as shown in *Figure 11*.

Figure 11. Peltier cell heating surface and bottom view of the STEVAL-IDS003V1 with exposed TEG plate surface



3 Software Setup

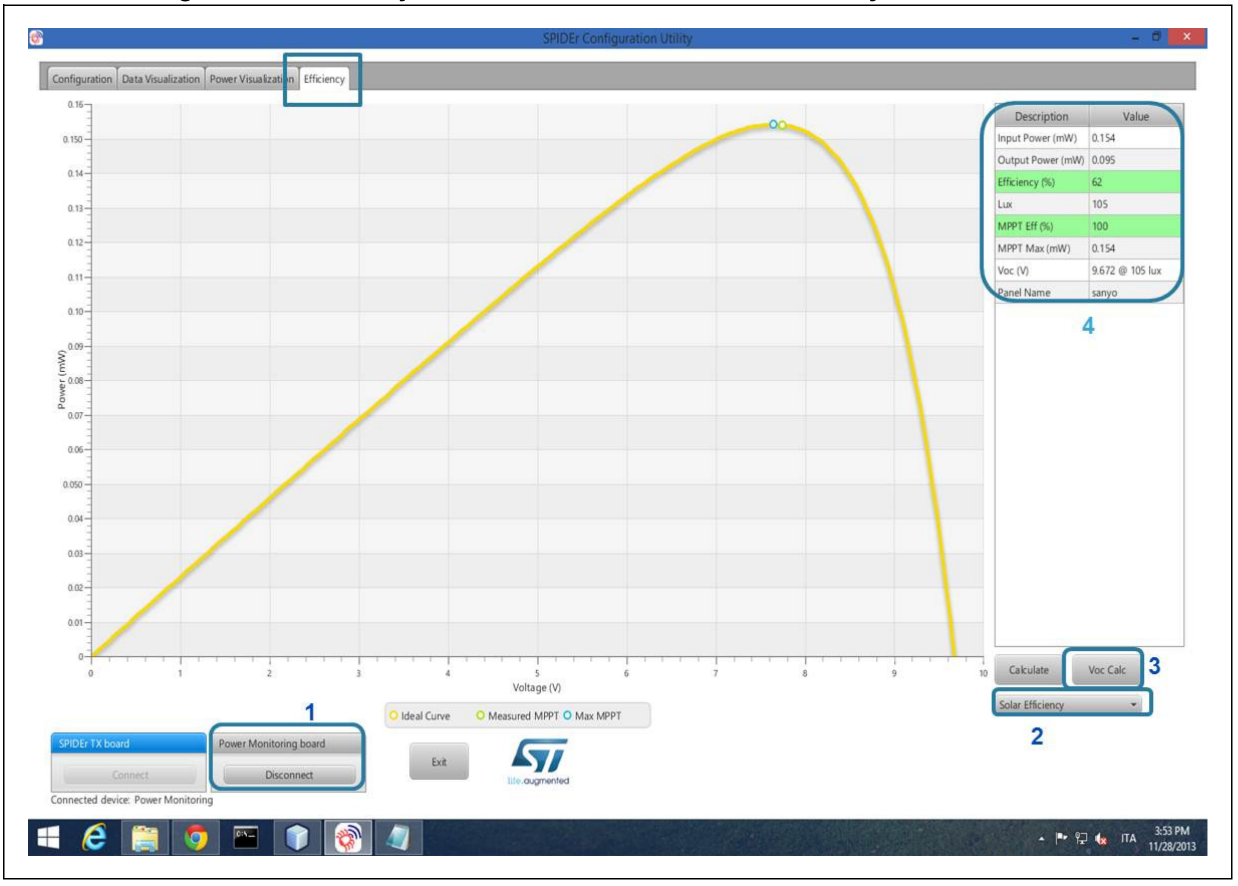
Unzip file "Software.zip" in any folder of the PC or laptop and then launch SpiderConf.exe. In the next sections it's reported how to perform the conversion efficiency measurement and the MPPT accuracy calculation.

3.1 Efficiency measurement and MPPT accuracy calculation using the STEVAL-IDS002V1 or the STEVAL-ISV021V1

Once the STEVAL-IDS002V1 or the STEVAL-ISV021V1 hardware setup is completed and the SpiderConf.exe GUI file runs, the following actions has to be taken:

1. Select the "Efficiency Tab"
2. Click "Connect" on PMB panel (highlighted by "1" in *Figure 12*)
3. Select "Solar Efficiency" in the drop-down box in the bottom right side (highlighted by "2" in *Figure 12*)
4. Click on "VOC Calc" button (highlighted by "3" in *Figure 12*). This is necessary only the first time the GUI starts and whenever the lighting conditions change.
5. After 20 seconds, efficiency conversion and system power budget will be displayed in the right side table (highlighted by "4" in *Figure 12*)

Figure 12. Efficiency tab: PV module curve with efficiency and MPPT data



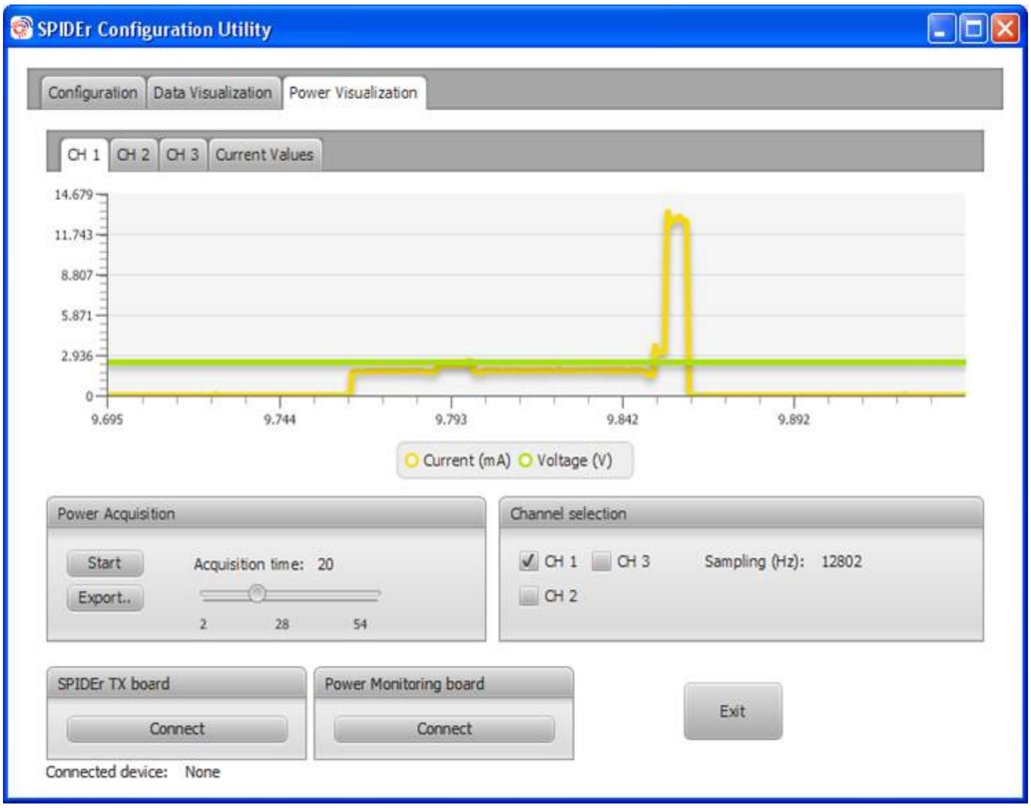
In the graph is depicted the real power-voltage characteristic curve of the PV panel at the current light intensity, the ideal maximum power point (blue dot), and the real operating maximum power point (green dot). Furthermore, in the table some data are listed as following:

- Input power extracted from the PV panel
- Output power carried out to the battery
- Conversion efficiency (output power / input power)
- Ambient light intensity
- MPPT accuracy (real maximum power / ideal maximum power)
- Open circuit voltage of the PV panel

To perform a faster evaluation it is possible to push on the “Calculate” button. In this case the evaluation time is only 2 seconds instead of 20 seconds as previously. By performing this action the open circuit voltage Voc is not detected, and then the P-V curve is determined starting from the ambient light intensity data. This method is faster but it introduces a small measurement error on efficiency measurement. Also, the “Power Visualization” tab (*Figure 13*) allows displaying the measures of other quantities like PV module and battery voltage and current. In particular:

- On channel 1 the V and I profiles of the panel are plotted as a function of time
- On channel 2 the V and I profiles of the battery are plotted as a function of time
- On Channel 3 the output V and I profiles of the ambient light sensor are plotted as a function of the time

Figure 13. Power Visualization tab

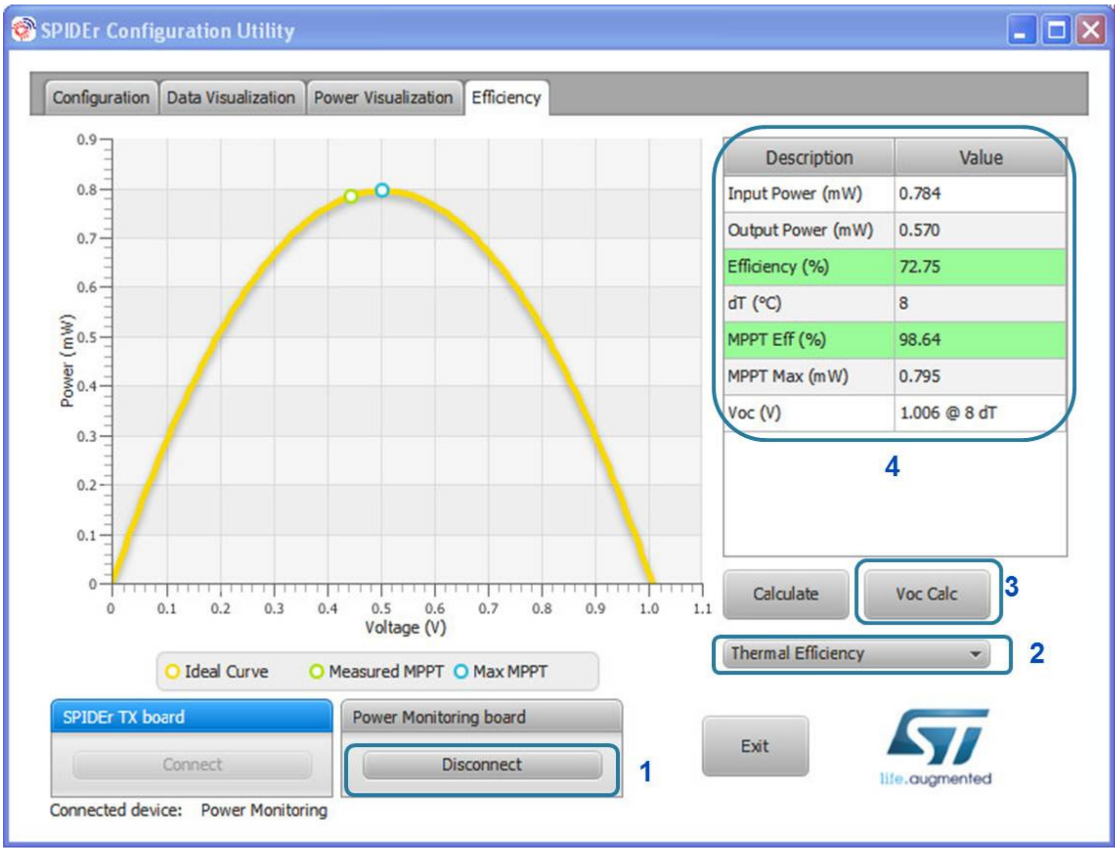


3.2 Efficiency measurement using the STEVAL-IDS003V1

Once the STEVAL-IDS003V1 hardware setup is completed and the SpiderConf.exe GUI file run, the following actions has to be taken:

1. Select the “Efficiency tab”
2. Click on “Connect” button in PMB panel (highlighted by “1” in *Figure 14*)
3. Select “Thermal Efficiency” in the drop-down box in the bottom right side (highlighted by “2” in *Figure 14*)
4. Click on “VOC Calc” button (highlighted by 3 in *Figure 14*)
5. After 20 seconds, efficiency conversion and system power budget will be displayed in the right side table (highlighted by 4 in *Figure 14*)

Figure 14. Efficiency tab: TEG module curve with efficiency and MPPT data



In *Figure 14* is depicted the real power-voltage characteristic curve of the TEG at the actual temperature gradient between its two hot and cold plate, the ideal maximum power point (blue dot), and the real operating maximum power point (green dot).

Furthermore, in the table some data are listed as following:

- Input power extracted from the TEG module;
- Output power carried out to the battery;
- Conversion efficiency (output power / input power);
- Temperature gradient;
- MPPT efficiency (real maximum power / ideal maximum power);
- Open circuit voltage of the TEG module;

Note: The current software GUI release does not support the “Calculate” button feature when using the STEVAL-IDS003V1.

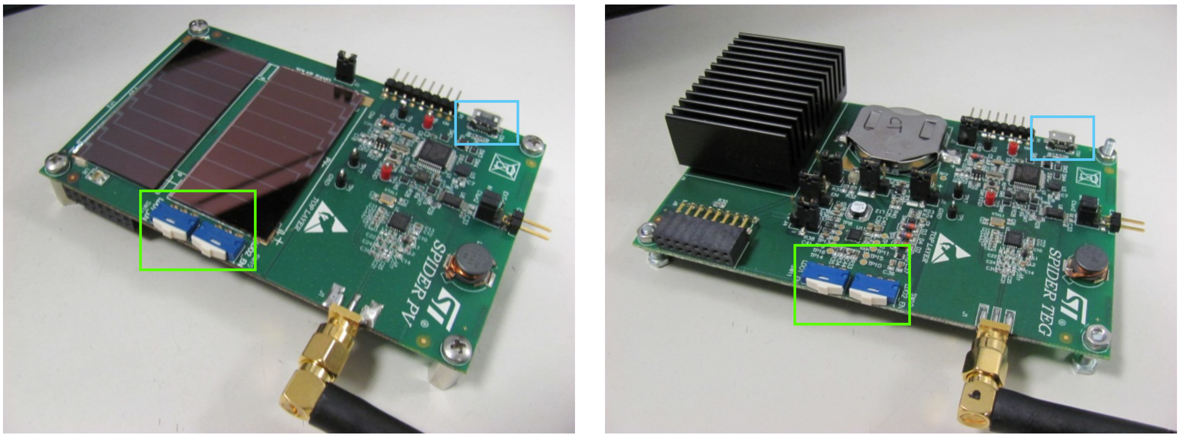
Like with PV solar cell, also when using the STEVAL-IDS003V1 the “Power Visualization” tab (*Figure 13*) allows displaying the measures of other quantities like PV module and battery voltage and current. In particular:

- On channel 1 the V and I profiles of the TEG are plotted as a function of time
- On channel 2 the V and I profiles of the battery are plotted as a function of time
- On channel 3 the output V and I profiles of the temperature sensors are plotted as a function of the time.

4 Wireless sensor node configuration and data transmission

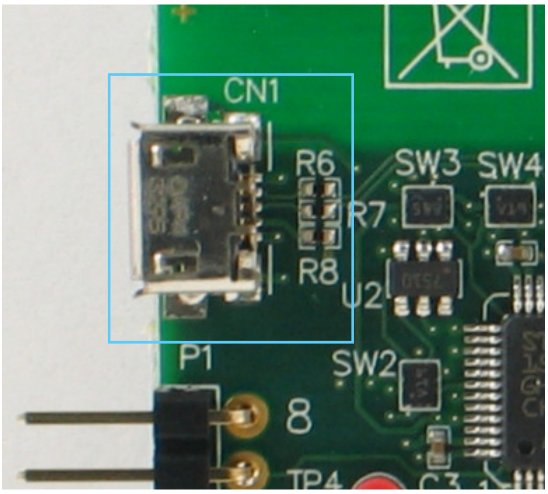
This section describes the configuration of the STEVAL-IDS002V1 and STEVAL-IDS003V1 (SPIDEr@ST), how to perform the data reading of environmental sensors and the transmission of data through wireless interface. By default, only the temperature sensor and the air pressure sensor are enabled, and related data are transmitted every 20 seconds. Position of USB connector and switches used are shown in *Figure 15*. In order to load a different configuration, please refer to the picture below and apply the listed steps:

Figure 15. STEVAL-IDS002V1 and STEVAL-IDS003V1: connector positioning



1. Physically connect the STEVAL-IDS002V1 or the STEVAL-IDS003V1 board to the PC through the micro-USB cable.

Figure 16. Micro USB connector



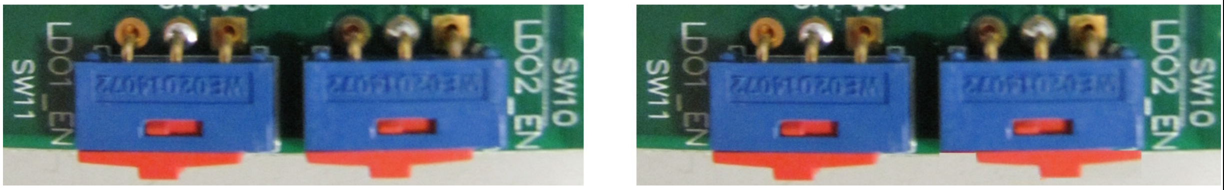
2. Launch the GUI software and click on “Configuration” tab (see *Figure 16*)
3. Click “Connect” on SPIDEr TX board panel after disconnecting the PMB panel first (if it was connected before) (highlighted by 1 in *Figure 16*)
4. Select a pre-loaded configuration (sensor type: Accelerometer, Temperature, Pressure and transmission period) (highlighted by 2 in *Figure 16*)
5. Click on “Write” button (highlighted by 3 in *Figure 16*)
6. Click “Disconnect” on SPIDEr TX board panel (highlighted by 1 in *Figure 16*)
7. Physically disconnect the STEVAL-IDS002V1 or the STEVAL-IDS003V1 board and the micro-USB cable from the PC.

Figure 17. Wireless sensor node configuration

At this stage the selected configuration is loaded into the node. To start data transmission, enable the supply voltage to the node through the LDO2 switch as shown in *Figure 18* and *Figure 20* (STEVAL-IDS002V1 and STEVAL-IDS003V1, respectively).

Figure 18. STEVAL-IDS002V1, LDO2 Switch: ENABLED (left) and DISABLED (right)

Figure 19. STEVAL-IDS003V1, LDO2 Switch: DISABLED (left) and ENABLED (right)

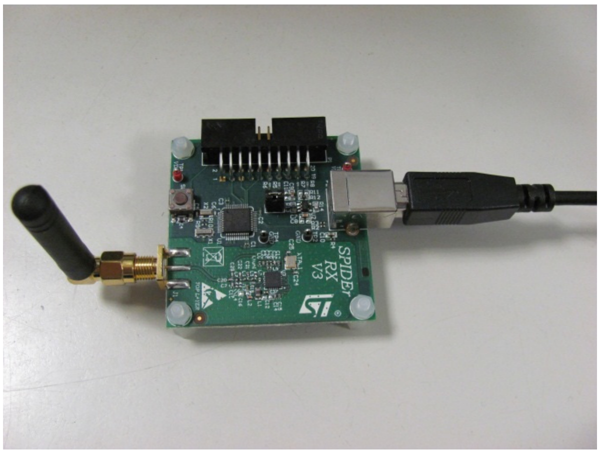


Once LDO2 switch is enabled the sensor node is active and starts transmitting data.

4.1 Reading data

In order to receive the transmitted data, the SPIDEr@ST™ RX board must be physically connected to the PC through the A-B type USB cable as shown in *Figure 20*.

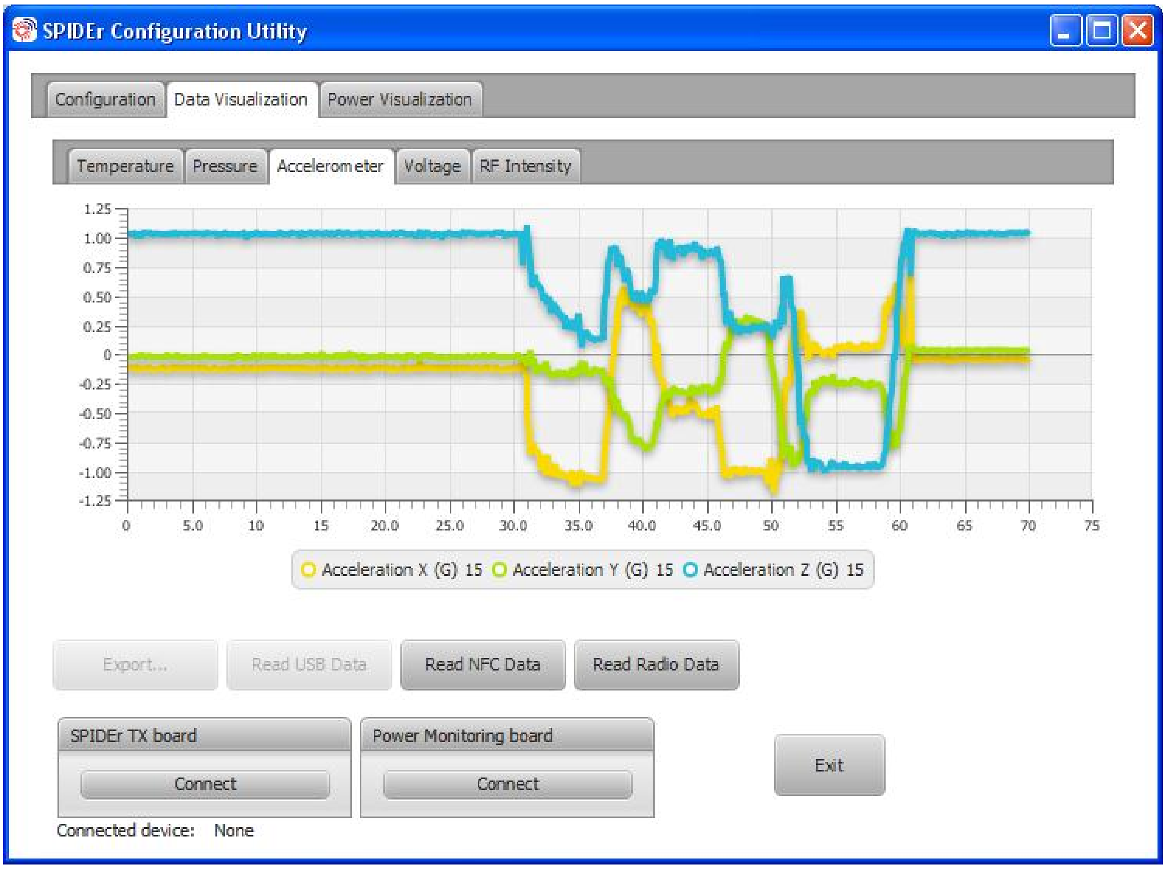
Figure 20. SPIDEr@ST™ RX board and A-B type USB connector to PC



Once connected the receiver the following steps must be followed (refer to *Figure 21*):

1. Launch the software GUI and click on “Data Visualization” tab
2. Disconnect the PMB board or the SPIDEr TX board
3. Click on “Read Radio Data” button
4. Data are shown in the related graphs along with node supply voltage and current, battery voltage and current, and RF radio signal power
5. Click on “X” button at the bottom right side of Data Visualization tab to stop data acquisition.

Figure 21. Data Visualization tab



4.2 Overall system efficiency and power budget

Overall system efficiency can be calculated during wireless sensor node working time also. In this case it will be significantly lower than in stand-by mode (no switching condition) because the sensors, the microcontroller and the transmitter are sinking current.

Nevertheless in such mode it is possible to check if the overall energy balance is positive or not or, in other words, if the energy harvested from the source is enough to supply the node or if it's draining current from the battery also. In order to calculate the total power budget, please follow the steps listed below (refer to *Figure 18*):

1. Launch the software GUI and select the “Power Visualization” tab
2. Disconnect the SPIDEr@ST™ TX board if previously connected, and then click on “Connect” button of PMB panel
3. Select Channel 2 only
4. Select an acquisition time value (which is multiple of node transmission time)
5. Click on “Start” button
6. After finishing acquisition, select the “current values” sub-tab (refer to *Figure 22*)
7. Select channel 2 and then click on “Calculate” button (refer to *Figure 22*)
8. The “Mean Power” box will show the value and the sign of mean power, and if the energy balance is positive or negative.

Figure 22. Power Visualization tab

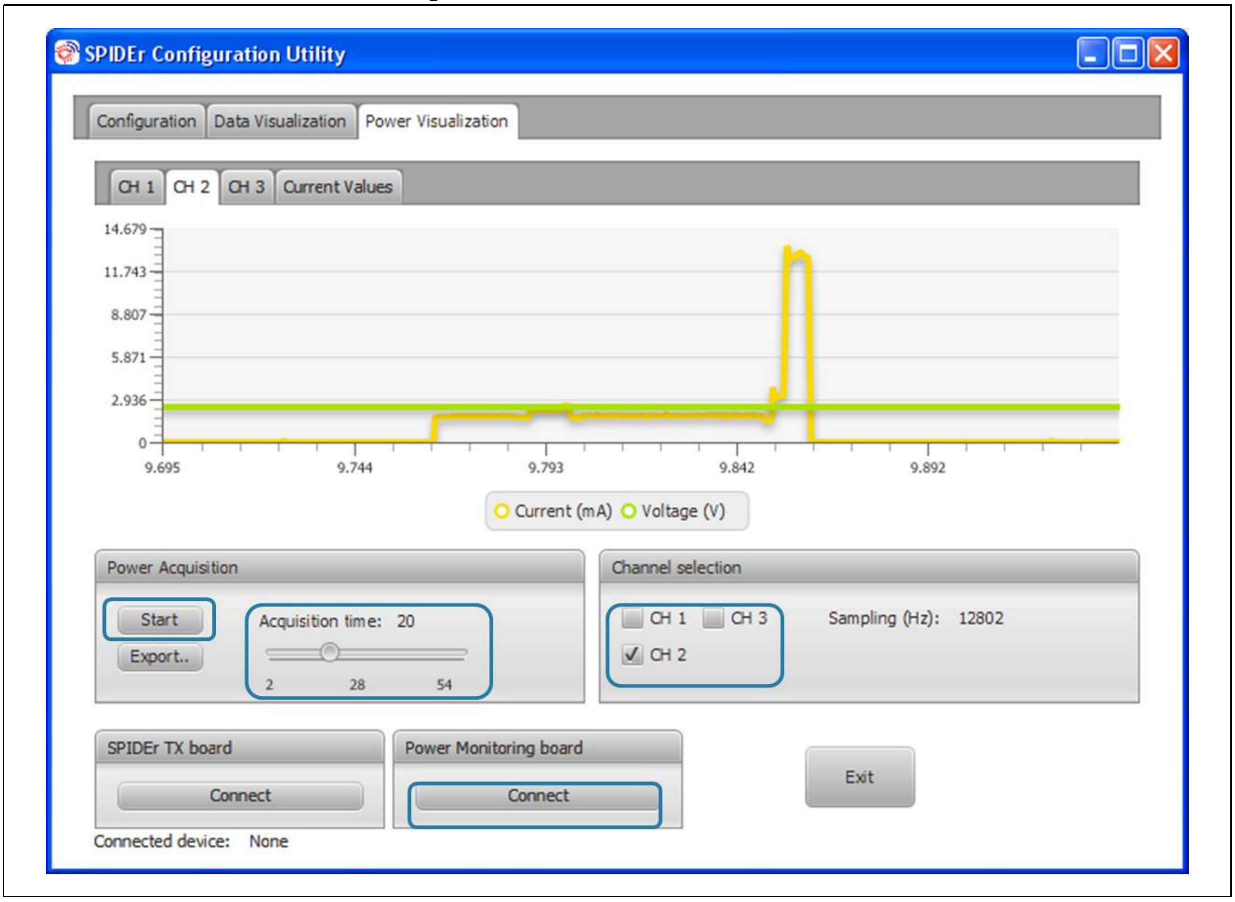
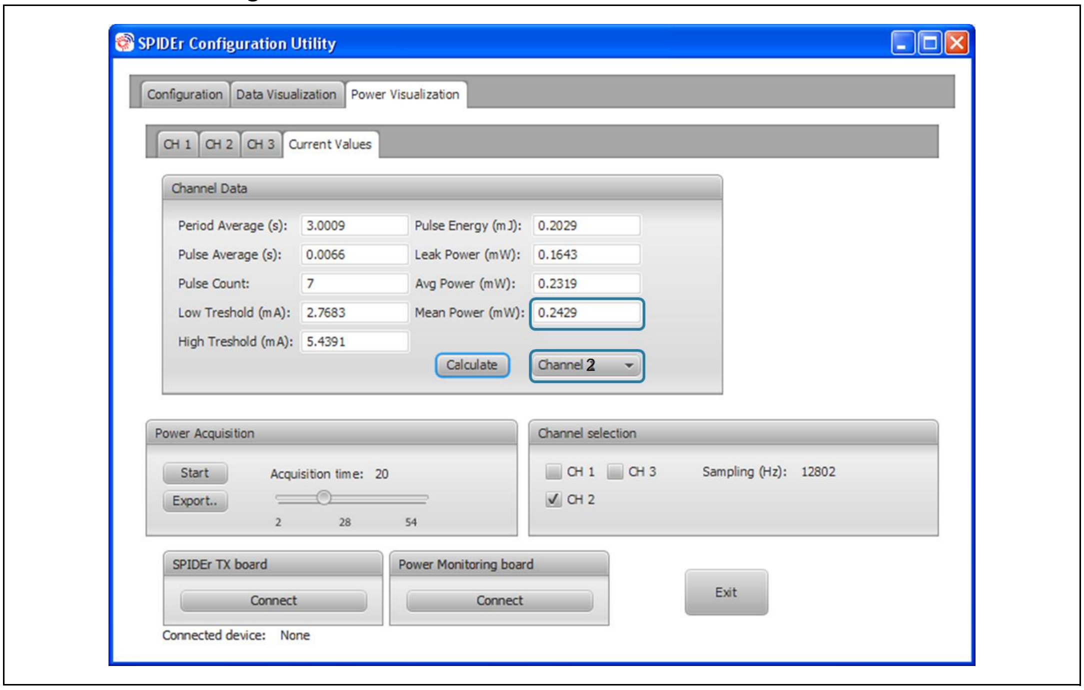


Figure 23. Power Visualization - Current Values tab



Finally, it is possible to use the STEVAL-IDS002V1 and the STEVAL-IDS003V1 as stand-alone wireless sensor node and the STEVAL-ISV021V1 as stand-alone battery charger, which means without connecting the PMB. In this case the correct jumper positions are shown in *Figure 24* and *Figure 25*, and described below:

For STEVAL-IDS002V1

- Leave J4 open and close pins 2-3 of J7 to supply the system by the on board PV panel
- Close pins 1-2 of J5 to bypass the input sampling circuitry of PMB
- Close pins 1-2 of J6 to bypass the output sampling circuitry of PMB

- For STEVAL-IDS003V1
  - Leave J4 open and close pins 2-3 of J7 to supply the system by the on board PV panel
  - Close pins 1-2 of J5 to bypass the input sampling circuitry of PMB
  - Close pins 1-2 of J6 to bypass the output sampling circuitry of PMB

- For STEVAL-ISV021V1
  - Leave CN1 open and close pins 2-3 of J4 to supply the system by the on board PV panel
  - Close pins 1-2 of J5 to bypass the input sampling circuitry of PMB
  - Close pins 1-2 of J6 to bypass the output sampling circuitry of PMB
  - Close pins 1-2 of J7 to bypass the ambient light sampling circuitry of PMB

In case the PMB is not connected, please note that efficiency, MPPT accuracy and input and output power data cannot be displayed.

Figure 24. Jumper positions for the STEVAL-IDS002V1 (left) and STEVAL-IDS003V1 (right) in stand-alone mode

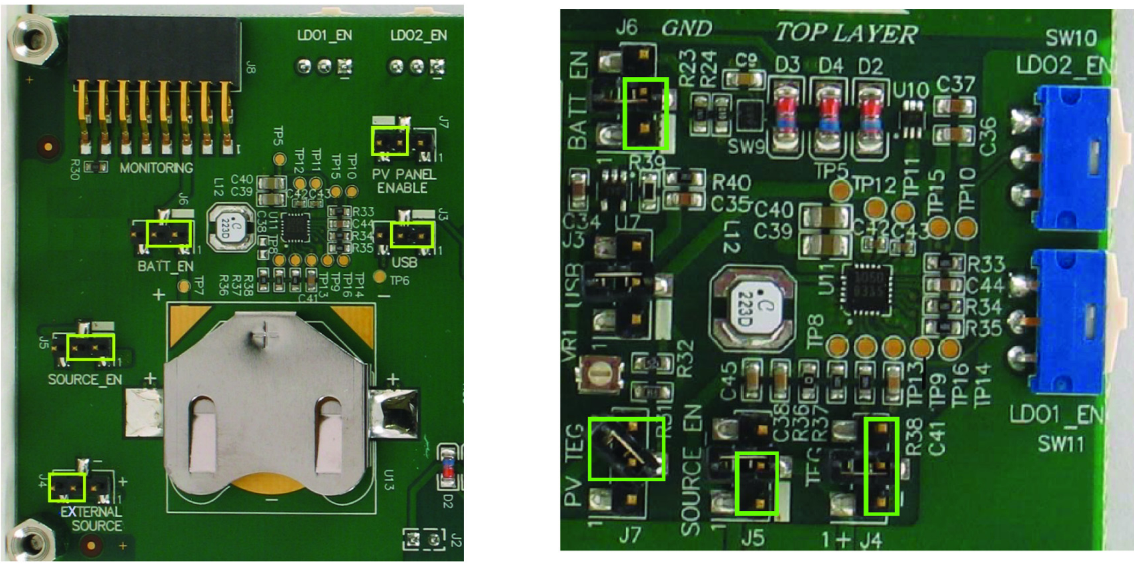
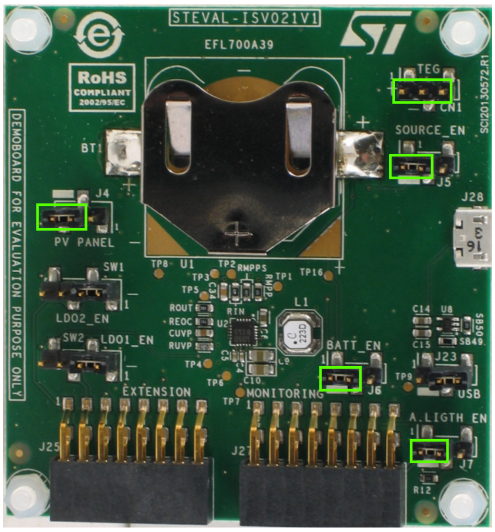


Figure 25. Jumper positions for the STEVAL-ISV021V1 in stand-alone mode



5 Revision history

Table 2. Document revision history

Date	Revision	Changes
29-Apr-2014	1	Initial release.
20-May-2015	2	Added: *Figure 19*