Overvoltage Surge Protection - Technical Note, Europe and APAC

Revision History

Version 2.2 (November 2017)

- Use of SolarEdge Surge Protection Device in three phase inverters
- Updated sample surge protection design drawing for commercial PV system

Version 2.1 (December 2016)

- Recommended External Surge Protection Devices for SolarEdge inverters

Version 1.0 (December 2014)

- Initial version

Contents

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.

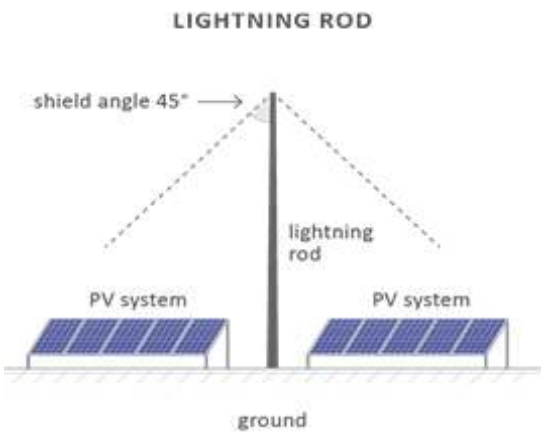
SolarEdge recommends that all three phase inverters be installed with external surge protection devices (SPDs) on the AC, RS485, and Ethernet lines to mitigate the effect of environmental factors which are beyond SolarEdge’s control and which fall outside of SolarEdge’s limited product warranty (http://solaredge.com/groups/service/warranty).

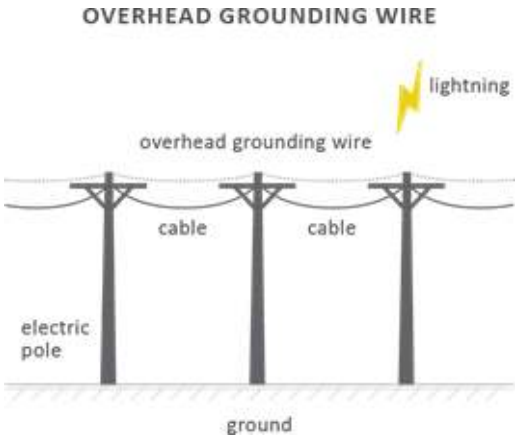
Lightning Strikes and Electromagnetic Pulses

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.

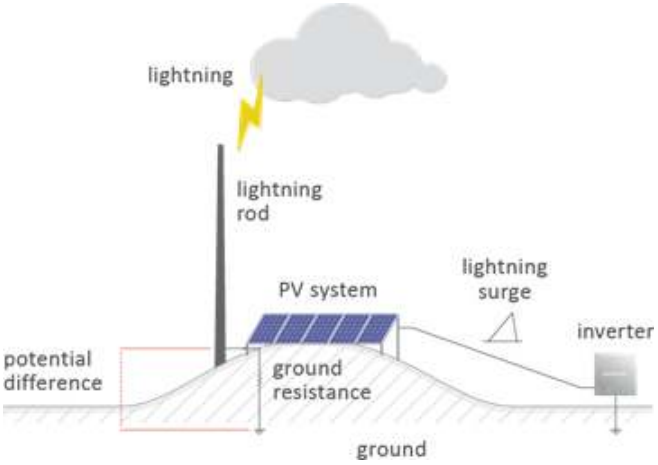
Direct Lightning Strike

Direct lightning strike energy is enormous, and a surge protector alone cannot protect the stricken instruments. External protection is required to attract the lightning and redirect it to the ground, during which SPDs only absorb residual energy. External protection equipment includes lightning rods, grounding wires, catching devices and conductors, as well as the accompanying ground system.



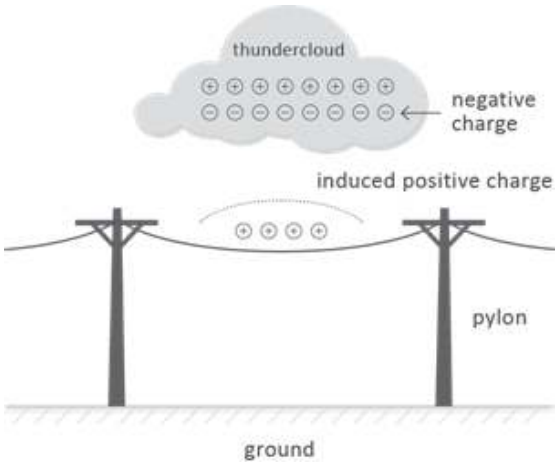


One effect of a direct lightning strike is increased ground potential – when the lightning strikes a building or a lightning rod, high current flows to the ground and the ground potential rises. This creates a potential difference between ground and external conductors, leading to surge behavior.

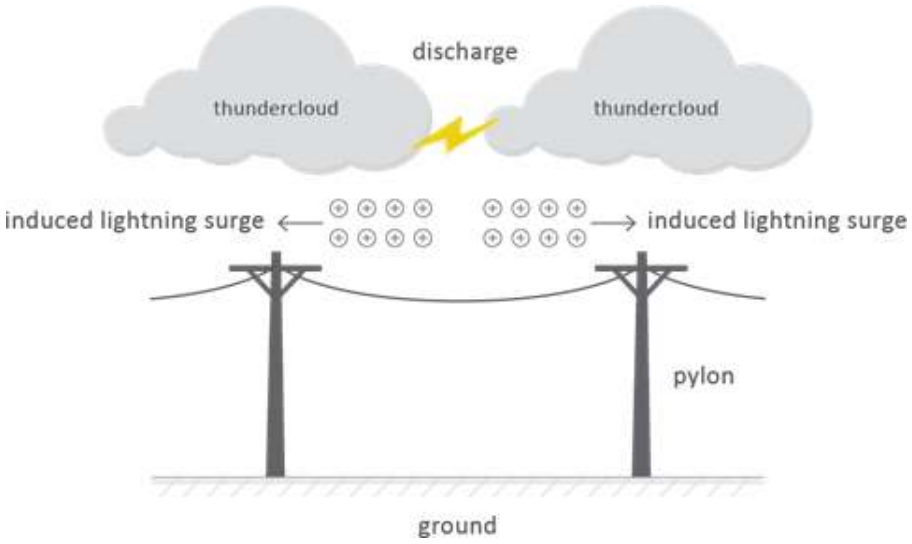


Electrostatic Induction

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.

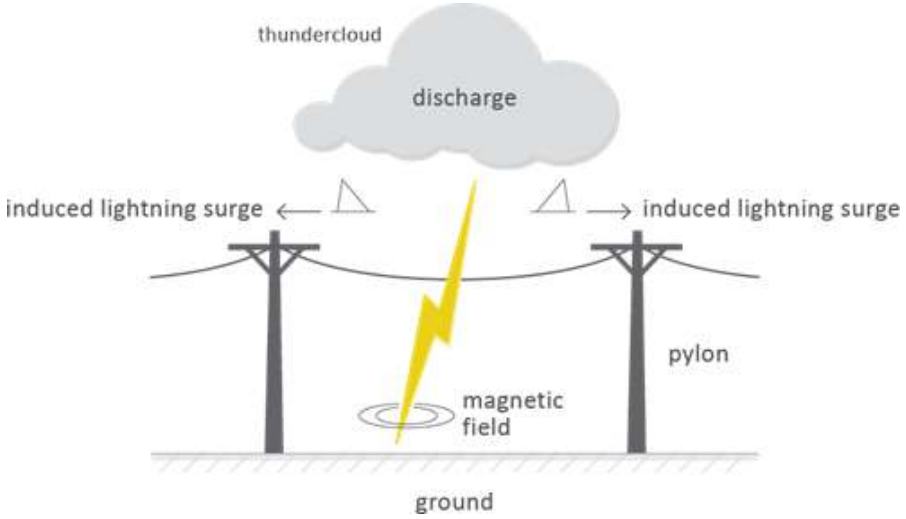


During discharge of the thundercloud (lightning), the positive charge accumulated in the cable is released, resulting in a surge in the cable in both directions.



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.



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.

NOTE

Overvoltage surge protection requirements depend on the system configuration, physical parameters and geographic location, and should be implemented according to installation requirements. The SolarEdge inverter's internal SPD 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.

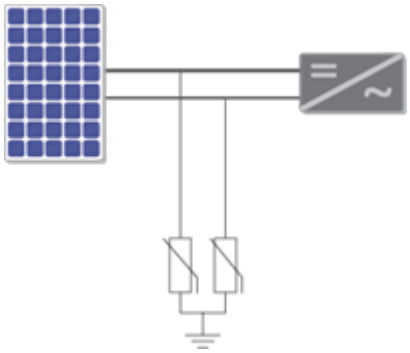
Internal RS485 Overvoltage Protection

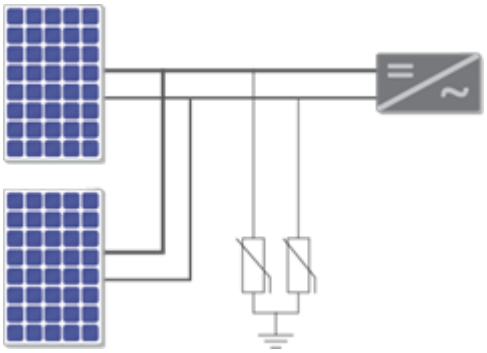
SolarEdge commercial three phase inverters (SE50K or higher) are supplied with a built-in RS485 SPD that protects the RS485-1 bus.

Adding External SPDs to Your PV System

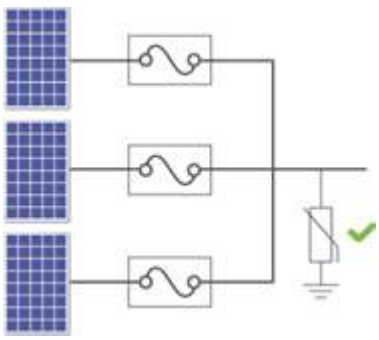
DC Side

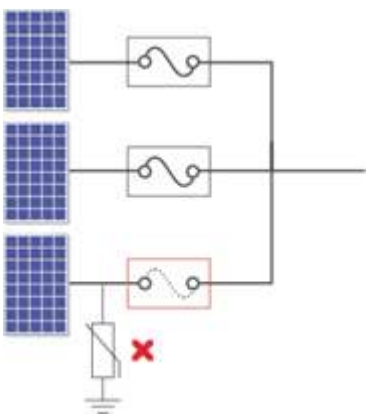
When using string protectors such as fuses, DC breakers or string diodes together with SPDs, the SPD must be installed between the fuses and the inverter, otherwise the PV strings would be unprotected if the fuse is triggered.





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.





SolarEdge recommends the Citel DS50VGPVS-1000 (or equivalent) for 277/480V inverters and the Citel DS50VGPVS-500 for 208V inverters: Citel DS50VGPV Series.

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 DS74US-277Y/G (or equivalent) for 277/480V inverters and the Citel DS74US-120Y/G (or equivalent) for 208V inverters: Citel DS70U Range.

Installation specifications:

- Maximum wire length (not physical distance) between the SPD and the protected inverters: 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, usually in the distribution panel closest to the inverters
- Multiple inverters can be connected to the same SPD if they share the same grid connection

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 external surge protection.

- For three phase inverters, an RS485 Surge Protection Device is available from SolarEdge. Refer to the datasheet for technical specifications and a part number. Installation instructions are supplied with the SPD.
- Commercial three phase inverters (SE50K or higher) are supplied with built-in RS485 SPD that protects the RS485-1 bus.
- For other types of communications lines (for example, Ethernet, or RS485 in single phase inverters), 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 Switch. 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

When routing communication wires from the DC Safety Switch into the inverter through the DC or AC power conduits, you may also put an insulating sleeve over the conductors – an example can be found here:
http://www.evita.lt/en/vpvc9_53-polivinilchlorido-pvc-izoliacinis-vamzdelis-9_53mm-1m-600v-105c

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 Switch 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 CAT5 cable may be used)
- Maximum nodes: 32
- Maximum wire length between first and last devices: 1 km / 3300 feet

For three phase inverter applications, SolarEdge recommends the SE-RS485-SPD2-K1 RS485 Surge Protection Device (SPD).

- Nominal Discharge Current: In(8/20)µs 5 kA
- Maximum Discharge Current: Im ax(8/20)µs 15 kA

For other types of applications, an alternative to the above RS485 SPD is the ZJBENY BUD-40/3 SPD.

- Nominal Discharge Current: In(8/20)µs 20 kA
- Maximum Discharge Current: Im ax(8/20)µs 40 kA

An additional alternative to the RS485 SPD is the Citel DLA-12D3 (CItel DLA Series) or equivalent:

Ethernet Surge Protection

Ethernet surge protection wiring requirements:

- Cable type: CAT5/CAT6
- Maximum wire length between the inverter and the router: 100 m / 330 feet

Devices should provide surge discharge ratings of:

- In: 10 kA 8/20 µs
- Imax: 20 kA 8/20µs

SolarEdge recommends the Citel MJ8 series Ethernet SPD or equivalent.

Appendix - Sample Commerical System with Surge Protection

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