

Safety Risks & Solutions in PV Systems



The purpose of this paper is to discuss and categorize the safety issues of PV systems for firefighters as well as outline how the SolarEdge system can mitigate these safety issues.

Firefighting

Risk - Electrocutation:

Firefighters and other first responders called to a blaze commonly cut off power to the burning building as a safety precaution. If the building has a PV installation however, the PV modules continue to generate voltage, even if the system is not actually connected to the AC grid. In electrical systems, extra-low voltage (SELV) indicates a safe voltage below 120V. Under these conditions there is a low risk of electrocution. Yet, 3 – 4 connected modules are enough to generate more than 150V. Residential and commercial installations include dozens or hundreds of modules with voltage that can reach 1000V.

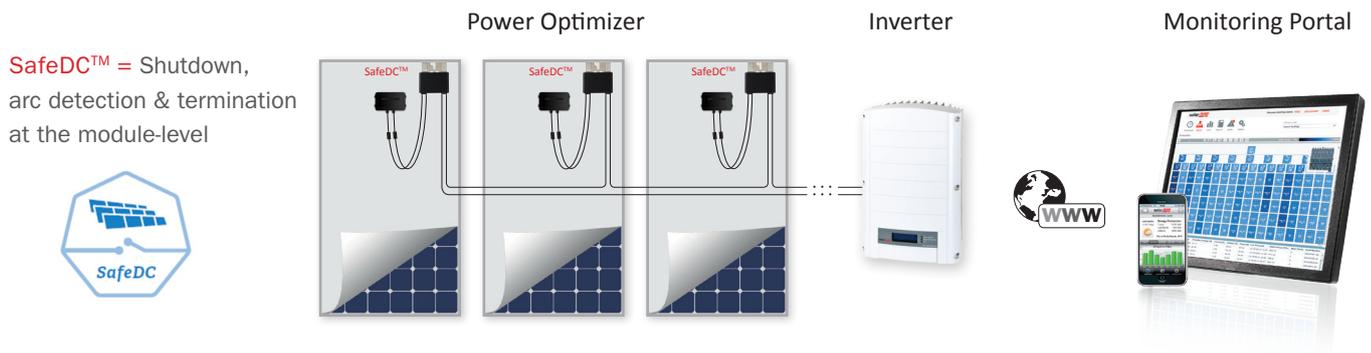
Ineffective Solutions:

1. Shutdown functions in traditional inverters merely interrupt current flow and voltages remain dangerously high.
2. Automatic DC breakers located on the inverter in the cabinet, cannot disconnect the voltage on the modules, adding cost without decreasing the risk.
3. PV module covering:
 - a. Spraying foam – this approach has proven to be ineffective because the foam evaporates or slides off the modules before extinguishing the fire.
 - b. Covering the module with an opaque material – this approach requires the firefighters to climb onto the burning roof, risking electrocution.

Effective Solution - Module-Level Shutdown:

SolarEdge offers a PV power harvesting system that consists of power optimizers connected to each module, a PV inverter and module-level monitoring. Additionally, SolarEdge systems have a built-in safety feature that eliminates safety risks.

When power optimizers are connected, modules continue in “operation mode” only as long as a signal from the inverter is constantly renewed. In absence of this signal, power optimizers automatically go into safety-mode, shutting down DC current as well as voltage in module and string wires. In safety mode, the output voltage of each module equals 1V. For example, if firefighters disconnect a PV system from the electrical grid during daylight and the PV system consists of 10 modules per string, the string voltage will decrease to 10V.



Since the maximum string length in a SolarEdge system is 50, the string voltage is limited to 50V_{DC}, safely below the risk level. Even under single faults, the solution has been certified to have SELV (<120V) voltages.

Module-level Shutdown Occurs Automatically:

- Either when a building is disconnected from the electrical grid
- Or when the inverter is shutdown
- Or when thermal sensors for each module detect the rising temperature (threshold 95°C)

Fire Prevention

When the connectors and/or cables in a PV system are damaged, the electric current may pass through the air, causing an electric arc. This generates a lot of heat and can start a fire as well as cause electrocution. As PV systems start to age and as damage to connector and/or cables increase, and though with low probability, electric arcs may occur.

Ineffective Solution - Inverter-Level Arc Detection:

Traditional inverters have a limited ability to detect arcs inside a PV array. As the distance from the inverter increases, the likelihood of arc detection decreases. Additionally, traditional inverters can only detect and terminate serial arcs which occur close to the inverter. Parallel arcs, however, cannot be terminated.

Effective Solution: Module-level Arc Detection and Termination

SolarEdge optimizers act as multiple module-level arc detection sensors in an array, which significantly increases detection accuracy. Optimizers can detect serial arcs and can automatically terminate them by eliminating any current in the wires by completely shutting off all modules in the array. Module-level shutdown can further terminate parallel arcs.

Conclusion

SolarEdge's SafeDC™ system, an inherent feature in SolarEdge power optimizers, the SolarEdge Inverter and the SolarEdge monitoring system. It is the only system that ensures complete safety for firefighters working with PV modules, eliminating the risk of electrocution and electric arcs, and which is certified in Europe as a DC disconnect.



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Certificate of compliance

Applicant: SolarEdge Technologies Ltd.
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Product: Disconnection device for PV generators

Model: Safe DC disconnect mechanism

Use in accordance with regulations:

Disconnection between a solar inverter and a photovoltaic generator

Applied rules and standards :

In dependence on

IEC 60947-3:1999 + Corrigendum:1999 + A1:2001 + Corrigendum 1:2001 + A2:2005
DIN EN 60947-3; VDE 0660-107:2006-03

"Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units"

and

IEC 60364-7-712:2002-05
DIN VDE 0100-712:2006-06

"Electrical Installations of Buildings - Part 7-712: Requirements for Special Installations or Locations - Solar Photovoltaic (PV) Power Supply Systems"

The safety concept of an aforementioned representative product corresponds at the time of issue of this certificate of valid safety specifications for the specified use in accordance with regulations.

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