SolarEdge Safety in PV Systems

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33 Historical incidents
47 New incidents
26 on site investigations
21 desktop investigations
7 laboratory examinations

Recommendations
- Fault protection for DC circuits
- Automatic DC shut-off devices
Dealing with PV fires

Issues noted by FRS:

- Potential for electrocution
- Fear of [roof] collapse
- Unable to isolate live PV cables.
- Problems accessing isolation devices [located in loft]
- Access issues to tackle fire
- Uncertainties on how to isolate systems
- Made safe systems of work for fire service unpredictable
Poor installation

Likely causes of electrical arcing:
- Moisture ingress
- Incorrectly crimped connector contacts
- Incompatible plugs and sockets
- Plugs and sockets not fully engaged
- Loose screw terminals
- Poorly soldered joints
- Damaged components
Arc Fault Circuit Interruption (AFCI)

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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.

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.
AFCI Setting

- The arc fault circuit interruption (AFCI) option is disabled by default

- To enable AFCI, enter the "Maintenance" menu

- Scroll down to the "AFCI" menu

- Change "Disable" to "Enable" and confirm with a long push of the button

- Exit all menus
Manual and Auto Reconnect

The inverter supports two modes of 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 setting.

The default inverter reconnection mode is Manual Reconnect.

To select Auto Reconnect:

- Enter the „Maintenance“ menu, and then the „AFCI Mode“ menu
- Select „Auto Reconnect“
- Exit all menus
Accessories

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Firefighter Gateway

Safety
Remote controls the built-in SafeDC™ mechanism
- Enables system DC shutdown by pressing an emergency stop button or receiving an alarm from Fire Alarm Control Panel
- Real time indication of system DC voltage for safety assurance
- Remote indication of PV system status

Diagram:
- Firefighter Gateway
- Emergency Stop Button
- Fire Alarm Control Panel
- RS485 connections between components
Topology

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System Topology

Inverter (DC/AC)
Fixed input/output voltage ratio for highest efficiency

Optimizer
DC/DC “Buck-Boost” converter can increase or decrease the output voltage.
Optimizer

EMC Filter

PLC

EMC Filter

Transient Protection

input

buck-boost converter

output to string
Single Phase Inverter Block Diagram
Wake-up Process

Inverter is in nightmode (standby)
Wake-up Process

Voltage >= 6V
Inverter wakes up from nightmode and starts sending out wake-up signals on the DC line

wake-up signal:
- Transmitted constantly during operation
Wake-up Process

Wake-up signal received
Optimizers switch from safety mode to production mode and start increasing their output voltage
Wake-up Process

Wake-up signal received
Optimizers switch from safety mode to production mode and start increasing their output voltage
Wake-up Process

When the required voltage is reached, the inverter checks the grid parameters and starts power production.

Voltage ~750V
Every 5min each optimizer sends out its measurement data on the DC line.

A flashing yellow LED signalizes reception of a measurement data set. This data is forwarded to the SolarEdge monitoring server.
Concept of Operation

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SolarEdge System – Safety Mode

20x Optimizer

\( V_{OC} \)

80V
0A
1.0V

80V
0A
1.0V

80V
0A
1.0V

80V
0A
1.0V

Safe voltage

20V

400V

“OFF”

OR

Safety mode
1V per Optimizer

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SolarEdge System – Ideal System

20x Optimizer

500W

500W

500W

500W

Fixed DC Input Voltage

3-ph inverter = 750V
(1-ph inverter = 350V)

13.3A

10000W = 750V

400V

10000W / 750V = 13.3A

500W / 13.3A = 37.5V

SolarEdge System – Ideal System

500W / 13.3A = 37.5V
SolarEdge System – Shaded Module

20x Optimizer

- 500W
- 250W
- 500W
- 500W

Fixed DC Input Voltage

- 750V
- 400V

9750W = 750V

9750W / 750V = 13A

250W / 13A = 19.2V

500W / 13A = 38.5V

19x38.5V + 1x19.2V = 750V

20x Optimizer
SolarEdge System – Dead Module

20x Optimizer

19x39.5V = 750V

9500W / 750V = 12.66A

500W / 12.66A = 39.5V

9500W = 750V

Fixed DC Input Voltage

500W / 12.66A = 39.5V
Enable the AFCI – this will detect arcs and Isolate the string voltage to below 50 volts DC.

SolarEdge inverters all have a safe mode with a DC string voltage below 50 volts DC three phase and 25 volts DC in single phase.

The optimiser will stay at 1 volt DC until the inverter tells it to wake up, and continually tells the optimisers to stay on.

If the switch, AC/DC isolator are turned off, or the cable is cut, or connectors unplugged. The heartbeat signal will be cut.

FFG will send a signal to the inverters, and these drop to below 50 volts DC.
Cautionary Note Regarding Market Data & Industry Forecasts

This power point presentation contains market data and industry forecasts from certain third-party sources. This information is based on industry surveys and the preparer’s expertise in the industry and there can be no assurance that any such market data is accurate or that any such industry forecasts will be achieved. Although we have not independently verified the accuracy of such market data and industry forecasts, we believe that the market data is reliable and that the industry forecasts are reasonable.

THANK YOU!