Application Note - Inverter Arc Detection in SolarEdge Systems (North America)

Revision History

- Version 1.3, May 2018: Addition of SetApp usage
- Version 1.2, Jan. 2018: Canadian Electric Code update
- Version 1.1, Nov. 2017: Error codes update according to new format released in inverter CPU v3.19xx
- Version 1.0, May 2017: 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 connecters 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 for 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.

Arc Fault Detection in SolarEdge Systems

SolarEdge inverters installed in North America are certified to UL1699B 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.

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.

SolarEdge inverters installed in North America comply with arc detection requirements as detailed below.

Inverters with DSP1 version 1.210.787 (single phase inverters) / 1.13.702 (three phase inverters) and above have arc fault circuit interruption (AFCI) enabled by default.

Inverters with lower versions, which support AFCI, have AFCI disabled by default; AFCI can be enabled from the inverter menu, as described in the next section.

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].

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[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.
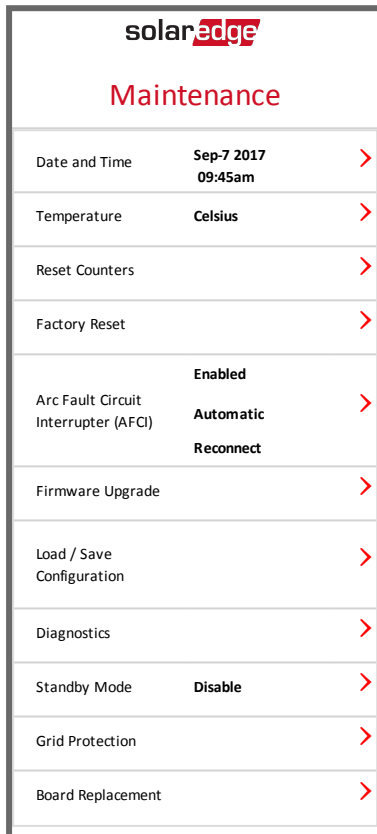
Enabling and Testing Arc Fault Detection

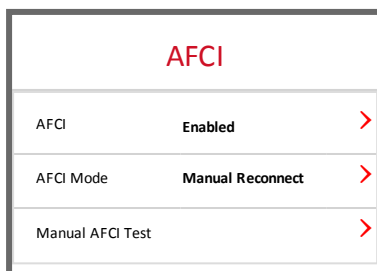The following sections describe how to enable and test the arc fault detection using :

- SetApp
- The inverter display (LCD)

Using SetApp

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

solar.edge		
Maintenance		
Date and Time	**Sep-7 2017 09:45am**	>
Temperature	**Celsius**	>
Reset Counters		>
Factory Reset		>
Arc Fault Circuit Interrupter (AFCI)	**Enabled** **Automatic Reconnect**	>
Firmware Upgrade		>
Load / Save Configuration		>
Diagnostics		>
Standby Mode	**Disable**	>
Grid Protection		>
Board Replacement		>

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

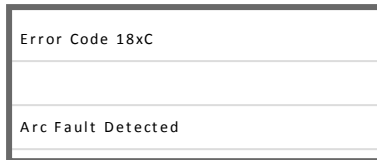| **AFCI**		
AFCI	**Enabled**	>
AFCI Mode	**Manual Reconnect**	>
Manual AFCI Test		>

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

▶ 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**.

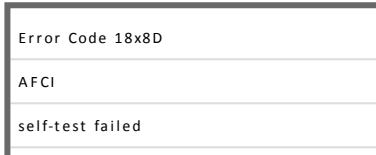   If the test is successful, the following message is displayed:

Manual Test PASS

The inverter production is then interrupted (as if a real arc detection has occurred), and the following error message is displayed:

```
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 inverter displays an error message indicating that the arc detector hardware failed during wake-up tests (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.

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**.

```
A F C I   < E n / D i s >
A F C I   M o d e   < M A N / A U T O >
```

► 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:

```
M a n u a l   T e s t   P A S S
```

The inverter production is then interrupted (as if a real arc detection has occurred), and the following error message is displayed :

```
E r r o r   C o d e   1 8 x C

A r c   F a u l t   D e t e c t e d
```

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 inverter displays an error message indicating that the arc detector hardware failed during wake-up tests (if the inverter is connected to the monitoring platform, the error is displayed there as well):

```
E r r o r   C o d e   1 8 x 8 D
A F C I
s e l f - t e s t   f a i l e d
```

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. The following error message is displayed on the LCD or SetApp; if the inverter is connected to the monitoring platform, the error is displayed there as well):

```
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 terminal blocks.
   - Verify all site-made connectors are firmly connected to their conductors by pulling from the conductor side of the connection.
3. Perform manual restart to resume system operation:
   - 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.