

SolarEdge isolation fault troubleshooting - Application note

Revision history

- Version 1.10 October 2024 – General update
- Version 1.9, May 2024 – updated PV module test procedure and added commercial Power Optimizer information.
- Version 1.8, February 2024 - editorial updates

Contents

Revision history	1
Introduction	1
Identify an isolation fault	2
Identify an isolation fault using SetApp	2
Identify an isolation fault using the inverter LCD display	3
Troubleshoot an isolation fault	3
Check the DC Voltage	3
Locate the leaking string	4
Locate the leakage within a string using the inverter LCD display	4
Locate the leakage within a string using SetApp	6
Use an insulation tester	7

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.

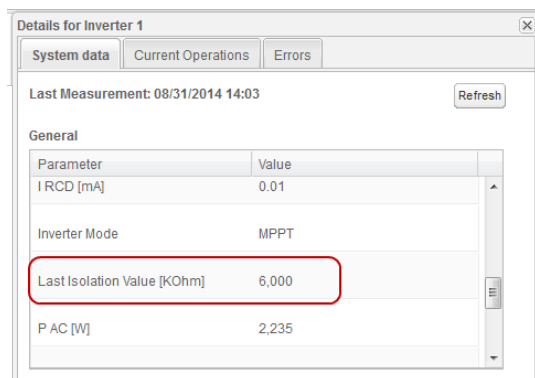
Identify an isolation fault

Every time the SolarEdge inverter enters operational mode and starts producing power, the resistance between 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 Ω in single phase inverters, or 1M Ω in three phase inverters. You can identify an isolation fault using either SetAPP or 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 disappears. Before troubleshooting on site, you can check the isolation value in the SolarEdge monitoring platform. If the value is borderline (within 10%) or below the limit (600k Ω for single phase inverters; 1M Ω 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. To display information about the inverter, right-click on the inverter and select **Info**.
3. In the General parameter list, check **Last Isolation Value**.

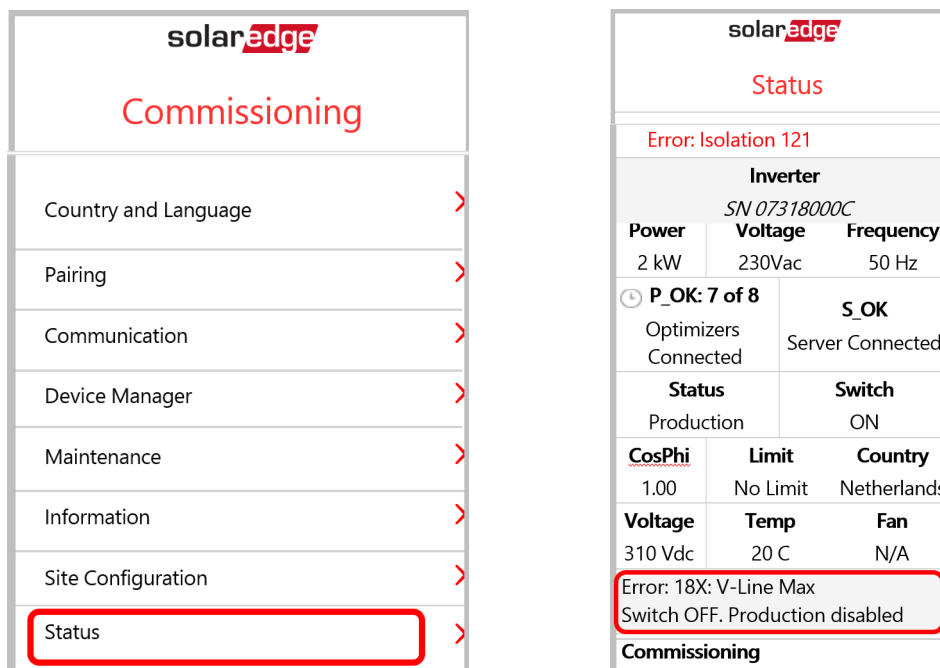


Identify an isolation fault using SetApp

If an isolation error occurs, error 18x86 (single phase inverters) or 8x58 (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 on the **Error** row for more details.



Identify an isolation fault using the inverter LCD display

If an isolation error occurs, the LCD displays error 2x19 (single phase inverters) or 8x58 (three phase inverters):

Error xxxx
Isolation fault
See diagnostics

Troubleshoot an isolation fault

The next sections describe how to identify the source of an isolation fault if Error 2x19 or 8x58 is displayed. You can troubleshoot the isolation fault using the Inverter diagnostics screen in the LCD display, the Status screen in SetApp, or using a Megger tester.



NOTE

When 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://knowledge-center.solaredge.com/sites/kc/files/upgrading_an_inverter_using_micro_sd_card.pdf

Check the DC Voltage

During the troubleshooting process, strings and/or Power Optimizers will be disconnected.

1. Set the inverter P/1/0 switch at the bottom of the inverter to **0** (OFF). If a Safety Switch or a DC isolation switch is installed, it should remain ON.
2. Wait until the DC voltage is reaches a safe level.
3. Disconnect the required string, Power Optimizer or module.

Set the inverter P/1/0 switch to **1** (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}

```
V a c [ V ]   V d c [ V ]   P a c [ W ]
240.7   371.9   2349.3
P _ O K : X X X / Y Y Y < S _ O K >
                      O N
```

solar edge		
Status		
Error: Isolation 18x86		
Inverter		
SN 07318000C		
Power	Voltage	Frequency
2 kW	230Vac	50 Hz
P_OK: 7 of 8		S_OK
Optimizers Connected		Server Connected
Status		Switch
Production		ON
CosPhi	Limit	Country
1.00	No Limit	Netherlands
Voltage	Temp	Fan
310 Vdc	20 C	N/A
Error: 18X: V-Line Max Switch OFF. Production disabled		
Commissioning		

Locate 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.

Locate the leakage within a string using the inverter LCD display

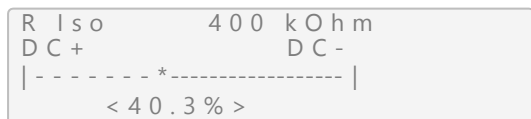
1. Enter the isolation status screen by pressing and holding down the LCD light button until the following message is displayed:

```
Keep holding button for pairing ,
release to enter menu ...
Remaining:          3 s e c
```

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



4. 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} is 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-

5. 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.
6. 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 the next step.
7. 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 the next step.
 - If after startup/pairing the fault re-appears, the leakage source is not in the removed module/Power Optimizer but near it.
8. Reconnect the module/Power Optimizer in the string. Check the modules/Power Optimizers before and after the suspected location by repeating steps 6 and 7, 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 Using an Insulation Tester.

To find whether the leakage is from the module or from the Power Optimizer

1. Disconnect the suspected module from the suspected Power Optimizer.
2. Turn OFF the inverter.
3. Connect the Power Optimizer to the string.
4. Turn the inverter ON, and check that V_{DC} is approximately at the nominal DC voltage (refer to the table above). Otherwise, perform pairing.
5. 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.
6. Repair or replace the faulty component.
7. Perform pairing. For information on the pairing process, refer to the SolarEdge Installation Guide.

Locate the leakage within a string using SetApp

1. From the **Commissioning** menu select **Maintenance > Diagnostics > Isolation Status**.

The screenshots show the following steps in the SetApp interface:

- Commissioning Menu:** The 'Maintenance' option is highlighted with a red box.
- Maintenance Menu:** The 'Diagnostics' option is highlighted with a red box.
- Diagnostics Menu:** The 'Isolation Status' option is highlighted with a red box.
- Isolation Status Screen:**
 - Isolation: 12.3 KOhm
 - DC+ to DC- percentage: 68%
 - Instruction: Multiply the number of optimizers in the string with the % result to get the estimated optimizer number from DC+ side where the Isolation is lowest.
- Estimated location of faulty optimizer:**
 - Diagram showing a bar from DC+ to DC- with a red dot at 68%.
 - Text: At approx. 68% of the string (starting from DC+ side)
 - Instruction: To find the the exact location, multiply the number of optimizers in the string with the % result.

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

The detailed view shows the following information:

- Isolation Status:**
 - Isolation: 12.3 KOhm
 - DC+ to DC- percentage: 68%
 - Instruction: Multiply the number of optimizers in the string with the % result to get the estimated optimizer number from DC+ side where the Isolation is lowest.
- Estimated location of faulty optimizer:**
 - Diagram showing a bar from DC+ to DC- with a red dot at 68%.
 - Text: At approx. 68% of the string (starting from DC+ side)
 - Instruction: To find the the exact location, multiply the number of optimizers in the string with the % result.

■ 0% indicates the fault is at DC+

- 100% indicates the fault is at DC-

2. Using the screen, identify the fault source area.
3. 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.

Use an insulation tester

In this procedure, you check the insulation resistance between 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. Set the inverter P/1/0 switch to **0** (OFF) 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 at least five minutes for the input capacitors of the inverter to discharge.

2. Disconnect all the DC cables connecting the strings to the inverter or the Safety Switch.
3. Test the insulation resistance of the extension DC cables between the strings (or the combiner box) and the inverter (homerun cables).
4. Disconnect the homeruns at both ends and measure each cable by connecting it to the positive probe, while the negative probe remains connected to the ground.

If the insulation resistance is less than $200\text{M}\Omega$, the cable is faulty. Replace any faulty cables. If the insulation resistance is $200\text{M}\Omega$ or more, the fault is in the string that was connected to this extension cable.

Check the string insulation resistance using the insulation tester without the extension cable as described below (Figure 2).

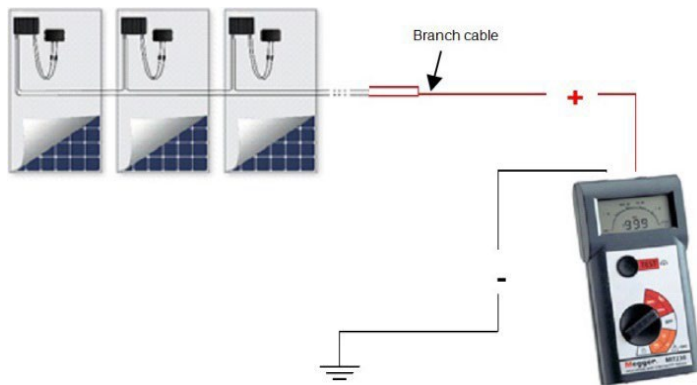
1. Verify safe string voltage and current (maximum 50V and 500mA).
2. Connect the positive and negative connectors of the first or last Power Optimizer in the string to the branch cable.
3. Connect the positive probe of the insulation tester to the branch cable.
4. Connect the negative probe of the insulation tester to a ground point.
5. Select 500V testing on the insulation tester.



NOTE

1000V testing is supported when using S-Series Power Optimizers.

6. Test the insulation resistance.



If the insulation 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 from the Power Optimizer to the tester using a branch cable.

To test the Power Optimizers' insulation resistance

1. Disconnect the Power Optimizer from the string. Keep it connected to the PV module.
2. Verify safe Power Optimizer voltage and current (maximum 1V and 500mA).
3. Connect the Power Optimizer's positive and negative output connectors to the branch cable.

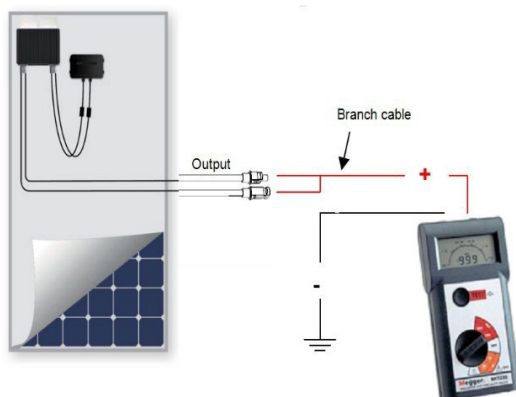


WARNING!

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.

4. Connect the positive probe of the insulation tester to the branch cable.
5. Connect the negative probe of the insulation tester to a ground point.
6. Select 500V testing on the insulation tester.

If the measured resistance is 200M Ω or more, the Power Optimizer and module are not faulty. If the measured value is less than 200M Ω , the Power Optimizer, the module or both are faulty. Continue checking as detailed in the following steps.



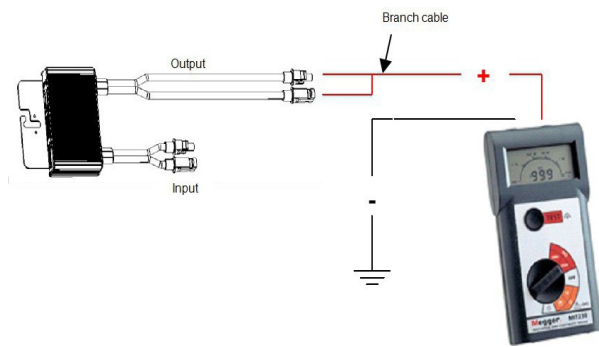
To find whether the leakage is from the module or from the Power Optimizer, test each component individually by measuring the insulation resistance between negative wires and ground, as follows:

1. Disconnect the module from the Power Optimizer.
2. Connect the Power Optimizer's positive and negative output connectors to the branch cable.
3. Connect the positive probe of the insulation tester to the branch cable.
4. Connect the negative probe of the insulation tester to the Power Optimizer frame (ground point).
5. Select 500V testing on the insulation tester.

**NOTE**

1000V testing is supported when using S-Series optimizers.

6. Measure the resistance. If the value is $\geq 200\text{M}\Omega$, the module is likely to be faulty. If the value is $< 200\text{M}\Omega$, replace the Power Optimizer and test the module in case it is faulty as well.

**NOTE**

If you replace Power Optimizers, repeat the pairing process. For more information refer to the relevant SolarEdge Installation Guide.

To test a PV Module's insulation resistance

The procedure for testing PV modules' insulation resistance is clearly specified in the following standard: *IEC61215 - Crystalline silicon terrestrial photovoltaic (PV) modules: Design, qualification, and type approval*.

**NOTE**

Before performing any insulation tests on the PV module, consult the panel manufacturer's specifications to make sure that there are no specific requirements for testing the insulation resistance.

The main applicable parts of IEC61215 that are relevant to the insulation resistance tests are in Section 10.3 and 10.15, and are summarized below:

1. Connect the shorted output terminals of the module to the positive terminal of a DC insulation tester with a current limitation.
2. Connect the exposed metal parts of the module to the negative terminal of the tester.
3. Perform the test as prescribed in IEC61215.

The value is calculated as $40\text{M}\Omega$ per each m^2 of panel ($40\text{M}\Omega \times \text{m}^2$) measured at 500V or maximum systems voltage, whichever is greater.

A typical PV module has an area of approximately 2m^2 . If the measured insulation resistance value for this size of module is less than $80\text{M}\Omega\text{m}^2$, the panel is faulty.

In commercial installations where two PV modules are connected to a single Power Optimizer, test each module individually by removing the wires connecting the modules together.

