

Application Note - Inverter Arc Detection in SolarEdge Systems

Revision History

- Version 1.4, March 2020: Merged North America and Europe/APAC versions
- Version 1.3 (Europe/APAC) January 2020: Automatic reconnection process is described
- Version 1.2, May 2018: Addition of SetApp usage
- Version 1.1 (North America), January 2018: Canadian Electric Code update
- Version 1.1, Nov. 2017:
 - Error codes update according to new format released in inverter CPU v3.19xx
 - Auto reconnection time is the grid reconnection time according to the country setting (Europe/APAC)
- Version 1.0, June 2016 - Initial release

Electric Arcs and Related Standards

An electric arc is an ongoing high-energy discharge, resulting from a current through a normally non-conductive material such as air.

When connectors or cables in a PV system are improperly connected or are damaged, the electric current may pass through the air, causing an electric arc. Arcs generate heat which can cause fires and they also pose an electrocution risk to those working near them. As PV systems age and connectors and cables degrade, the risk of electric arcs, while still low, increases.

In **North America**, UL/CSA safety requirements pertaining to arcs (UL1699B), requiring the ability to detect and terminate an arc through inverter shut down. The system has to remain shut down until an installer has checked the site and replaced any components if needed. Only then can the system be manually restarted.

In **Europe and APAC**, there are currently no standards for arc fault detection. In addition, there is no IEC or EN product standard available for arc fault detection (however there are recommendations in installation standards, e.g. IEC 62548). Since the risk of arcs in PV systems exists everywhere, arc fault detection is recommended and may be required in the future.

Arc Fault Detection in SolarEdge Systems

North America

SolarEdge inverters with model numbers 3000H/9K and higher are compliant with the North American UL1699B safety requirement, and are designed to detect arcs as specified in this standard. After detection, the power optimizers and inverter interrupt production, and, as required by this standard, a qualified person must re-enable the inverter after properly checking the installation.

The above-mentioned SolarEdge inverter models (*excluding* the Single Phase Inverter with compact technology) with CPU version 3.19xx / 4.xx and higher support Arc Fault Circuit Interruption (AFCI) functionality as follows:

- In inverters with DSP1 version 1.210.787 (single phase inverters) / 1.13.702 (three phase inverters) and above, the AFCI function is enabled by default.
- In inverters with lower versions that support AFCI, the AFCI function is disabled by default. The AFCI function can be enabled from the inverter menu, as described in the section, [Enabling and Testing Arc Fault Detection](#).

When AFCI is enabled, the inverter performs an automatic self-test for the arc fault detector each time the inverter “wakes-up” or is switched ON.

Canadian Electric Code

The optimizer is a DC/DC converter located at the PV modules. Once an arc is detected, the optimizer stops production instantly. This is SolarEdge's SafeDC™ technology and is commonly referred to as "module level shutdown". Optimizer outputs are connected in series to build a DC output circuit that connects to the inverter which also stops production when an arc is detected.

Canadian Electric Code 2015 has specific requirements for protection against damage from rodents. Rule 64-210(5) states, "Where the dc arc-fault protection referred to in Rule 64-216 is not located at the module, photovoltaic source circuit conductors and cables installed on or above a building and installed in accordance with Subrules (1), (2) and (3) shall be provided with mechanical protection, in the form of an enclosed raceway or other acceptable material to protect against damage from rodents." The SolarEdge DC arc-fault prevention and protection is located at both the module level and the inverter level. Therefore PV arrays with SolarEdge optimizers and inverters do not require additional mechanical protection of the conductors to comply with 64-210(5).

For additional information refer to *Safety Risks & Solutions in PV Systems for North America*

https://www.solaredge.com/sites/default/files/fire_safety_white_paper-na.pdf

In the event of rodent damage that results in a fault on the DC input conductors to the optimizer, the available fault current and voltage are limited to the input of the optimizer. In the event of rodent damage at the DC output conductors that results in a fault, the available fault current is zero and voltage is less than 30 volts DC⁽¹⁾.

Europe and APAC

SolarEdge inverters with model numbers 2200H/3K and higher are compliant with the North American UL1699B safety requirement. The same inverters with CPU version 3.19xx / 4.xx and higher support Arc Fault Circuit Interruption (AFCI) functionality. When AFCI is enabled, the inverter performs continuous arc testing.

There are two modes of inverter reconnection after an arc detection event:

- **Manual Reconnect** - The system must be manually restarted on site following inverter shut down.
- **Auto Reconnect** - Reconnects the system automatically after grid reconnection time according to the country-specific setting. If no country-specific reconnection time is specified, the default reconnection time is 30 seconds following inverter shutdown. If the arc detection persists, the inverter again disconnects and reconnects after the grid connection time, which is doubled following each detection, until the event is resolved.

⁽¹⁾Each optimizer has a 1V output when the system is shut down. To comply with rapid shutdown, string length is limited to 30 optimizers in series, resulting in no more than 30V present on the DC circuit conductors after a fault is detected.

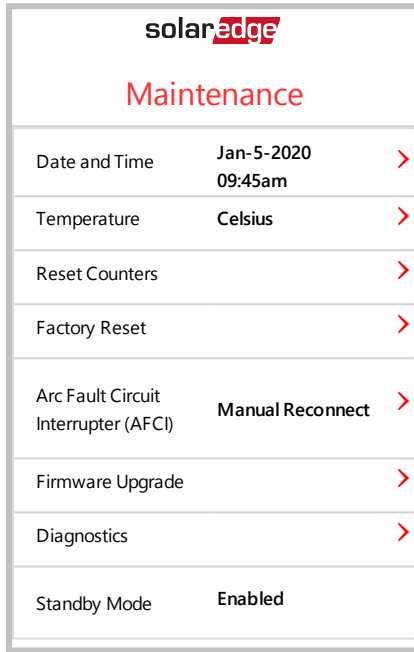
Enabling and Testing Arc Fault Detection

The following sections describe how to enable and test the arc fault detection using :

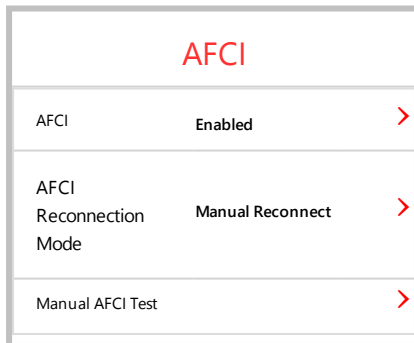
- [SetApp](#)
- [The inverter display \(LCD\)](#)

Using SetApp

1. Access SetApp from your mobile device and select **Commissioning** → **Maintenance** . The Maintenance screen is displayed.



2. Tap **Arc Fault Circuit Interrupter (AFCI)**. The AFCI screen is displayed.



3. Select **AFCI** → **Enable** or **Disable**.

→ To enable manual reconnect / auto connect (Europe and APAC only):

1. From the **AFCI** screen tap **AFCI Reconnection Mode** and choose the required mode: **Manual Reconnect** or **Automatic Reconnect**.



→ To manually test the arc detection functionality:

1. Make sure the inverter ON/OFF switch is turned ON.
2. From the **AFCI** screen tap **Manual AFCI Test**.

If the test is successful, the following message is displayed:



The inverter production is then interrupted (as if a real arc detection has occurred), and one of the following error codes is displayed, as shown in the example below:

- Single phase inverter error codes: 18xC, 18xD
- Three phase inverter error codes: 8xC, 8xD, 8xBA



3. Perform manual restart to resume system operation: Turn the inverter ON/OFF switch to OFF and then to ON. The inverter performs an arc detection self-test and starts normal operation. If the test fails, contact SolarEdge support.

→ To troubleshoot self-test failures:

If the self-test fails, the SetApp displays an error message indicating that the arc detector hardware failed during the wake-up tests, as shown in the example below. If the inverter is connected to the monitoring platform, the error is displayed there as well.



The inverter continuously repeats the arc detection self-test until it is successful.

If the problem persists, contact SolarEdge support.

Using the Inverter Display (LCD)

→ To enable/ disable arc detection:

1. Enter Setup mode and scroll to the **Maintenance** menu.
2. Select **AFCI** → **Enable** or **Disable**.

AFCI <En/Dis>
AFCI Mode <MAN/AUTO>

→ To enable manual reconnect / auto connect (Europe and APAC only):

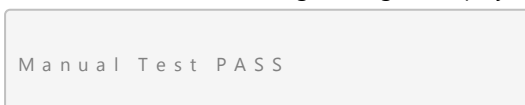
1. Enter Setup mode and scroll to the **Maintenance** menu.
2. Select **AFCI** → **AFCI Mode** and choose the required mode: **Manual Reconnect** or **Auto Reconnect**.

Manual Reconnect
Auto Reconnect

→ To manually test the arc detection functionality:

1. Make sure the inverter ON/OFF switch is turned ON.
2. Select **Maintenance** → **Manual AFCI Test**.

If the test is successful, the following message is displayed:



The inverter production is then interrupted (as if a real arc detection has occurred), and one of the following error codes is displayed, as shown in the example below:

- Single phase inverter error codes: 18xC, 3x11
- Three phase inverter error codes: 8xC, 8xBA



```
Error Code 18xC
Arc Fault Detected
```

3. Perform manual restart to resume system operation: Turn the inverter ON/OFF switch to OFF and then to ON. The inverter performs an arc detection self-test and starts normal operation. If the test fails, contact SolarEdge support.

→ To troubleshoot self-test failures:

If the self-test fails, the SetApp displays an error message indicating that the arc detector hardware failed during wake-up tests, as shown in the example below. If the inverter is connected to the monitoring platform, the error is displayed there as well.



```
Error Code 18x8D
AFCI
self-test failed
```

The inverter continuously repeats the arc detection self-test until it is successful.

If the problem persists, contact SolarEdge support.

Troubleshooting Arc Fault Events

The inverter continuously performs arc detection while producing power. If an electric arc is detected, the inverter stops producing power, and an error code is displayed on the LCD or SetApp, as shown in the example below; if the inverter is connected to the monitoring platform, the error is displayed there as well):

- Single phase inverter error codes: 18xC, 3x11
- Three phase inverter error codes: 8xC, 8xBA



```
Error Code 18xC
Arc Fault Detected
```



```
Error 18xC: Arc Fault Detected >
```

If this message is displayed:

1. Turn the inverter ON/OFF switch to OFF.
2. Check all PV strings for the correct open-circuit voltage:
 - Inspect all connections and cables between the power optimizers in the strings: Verify they are connected properly by firmly pushing and pulling the plugs and verifying the connectors are locked.
 - Inspect all connections and cables between the PV modules and the power optimizers: Verify they are connected properly by firmly pushing and pulling the plugs and verifying the connectors are locked.
 - Verify that the strings are firmly attached to the DC Safety Unit (if applicable) terminal blocks.
 - Verify all site-made connectors are firmly connected to their conductors by pulling from the conductor side of the connection.
3. If the system is set to manual reconnect, do the following:
 - Turn the inverter ON/OFF switch to OFF.
 - Turn the inverter ON/OFF switch to ON. The inverter performs an arc detection self-test and starts normal operation.