Safety Risks and Solutions in PV Systems for Europe and APAC

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

Firefighting

Risk — Electrocution

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 DC 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. PV modules typically have an output voltage of 30-60V, and three-four connected modules are enough to generate more than 150V. When connected in a string, voltage in residential and commercial installations can reach 600-1500V, which can be dangerous to installers during system installation, maintenance personnel during O&M, and first responders during an emergency.

Ineffective Solutions

- Shutdown functions in traditional inverters merely interrupt current flow, and voltages remain dangerously high.
- Automatic DC breakers located on the inverter in the cabinet cannot disconnect the voltage on the modules, adding cost without decreasing the risk.
- Rooftop array disconnect switches only terminate the flow of current from the roof to the inverter. The modules on the roof, their cabling, and the cabling all the way to the inverter remain energized and dangerous while there is daylight.
- PV module covering:
  - » Spraying foam — this approach has proven to be ineffective because the foam evaporates or slides off the modules before extinguishing the fire.
  - » Covering the module with an opaque material — this approach is not practical to implement and even dangerous, as it requires the firefighters to climb onto the burning roof carrying heavy covering material, and risking electrocution.

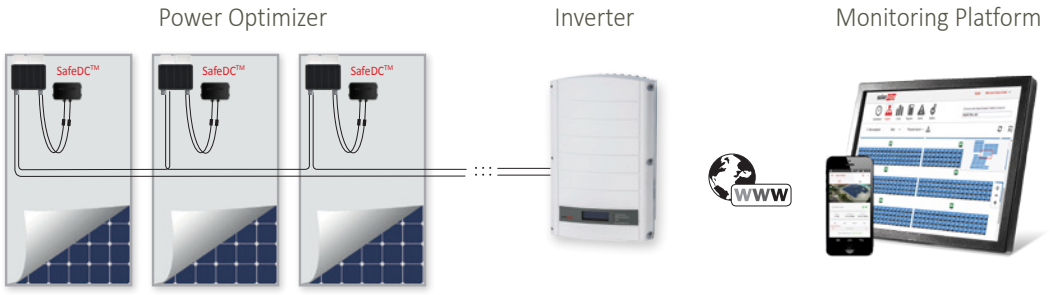
Effective Solution — Module-Level Shutdown

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 SafeDC™ safety feature that minimizes safety risks. When power optimizers are connected, modules continue to operate only as long as a signal from the inverter is constantly renewed. If there is no signal from the inverter, or if the inverter is not operating, SolarEdge's SafeDC™ feature is designed to automatically shut down the 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 10VDC. Since the maximum string length in a SolarEdge system is 50, the string voltage is limited to 50VDC, safely below the risk level. Even under single faults, the solution has been certified to have SELV (<120V) voltages.

Module-level shutdown occurs automatically in any of these cases

- A building is disconnected from the electrical grid
- The inverter is turned off
- Power optimizer thermal sensors for each module detect the rising temperature (threshold 85˚C)

SafeDC™ = Voltage shutdown at the module-level



Global trends

Increasing numbers of fire authorities, insurance companies, and electrical authorities are introducing new standards and regulations aimed at increasing PV safety and protecting personnel and property.

NEC 2014/2017

In the United States, for example, the National Electric Code, NEC 2014, and the more recent NEC 2017, requires rapid shutdown of PV systems on buildings. As part of this requirement, DC voltage in circuits running more than a certain distance from the array to the inverter (10 feet for NEC 2014, one foot for NEC 2017) has to be lower than 30VDC within 30 seconds of rapid shutdown initiation (NEC 2017), or 10 seconds (NEC 2014). The SolarEdge solution complies with this requirement. Published by the NFPA (National Fire Protection Association), the NEC code is voted on and approved by firefighters and code officials. SolarEdge has also received a NRTL listing to UL 1741 CRD for PVRSS (Photovoltaic Rapid Shutdown System). This is now required for NEC 2017 compliance.

An additional example is the German application guide; VDE-AR-E 2100-712.

VDE compliance

The German application guide VDE-AR-E 2100-712 requires, among other things, that after switching off the AC power supply, first responders will not expose themselves to the risk of direct contact with DC cables, which still carry a voltage greater than 120 volts DC. SolarEdge P series power optimizers meet this requirement by the patented SafeDC™ function (1V safety voltage). SolarEdge power optimizers allow automatic and fail-safe reduction of DC-voltage to a safe voltage (below 120VDC) within the required time. This function is integral to the system and therefore does not require any additional hardware or fire proof constructional measures, leading to a reduction of installation costs. SolarEdge's conformity to the technical requirements in sections 7.1 and 7.4 of the application rule were confirmed by Primara (see last page).

Conclusion

The SolarEdge system, with the integral SafeDC™ feature, ensures complete safety for firefighters working with PV modules and eliminates the risk of electrocution. The SolarEdge SafeDC™ feature is certified in Europe as a DC disconnect according to IEC/EN 60947-1 and-3 and to the safety standards VDE AR 2100-712 and OEVE R-11-1.

primara
Test- und Zertifizier-GmbH

Declaration of Conformity

Applicant:	**SolarEdge Technologies** 1 HaMada Street. Herzeliya 4673335 **Israel**
Product type:	Disconnect device for PV generators
Model:	Safe DC disconnect mechanism
Rating:	Disconnection between a PV inverter and a PV generator
Applied rules and standards:	In dependence on: **IEC 60947-3:1999 + Corr:1999 + A1:2001 + Corr1:2001 + A2:2005 in conjuction with IEC 60947-1:2004 (4th edition)** "Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units"

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

Report no:	13KFS109-01
Certificate no:	16-167-00
Date of issue:	2016-11-09

Andreas Aufmuth

Primara Test- und Zertifizier-GmbH | Gewerbestraße 28 | 87600 Kaufbeuren | Germany | www.primara.net

primara
Test- und Zertifizier-GmbH

Konformitätsbescheinigung

Antragsteller: **SolarEdge Technologies**
6 HeHarash St.
Hod Hasharon, 45240
Israel

Produkt Typ: **Leistungsoptimierer**

Modell:	**Pxxx, PxxxI** **OPJxxx-LV**

xxx kann stellvertretend für die Leistung eine Zahl von 0-9 sein

Die Leistungsoptimierer in Kombination mit SolarEdge Wechselrichtern oder SolarEdge SMI erfüllen zum Zeitpunkt der Ausstellung der Bescheinigung folgende Punkte der nachfolgenden VDE Anwendungsregel.

Anwendungsregel: **VDE-AR-E 2100-712:2013-05**
Maßnahmen für den DC-Bereich einer Photovoltaikanlage zum Einhalten der elektrischen Sicherheit im Falle einer Brandbekämpfung oder einer technischen Hilfeleistung
§7.1 Einrichtungen zum Schalten, Trennen oder Kurzschließen im DC-Bereich einer PV-Anlage
§7.4 Einrichtung zum Abschalten eines PV-Moduls

Für volle Konformität einer Photovoltaikanlage im Sinne der Anwendungsregel sind vom Errichter/Installateur der Anlage vor Ort zusätzlich die geforderten Maßnahmen gemäß
§5 Kennzeichnung von Anlage und PV-DC-Leitungsführung
zu treffen.

Bericht Nr.: 13KFS090-01

Bescheinigung Nr.: 14-007-01

Datum: 2014-02-26

Andreas Aufmuth

Primara Test- und Zertifizier-GmbH | Gewerbestraße 28 | 87600 Kaufbeuren | Germany | T +49 (0) 8341 955 48 93 | T +49 (0) 8341 955 48 94