# Overvoltage Surge Protection–Technical Note

## Revision History

**Version 2.5 (November 2020)**

- Merged North American and Rest-of-World versions
- Added SPD options for commercial inverters

## Overview

The purpose of this Technical Note is to describe proper protection of SolarEdge products in the field from overvoltage surges caused by lightning strikes, grid overvoltage events and ground faults. Properly installed surge protection can reduce the likelihood of permanent damage to inverter components, Control and Communication Gateways (CCGs), communication devices and interconnected meters.

Rapidly changing currents create electromagnetic pulses (EMPs) that radiate and create current and voltage "surge" when passing over conductive elements like electrical wires, communication lines, or metallic pipes. These surges may result in the destruction of delicate electronics and semiconductors. Devices known as surge protectors (SPD) or transient voltage surge suppressors (TVSS) connected to these conductors can route these transient currents to the ground, protecting the equipment from damage.

SolarEdge recommends that all three phase inverters should have surge protection devices on the AC, RS485, and Ethernet lines to mitigate the effect of environmental factors which are beyond SolarEdge's control and which fall outside of SolarEdge's limited product warranty:

https://www.solaredge.com/sites/default/files/solaredge-warranty-may-2020.pdf

The latest SolarEdge commercial inverter models include multiple built-in SPD options. For additional details, see *Internal Protection for SEXXK-XXXXIBXX4 Commercial Inverters* on page 4

## Lightning Strikes and Electromagnetic Pulses

One of the common sources of voltage surge is lightning strikes. It is not necessary for lightning to strike the PV site to damage it; therefore, it is worthwhile to consider all the ways in which lightning can induce surge, including electrostatic and magnetic induction.

### Direct Lightning Strike

A surge protection device alone cannot protect electronic equipment from a direct lightning strike. External protection is required to attract the lightning and redirect it to the ground, while the SPD absorbs residual energy. External protection equipment includes lightning rods, grounding wires, catching devices and conductors, as well as the accompanying ground system.

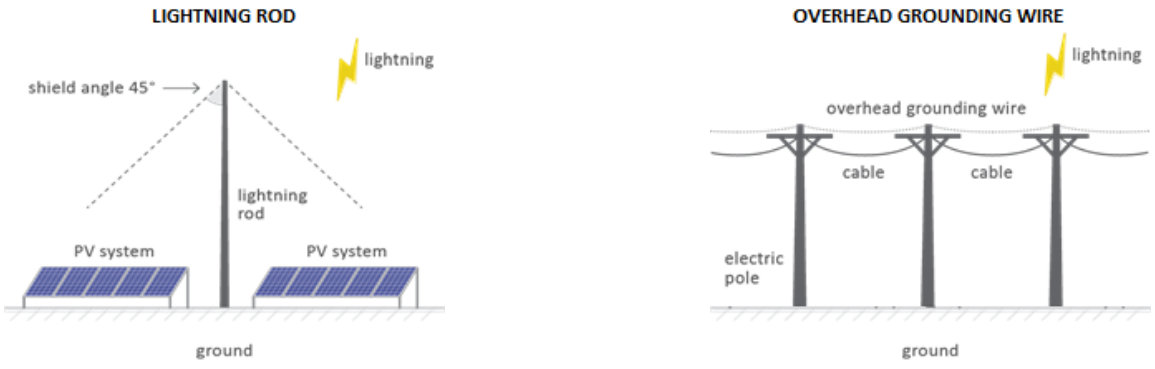



Figure 1: Direct lightning strike protection equipment

One effect of a direct lightning strike is increased ground potential – when the lightning strikes a building or a lightning rod, high current flows to the ground and the ground potential rises. This creates a potential difference between ground and external conductors, leading to surge behavior.

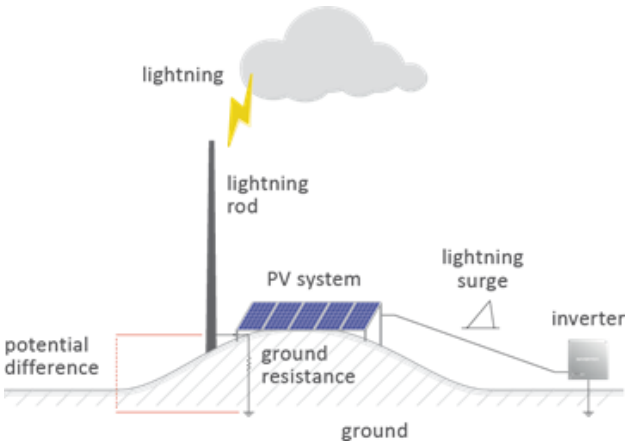



Figure 2: Increased ground potential following a lightning strike

## Electrostatic Induction

Thunderclouds contain negative charges in their lower sections. These high negative charges can induce high positive charges within nearby cables, especially power lines and communication cables.

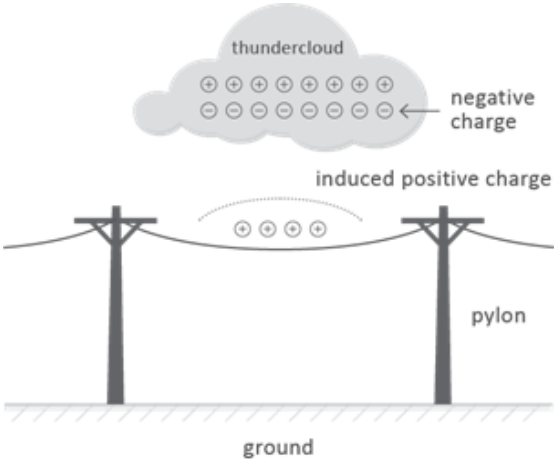



Figure 3: Electrostatic induction - before discharge

During discharge of the thundercloud (lightning), the positive charge accumulated in the cable is released, resulting in a surge in the cable in both directions.

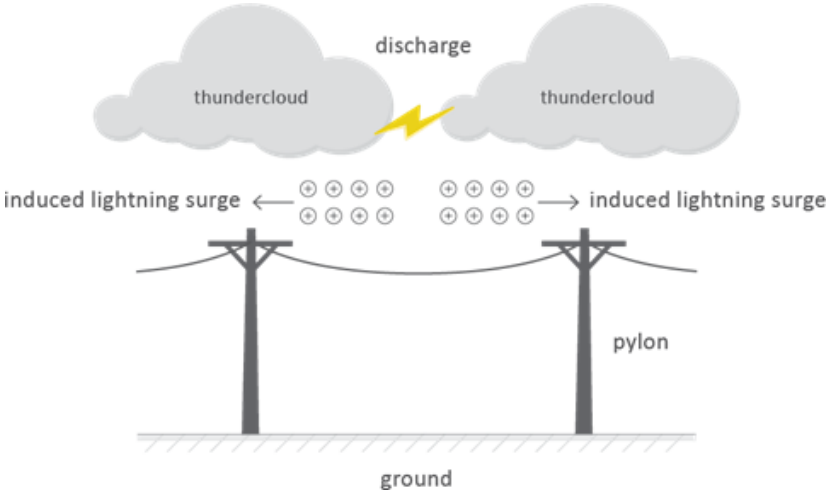



Figure 4: Electrostatic induction - during discharge

### Electromagnetic Induction (Indirect Lightning)

A discharge between clouds and the ground generates a surging magnetic wave. When the magnetic wave reaches AC lines or communication cables, it induces a voltage surge.

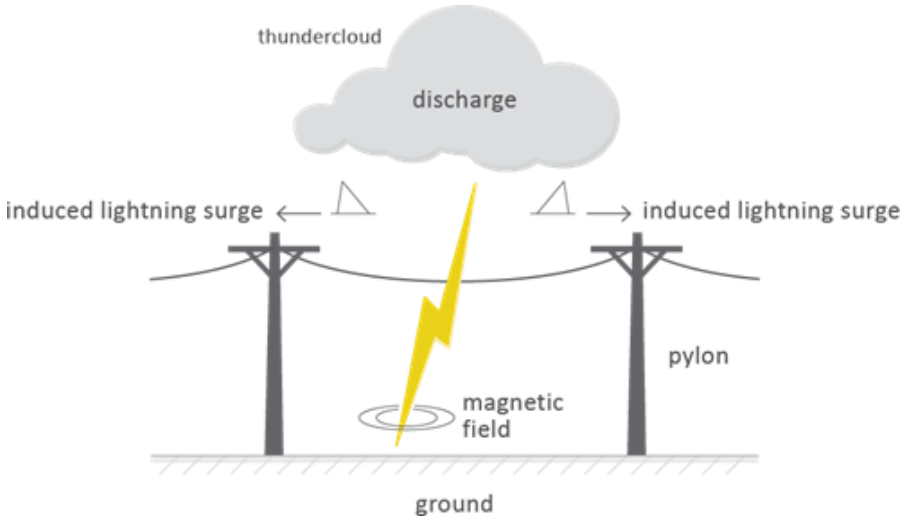



Figure 5: Electromagnetic induction

## What is a Surge Protection Device?

In order to avoid high voltage damage to a PV system, voltage surges should have a path to ground to avoid high energy from passing through electronics. In order to provide this path, all of the wiring exiting and entering the system should be coupled to ground through a Surge Protection Device (SPD), and all conductive surfaces should be directly grounded.

Examples of lines exiting and entering the system include the AC mains and communication lines, such as Ethernet cables, RS485 cabling and telephone lines. Note that SPDs on power lines provide protection that is different from circuit breakers; breakers protect equipment from overcurrent while SPDs protect equipment fromover voltage.

SPDs are usually a combination of Metal Oxide Varistors (MOVs), Gas Discharge Tubes (GDT) and/or Zener diodes, and current limiting devices that act to shunt charge to ground and to divert it from entering the protected system in the event of high voltage or current surges. Both MOVs and GDTs have a limited lifetime, and can handle a finite number of surge events.

## Protection of SolarEdge Systems

### Internal AC and DC Overvoltage Protection

The SolarEdge inverters and power optimizers conform to the IEC62109 safety standard. According to this standard, equipment permanently connected to AC must withstand Overvoltage Category III (marked OVC III), while DC connection must withstand OVC II. Impulse-withstand voltage ratings for the mains circuit are assigned based on the above OVC and on the mains system voltage, as in section 7.3.7.1.4 of IEC62109 and is > 4kV.

The inverter is manufactured with internal overvoltage protection on the AC and DC (PV) sides. If the PV system is installed on a building with an existing lightning protection system, the PV system must also be properly included in the lightning protection system. The inverters are classified as having Type III (class D) protection (limited protection). Varistors in the inverter are connected between phase and neutral cables, between neutral and PE cables, and between PV plus and PV minus terminals.

SolarEdge inverters and power optimizers supplied in North America conform to the UL1741/IEEE1547 safety standards, which include internal overvoltage protection. Varistors and GDTs in the inverters connect between phase and neutral cables, between neutral and ground conductors, and between PV terminals.

NOTE

Overvoltage surge protection requirements depend on the system configuration, physical parameters and geographic location, and should be implemented according to installation requirements. Internal SPDs provided by SolarEdge cannot match the surge protection capabilities provided by external protection devices.

The SolarEdge power optimizers have the same protection level as regular protection diodes that exist in every PV module. This means that the power optimizers can withstand the same surge events and voltages as the PV module.

## Internal Protection for SEXXK-XXXXIBXX4 Commercial Inverters

SolarEdge commercial inverters with part numbers in the SEXXK-XXXXIBXX4 range offer multiple SPD options for every need.

- RS485: pre-installed or available as an external kit
- AC Type 2 SPD: pre-installed or available as an external kit
- DC Type 2 SPD: pre-installed or available as an external kit

## Internal RS485 Overvoltage Protection

SolarEdge three phase inverters with Synergy technology are supplied with a built-in RS485 SPD that protects the RS485-1 bus.

## Adding External SPDs to Your PV System

### Installation Guidelines

The following are the guidelines for adding SPDs to your PV system

- The maximum wire length a+b (as shown in the following figure) should not be longer than 50 cm/19.6 inch.

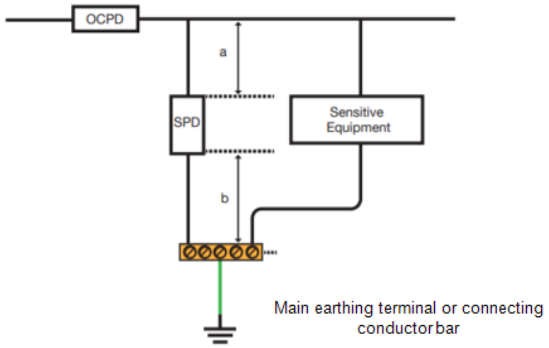



Figure 6: Wire length guidelines

- The grounding wire should be at least or longer than 4 mm/ 12 AWG.
- The SPD should be installed as close as possible to the inverter.
- It is recommended to use Type 1 or Type 1+2 AC SPD for unstable grids.
- In case the PV System is located further than 50 cm/19.6 inch from the lightning protection system, you must connect the PV system to the lightning protection system and vice versa.

  WARNING!

  In this case the Type 2 SPD will not be sufficient and might ignite in the event of an impact.

- In case the PV System is located closer than 50 cm/19.6 inch from the lightning protection system, you must install the PV system separately. In this case the inverter must be connected with a Type 2 SPD.

  NOTE

  There must be sufficient lightning catchers to prevent impact on the panels.

### DC Side

When using string protectors such as fuses, DC breakers or string diodes together with SPDs, the SPD must be installed between the fuses and the inverter, otherwise the PV strings would be unprotected if the fuse is triggered.

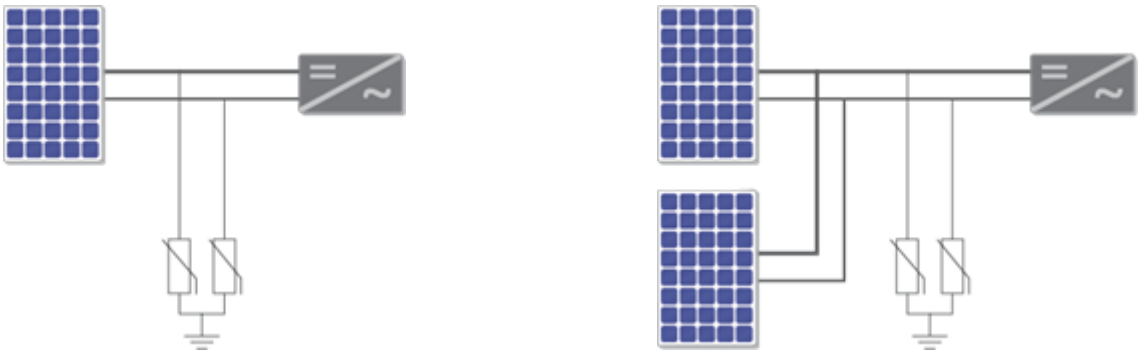


Figure 7: Connecting SPDs to inverters with fuses/circuit breakers

For inverters with an integrated fuse box, internal fuses should be bypassed in order to connect an SPD, and external string fuses should be connected.

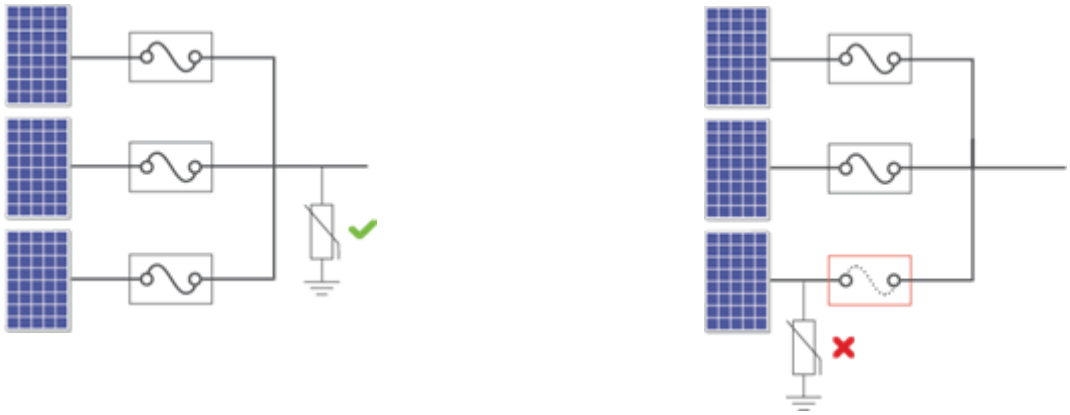


Figure 8: Connecting SPDs to inverters with integrated fuse

SolarEdge recommends the Citel DS50VGPV Series SPDs (or equivalent) for protecting SolarEdge inverters.

Installation specifications:

- Devices must be mounted outside of the inverter and in a NEMA Type 3R or higher enclosure for outdoor applications
- Each string can have an individual SPD, or multiple strings may be combined in a combiner box prior to wiring into the SPD

## AC Side

SolarEdge recommends the Citel DS70U Series SPDs (or equivalent) for protecting SolarEdge inverters.

Installation specifications:

- The SPD should be installed as close as possible to the inverter, while taking into consideration the following conditions:
  - the length of the wire between the inverter and the SPD unit **may** exceed 9 m / 30 feet
  - the physical distance between the SPD and the inverter units **must not** exceed 9 m / 30 feet
- Many SPDs are DIN rail mountable, and should be mounted in a NEMA Type 3R or higher enclosure for outdoor applications.
- Multiple inverters can be connected to the AC SPD output side. In this case the total length

of the AC wires between the AC SPD unit and all the inverters should not exceed 9 m / 30 feet.

## Communications Lines

Power lines are not the only conductive cables that provide a path for voltage surges into inverter electronics. The communication lines (RS485 and Ethernet) should also be protected using surge protection devices.

- In some cases, the SPD is built into the inverter. In other cases, the SPD can be purchased separately from SolarEdge. Refer to the datasheet for technical specifications and part numbers. Installation instructions are supplied with the SPD.
- For other types of communications lines (for example, Ethernet), SolarEdge recommends using external surge protection devices on each communication line when the following conditions apply:
  - The distance between devices is more than 10 m / 33 feet
  - There is a risk of induced surges

When possible, it is recommended to mount the communications SPD inside the SolarEdge inverter DC Safety Unit. Otherwise, when routing communication wires near AC and DC power lines, ensure that the conductor insulation used in the communications wires is rated as follows:

- When routing near DC power lines: 600V
- When routing near AC power lines: 300V

For North America and Australia: When routing communication wires from the DC Safety Unit into the inverter through the DC or AC power conduits, it is recommended to put an insulating sleeve over the conductors.

NOTE

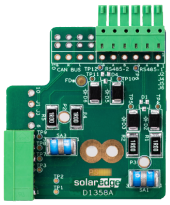
It is not advisable to route communication lines in the same conduit as DC or AC power lines external to the inverter. Instead, a separate conduit should be provided, using one of the DC Safety Unit knockouts as a point of entry.

### RS485 Surge Protection

RS485 surge protection wiring requirements:

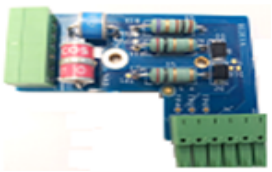
- Cable type: minimum 3-wire shielded twisted cable (a 4-wire cable may be used)
- Wire cross-section: 0.2-1.0 mm2/24-18 AWG (a CAT6 cable may be used)
- Maximum nodes: 32
- Maximum wire length between first and last devices: 1 km / 3300 feet
- It is recommended to use wires rated at 85°C / 185°F

**For applicable three phase inverter applications**, SolarEdge recommends the SE-RS485-SPD3-B-K4 RS485 Surge Protection Device (SPD).



- Nominal discharge current: In(8/20)µs 5 kA
- Maximum discharge current: Imax(8/20)µs 15 kA

**For applicable single phase inverter applications**, SolarEdge recommends the SE-RS485-SPD2-K2 RS485 Surge Protection Device (SPD).



- Nominal discharge current: In(8/20)µs 5 kA
- Maximum discharge current: Imax(8/20)µs 15 kA

**Alternative SPDs**

ZJBENY BUD-40/3 SPD or equivalent.

- Nominal discharge current: In(8/20)µs 20 kA
- Maximum discharge current: Imax(8/20)µs 40 kA

Citel DLA-12D3 or equivalent:

- Nominal discharge current: In(8/20)µs 5 kA
- Maximum discharge current: Imax(8/20)µs 20 kA

### Ethernet Surge Protection

Ethernet surge protection wiring requirements:

- Cable type: CAT6
- Maximum wire length between the inverter and the router: 100 m / 330 feet

Devices should provide surge discharge ratings of:

- Nominal discharge current: In(8/20)µs 10 kA
- Maximum discharge current: Imax(8/20)µs 20 kA

SolarEdge recommends the Citel MJ8 series Ethernet SPD or equivalent.

## Sample Commercial System with Surge Protection

A sample SPD line diagram for a small commercial system appears in the figure below.

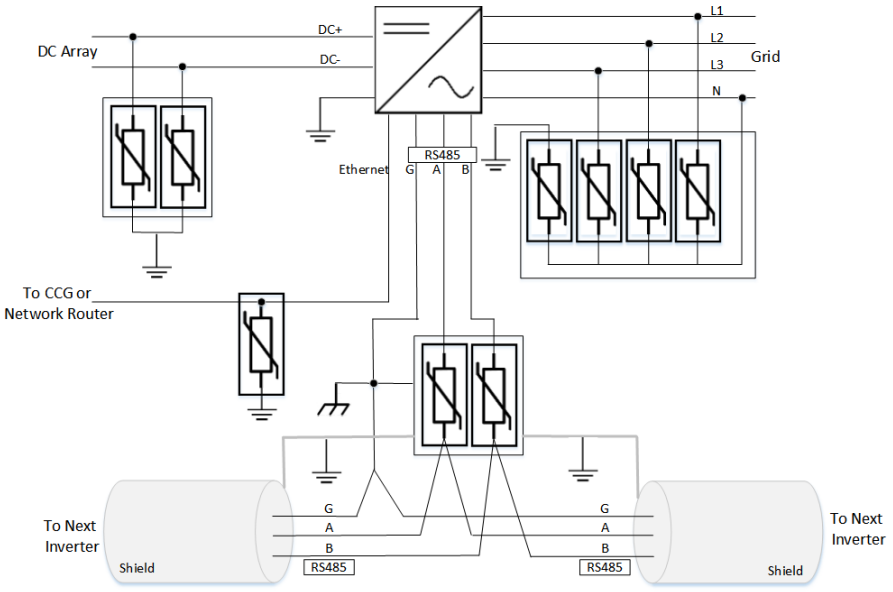



Figure 9: Sample surge protection scheme