

Isolation Fault Troubleshooting - Application Note

Version History

- Version 1.4 - Feb. 2019 - in 'Using an Insulation Tester' procedure , step 6/h modified resistance value to $40M\Omega \cdot m^2$.
- Version 1.3 - April 2018 - Added the SetApp option
- Version 1.2 - Updated the images in the test procedure and the procedure for measuring if the leakage is from the module or from the power optimizer.
- Version 1.1:
 - Added – option to set the insulation tester to 1000V (required to comply with NEN-EN-IEC 62446)
 - Updated inverter DC voltage table
- Version 1.0 - initial release

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Introduction

In photovoltaic systems with a transformer-less inverter, the DC is isolated from ground. Modules with defective module isolation, unshielded wires, defective power optimizers, or an inverter internal fault can cause DC current leakage to ground (PE - protective earth). Such a fault is also called an isolation fault.

This document describes how to identify and locate an isolation fault in a SolarEdge system.

WARNING!



This guide is intended to aid in troubleshooting a SolarEdge installation which has a ground fault. Persons using this guide should be completely familiar with SolarEdge systems, their concept of operation, safety features, and all applicable safety procedures and requirements. Do not attempt any troubleshooting without adequate safety equipment and a thorough understanding of all procedures.

WARNING!



Troubleshooting of PV systems may involve exposure to hazardous voltage levels and should be conducted by qualified personnel only. Presence of ground faults in PV systems may result in hazardous voltages or currents on normally grounded conductors or exposed metal elements. Extreme caution must be used when troubleshooting PV systems with ground faults.

Identifying an Isolation Fault

Every time the SolarEdge inverter enters operational mode and starts producing power, the resistance between the ground and the DC current-carrying conductors is checked. The inverter displays an isolation error when it detects a total combined isolation resistance of less than $600k\Omega$ in single phase inverters, or $1M\Omega$ in three phase inverters.

You can identify an isolation fault using

- [SetAPP](#)
- [The inverter LCD display](#)

An isolation fault may disappear and recur after a short period (especially if it is caused by morning moisture), therefore it is recommended to troubleshoot the fault as soon as it occurs, before it may temporarily disappear. Before troubleshooting on site, you may check the isolation value in the SolarEdge monitoring platform. If the value is borderline (within 10%) or below the limit ($600k\Omega$ for single phase inverters / $1M\Omega$ for three phase inverters), troubleshoot the fault on site. If the value is at least 10% higher than the limit, it is better to wait until an isolation fault error recurs.

→ To check the isolation value in the monitoring platform:

1. In the **Layout** window right-click on the inverter and select **Choose operations** → **Reset**.
2. Right-click on the inverter and select **Info** to display information about the inverter.

3. In the **General** parameter list, check the **Last Isolation Value**.

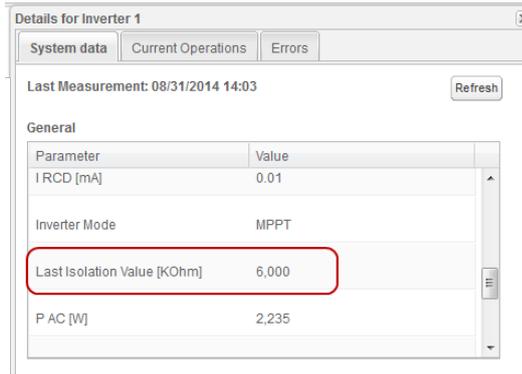


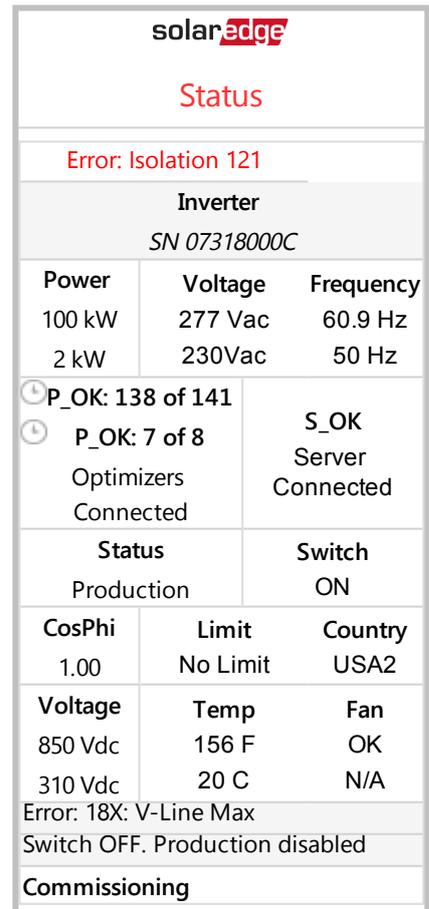
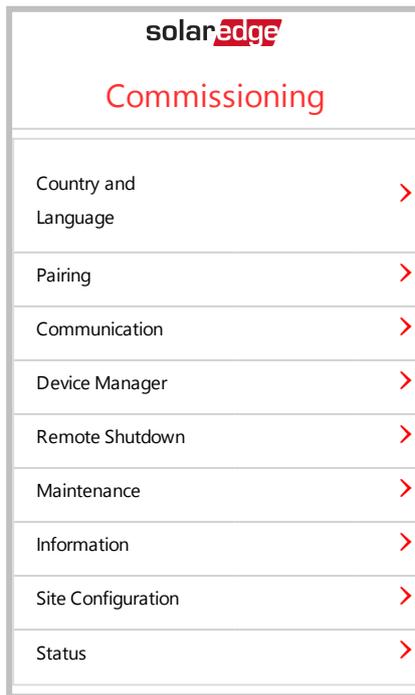
Figure 1: System data tab in the Details window

Identifying an Isolation Fault Using SetApp

If an isolation error occurs, error 25 (single phase inverters) or 121 (three phase inverters) is displayed in the SetApp Status screen (see following figures).

→ To access the SetApp status screen and view error details:

1. From the **Commissioning** menu select **Status**. The inverter Status is displayed (see following figures)
2. Tap the error line for details.



Identifying an Isolation Fault Using the Inverter LCD Display

If an isolation error occurs, the LCD displays error 25 (single phase inverters) or 121 (three phase inverters):

```
Error xxxx
Isolation fault
See diagnostics
```

Troubleshooting an Isolation Fault (Using the Inverter LCD Display or SetApp)

The next sections describe how to identify the source of an isolation fault if Error 25 or 121 are displayed. You can troubleshoot the isolation fault using the following methods:

- The Inverter Diagnostics Screen in the LCD Display or the Status Screen in SetApp.

NOTE



If using the LCD Display, this method is available from DSP1 firmware version 1.13.181 in three-phase inverters, and 1.210.693 in single phase inverters. The version can be checked from the ID status screen of the LCD. If required, upgrade the inverter software as described in

https://www.solaredge.com/sites/default/files/upgrading_an_inverter_using_micro_sd_card.pdf

- An insulation tester (Megger).

Checking the DC Voltage

During the troubleshooting process, strings and/or power optimizers will be disconnected. If V_{dc} does not reach the nominal voltage, perform pairing. For information on the pairing process, refer to the *SolarEdge Installation Guide*.

1. Turn the inverter ON/OFF switch at the bottom of the inverter to OFF. If a Safety Switch or a DC isolation switch is installed, it should remain ON.
2. Wait until the DC voltage is safe.
3. Remove the required string, power optimizer or module.
4. Turn the inverter ON, and check that V_{dc}, shown in the inverter screen below, is approximately the nominal DC voltage according to the following table:

Inverter type	Europe & APAC	North America	Unit
Single phase	350	350	V _{dc}
Three phase	750	For 208V – 400	V _{dc}
	For Medium Voltage – 850	For 277/ 480V – 850	V _{dc}

```
Vac[V] Vdc[V] Pac[W]
240.7 371.9 2349.3
P_OK: XXX/YYY <S_OK>
ON
```

solar edge		
Status		
Error: Isolation 121		
Inverter		
SN 07318000C		
Power	Voltage	Frequency
100 kW	277 Vac	60.9 Hz
2 kW	230Vac	50 Hz
P_OK: 138 of 141		S_OK Server Connected
P_OK: 7 of 8 Optimizers Connected		
Status		Switch
Production		ON
CosPhi	Limit	Country
1.00	No Limit	USA2
Voltage	Temp	Fan
850 Vdc	156 F	OK
310 Vdc	20 C	N/A
Error: 18X: V-Line Max		
Switch OFF. Production disabled		
Commissioning		

Locating the Leaking String

1. If multiple strings are connected to the inverter, find the faulty string by connecting one string at a time to the inverter and checking if the error is still displayed (follow the procedure [Identifying an Isolation Fault Using SetApp on page 2](#)).
2. Verify that only the faulty string is connected to the inverter. If there is more than one faulty string, check each string separately.

Locating the Leakage within a String Using the Inverter LCD Display

1. Enter the isolation status screen by pressing and holding down the LCD light button until the following message is displayed:

```
Keep holding button
for pairing, release
to enter menu...
Remaining: 3 sec
```

2. Release within 5 seconds to enter setup mode.
3. Short-press (one second) to scroll down to the **Maintenance** menu and long-press to enter the menu. The following screen is displayed:

```
Date and Time
Reset Counters
Factory Reset
FW Upgrade
AFCL <Dis>
Diagnostics
Standby Mode
Grid Protection
Board Replacement
```

- Short-press to scroll down to the Diagnostics menu and long -press to select **Diagnostics** → **Isolation Status**. The following status screen is displayed:



R Iso: The value of the isolation resistance (in kOhm)

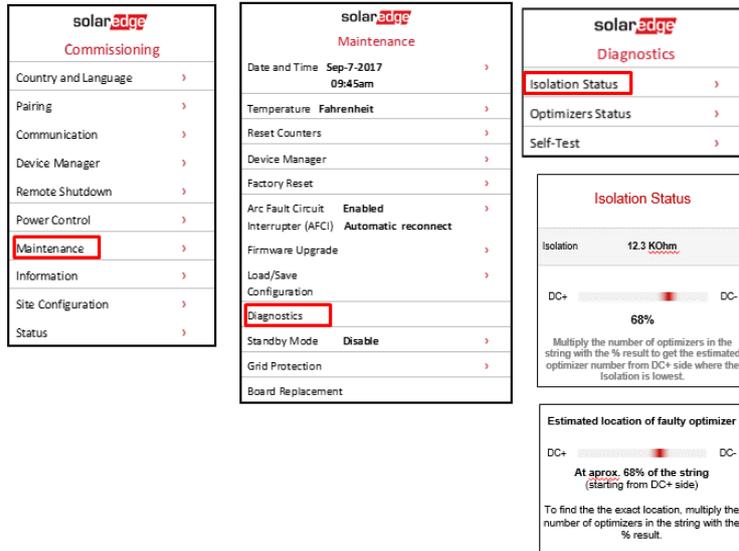
The asterisk (*) and the percentage value indicate the approximate location of the fault within the string, relative to DC+:

- 0% indicates the fault is at DC+
- 100% indicates the fault is at DC-

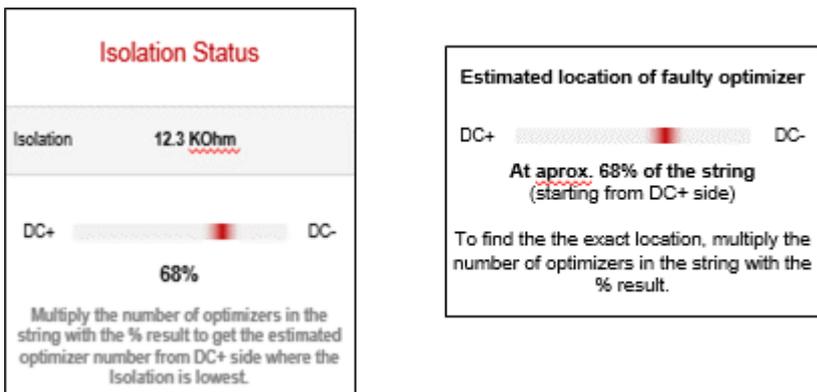
- Using the screen, identify the fault source area: Multiply the number of power optimizers in the string by the percentage value. The result is the module near which the fault occurred. For example, in a string with 15 modules and power optimizers and a percentage value of 55%: $15 \times 55\% = 8.25$. This means that the fault is near module #8, counted from the DC+ side.
- Check if there are damaged connectors or DC wires between the suspected power optimizer and its module and between the suspected power optimizer and its neighboring power optimizers. If there are, replace them and recheck the isolation status by turning ON the inverter as described in [Identifying an Isolation Fault Using SetApp on page 2](#). If the fault persists, proceed to [step](#)
- Remove the suspected fault source by disconnecting the suspected power optimizer from the string (following the steps in [Identifying an Isolation Fault Using SetApp on page 2](#)). Use a DC extension cable with MC4 connectors (male at one end and female at the other end) to bypass the removed power optimizer. Recheck the isolation status.
 - If after startup/pairing the fault is eliminated, the fault is in the removed module/power optimizer. Proceed to [step 9](#).
 - If after startup/pairing the fault re-appears, the leakage source is not in the removed module/power optimizer but near it.
- Reconnect the module/power optimizer in the string. Check the modules/power optimizers before and after the suspected location by repeating [step 7](#) and [step 8](#), one module/power optimizer at a time. If the fault re-appears, check the next modules/power optimizers one a time. The location of the fault is detected with an accuracy of ± 1 for single phase inverters and ± 2 for three phase inverters. If after checking around this tolerance the problem was not found, the string might have multiple isolation faults. In this case, you should use an isolation tester as described in the [Using an Insulation Tester on page 7](#).
- Find whether the leakage is from the module or from the power optimizer:
 - Disconnect the suspected module from the suspected power optimizer.
 - Turn OFF the inverter.
 - Connect the power optimizer to the string.
 - Turn the inverter ON, and check that V_{dc} is approximately the nominal DC voltage (refer to the table above). Otherwise, perform pairing.
 - If after startup / pairing the fault is eliminated, the fault is in the module that was removed. If the fault re-appears, the power optimizer is the leakage source.
- Repair or replace the faulty component.
- Perform pairing. For information on the pairing process, refer to the *SolarEdge Installation Guide*.

Locating the Leakage within a String Using SetApp

1. Access the isolation status screen: From the Commissioning menu select Maintenance →Diagnostics → Isolation Status.



2. The value of the isolation resistance (in kOhm) indicates whether the fault is at DC+ or DC-



- 0% indicates the fault is at DC+
- 100% indicates the fault is at DC-
- Using the screen, identify the fault source area: Multiply the number of power optimizers in the string by the percentage value. The result is the module near which the fault occurred. For example, in a string with 15 modules and power optimizers and a percentage value of 55%: $15 \times 55\% = 8.25$. This means that the fault is near module #8, counted from the DC+ side.

Using an Insulation Tester

In this procedure, you check the resistance of system components, drilling-down from string level, through power-optimizer/module pairs, and finally a single component – a power optimizer or a module. You also check the wiring between components.

For this procedure, use an insulation tester and a connector branch cable.

1. Turn OFF the inverter ON/OFF switch, and wait until the LCD indicates that the DC voltage is safe (<50V), or wait five minutes before continuing to the next step.

WARNING!

If you cannot see the inverter panel, or if a malfunction is indicated on the LCD panel, wait five minutes for the input capacitors of the inverter to discharge.



AVERTISSEMENT!

Si vous ne pouvez pas voir l'écran de l'onduleur ou si un dysfonctionnement est indiqué sur l'écran LCD, attendez cinq minutes pour que les condensateurs d'entrée de l'onduleur soient déchargés.

2. Disconnect all the DC cables connecting the strings to the inverter or the Safety Switch.
3. Test the resistance of the extension DC cables between the strings (or the combiner box) and the inverter (home-run cables): Disconnect the home-runs at both ends and measure each wire by connecting it to the positive probe, while the negative probe remains connected to the ground.

If the wiring resistance is less than 200M Ω , the wire is faulty; replace any faulty wires. If the wiring resistance is 200M Ω or more, the fault is in the string that was connected to this extension cable; check the string (without the extension cable) as described in the following step.
4. Test the string resistance using the insulation tester ([Figure 2](#)):
 - a. Verify safe string voltage and current: max. 50V and 500mA.
 - b. Connect the positive and negative connectors of the first or last optimizer in the string to the branch cable.
 - c. Connect the positive probe of the insulation tester to the branch cable.
 - d. Connect the negative probe of the insulation tester to a ground point.
 - e. Select 500V testing on the insulation tester.
 - f. Test the insulation.

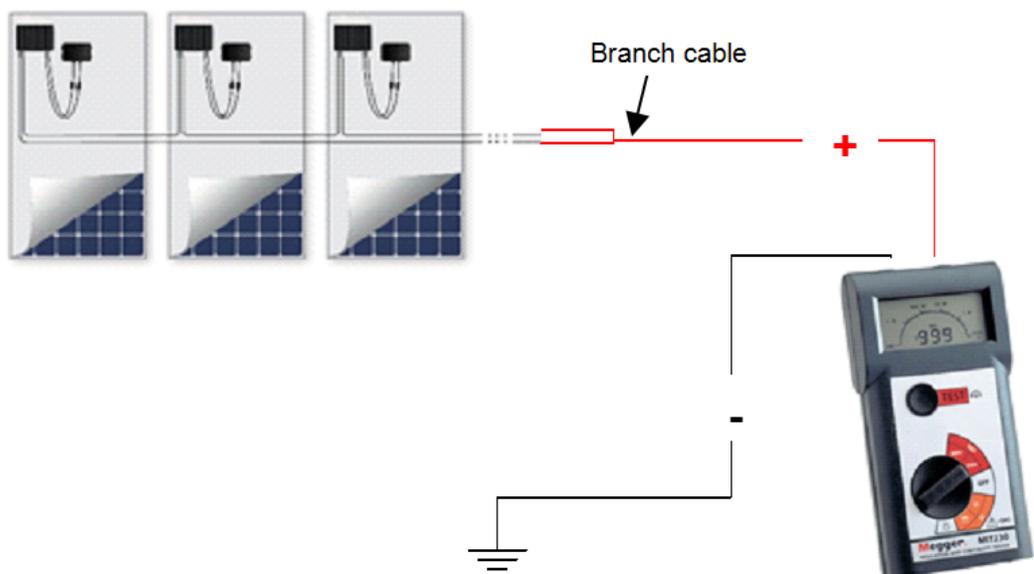


Figure 2: Connecting the insulation tester to the PV string

If the resistance is less than 600k Ω in a single phase inverter or less than 1M Ω in a three phase inverter, continue checking this string's components to isolate the source of leakage, as detailed in the following steps. Always make sure to connect both negative and positive output connectors to the tester using a branch cable.

5. Test the power optimizers' and modules' resistance using the insulation tester ([Figure 3](#)):
 - a. Disconnect the power optimizer from the string; it should remain connected to the PV module.
 - b. Verify safe power optimizer voltage and current: max. 1V and 500mA.
 - c. Connect the power optimizer's positive and negative output connectors to the branch cable.

**WARNING!**

Connecting the insulation tester to just one of the power optimizer connectors or to just one of the DC cables may cause irreversible damage to the power optimizer.

- d. Connect the positive probe of the insulation tester to the branch cable.
- e. Connect the negative probe of the insulation tester to a ground point.
- f. Select 500V testing on the insulation tester.
- g. If the measured resistance is $200\text{M}\Omega$ or more, the power optimizer and module are not faulty. If the measured value is less than $200\text{M}\Omega$, the optimizer, the module or both are faulty. Continue checking as detailed in the following steps.

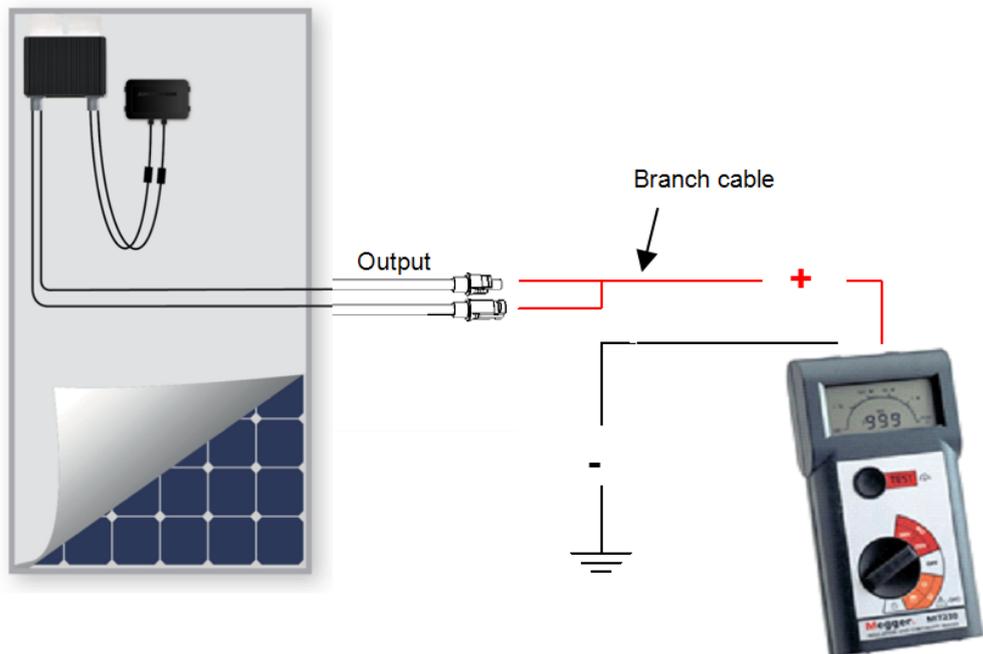


Figure 3: Connecting the insulation tester to the power optimizer and module

6. Find whether the leakage is from the module or from the power optimizer. Test each component individually by measuring the resistance between negative wires and ground:
 - a. Disconnect the module from the power optimizer.
 - b. Connect the power optimizer's positive and negative output connectors to the branch cable ([Figure 4](#)).
 - c. Connect the positive probe of the insulation tester to the branch cable.
 - d. Connect the negative probe of the insulation tester to the power optimizer frame (ground point).
 - e. Select 500V testing on the insulation tester.
 - f. Measure the resistance; if the value is $200\text{M}\Omega$ or more – the module is faulty; if the value is less than $200\text{M}\Omega$, replace the optimizer and test the module in case it is faulty as well.

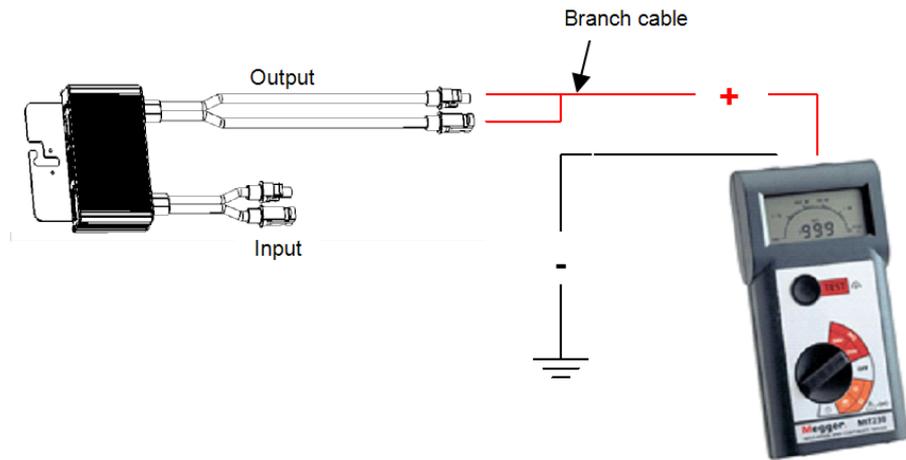


Figure 4: Connecting the insulation tester to the power optimizer

- g. Disconnect the branch cable from the power optimizer and connect it to the module ([Figure 5](#)).
- h. Measure the resistance; if the value is with $40\text{M}\Omega\cdot\text{m}^2$ or more – the module is OK; if the value is less than $40\text{M}\Omega\cdot\text{m}^2$, the module is faulty. The typical value is $80\text{M}\Omega$ for each panel.

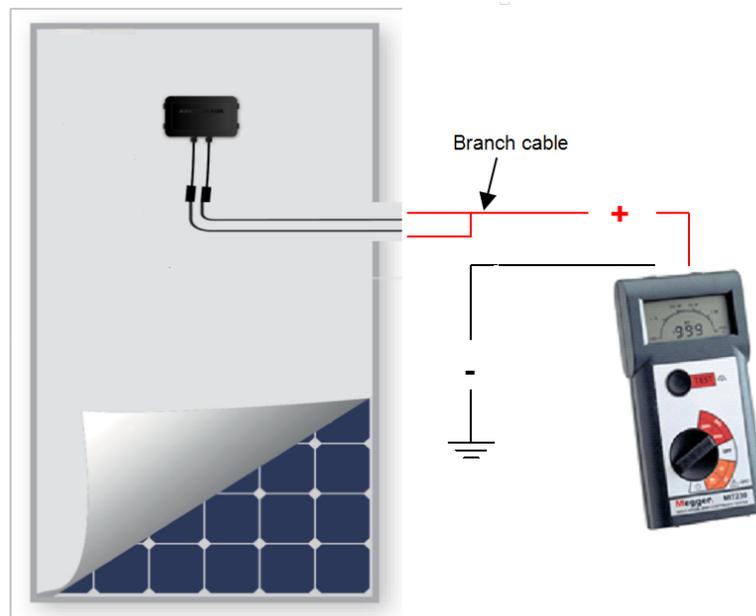


Figure 5: Connecting the insulation tester to the module

7. Replace the faulty component(s).



NOTE

If you replace power optimizers, repeat the pairing process. For information refer to the SolarEdge Installation Guide.

