Application Note - Energy Metering at a Medium Voltage Connection Point using a Voltage Transformer

This document describes the connection and configuration of a Janitza meter at a medium voltage (MV) connection point to a SolarEdge device. This specific set-up may also be useful for export limitation applications.

NOTE

Medium voltage typically ranges from (but is not limited to) 6 kV to 33 kV.

Use of the meter is not limited to a commercial site's MV-side connection point. It can be used in low-voltage applications as well.

The meter connection referred to in this application note is characterized by:

- Use of a voltage transformer to downscale high voltage.
- Direct measurement of the voltage of the connection point phases in 3-phase 3-conductor systems using two voltage transformers (Aron circuit) and two current transformers.

Revision History

Version 1.1 (June 2018)

- Updated connectivity procedure

Version 1.0 (March 2018)

- Initial release

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Introduction

The meter can be connected to a SolarEdge inverter or Control and Communication Gateway (CCG). An example of such a connection appears in the figure below.

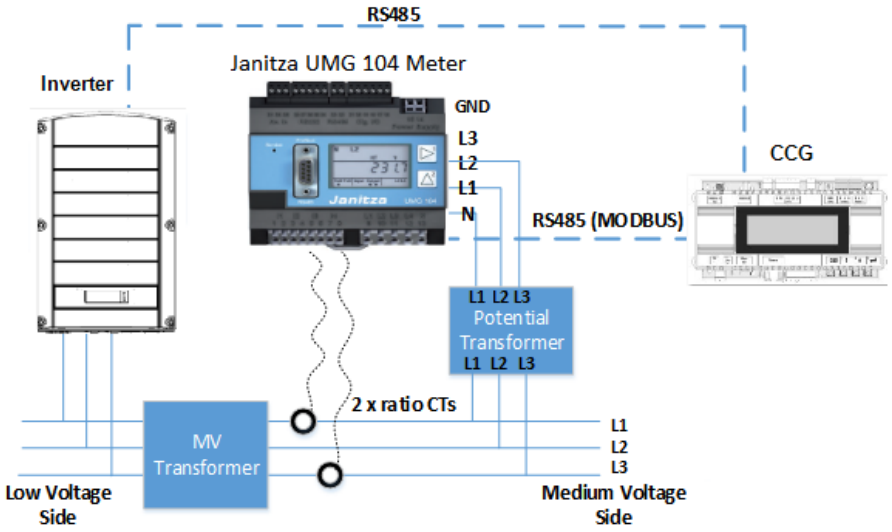


Figure 1: MV meter connection example

The meter can be connected via the CCG (as shown in this example), or directly to the inverter. The SolarEdge device reads the energy data from the meter and forwards the data to the monitoring platform. In addition, export limitation can be configured.

Supported MV Meter

The Janitza® **UMG 104 Power Analyzer** is a three phase meter intended for commercial use in medium-voltage and low-voltage grid environments, and can be used to implement export limitation. For detailed information, refer to: https://www.janitza.com/umg-104.html.

SolarEdge Device Firmware Version

To use an MV meter connection, the inverter communication board firmware (CPU) version must be 3.2228 or later (but not version 4.xxxx).

To check the inverter CPU version:

1. Verify that the inverter has been activated using the activation card supplied with the inverter.
2. To check the firmware version of the CPU short press the LCD light button on the inverter until the screen below is displayed:

```
ID:  ########  ##
ID:  7F10373E  03
DSP1/2:1.0210/1.0034
DSP1:1.0210
CPU:0003.19xx
Country:ESP
```

3. To upgrade inverters with earlier firmware versions, refer to https://www.solaredge.com/sites/default/files/upgrading_an_inverter_using_micro_sd_card.pdf.

Meter Connections

AC Power Connection

For detailed information on how to connect the meter's AC side, refer to the installation guide provided with the meter.

Site current transformers (CT) are connected to the meter CT inputs. For lowering the medium voltages to the operating range of the meter, voltage transformers (VT) are connected to the meter phase inputs.

The following figures illustrate CT and VT connections.

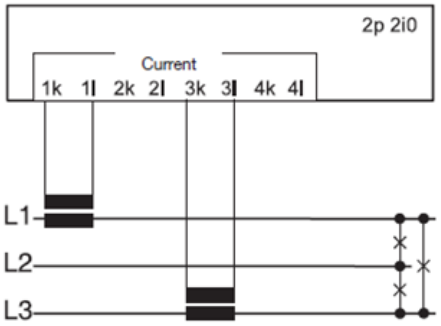


Figure 2: Connecting Current Transformers to the Janitza UMG 104

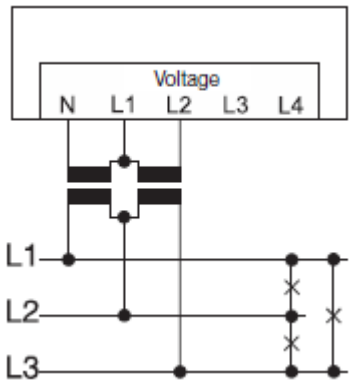


Figure 3: Connecting Voltage Transformers to the Janitza UMG 104

RS485 Communication Connection

RS485 wiring specifications:

- Cable type: Min. 3-wire shielded twisted pair (a shielded Ethernet cable (Cat5/5E STP) may be used)
- Wire cross-section area: 0.2- 1 mm²/ 24-18 AWG (a CAT5 cable may be used)
- Maximum nodes: 32
- Maximum distance between first and last devices: 1 km /3300 ft.

NOTE

If using a cable longer than 10 m/33 ft in areas where there is a risk of induced voltage surges by lightning, it is recommend to use external surge protection devices. For details refer to: https://www.solaredge.com/sites/default/files/lightning_surge_protection.pdf.

If grounded metal conduit are used for routing the communication wires, a lightning protection device is not required.

If not using surge protection, connect the grounding wire to the first inverter in the RS485 chain; make sure the grounding wire is not in contact with other wires. For inverters with a Connection Unit, connect the grounding wire to the grounding bus-bar in the Connection Unit.

To connect a communication cable to the meter:

1. Loosen the screws of pins 485A and 485B on the meter, as shown below:

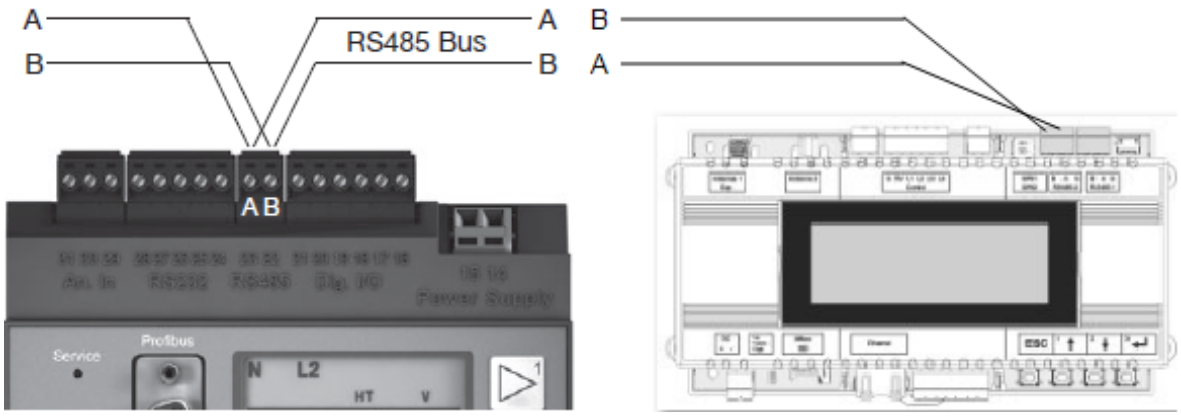


Figure 4: Meter to SolarEdge RS485 Connection

2. Insert the wire ends into the 485A and 485B pins.
3. Tighten the terminal screws.
4. Connect the other end of the cable to the SolarEdge device as detailed in *RS485 Communication Connection* on page 4.

NOTE

Make sure to perform a "cross" RS485 cable connection between:
* Connect wire A on the meter to wire B on the SolarEdge device.
* Connect wire B on the meter to wire A on the SolarEdge device.

5. If multiple meters are used, commission each meter separately when only one meter is connected on the RS485 bus. Refer to *Device Configuration* on page 6.

To connect the meter to a three phase inverter :

NOTE

An additional RS485 port (RS485-E) is available from SolarEdge, allowing configuration of multiple RS485 buses for communications in large sites; Refer to http://www.solaredge.com/files/pdfs/RS485_expansion_kit_installation_guide.pdf).

1. Turn the inverter ON/OFF switch to OFF.
2. Turn OFF the DC Safety Unit (if applicable) and the AC switch of the main circuit board.
3. Open the inverter cover.

4. Remove the seal from one of the openings in communication gland #2 at the bottom of the inverter, and insert the wire through the opening.
5. Pull out the 9-pin RS485 terminal block connector located on the communication board, as shown below:

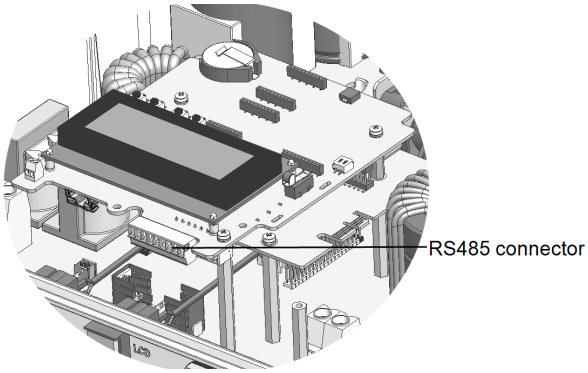


Figure 5: The RS485 terminal block

6. Loosen the screws of pins A and B of the RS485 port, as shown below:
   - Inverter: use the RS485-1 port or RS485-E if an RS485 Expansion Kit is connected

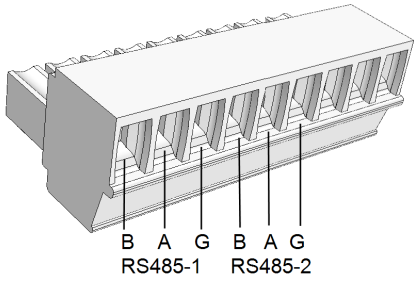


Figure 6: RS485 terminal block

7. Insert the wire ends from the meter into the pins shown above:
   - Connect the wire from RS485 A in the meter to pin A.
   - Connect the wire from RS485 B in the meter to pin B.
8. Tighten the terminal block screws.
9. Push the RS485 terminal block firmly all the way into the communication board.
10. Terminate the inverter by switching a termination DIP-switch inside the inverter to ON. The switch is located on the communication board and is marked SW7.

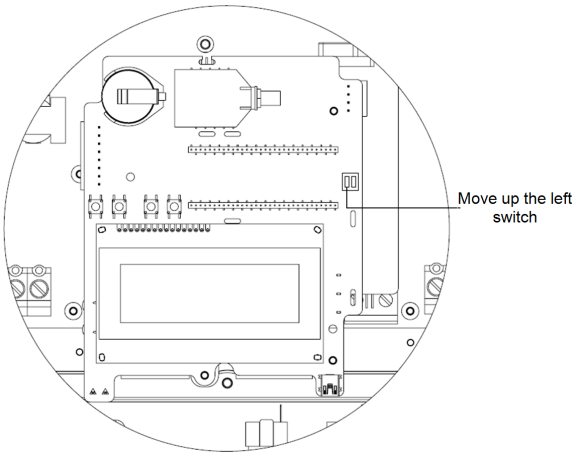


Figure 7: RS485 termination switch

To connect the meter to a Control and Communication Gateway (CCG):

1. Pull out the 3-pin RS485-2 terminal block connector.

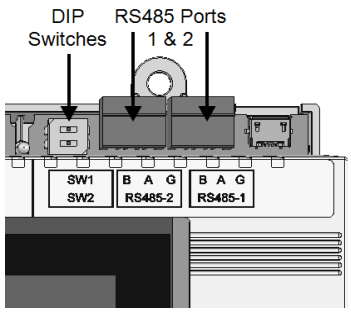


Figure 8: Gateway RS485 connections and DIP switches

2. Loosen the screws of terminals A, B and G.
3. Insert the wire ends from the meter into the A and B pins shown above, in "crossed" fashion:
   - Connect the wire from RS485 A in the meter to pin B.
   - Connect the wire from RS485 B in the meter to pin A.
4. Tighten the terminal block screws.
5. Push the RS485 terminal block firmly into its port.
6. Terminate the gateway by switching the SW2 termination DIP-switch to ON, as shown in the figure above.

Power Supply Connection

The input power supply of the meter is specified on the meter's rating plate.

NOTE

Before applying the power supply voltage, ensure that the voltage and frequency match the information provided on the rating plate.

The connection cables for the power supply voltage must be fused with a UL-listed fuse (6A type C), as depicted in the figure below.

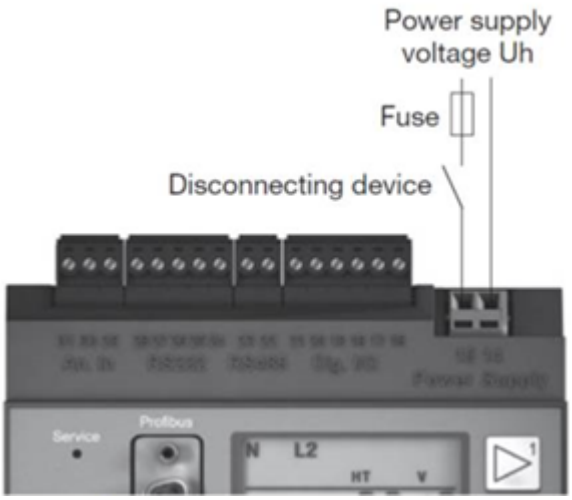


Figure 9: Power Supply Connection

Device Configuration

This section describes basic configuration of SolarEdge devices (inverter/CCG) for using an MV meter. In addition, export limitation may be required. Refer to http://www.solaredge.com/sites/default/files/feed-in_limitation_application_note.pdf.

Establishing Connectivity

When first establishing connectivity between the SolarEdge device and the Janitza meter, the *meter's Modbus address* must be synchronized between the devices.

Configure the Janitza meter using the arrow keys adjacent to the screen. For detailed information, refer to the manual provided with the product.

Figure 10: Janitza meter screen and buttons

To establish connectivity between the SolarEdge device and the Janitza UMG 104 Meter:

1. Switch the Janitza meter to Program mode: Simultaneously press keys 1 and 2 for around one second. The PRG symbol for programming mode appears. The content of address 000 is displayed.
2. Access the memory address 200 to display the meter's Modbus address. Set the address to "2".
3. Exit program mode: Simultaneously press both keys for around 1 second. The setting is saved and the meter returns to display mode.
4. Access the SolarEdge device, and enter the setup mode.
    a. Enter Setup mode by pressing the **Enter (3)** button for at least five seconds. The following message is displayed:

```
Please enter
 Password
********
```

    b. Use the three right-most buttons (Up-1, Down-2 and Enter-3) to type in the default password: **12312312**.
5. **Communication ➔RS485-X Conf** . The RS485-X screen is displayed:

```
Device Type <SE>
Protocol <M>
Device ID <1>
Slave Detect <#>
Cluster SLV Detect
Long Slave Detect <#>
Slave List <#>
Multi-Inv. Set
```

6. Select **Device Type➔Multi Devices**.
7. Select **Meter 1**. The meter configuration screen is displayed:

```
Device Type <MTR>
Protocol <JN>
Device ID <2>
CT Rating <0>
Secondary CT <5>
VT Rating <11000>
Secondary VT <110>
Meter Func. <None>
Meter Commission
Topology <Wye>
```

8. Select **Device ID**, and set the ID to 2 (the same Modbus address configured earlier in the Janitza meter).
9. Select Meter Commission to display the following menu:

```
Set Serial Conf
Set Meter ID
```

NOTE

Make sure that the Device ID is always synchronized with the Modbus address set in the Janitza meter. If the values are different, *the connection between the devices will be lost*. In the event that you need to modify the address, use the **Set Meter ID** function in the SolarEdge device. This function modifies the address setting simultaneously in the Janitza meter and the SolarEdge device, thus preserving the connection. See the procedure, *To modify the Modbus address of a connected meter*.

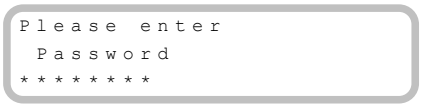
10. Select **Set Serial Conf** to auto-configure the meter's serial interface baud rate to 9600. Wait for the message "Applied" to appear. To check the setting, switch the Janitza meter to Program mode, and make sure that the value at address 202 is set to '0' (9600 baud). If the value is **not** set to '0' , then modify the value manually.

To modify the Modbus address of a connected Janitza meter:

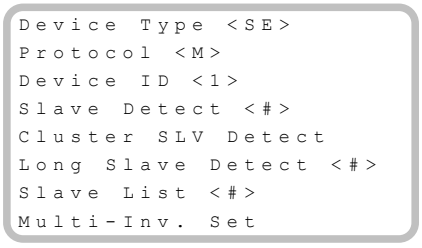
1. Perform steps 1 to 7 of the procedure,*To establish connectivity between the SolarEdge device and the Janitza UMG 104 Meter*.
2. Select **Meter Commission**, and in the Meter Commission menu, select **Set Meter ID**.
3. The message "Make sure single device is connected. Continue?" is displayed. Make sure that only one Modbus device is connected to the SolarEdge device, and respond YES.
4. Enter the existing Meter ID, and press <Enter>.
5. Enter the new Meter ID, and press <Enter>. Wait while the meter ID is modified, and the value in the SolarEdge device is modified. The message "Applied" is displayed.

To configure the SolarEdge device for using Janitza meters:

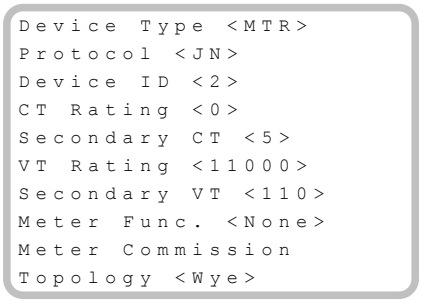
1. Access the SolarEdge device, and enter the setup mode. :
    a. Enter Setup mode by pressing the **Enter (3)** button for at least five seconds. The following message is displayed:



    b. Use the three right-most buttons (Up-1, Down-2 and Enter-3) to type in the default password: **12312312**.
2. **Communication ➔RS485-X Conf** . The RS485-X screen is displayed:



3. Select **Device Type➔Multi Devices**.
4. Select **Meter 1**. The meter configuration screen is displayed:



5. Configure the following settings:
    - Device/Meter Type: Revenue Meter
    - Meter Protocol: Janitza
    - Device Id: 2 (as was set in the previous procedure)
    - CT Rating: <200> according to the primary MV CT
    - Secondary Rating: <5> according to the secondary MV CT
    - VT Rating : <11000> according to the primary potential transformer
    - Secondary VT: <110> according to the secondary potential transformer
    - Meter Func.: <Export+Import>

NOTE

CT Rating and Secondary CT should reflect the downscaling ratio of the existing current transformer ratio installed at the site:
Downscale Ratio = (CT Rating) / (Secondary CT). For example, using the values above - current downscale ratio = 200/5 = 40

VT Rating and Secondary VT should reflect the downscaling ratio of the existing potential transformer ratio installed at the site:
Downscale Ratio = (VT Rating) / (Secondary VT). For example, using the values above - potential downscale ratio = 11000/110 = 100

To verify meter connection:

1. Short-press the LCD light button (on the inverter) or the Enter button (inside the inverter) until the Communication status screen is displayed as shown below. This screen shows the number of external devices that communicate on each port, the device type, and the protocol to which each port was configured.
2. Verify that the setting of the relevant RS485 port is correct and that the port is communicating with the meter.
   For example, if the meter is connected to the RS485-1 port, the Communication status screen should display the following:

```
          Dev  Prot  ##
RS485-1<MTR><JN><  1>
RS485-2<---><---><--->
ZigBee  <---><---><--->
```

   Dev: the type of device configured to this port. **MTR** indicates a meter.

   Prot: the communication protocol

   ## = 1: Indicates that the connection to the meter is successful.
3. Continue pressing the Enter button or the LIGHT button using short presses until reaching the meter status screen showing the **Energy [Wh]** total. If there is more than one meter/ function, there is a status screen for each one. The following is an example of an Export meter:

```
Export  Meter
Status:      <OK/Error#>
Power[W]:       xxxxx.x
Energy[Wh]:     XXXXX.X
```

   Status: Displays OK if the meter is communicating with the inverter.

   <Error message>: If an internal meter error occurs, it will be displayed here. Refer to *Troubleshooting the Janitza Meter Connection* on page 10.

   Energy [Wh]: Displays the accumulated lifetime energy of the meter.

   If the SolarEdge device is connected to the monitoring platform, this value will also be displayed in the monitoring platform.

To display the meter serial number:

1. Enter Setup mode and select **Information**. The following screen is displayed:

```
Versions
Error  Log
Warning  log
Hardware  IDs
```

2. Select **Hardware IDs**. The following is displayed showing the ID of the inverter and any meter connected to it:

```
ID  5000FFFF4E
RGM:12345678
```

Appendix A: Troubleshooting the Janitza Meter Connection

This section describes how to troubleshoot installation and performance errors.

Communication Status Screen Troubleshooting

The Communication status screen should display the following:

```
          Dev  Prot  ##
RS485-1<MTR><JN><  1>
RS485-2<---><---><-->
 ZigBee  <---><---><-->
```

Device Type or Protocol are configured incorrectly

- 1. Select **Communication ➔ RS485-x Conf ➔ Device Type ➔ Revenue Meter**.
  2. Select **Communication ➔ RS485-x Conf ➔ Protocol ➔ Janitza**.
  3. Check that the Device ID under **Communication ➔ RS485-X Conf ➔ Device ID** is set to 2.
  4. Select a meter type: **Revenue Meter ➔ Meter Func. ➔ Export+Import / Export / Import / Consumption / Site Production / Inv. Production.**

Number of devices is not displayed

- If **<-->** is displayed under the ## column in the Communication status screen, the meter is not communicating with the inverter.

Check the following:

- Ensure that the meter configuration in the inverter is set as described in the previous section.
- Check that the meter's settings are configured as specified in the meter's User's Manual.
- Check that the wiring between the meter and the RS485 terminal block on the communication board is correct and well connected.
- Use a Voltmeter to measure the voltage on the meter's 10-pin terminal block . The L1 – L2 line to line voltage should be 400 Vac ± 20% .

Meter Status Screen Troubleshooting

```
Export  Meter
Status:      <OK/Error#>
Power[W]:       xxxxx.x
Energy[Wh]:     XXXXX.X
```

<OK> is not displayed

If **<OK>** is not displayed in the Status line of the status screen shown above, the meter is not communicating with the inverter. Check the following:

- There are no loose connections at the inverter communication board and at the meter.
- The wiring between the black 4-pin terminal block on the meter and the RS485 terminal block on the communication board is correct.

An error message is displayed

- If **Comm. Error** is displayed in the meter status screen, verify proper connection of:
  - The RS485 cables and connectors
  - The AC connection of the meter
- If the message **Error code 3x6E** or **Error 185 Meter Comm. Error** is displayed, contact SolarEdge support.

Energy [Wh] value is not advancing

If the Energy [Wh] value displays a steady value although the the site is exporting/ importing power, check the following:

- There are no loose connections at the inverter connectors and at the meter, specifically the AC wiring on the meter 10-pin connector.
- The current transformers are connected to the meter as illustrated in *Figure 2*.

Appendix B: External Lightning Protection Connection

Protection devices are most often installed from each data line to the local earth ground, and should be selected to begin conducting current at a voltage as close to the system's normal communication level as possible, but never lower. For RS485 communication lines, the selected voltage rating is typically 6-8 V. Transient suppressors should be installed as close as possible to the port that is being protected, and the user must provide an extremely low impedance connection to the local earth ground of the SolarEdge device. This ground connection is crucial for proper suppression device operation. The ground connection should be made using a heavy gauge wire and kept as short as possible. If the cable between the SolarEdge device and the protection device must be longer than 1m/3.3 ft., a copper strap or a braided cable intended for grounding purposes must be used for the protection device to be effective. In addition to the high frequency nature of transients, extremely high current may flow.

A protective device with surge discharge ratings of **In**: 10kA 8/20µs and **Imax**: 20kA 8/20µs is recommended.

Various lightning protection devices are available for RS485 communication lines.

The diagram below shows a connection example using the Raycap *RayDat RS 485* data protocol protection device. A detailed specification can be found at: http://www.raycap.com/wp-content/uploads/2016/06/Signal-Catalog-2016-Final-rev.pdf, pages 76-77.

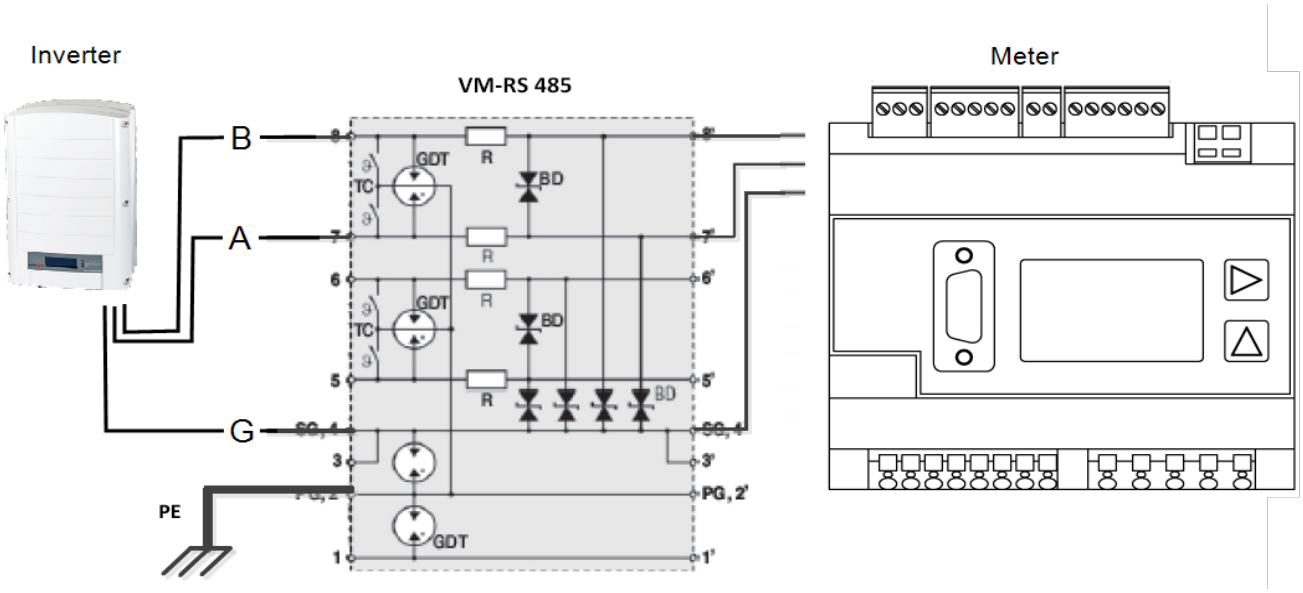


Figure 11: Protection connection