LOW VOLTAGE

OVR PV T1-T2 QS Series

Complete Protection of Photovoltaic (PV) systems

ABB effort to guarantee your photovoltaic (PV) system security

Photovoltaic systems are the future of renewable energies, but they need a certain degree of protection according to the system installation differences.

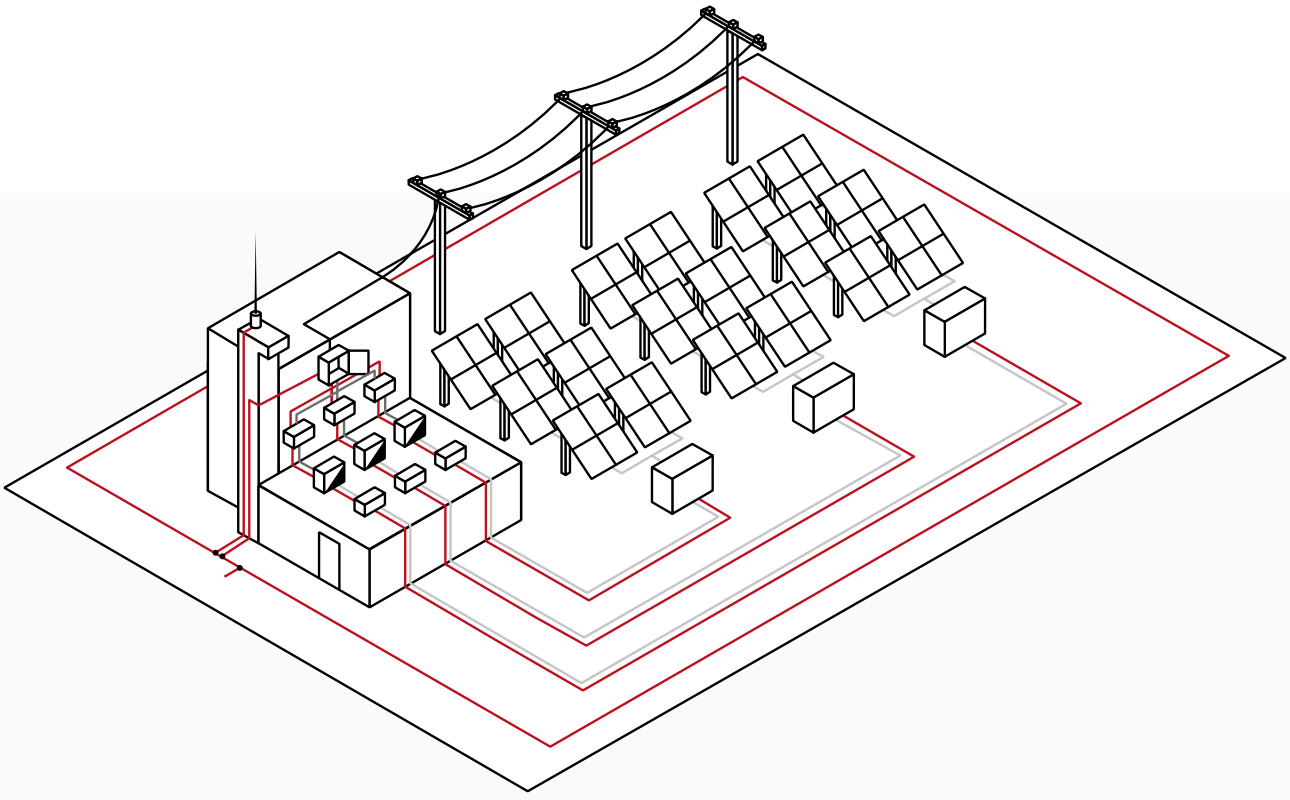
The production of electricity with solar panels is one of the most important in the context of renewable energy sources.

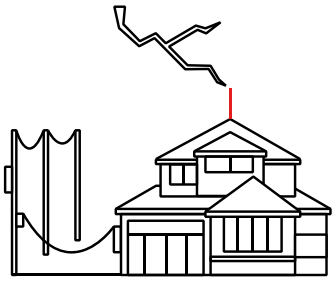
The photovoltaic installations are increasing all over the world and this trend does not only involve the most developed countries but also emerging countries such as China. This business is growing and will grow more and more because the goal is to generate clean and renewable energy with lower costs. Moreover, the advantages of photovoltaic panels are numerous, both in terms of duration of the installation and in terms of reduced maintenance costs, this ensures that the trend and the investments are destined to continue. In this context, ABB cannot avoid guaranteeing its effort to make the Photovoltaic industry safer and more affordable.

The goal is to give the possibility to have a cleaner and more efficient PV installation with at the same time the higher possible level of protection...

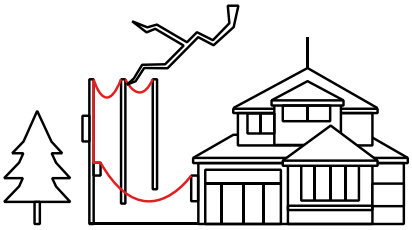
Risks of the installation
For photovoltaic panels, characterized by a very extensive surface, lightning is considered an important risk factor.

Lightning strikes can cause different effects on electrical systems, due to direct or indirect discharges. Direct lightning strikes are a particularly harmful phenomenon for electrical equipment connected to the circuit. A direct lightning strike can damage in two main ways, through galvanic coupling or conductive coupling, while Indirect lightning strike damage through the inductive coupling.

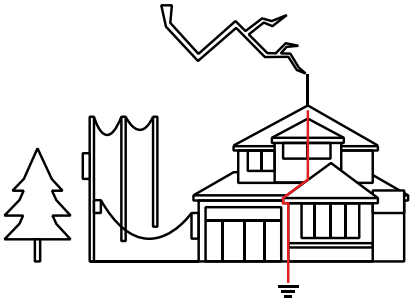


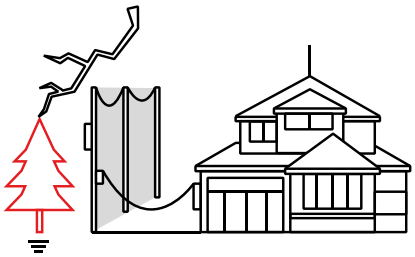


- Galvanic coupling occurs when lightning hit a lightning rod or the roof of a building.



- Conductive coupling occurs when lightning hit an aerial electric line or a low voltage line.





- Inductive coupling occurs in two main scenarios, when lightining hits a roof equipped with earthing system or when lightning takes place near some aerial electric lines causing an overvoltage that propagates in each near circuit.

Risks management
According to the IEC/EN 62305-2 standard, there are several types of risks, based on different elements that must be taken under consideration when deciding the right type of lightning protection.

As first, risks should be evaluated: R1, R2, R3, R4. According to the level of risk, a certain level of protection should be adopted. Jurisdiction must define a so-called Tolerable risk Rt and it's important that the calculated risk R is lower than the tolerable one.

R <= Rt

If this situation is not respected a certain level of protection is needed, according to the IEC 62302-2 standard.

The Lightning protection system (LPS)
The huge power of a lightning strike would create issues like:
- Thermal or mechanical damage
- Dangerous sparking which can generate fire or explosions.

IEC/EN 62305-3 explains that the LPS system is based on five major characteristics:

- Air termination system
- Down conductors
- Earth termination system
- Separation distances
- Lightning equipotential bonding

The goal of the LPS is to guarantee that the current flow is safely led to the ground when lightning hits the air termination system.
The LPS is formed by the lightning rod, the down conductors and the earth termination system. These three elements constitute the so-called External lightning protection.

On the other hand, the internal lightning protection is based on the need for protection from dangerous sparking occurring within the structure of the external LPS.

The Avoidance of this dangerous phenomenon can be achieved through an equipotential bonding or thanks to the right separation distance between the external protection system and the equipment.

SPD's
The LPS needs support to achieve the complete protection of the photovoltaic installation, both in case of a direct and indirect strike.

For this reason, surge protective devices (SPDs) need to be installed to guarantee the protection from the overvoltage to all the electrical systems of the photovoltaic installation.

How SPD work (IEC 61643-12)?

- Providing a limitation of an overvoltage by carrying the energy of the surge to the ground

There are different types of SPD's:

- The type 1, protect from the direct lightning, they can discharge a very big amount of energy, even if they are not able to protect more sensitive equipment.
  - Type One SPD's are tested with waveform (10/350 µs), this test is based on the simulation of a direct strike. The intensity of peak current of type I is called I imp.

- Type 2 protects from the indirect lightning, they can protect several times and with a good level of protection.
  - The SPD's type 2 are tested with waveform (8/20 µs), this test guarantees protection for lower energy surges representing indirect strikes. The intensity of peak current is Imax.

- Type 1+2, it's the newest generation of SPD's, this type includes both the direct strike protection and the indirect one.
  - This kind of SPD's is particularly useful because they are very easy to select, to install and can guarantee a high level of protection for all the situations in which can occur a surge. Tested with both waveforms (8/20 µs) and (10/350 µs).

Photovoltaic AC and DC sides protection
According to the IEC 61643-32 regulation, the PV installations must be always protected by SPD's both on the AC side and the DC side.
The regulation makes a distinction between the two situations because they need different degrees and types of protection.
For the AC side, the protection to follow is based on the IEC 61643-11, the devices are designed to be connected to 50/60 Hz AC circuits, and equipment rated up to 1 000 V r.m.s.
That's why ABB offers solutions to address the protection of the ac side that goes to 1000 V.
Far more interesting is what concern about the DC side, regulated in 2018 through the IEC 61643-31 and 61643-32.

In this context, the peculiarity is that the SPD's are designed to be connected to the DC side of photovoltaic installations rated up to 1 500 V DC and Due to the specific U/I-characteristic of PV systems only SPDs explicitly designated for use on the DC side of PV systems shall be installed.
Because of the non-linear characteristics of a Photovoltaic installation, the short circuit current of the PV system is higher than the maximum power point (MPP) current.
The overcurrent protective devices may not trip.
That's why ABB has created an "ad hoc" offering specifically for the Photovoltaic installation, in order to guarantee the right level of protection for all the situations.

SPD criteria of selection for DC systems
The selection should follow the rules of IEC 60364-7-71 regulation. There are several important elements to take in consideration while selecting an SPD for DC systems:

- Generally, SPDs will be class II tested but if an LPS is present, class I or class I+II tested SPDs shall be used.
- The maximum continuous operating voltage should be greater or equal than the PV system open circuit voltage multiplied by 1.2

Ucpv ≥ 1.2 x Uoc stc

- The protective voltage must be less than the impulse withstands voltage of the equipment to be protected

Up << Uw

- The short-circuit current rating should be greater or equal to the maximum current that can be delivered by the PV array.
- Photovoltaic installation, the short circuit current of the PV system is higher than the maximum power point (MPP) current.

ISCPV ≥ ISCMAX

- The minimum value of the nominal discharge current In of Class II tested SPDs shall be 5 kA.

T2 **In ≥ 5 kA**

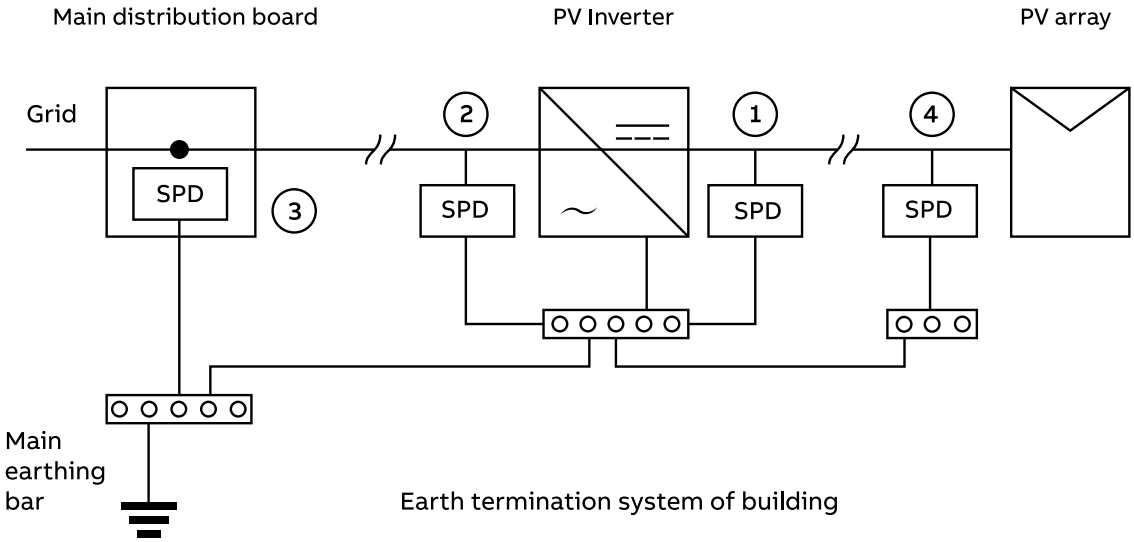
- For the Class I tested SPD's If the impulse current I imp cannot be calculated, I imp shall not be less than 12,5.

T1 **Iimp ≥ 12.5 kA**

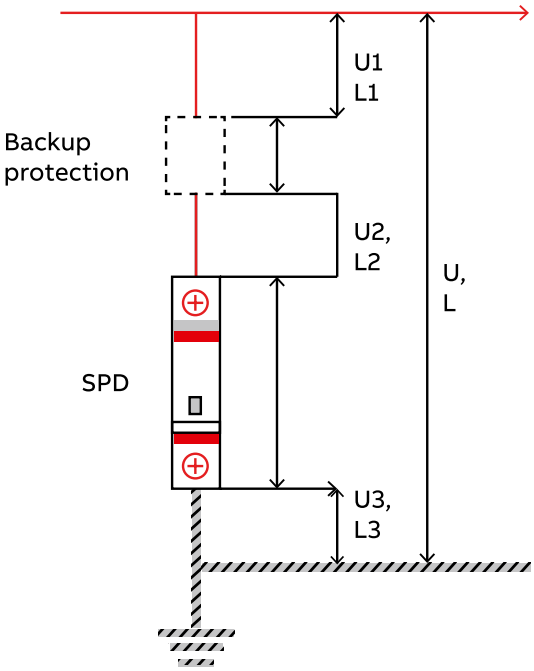
Installation of SPDs in the PV systems

As for the selection, even the SPD's installation for DC PV systems should follow the IEC 60364-7-712, this regulation underlines that the installing of SPDs on DC and AC sides of a PV installation is mandatory unless indicated otherwise by a risk assessment.

As many SPD's as needed must be installed as close as possible to the PV array to the inverter and the main distribution board.



In the switchboard to maintain the level of protection below the impulse withstand voltage (Uw) of the devices to be protected, the total length (L = L1 + L2 + L3) of the connecting cables must be shorter than 50 cm, as shown in the picture below.

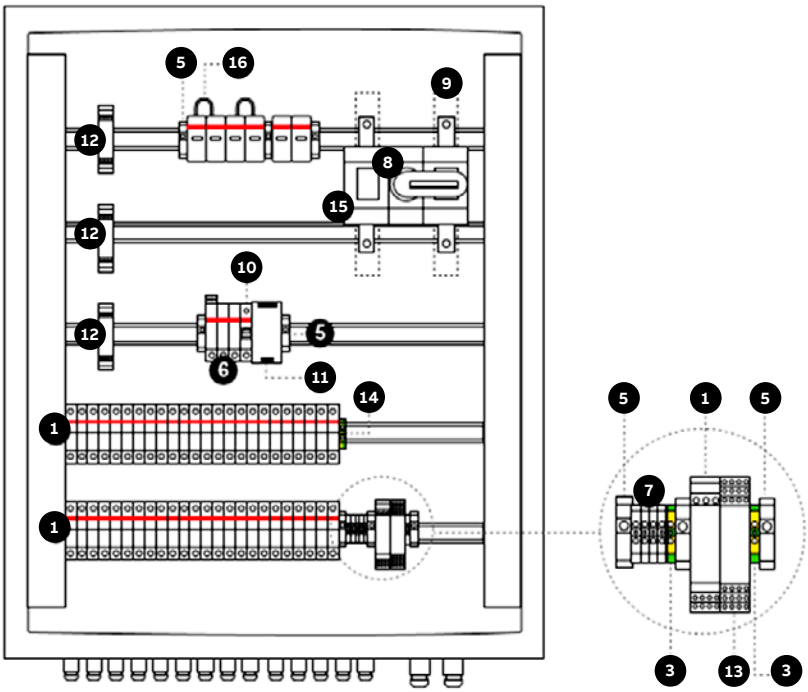


While installing the SPD's in the Enclosures Is very important to take care of issues coming from the wrong temperature and humidity.

To avoid the possibility for the water to come inside the enclosure is mandatory the installation of enclosures specifically designed for external use.

As a general rule, it's important to take care of the enclosures, guaranteeing that there is no humidity, water or moisture inside them.

In some specific situation could be suggested the usage of ventilation or thermoregulation accessories, to maintain the right condition in terms of condensation and temperature.



1. Fuse holder
2. SCK-M-1500V (special accessory)
3. Terminal block M4 PE
4. Distribution block DBL160
5. Stop BAM3
6. Surge protection OVR TS
7. Terminal block M4 GREY
8. Switch disconnector OTDC400EV11K
9. Shroud for OTDC
10. Switch E211
11. Power supplier CP-E 2,5 24V
12. SCK-M-I-8S-20A
13. SCK-C-MODBUS
14. Terminal block M35 PE
15. Aux contact OTDC (special accessory)
16. Erico 1ST622

OVR PV T1-T2 QS, special SPD's for the DC side of a PV systems

It's the newest type of SPD, it is a hybrid solution based on the most advanced MOV varistors Y system specially designed and engineered to fit D.C photovoltaic application, bringing self-protected feature (no back-up needed) up to 11 kA PV short circuit current.

This product is a combination of the type 1 and type 2 SPD, it can keep the system protected in situations of both direct and indirect lightning strike in fact it has been tested under 10/350 µs waves and 8/20 µs.

With its uncompromising quality this product can cover practically all systems configurations.

This new SPD meets theEN 50539-11 / IEC 61643-31 / UL 1449 4th Ed.
The T1 + T2 SPD represents the most versatile solution that ABB could bring to the market, that's why it's available in several different configurations, starting 1000 voltage going up to 1500 V.

Furthermore, the product has a Contemporary design, space-saving shape and Cartridge locking mechanism that guarantee an easy and safe cartridge replacement.
Another advantage is that is very easy to understand when to change cartridge due to the fact that in the cartridges is present a mechanical system that turns the green window into red when the varistor is exhausted.

This solution can guarantee you:

- **Higher productivity for your investments** thanks to these the solar cells are generating more energy even in extreme conditions.
- **Uncompromising safeness**, the product is protected by the Quick Safe system, it guarantees a safe failure mode of the SPD's.
- **Saving money**, these SPD's can guarantee a very high level of protection by protecting the system from dangerous overvoltage that can cause huge economic damage.

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