STSW-IDS002V1: GUI for for STEVAL-ISV021V1, STDES-IDS002V1 and STDES-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

STEVAL-ISV021V1: Energy harvesting demonstration kit based on SPV1050
STDES-IDS002V1: SPIDEr™ Autonomous wireless multi-sensor node powered by PV cells and based on SPV1050
STDES-IDS003V1: SPIDEr™ Autonomous wireless multi-sensor node powered by TEG and based on SPV1050

The pictures of evaluation boards listed above and of STDES- ERH001D (power monitoring board, PMB) are shown in Figure 1. STDES-ERH003V1 (SPIDEr@ST™ with PV module): top and bottom, Figure 2. STDES-ERH001V1 (SPIDEr@ST™ with TEG): top and bottom, Figure 3. STEVAL-ISV021V1 (Energy harvesting module): top and bottom and Figure 4. STDES-ERH001D (power monitoring board, PMB): top and bottom.

Please refer to the related databriefs for further details.

The dedicated software GUI (STSW-IDS002V1) 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.

1 Evaluation board photos

Figure 1. STDES-ERH003V1 (SPIDEr@ST™ with PV module): top and bottom

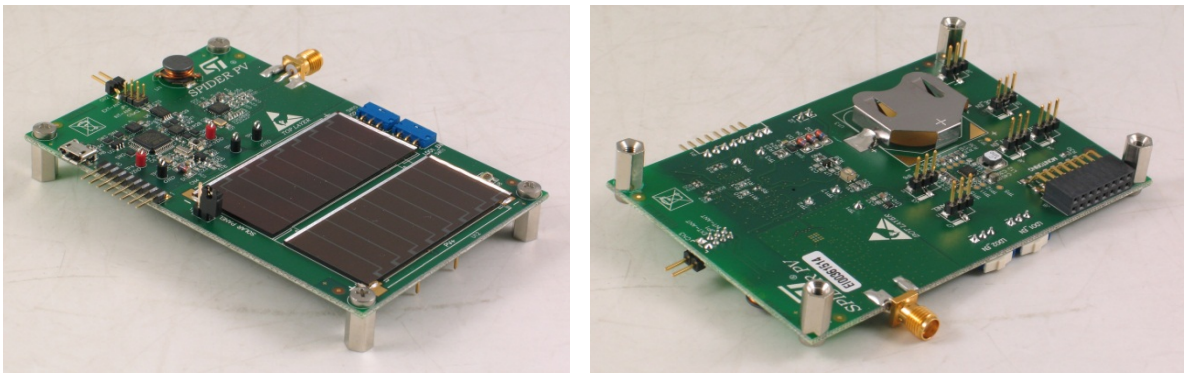


Figure 2. STDES-ERH001V1 (SPIDEr@ST™ with TEG): top and bottom

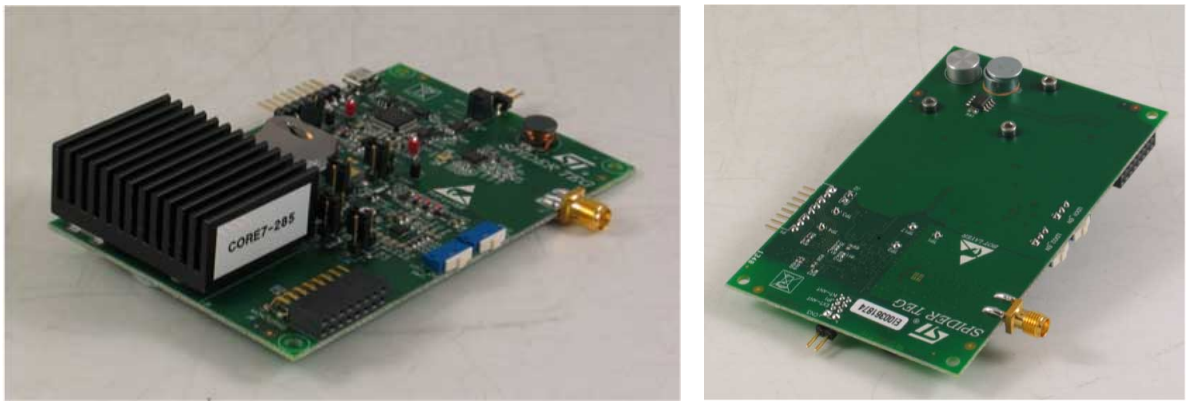


Figure 3. STEVAL-ISV021V1 (Energy harvesting module): top and bottom

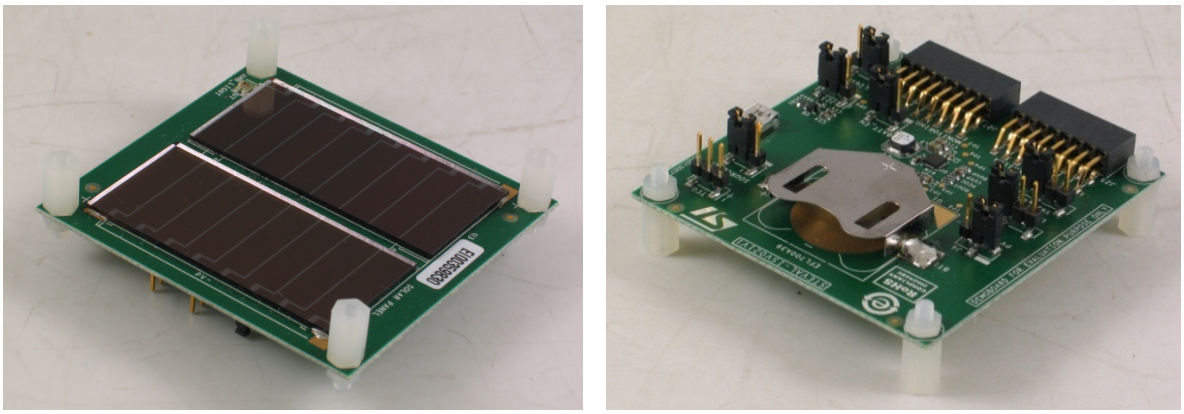
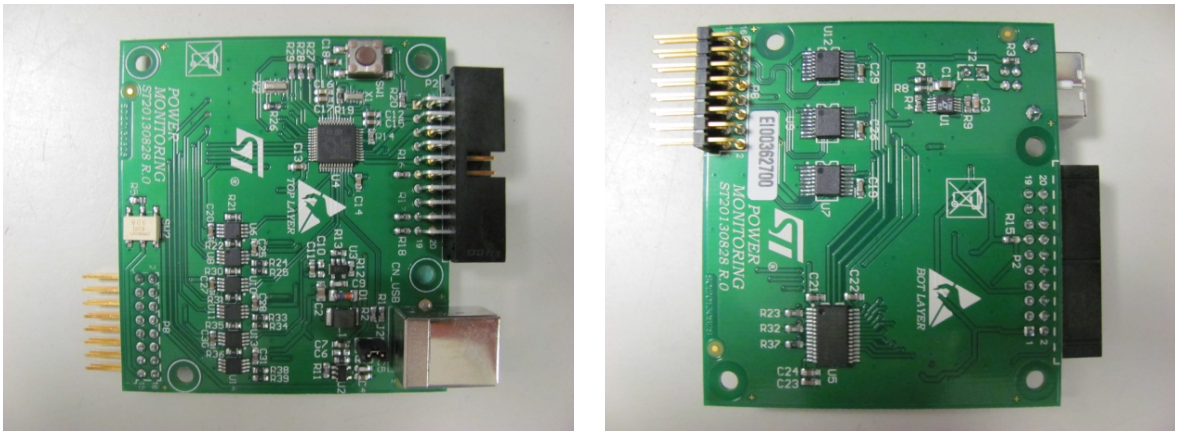


Figure 4. **STDES- ERH001D (power monitoring board, PMB): top and bottom**

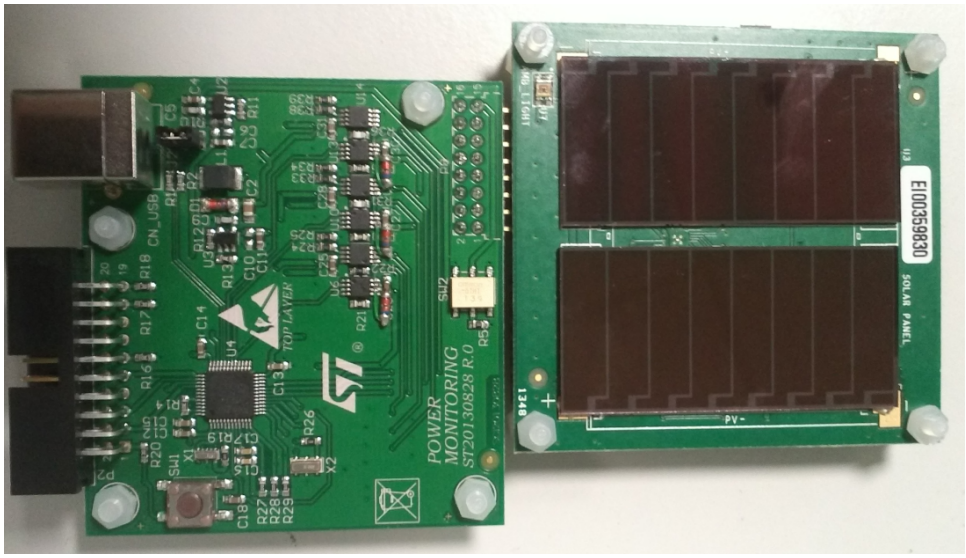


2 Hardware setup

2.1 STEVAL-ISV021V1

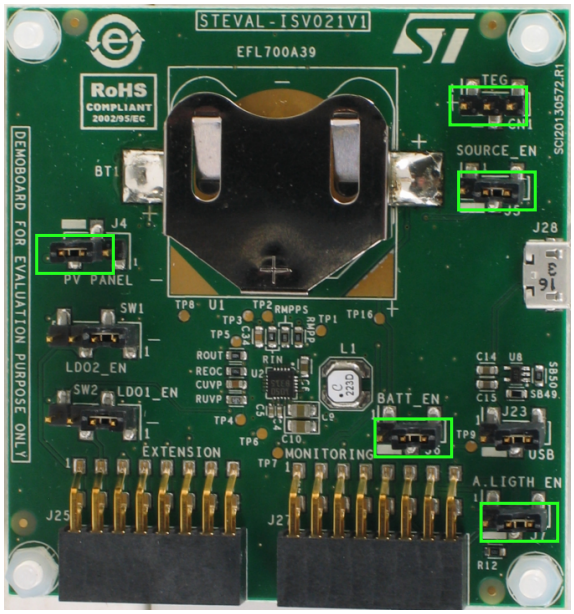
Connect the PMB through the USB cable to the PC first and then connect the STEVAL-ISV021V1 to it as shown in Figure 5. STEVAL-ISV021V1 and PMB connection. It's strongly recommended to not connect the PMB to the STEVAL-ISV021V1 if it is not yet powered by the USB cable as its current draining could damage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

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



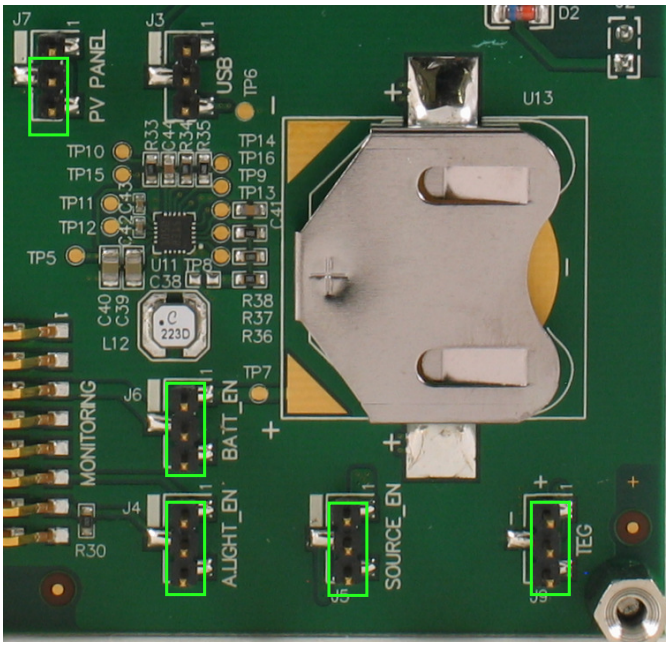
2.2 STDES-IDS002V1

Connect the PMB through the USB cable to the PC first and then connect the STDES-ERH003V1 to it as shown in Figure 7. STDES-ERH003V1 and STDES-ERH001D connection. It's strongly recommended to not connect the PMB to the STDES-ERH003V1 if it is not yet powered by the USB cable as its current draining could damage the battery on the board.

Figure 7. **STDES-ERH003V1 and STDES-ERH001D 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 STDES-ERH003V1 is connected to PMB, the jumpers J5 and J6 must be left open, as shown in Figure 8. Jumpers positioning on bottom side of STDES-ERH003V1.

Figure 8. Jumpers positioning on bottom side of STDES-ERH003V1



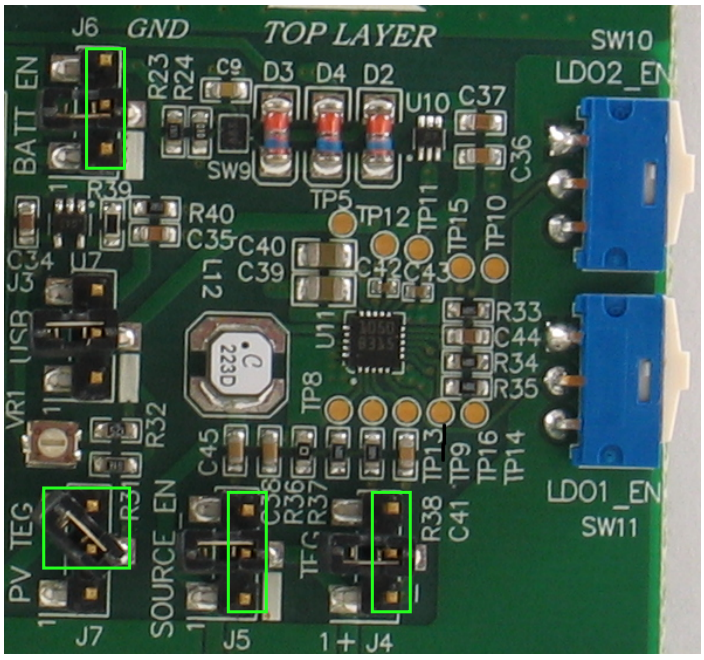
2.3 STDES-IDS003V1

Connect the PMB through the USB cable to the PC first and then connect the STDES-ERH001V1 to it as shown in Figure 9. STDES-ERH001V1 and STDES-ERH001D connection. It's strongly recommended to not connect the PMB to the STDES-ERH001V1 if it is not yet powered by the USB cable as its current draining could damage the battery on the board.

Figure 9. **STDES-ERH001V1 and STDES-ERH001D connection**

Check jumper position on top side of the STDES-ERH001V1. In order to supply the system by the on board TEG, close pins 2-3 of J7 and leave J4 open. When the STDES-ERH001V1 is connected to the PMB, the jumpers J5 and J6 must be left open, as shown in Figure 10. Jumpers positioning on top side of STDES-ERH001V1.

Figure 10. **Jumpers positioning on top side of STDES-ERH001V1**

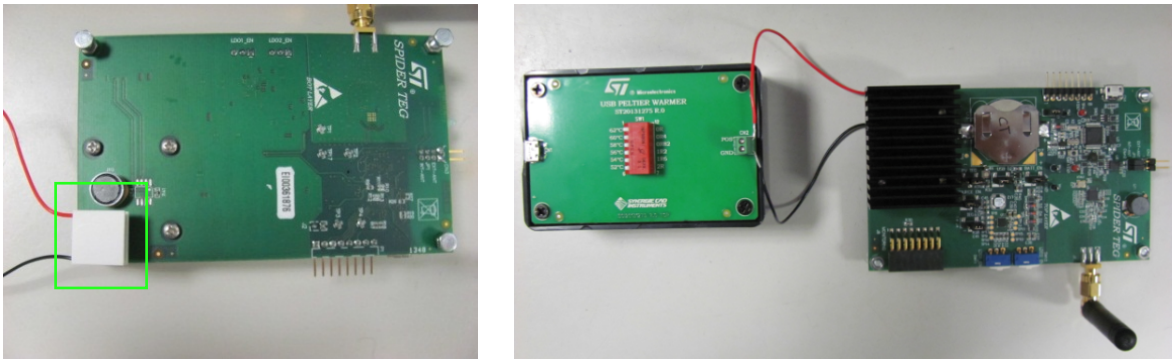


2.4 Heater board

The TEG mounted on the STDES-ERH001V1 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 STDES-ERH001V1 to guarantee the maximum heat transfer as shown in Figure 11. Peltier cell heating surface and bottom view of the STDES-ERH001V1 with exposed TEG plate surface.

Figure 11. Peltier cell heating surface and bottom view of the STDES-ERH001V1 with exposed TEG plate surface



3 STSW-ISV002V1 Set-up

Install and launch the STSW-ISV002V1 in your PC/laptop.

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 STDES-ERH003V1 or the STEVAL-ISV021V1

Once the STDES-ERH003V1 or the STEVAL-ISV021V1 hardware setup is completed and the STSW-IDS002V1 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. Efficiency tab: PV module curve with efficiency and MPPT data)
3. Select “Solar Efficiency” in the drop-down box in the bottom right side (highlighted by“2” in Figure 12. Efficiency tab: PV module curve with efficiency and MPPT data)
4. Click on “VOC Calc” button (highlighted by “3” in Figure 12. Efficiency tab: PV module curve with efficiency and MPPT data). This is necessary only thefirst time the GUI starts and whenever the lighting conditions change
5. After 20 seconds, efficiency conversion and system power budget will be displayed inthe right side table (highlighted by “4” in Figure 12. Efficiency tab: PV module curve with efficiency and MPPT data)

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

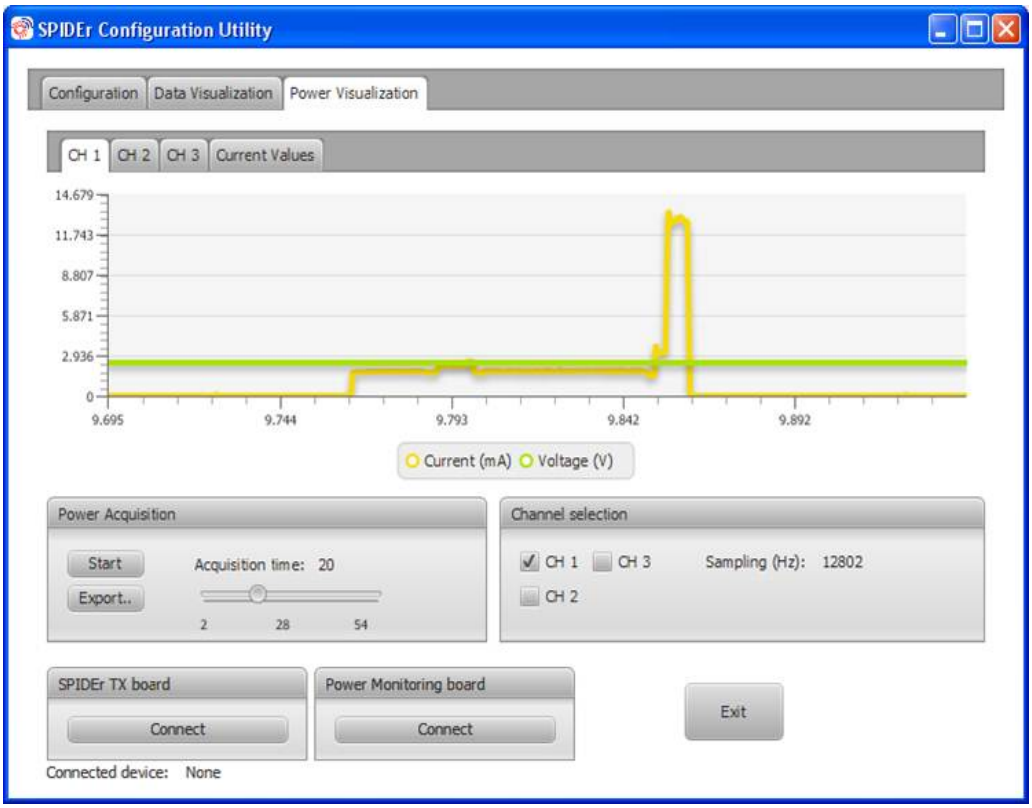
In the graph is depicted the real power-voltage characteristic curve of the PV panel at the current light intensity, the ideal maximum power point (blue dot), and the real operating maximum power point (green dot). Furthermore, in the table some data are listed as following:

- 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. Power visualization tab) 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



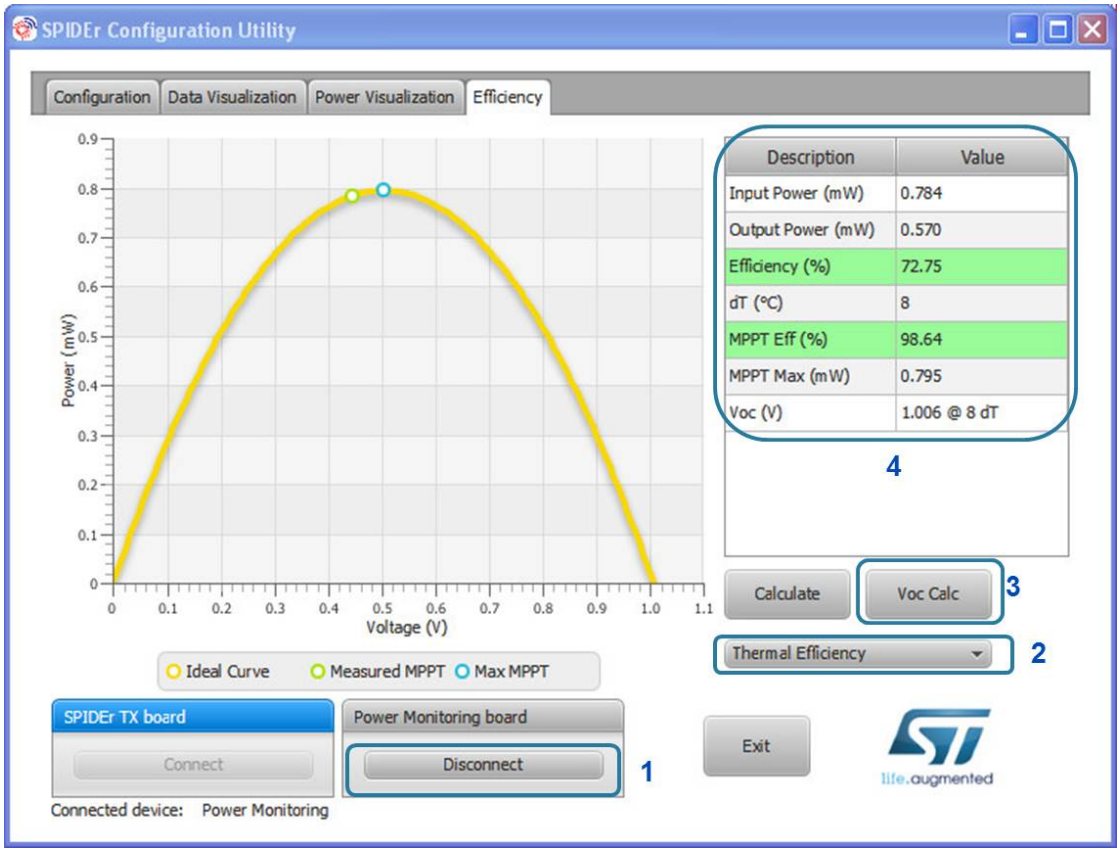
3.2 Efficiency measurement using the STDES-ERH001V1

Once the STDES-ERH001V1 hardware setup is completed and the STSW-IDS002V1 runs, 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. Efficiency tab: TEG module curve with efficiency and MPPT data)

3. Select “Thermal Efficiency” in the drop-down box in the bottom right side (highlighted by “2” in Figure 14. Efficiency tab: TEG module curve with efficiency and MPPT data)
4. Click on “VOC Calc” button (highlighted by 3 in Figure 14. Efficiency tab: TEG module curve with efficiency and MPPT data)
5. After 20 seconds, efficiency conversion and system power budget will be displayed in the right side table (highlighted by 4 in Figure 14. Efficiency tab: TEG module curve with efficiency and MPPT data)

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



In Figure 14. Efficiency tab: TEG module curve with efficiency and MPPT data 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 STDES-ERH001V1

Like with PV solar cell, also when using the STDES-ERH001V1 the “Power Visualization” tab (Figure 13. Power visualization tab) allows displaying the measures of other quantities like PV module and battery voltage and current. In particular:

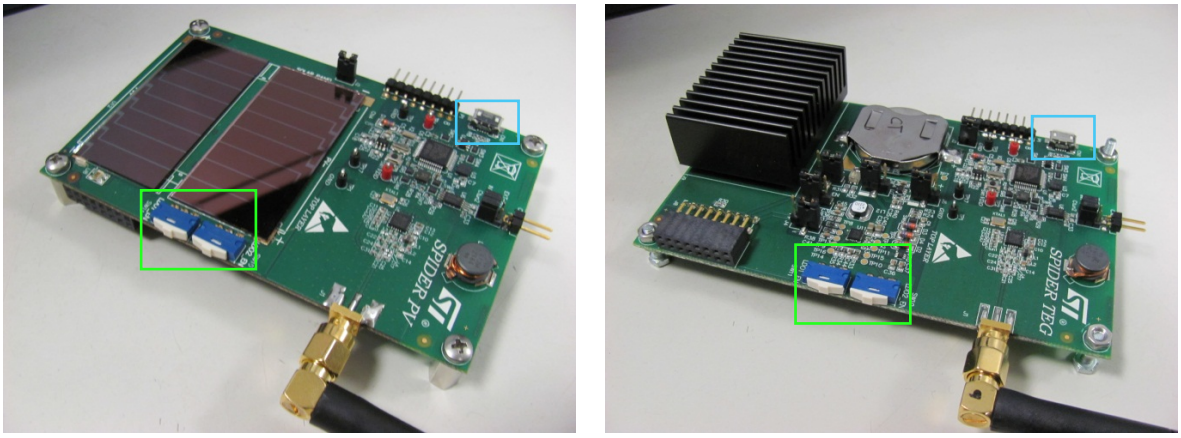
- On channel 1 the V and I profiles of the TEG are plotted as a function of time

- 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 STDES-IDS002V1 and STDES-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. STDES-ERH003V1 and STDES-ERH001V1: connector positioning.

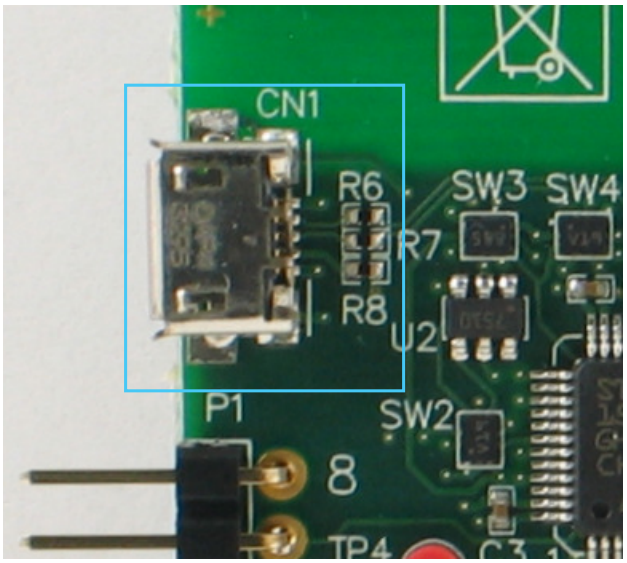
Figure 15. STDES-ERH003V1 and STDES-ERH001V1: connector positioning



In order to load a different configuration, please refer to the picture below and apply the listed steps.

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

Figure 16. Micro USB connector



2. Launch the STSW-IDS002V1 and click on “Configuration” tab (see Figure 16. Micro USB connector)
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. Micro USB connector)

4. Select a pre-loaded configuration (sensor type: accelerometer, temperature, pressure and transmission period) (highlighted by 2 in Figure 16. Micro USB connector)
5. Click on “Write” button (highlighted by 3 in Figure 16. Micro USB connector)
6. Click “Disconnect” on "SPIDEr TX" board panel (highlighted by 1 in Figure 16. Micro USB connector)
7. Physically disconnect the STDES-ERH003V1 or the STDES-ERH001V1 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. STDES-ERH003V1, LDO2 Switch: ENABLED (left) and DISABLED (right) and Figure 19. STDES-ERH001V1, LDO2 Switch: DISABLED (left) and ENABLED (right) (STDES-ERH003V1 and STDES-ERH001V1, respectively).

Figure 18. STDES-ERH003V1, LDO2 Switch: ENABLED (left) and DISABLED (right)

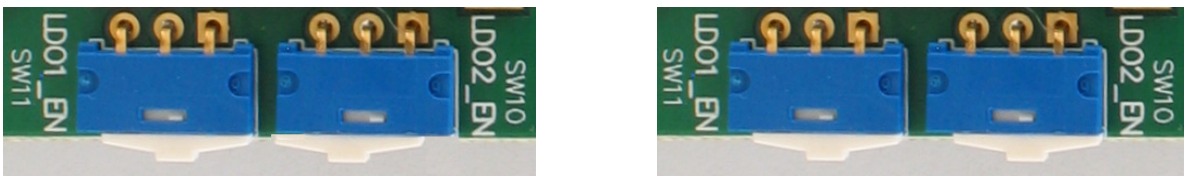
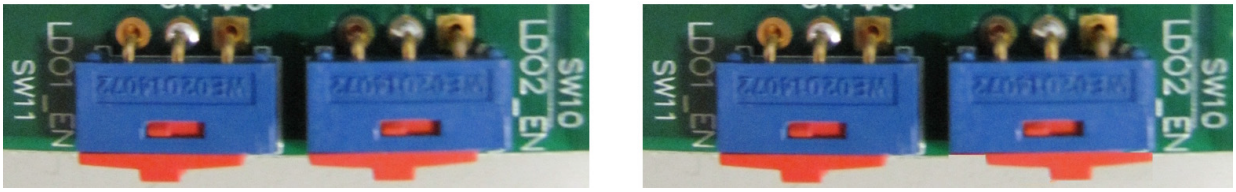


Figure 19. **STDES-ERH001V1, LDO2 Switch: DISABLED (left) and ENABLED (right)**

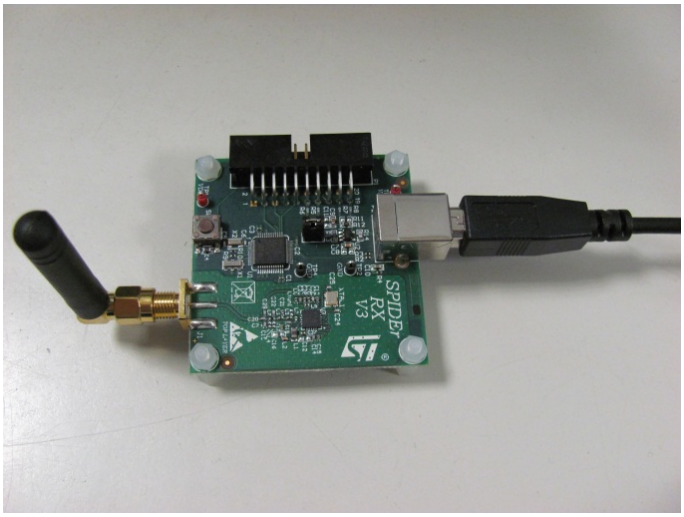


Once LDO2 switch is enabled the sensor node is active and starts transmitting data.

4.1 Reading data

In order to receive the transmitted data, the STDES-ERH002V1 receiver board must be physically connected to the PC through the A-B type USB cable as shown in Figure 20. STDES-ERH002V1 RX board and A-B type USB connector to PC

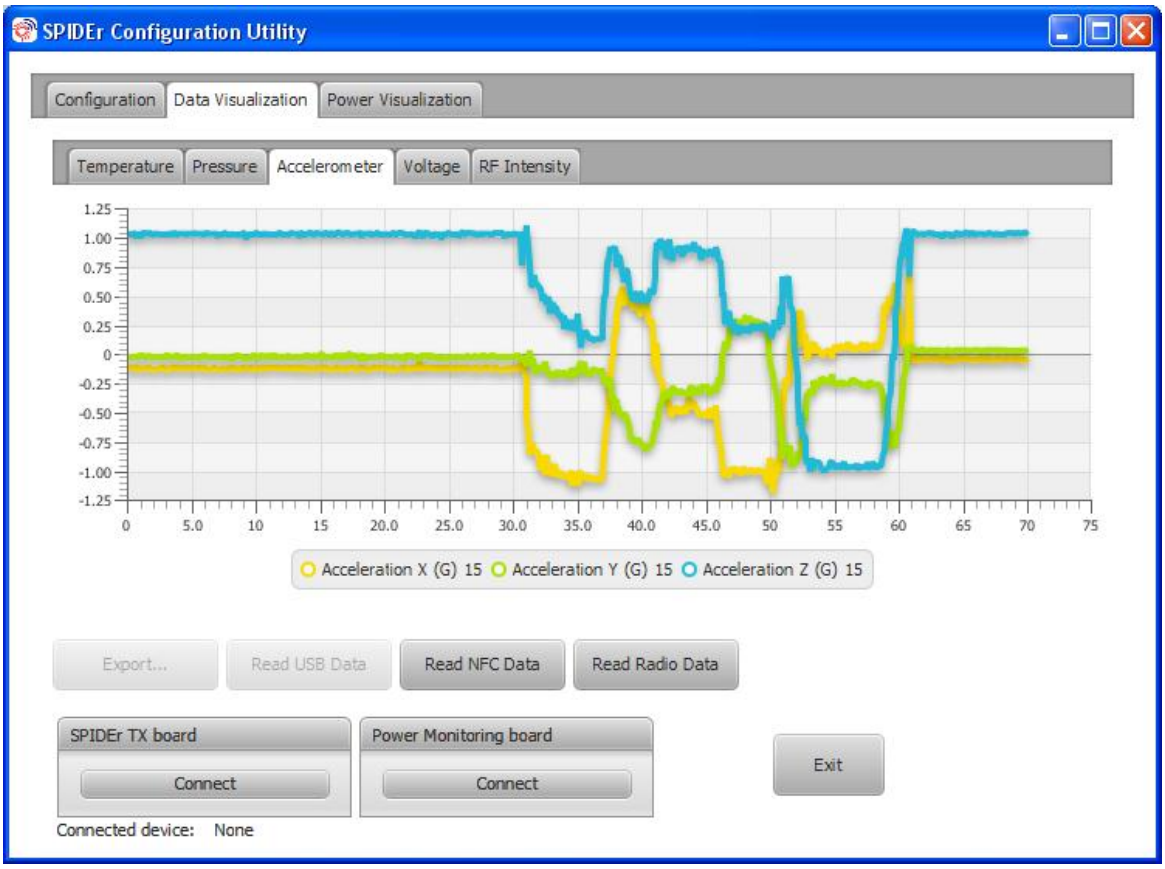
Figure 20. **STDES-ERH002V1 RX board and A-B type USB connector to PC**



Once connected the receiver the following steps must be followed (refer to Figure 21. Data Visualization tab):

1. Launch the STSW-IDS002V1 and click on “Data Visualization” tab
2. Disconnect the PMB board or the transmitter 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. STDES-ERH003V1, LDO2 Switch: ENABLED (left) and DISABLED (right)):

Step 1. Launch the STSW-IDS002V1 and select the “Power Visualization” tab

Step 2. Disconnect the transmitter board if previously connected, and then click on “Connect” button of PMB panel

Step 3. Select Channel 2 only

Step 4. Select an acquisition time value (which is multiple of node transmission time)

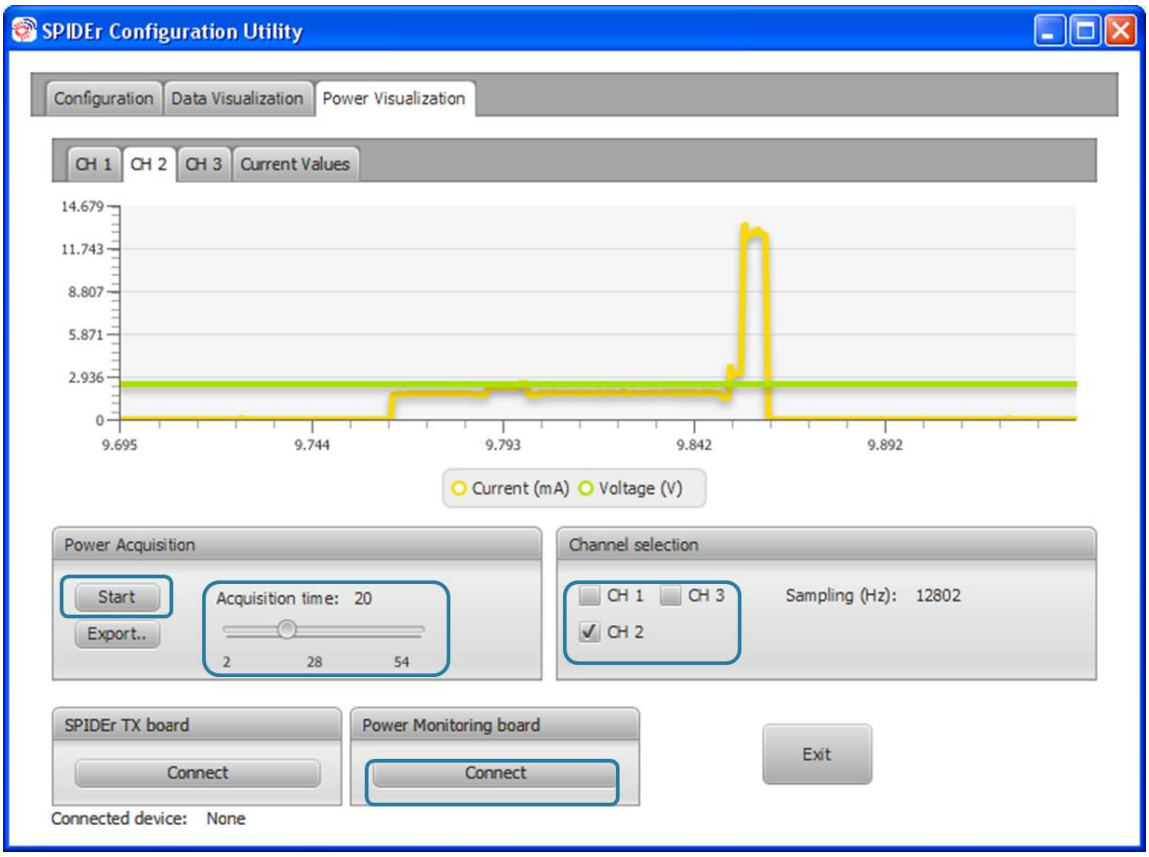
Step 5. Click on “Start” button

Step 6. After finishing acquisition, select the “current values” sub-tab (refer to Figure 22. Power Visualization tab)

Step 7. Select channel 2 and then click on “Calculate” button (refer to Figure 22. Power Visualization tab)

Step 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**



Finally, it is possible to use the STDES-IDS002V1 and the STDES-IDS003V1 as standalone 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 23. Jumper positions for the STDES-ERH003V1 (left) and STDES-ERH001V1 (right) in stand-alone mode and Figure 24. Jumper positions for the STEVAL-ISV021V1 in stand-alone mode, and described below:

For STDES-ERH003V1

- 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 STDES-ERH001V1

- 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 23. **Jumper positions for the STDES-ERH003V1 (left) and STDES-ERH001V1 (right) in stand-alone mode**

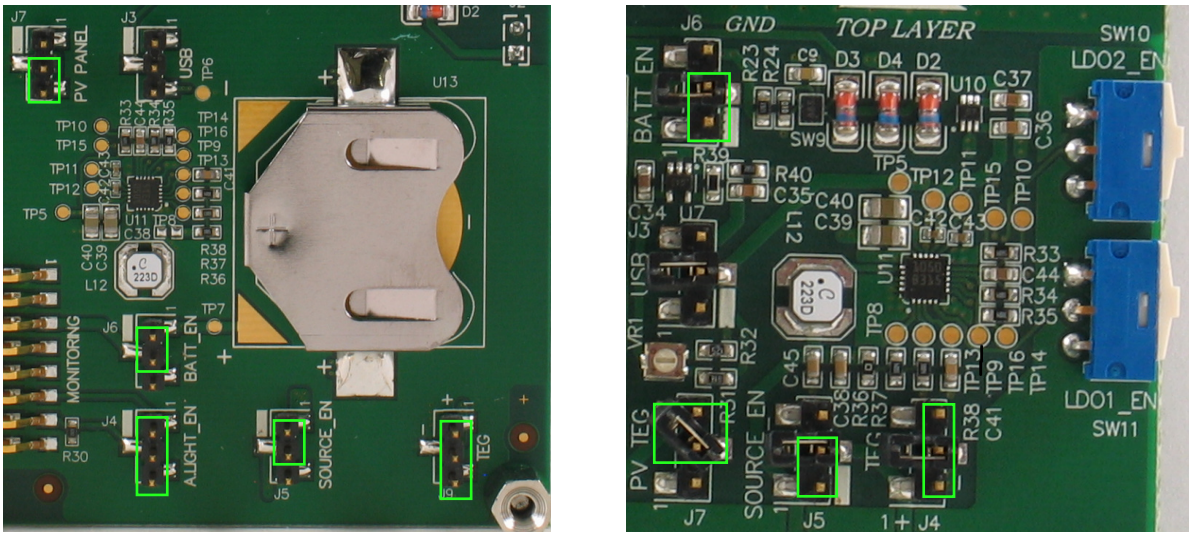
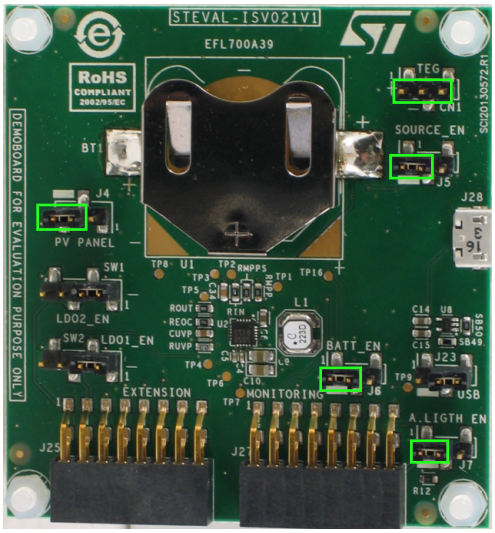


Figure 24. **Jumper positions for the STEVAL-ISV021V1 in stand-alone mode**



Revision history

Table 2. **Document revision history**

Date	Version	Changes
29-Apr-2014	1	Initial release.
20-May-2015	2	Added: Figure 19
04-Mar-2019	3	Updating to align the document to the the new boards names: STEVAL-IDS003V1 → STDES-ERH001V1; Transmitter board → STDES-ERH002V1; Power monitoring board → STDES-ERH001D; STEVAL-IDS002V1 → STDES-ERH003V1;

Contents

List of tables

List of figures