Main catalog August 2016

Practical guide
Protection against surges with QuickSafe® technology

Power and productivity
for a better world™

Practical guide
Protection against surges with QuickSafe® technology

1TXH000416C0201 - Edition August 2016

Panorama

OVR Type 1 and Type 1+2 main entrance lightning protection

- Surge and lightning protection (LPZ 0 to LPZ 1 and 2)
- Protection of the installation against direct lightning
- Impulse discharge current (limp) from 12.5 to 100 kA.

Exposed building to lightning surges shall be protected with Type 1 or Type 1+2 surge protective devices (SPDs). With a high impulse current discharge capacity (limp), they are located at the service entrance of the installation to avoid the destruction of the main switch board. Building protected against lightning with an external lightning protection (simple rod, meshed cage or ESE) must have at least a Type 1 SPD in the main distribution board.

OVR Type 2 and OVR Plus surge protective devices

- Surge protection (LPZ 1 to 2...)
- Sub-distribution board installation
- Prolonged life time of sensitive equipment
- Autoprotected surge protective devices with the OVR Plus range.

Most of the equipment sustain repetitive transient surges. Generated by indirect lightning strikes or by industrial environment, these transient overvoltages deteriorate and drastically reduce the life time of sensitive equipment like computers. Located in the sub-distribution boards of the installation, as close as possible to the equipment to protect, they offer a reliable and safe surge protection.

OVR PV and OVR WT specific surge protection solutions

- Dedicated SPDs for solar and wind application
- Surge and lightning protection from LPZ 0 to LPZ 2
- Cost saving in avoiding down time of installations.

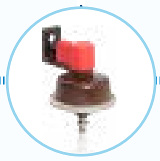
Due to their high exposure to lightning and their specific electrical configuration, solar and wind turbine installations require a dedicated surge and lightning protection which take into consideration their specificities, high DC voltages for solar and high repetitive peak voltages for wind turbines. The use of standard surge protection on such installation may lead to down time or even destruction of the installation.

A bit of history...

1862
M. François Soulé creates the Soulé company.

1932
The External Lightning protection company Hélita is created.

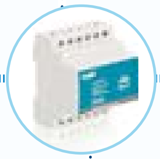
1960
First SPD by Soulé using Silicon Carbide.



1980
First Din Rail SPD with Metal Oxide Varistor (MOV).

1984
Invention of the first Early Streamer Emission Terminal, type Pulsar, by Hélita and CNRS.

1989
Soulé purchases the Hélita company to offer a complete lightning and overvoltage solution.



1990
SPD with thermal disconnection and end of life indication.

1999
Split between MV, HV and Low Voltage activities. Soulé sales non-core businesses.

1999
New Wavy design and phase + neutral version.

OVR TC dataline protection

- Complete range from 6 to 200 V DC
- RJ 45 bases.

In order to prevent data losses in Data Centers or to protect flow-meters in water treatment plans, a special range of surge protectors for Data Application has been developed.

OPR external air terminal lightning protection

- Early streamer emission air terminal
- Complete autonomy
- High efficiency (radius of protection Rp)
- Certified according to NF C 17-102 September 2011.

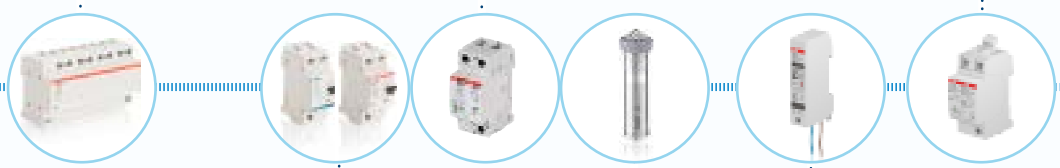
Lightning is one of the most spectacular meteorological phenomena. Generated by the interaction of clouds elements (water and ice), it can kill, injure and damage.
Building and equipment installed in exposed areas should be protected by an external air terminal.

2000
Soulé is purchased by Entrelec®.

2004
First Type 1 Spark gap technology. ABB branded.

2010
Launch of the System Pro *M* Compact® range with Safety Reserve System as option. Unique product in the market back then.

2015
QuickSafe® launch



2001
Entrelec® is purchased by ABB. Soulé & Hélita become the Low Voltage lightning protection experts within the ABB group.

2009
Self Protected SPD, with MCB or fuse.

2011
Fitted as standard with a lightning strike indicator RodCheck®.

2014
Launch of the OVR for Street Lightning protection.

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Surge and lightning protection solutions
ABB expertise

With its experience gained over the last few decades, ABB is using its technological expertise for lightning and overvoltage protection.

The ABB laboratory with several generators can simulate the impact of a direct lightning strike (10/350 µs impulse wave) or an indirect lightning strike (8/20 µs impulse wave) to be able to test the surge protective devices.
Through its wide product range, ABB is able to offer a complete solution to protect power and low voltage networks.

Seminars are organized to the needs of all professionals: design offices, consultants, distributors, electricians, sales staff. These training sessions combine practical and theoretical aspects and cover a varied range of topics such as direct impact protection and overvoltage protection.

The ABB laboratory is able to handle tests on AC surge protective devices (SPDs) according to IEC 61643-11 (2011) and on PV SPDs according to EN 50539-11 (2013).

High power lightning generators	Standardized electrical waves 8/20 µs and 10/350 µs. Maximum shock current 100 kA for the two waves, superposed on the electrical network. Stored energy 800 kJ.
200 kV generator	1.2/50 µs impulse wave Maximum voltage 200 kV Stored energy 10 kJ.
Combinated wave generator	Standardized 8/20 - 1.2/50 µs impulse wave 30 kV maximum 15 kA maximum Stored energy 5 kJ.
Electrical tests	275 V, 18 000 A and 440 V, 10 000 A short-circuit AC testing. 1500 V, 1000 A short-circuit DC testing.
Climatic tests	Ageing and damp heat tests.
High Speed Camera	Up to 120 000 frames/s

ABB laboratory at Bagnères-de-Bigorre, France

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Surge and lightning protection solutions
Causes of transient overvoltages

Transient surges represent the main cause of electrical devices failure and loss of productivity. They are the result of lightning strikes, switching operations on the electrical network or parasitic interferences.

Nowadays, in all the sectors (residential, commercial and industrial), in the data center industry, they rely on their computer systems.

A downtime in one of these computer systems, due to transient surges, can have catastrophic consequences. Loss of operation, loss of service, loss of data and of productivity involve, in most of the cases, huge consequences which are, by far, higher than the costs of the equipments for protection against overvoltages.

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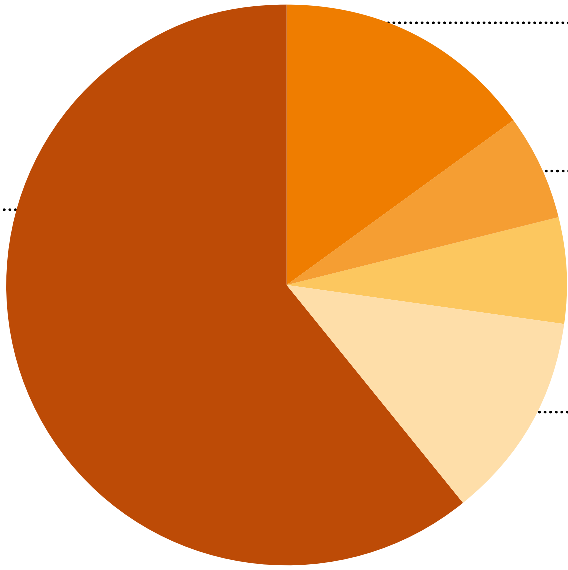
The use in electronic systems of more and more sensitive electronic equipments, with interconnection and complexity of the networks increase the probability of damages caused by the transient overvoltages.

Surge and lightning protection solutions
Causes of transient overvoltages



Damages to electronic equipment. Analysis conducted in France for residential segment by AVIVA, one of the largest insurance company (www.aviva.com)

At the same time, the following trends shall be underlined:

– Increasing use of electronic systems such as computers, telecommunication equipment. Overvoltage consequences are of huge importance in a global economy based and relying on power networks and information systems

– Electronic equipment more and more sensitive. With miniaturization process of circuits and components in electronic, modern equipment is now more incline to be damaged from transient overvoltages

– Interconnection and complexity of system networks. In big cities, the effects induced by lightning current are very high due to the fact that they can be propagated by the service lines over many kilometers. Furthermore, the use of lots of industrial equipment generates disturbances, transient overvoltages, on the lines that damage expensive equipment.

Transient overvoltage effect

Therefore, the protection against lightning current and transient overvoltages is now a fundamental aspect of our electrical system configuration.

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Surge and lightning protection solutions
Origins of surges - Atmospheric discharges

Atmospheric discharges are a powerful natural phenomenon. Lightning can reach a power of several hundred gigawatts and can have a destructive or disturbing effect on electrical systems located miles away from the point where the lightning strikes.

Damage caused by direct lightning strikes is generally serious, with large economic consequences. As an example, the electrical switchboard can catch fire, causing devastation of industrial equipment and even the building. The best and only way to avoid this is the installation of an External Lightning Protection.

Atmospheric discharges can determine various phenomena in an electrical system, resulting both from direct and indirect lightning strikes.

Direct lightning strikes on lightning rods/conductors (LPS, Lightning Protection System) or external conductive elements (antennas, metallic pipes/guttering etc.).
Galvanic coupling

When lightning strikes the lightning conductor or roof of an earthed building directly, the current flows to earth and through the power supply lines. The resistance of the PE system, when dispersing the lightning current, causes an increase in the PE conductor up to several thousand volts (ohmic effect). On the other hand, the potential of the active conductors remains at 230 V for the phases and zero for the neutral (remote potential of the transformer). The electrical equipment connected between the power supply network and earth can break their isolation and a part of the lightning current flows through them, resulting in damage.

Direct lightning strike on aerial power lines.
Conductive coupling

When lightning strikes a low voltage aerial power line, very strong currents flow through it, entering the buildings it supplies and giving rise to large overvoltage surges. The large amount of energy entering directly into the system causes faults and failures of electrical or electronic equipment connected to the power supply.

Indirect lightning strikes.
Electromagnetic coupling

The electromagnetic field created by atmospheric discharges in the vicinity of aerial electricity lines or electrical systems generates an overvoltage surge in each loop of the circuit.
The electricity lines incorporate loops since the neutral or PE is connected repeatedly to earth (every two or three poles).
Even lightning striking the external protection system (LPS) creates a surge in the loops formed by the electrical internal wiring.
With a range of hundreds of yards or even miles, the electromagnetic field generated in cloud lightning can create sudden voltage increases.
In these cases the damage, less spectacular than in the previous cases, can still have a permanent effect on the most sensitive electronic equipment such as computers, photocopiers and security and communications systems.

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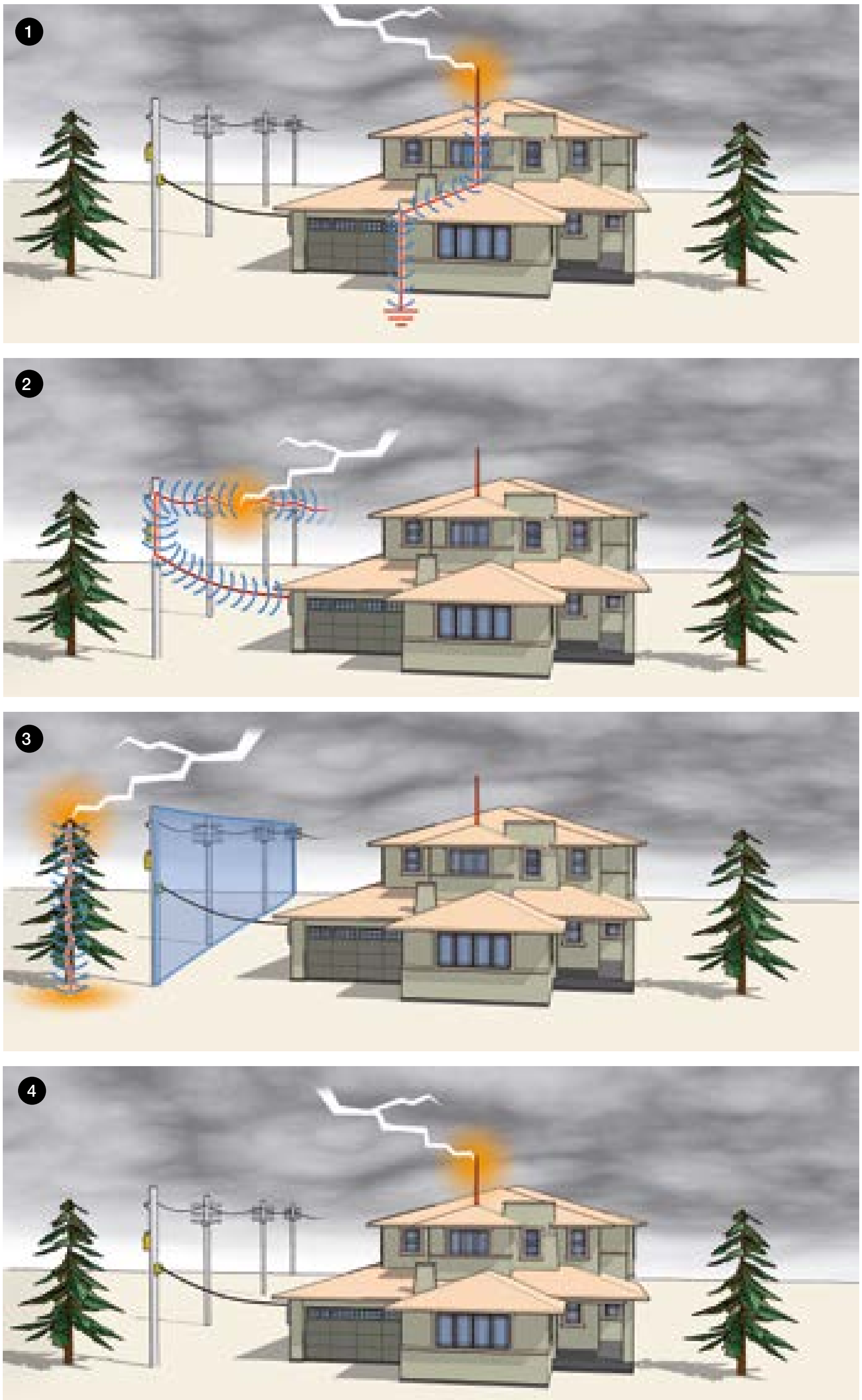
Surge and lightning protection solutions
Origins of surges - Atmospheric discharges



1 - Direct lightning strike on external lightning protection system (lightning rod)
2 - Direct lightning strike on aerial electricity lines
3 - Electromagnetic coupling: lightning striking a tree near the building and near an aerial electricity line
4 - Electromagnetic coupling: effect of the passage of current in the ELP down conductors (indirect lightning strike resulting from case 1)

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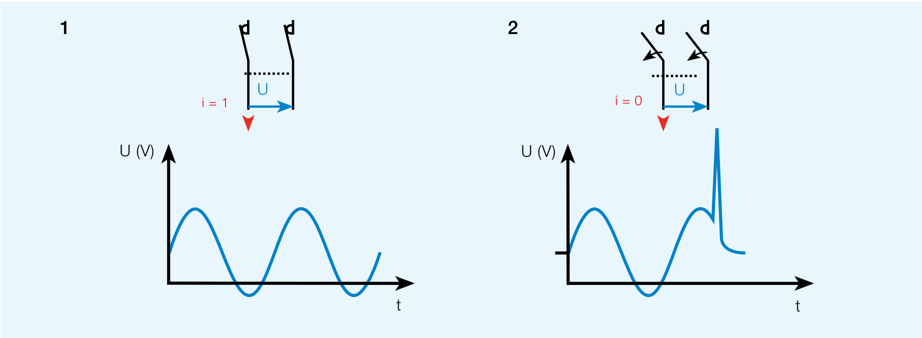
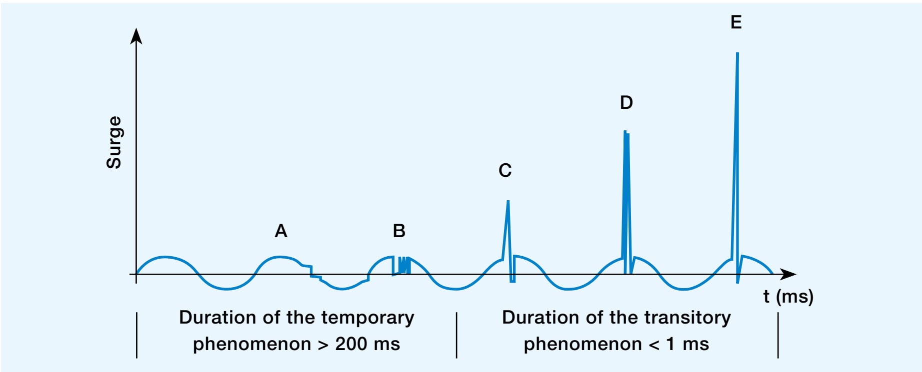
Surge and lightning protection solutions
Origins of surges - Electrical operations on the distribution grid

The switching of breakers, transformers, motors and inductive loads in general or the sudden modification of loads causes sudden current variations (di/dt), generating transient voltage surges. They are less energetic than surges caused by lightning, but they are much more frequent and are damaging as they are generated directly in the power supply network. Their brief duration, the sharp rising edge and the peak value (which can reach several kV) leads to premature wear of electronic equipment. These types of surges are called industrial surges.



Switching of breakers
1- closed circuit
2- opening of circuit

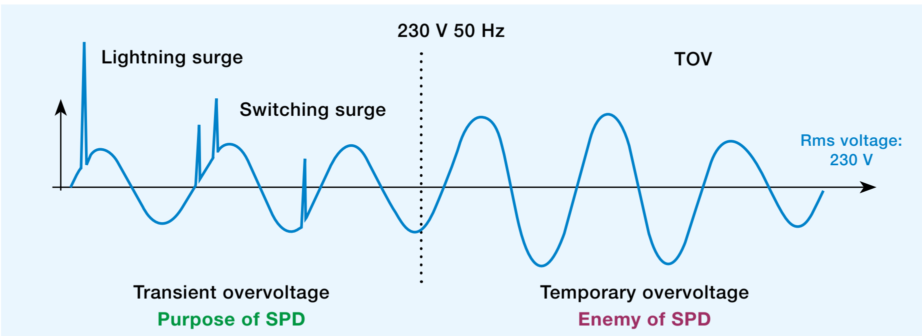
Order of magnitude of the disturbances.



Representation of the different disturbances on the electricity supply grid in AC

A - Harmonics
B - Micro-interruptions
C - Surges from switching
D - Indirect lightning strikes
E - Direct lightning strikes

From the point of view of overvoltage surges, direct lightning strikes carry the highest risk.



Where to find more
OVR Practical guide for the protection against surges with QuickSafe® technology, 1TXH000416C0201.

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Surge and lightning protection solutions
General information on lightning

The stress caused by a lightning strike on the network almost always represents the most important parameter when selecting a SPD (Surge Protective Device).

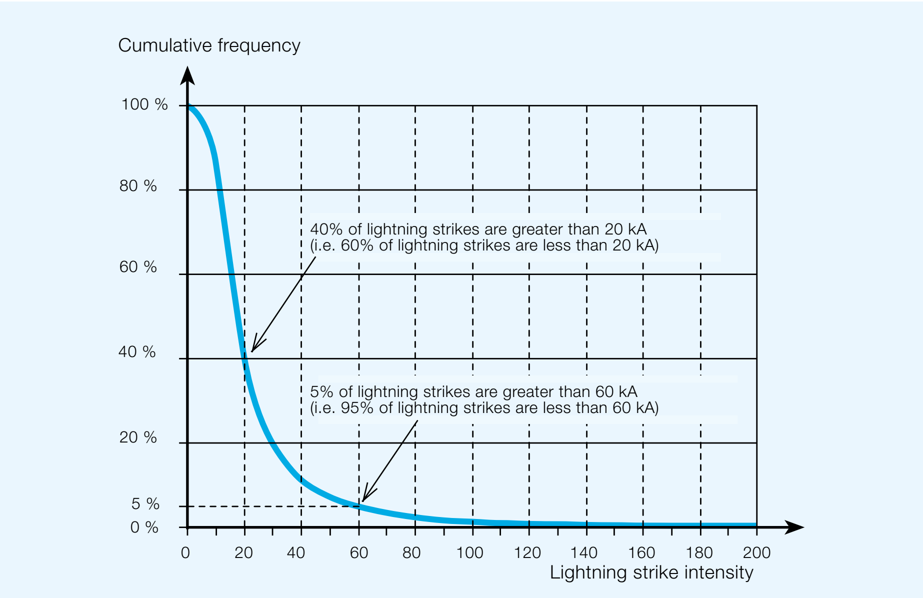
Intensity of direct lightning strikes

The French institute Meteorage conducted a serie of measurements of the intensity of over 5.4 million lightning strikes in France over the ten years from 1995 to 2013.

The following curve summarizes the cumulative frequency of the lightning strikes with respect to their intensity, according to the results of this enormous measuring campaign:

– 1,35% of the lightning strikes are greater than 100 kA
– 0,38% of the lightning strikes are greater than 150 kA
– 0,14% of the lightning strikes are greater than 200 kA
– 0,057% of the lightning strikes are greater than 250 kA.

These are values measured in France, however the intensity of lightning has no correlation with the geographical position, and equivalent results would be obtained by performing the same analysis in other countries. What does, however, characterize each geographical area is the lightning density Ng (described on the following page).



Cumulative frequency of lightning strikes - positive and negative - with respect to their intensity.

Data supplied by Meteorage (www.meteorage.fr) recorded on French territory.

Where to find more
OVR Practical guide for the protection against surges with QuickSafe® technology, 1TXH000416C0201.

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Surge and lightning protection solutions
General information on lightning

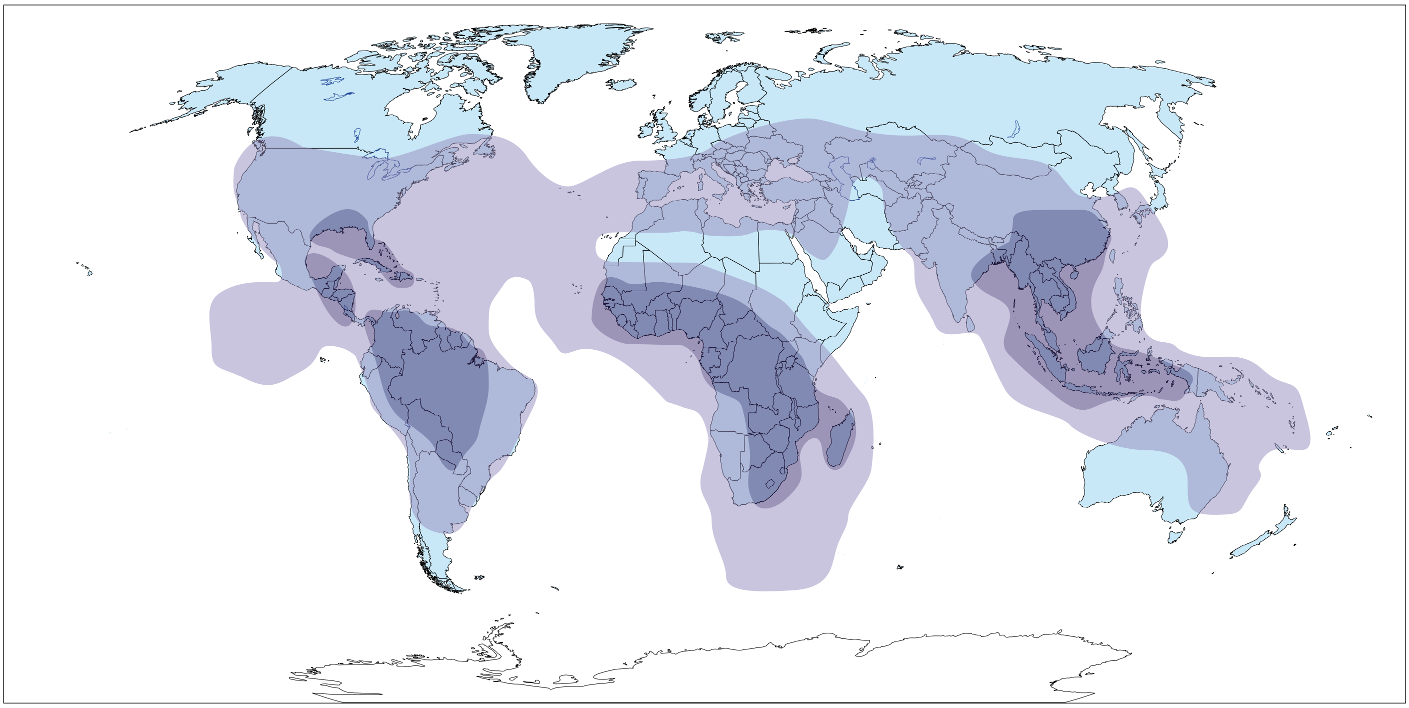
Lightning density by geographical area Ng
At any moment in time there are between 2 000 and 5 000 storms active in the world. At a local level, the estimation of the risk of lightning strikes is performed by consulting Ng charts, a parameter which indicates the density of electrical discharges from lightning by geographical area. Obtained by observation or with lightning localization system (LLS), this gives the number of lightning strikes per square kilometer and per year.

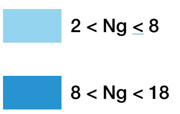
If the Ng value should not be available, it can be estimated with the following formula:

$$Ng \approx 0.1\ Td$$

where Td represents the number of days with thunderstorm per year (a value which can be obtained from isokeraunic maps, Td Keraunical Level).

Lightning flash density map (flashes per km² per year)





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Ng charts are available in many countries; consult local regulations for more information on the lightning density.

Risk assessment, according to lightning protection standard IEC 62305-2.

The international regulation IEC 62305, in force since April 2006, supplies all elements for evaluating the risk a building is subject to and for the selection of suitable protective measures against lightning for buildings, systems and people inside them and services connected to them.

The risk assessment is the first step towards protecting the electrical system from voltage surges and must be performed by an electrical project manager for each building and systems connected.

The assessment process starts with the analysis of the structure to be protected: type and dimensions of the building, its use, the number and type of services entering it, the characteristics of the surrounding environment and local lightning density.
The losses that a building can face are then defined, with reference to four different types of loss:

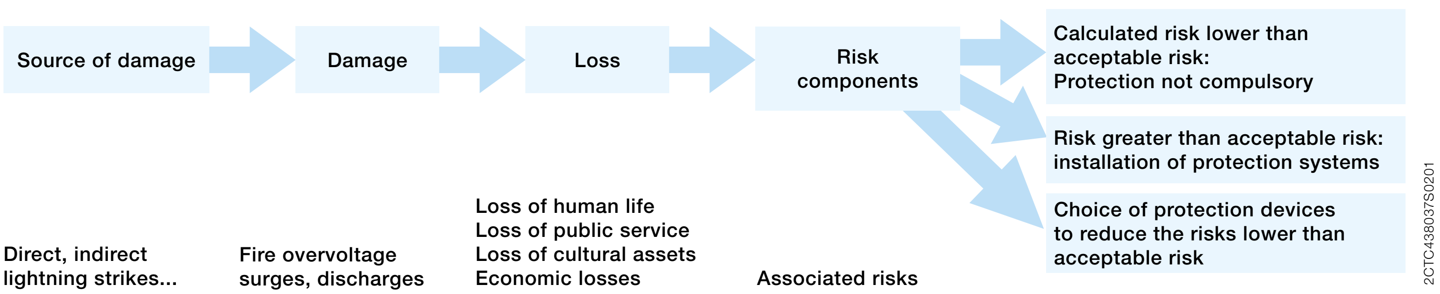
- **L1:** loss of human life
  Number of deaths per year, related to the total number of people exposed to the risk
- **L2:** Loss of essential public services
  Product of the number of users not serviced by the annual duration of the down time, related to the total number of users served in a year
- **L3:** Loss of irreplaceable cultural heritage
  Annual value of lost heritage, related to the total value of the heritage exposed to the risk
- **L4:** Loss of purely economic value
  The analysis of acceptable damage is a pure cost/benefit comparison

A specific risk R is associated with each type of loss: $\mathbf{R_1}$ is the risk of loss of human life; $\mathbf{R_2}$ is the risk of losing essential public services; $\mathbf{R_3}$ is the risk of losing cultural heritage; $\mathbf{R_4}$ is the risk of economic loss.

For example, the installation of a Type 1 SPD with I_{imp} = 25 kA per pole at the origin of a three-phase + neutral system allows the risk component R_B (risk of fire due to direct lightning strike on structure) to be reduced, as a Type 2 SPD with I_n = 20 kA reduces the R_M risk component (risk linked to induced overvoltages from lightning striking near the building).

Each type of risk can be expressed on the basis of its different components relative to the cause of the damage (damage to persons by step and touch potentials; material damage due to fire, explosion etc.; damage to electrical systems by voltage surges) and the source of the damage (direct lightning strikes on buildings or external electricity lines, indirect lightning strikes near buildings or lines).
For each of the three risks (R1, R2, R3), a maximum admissible value RT is defined: if the value is greater than that admissible, suitable measures must be taken to protect the building (LPS, equipotential bonding, SPDs). For the fourth risk component (R4), protection is always optional – it is recommended if the cost/benefit analysis is favorable.

Whenever the risk analysis requires the structure to be protected, the regulations also supply selection criteria for the appropriate SPDs to reduce the specific risk components below the acceptable risk values.



General information on SPDs
How do they work

SPDs, or Surge Protective Devices, are designed to prevent electrical systems and equipment against transitory surges and impulses
such as, for example, those caused by lightning and operations on the electrical grid (industrial surges).

Transient overvoltage surges consist of a small voltage peak of a short duration (less than a millisecond) which can reach tens of times the standard mains voltage.
The resistance to transitory surges – known as "impulse withstand voltage" – is of great importance in electrical and electronic equipment, and for this reason equipment is fitted with systems isolating the parts connected to the phases from earth or neutral. This isolation can vary from a few hundred volts, for sensitive electronic equipment, to several kilovolts for a breaker.
SPDs contain at least one non-linear component (a varistor or spark gap). Their function is to divert the discharge or impulse current and to limit the overvoltage at the downstream equipment.

Operation of a SPD:

- During normal operation (e.g. in the absence of surges), the SPD has no influence on the system where it's installed. It acts like an open circuit and maintains the isolation between the active conductors and earth.
- When a voltage surge occurs, the SPD reduces its impedance within a few nanoseconds and diverts the impulse current. The SPD behaves like a closed circuit, the overvoltage is short-circuited and limited to an acceptable value for the electrical equipment connected downstream.
- Once the impulse surge has stopped, the SPD will return to its original impedance and return to the open circuit condition.

Example of operation

Without a SPD (figure 1), the surge reaches the electrical equipment. If the surge exceeds the electrical equipment's impulse withstand voltage, the isolation is broken and the impulse current flows freely through the device, damaging it.
With the use of a SPD (figure 2) between the active conductors and earth (TT network), the overvoltage is limited and the discharge current is safely diverted, establishing an equipotential connection between phase and earth.

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General information on SPDs
How do they work

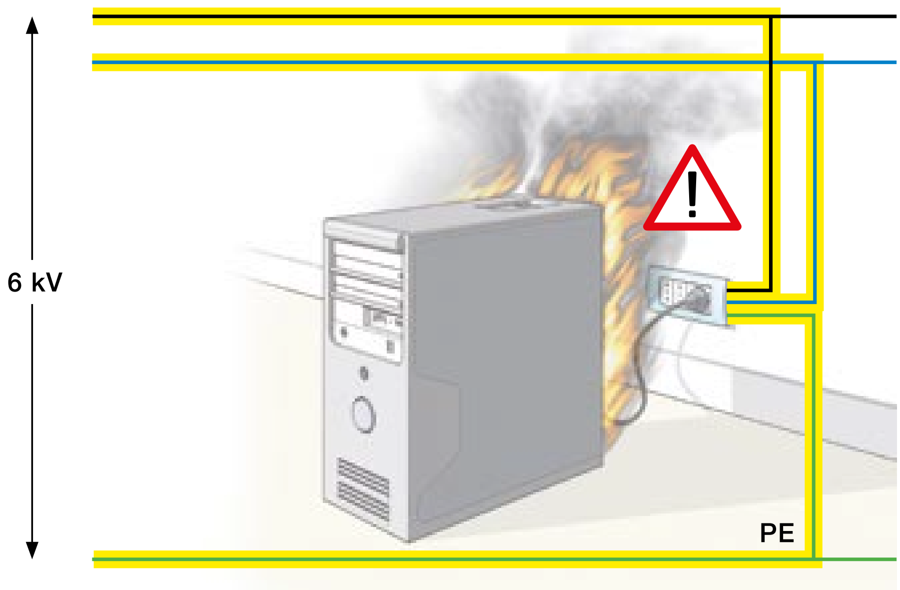

Figure 1

Without SPD:
- A 6 kV surge flow to the server power supply
- The electrical isolation between the circuits is irreparably damaged
- A discharge to earth is generated by sparking
- When the surge ends, the server is out of service and there is a fire risk present.

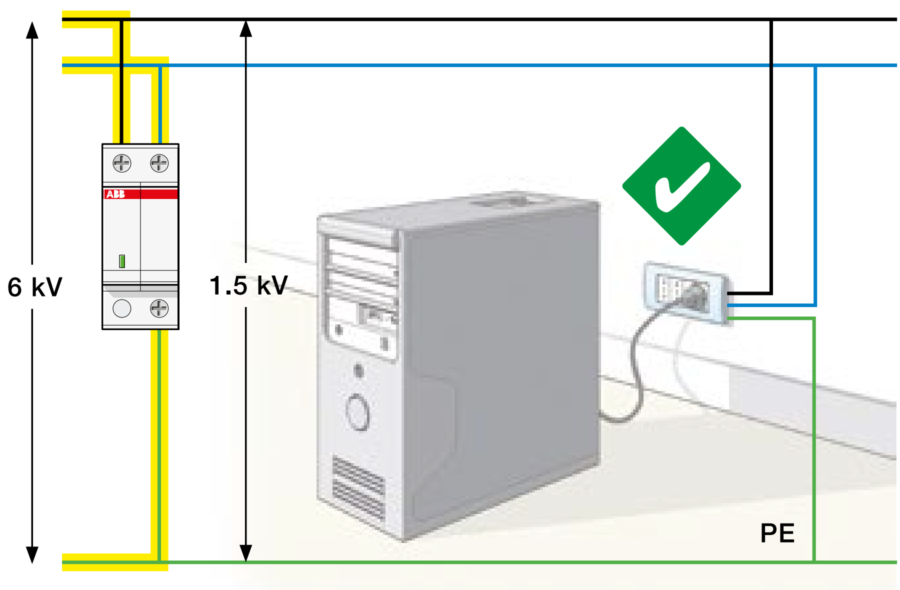

Figure 2

With SPD:
- A 6 kV surge flow to the SPD
- The SPD connects the active conductors (phase and neutral) to earth
- The discharge current is diverted to earth
- The server "sees" an overvoltage of 1.5 kV across the SPD
- The server continues to operate normally
- The effect of the surge has been limited by the SPD, preserving the server's integrity.

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Test waveforms

Based on decades of research, recordings and measurement of lightning and overvoltage surge phenomena, the Standards introduced two waveforms to simulate direct and indirect lightning strikes and the effects of operations on the electrical grid.

The waveform (10/350 µs) simulates a direct lightning strike, with a sudden and intense increase of the current with a very high associated energy level. The lightning can, indeed, be considered the ideal current generator, injecting a 10/350 µs wave of current into the network with a very high peak value.

The waveform (8/20 µs) with reduced energy represents an indirect lightning strike, as well as the effects of electrical grid operations and parasitic interference.

The energy associated with this waveform depends on the area under the curve: **Energy** $\approx \int_0^T i^2 dt$. The energy associated with the 10/350 µs waveform is therefore significantly greater than that of the 8/20 µs one (approximately 10 times greater).

	Duration of rising edge T_1 (from 10 % to 90 % of maximum value)	Duration of half value T_2	I (peak current)
10/350 µs wave	10 µs	350 µs	I_{imp}
8/20 µs wave	8 µs	20 µs	I_n or I_{max}
1.2/50 µs wave	1.2 µs	50 µs	U_{oc}

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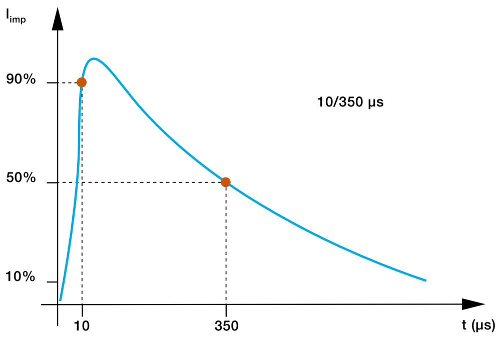
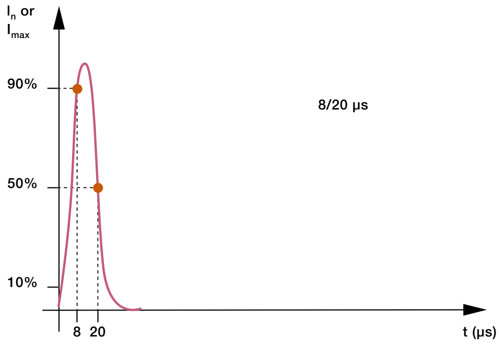
General information on SPDs
Test waveforms

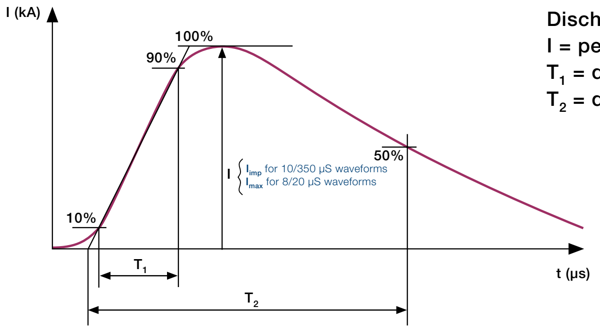
Over 75 % of lightning strikes have secondary discharges, which follow the initial one by 30-200 milliseconds. On average, the main discharge is followed by three secondary ones, but in some cases up to 34 discharges have been recorded in quick succession. The initial discharge ionizes a channel between the cloud and the ground, which then becomes a preferential path for successive discharges.
The rising edge of the lightning's current can reach 100 kA/µs for the primary discharge, a value which can be even greater for the discharges which follow. Rising edges have been recorded for voltages up to 12 000 V/µs, more than enough to damage even the more robust circuits.
In order to characterize lightning, international standards define a 10/350 microsecond standard waveform for the first positive discharge and one of 0.25/100 microseconds for subsequent negative discharges (IEC 62305-1, Annex B).
Only the first discharge is taken into consideration, both when designing and choosing a SPD, as it represents the most important stress on the device.



10/350 µs waveform for direct lightning strike tests. Current impulse with 10 µs rising edge and half value duration of 350 µs.



8/20 µs waveform for tests on indirect lightning strikes and surges caused by operations on the electrical grid. Current impulse with 8 µs rising edge and half value duration of 20 µs.



Discharge wave parameters
I = peak current
T_1 = duration of rising edge
T_2 = duration of half value

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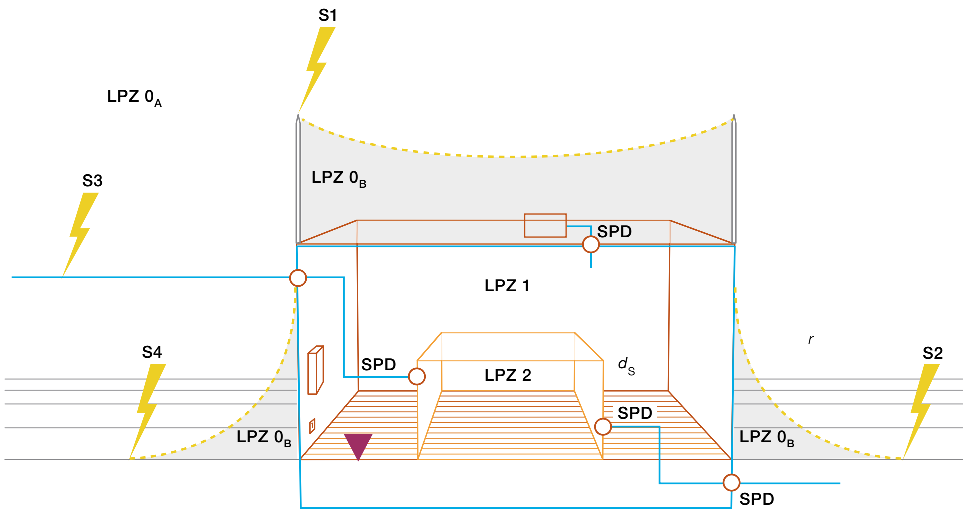
General information on SPDs
Protection zones LPZ (Lightning Protection Zones)

Surge protection starts at the origin of the electrical system and finishes near the most sensitive equipment. The discharge energy is reduced in various stages, first with the more robust SPDs (Class 1), then with finer protection (Class 2 devices). This protection co-ordination is represented with the LPZs, which divide up the structure on the basis of the effects of the lightning strike.

A structure for protecting equipment and systems against the electromagnetic effects of lightning currents (LEMP, Lightning electromagnetic impulse), can be divided into LPZs (Lightning Protection Zones), meaning homogeneous electromagnetic environments, not necessarily delimited by walls, floors and ceilings, but rather ideal, with homogeneous protection measures represented by LPS, shielding and SPDs. The type of electric and electronic systems and their vulnerability to LEMP also contribute to the identification of the various zones. Electromagnetic conditions of different severity are associated with the protection zones, with a reduction in LEMP going downstream, in relation to the impulse withstand voltage level of the equipment's isolation.

The zones are defined as follows in the IEC 62905-1 standard:
- LPZ 0_A: open zone, not protected by external LPS protection area, in which the component elements are directly exposed to atmospheric discharges and must support the total current generated by them and are exposed to the complete magnetic field;
- LPZ 0_B: zone contained within the external LPS, and for which protection against direct lightning strikes is ensured, but the danger is coming from total exposure to the magnetic field;
- LPZ 1: interior zone, in which objects are not exposed to direct lightning strikes and the induced currents are less than zone 0_A. It is characterized by the presence of shielding and the installation of appropriate SPDs on the lines coming in;
- LPZ 2, LPZ n: zones with further shielding and SPDs, both at the limits of the different zones and protecting the terminal equipment, allowing a reduction of the induced current in relation to the requirements of the equipment to be protected.



1 Structure (shield of LPZ 1)
2 Air-termination system
3 Down-conductor system
4 Earth- termination system
5 Room (shield of LPZ 2)
6 Lines connected to the structure
S1 Flash to the structure
S2 Flash near to the structure
S3 Flash to a line connected to the structure
S4 Flash near to a line connected to the structure
r Rolling sphere radius
d_S Safety distance against too high magnetic field
LPZ 0_A Direct flash, full lightning current, full magnetic field
LPZ 0_B No direct flash, partial lightning or induced current, full magnetic field
LPZ 1 No direct flash, limited lightning or induced current, damped magnetic field
LPZ 2 No direct flash, induced currents, further damped magnetic field
Protected volumes inside LPZ 1 and LPZ 2 must respect safety distances d_S

▼ Ground level

◯ Lightning equipotential bonding by means of SPD

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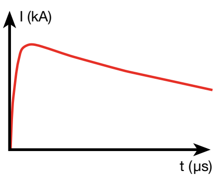
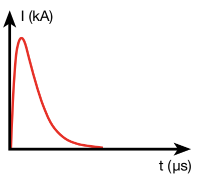
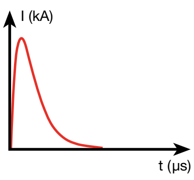
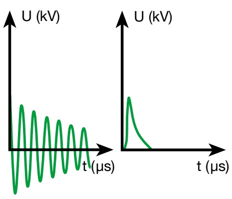
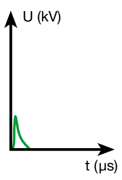
General information on SPDs

Protection zones LPZ (Lightning Protection Zones)

	LPZ 0_A	LPZ 0_B	LPZ 1	LPZ 2	LPZ 3
Location	Zone outside the building and outside the catchment area of the external LPS.	Area outside the building and inside the catchment area of the external LPS.	Area inside the building.	Area inside the building.	Area inside the building for highly sensitive equipment.
Possibility of direct lightning strikes	Yes	No	No	No	No
Electromagnetic field	Not attenuated	Not attenuated	Attenuated		Additional shielding to reduce the effects of the magnetic fields (for example, metal cages for equipment) Very attenuated
Current waveforms carried by the power lines	10/350 μs and 8/20 μs – Partial lightning currents from direct lightning strikes (10/350 μs). – Electromagnetic field coupling coming from direct lightning strikes (8/20 μs). – Surges from operations on the grid (8/20 μs). 	8/20 μs – Electromagnetic field coupling deriving from a direct lightning strike (the electromagnetic field is not attenuated in LPZ 0_B) – Voltage surges from operations on the grid. 	8/20 μs Residual effects of: – Electromagnetic field coupling attenuated. – Impulse current of the lightning (low energy). – Voltage surges from operations on the grid. 	1.2/50 μs (Voltage impulse) – Resonance effects / amplification phenomena). – Electromagnetic field coupling attenuated. – Voltage surges from operations on the internal wiring. 	1.2/50 μs – Voltage impulse with very low energy. – Electromagnetic field very attenuated. 
SPD at the entrance of the zone		Type 1 Type 1 + 2	Type 2	Type 1 products divert the impulse current from the lightning (10/350 wave), stopping it entering the installation. Type 2 products handle a reduced energy level, coming from direct lightning strikes, surges due to electrical operations on the grid and electromagnetic field coupling. Type 3	

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General information on SPDs
Technologies used

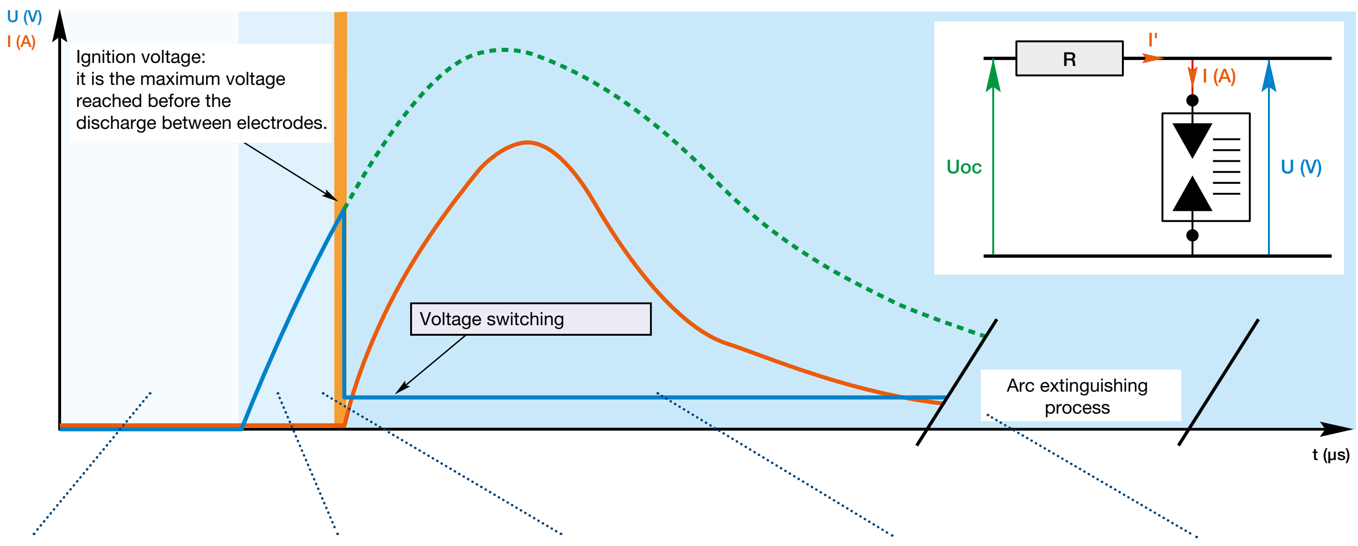
A SPD contains at least one non-linear component, its electrical resistance varying in function of the voltage which is applied to it.

SPDs based on spark gaps

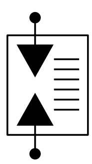
They are called switching SPDs. The spark gap is a component composed of two electrodes in close proximity which isolate one part of the circuit from the other up to a certain voltage level. These electrodes can be in air or encapsulated with a gaz.

During normal operation of the system (at rated voltage), the spark gap does not conduct current between the two electrodes. In the presence of a voltage surge, the impedance of the spark gap rapidly decreases to 0.1-1 Ω with the formation of an electric arc between the electrodes, typically in 100 ns. The electric arc is extinguished when the surge finishes, restoring the isolation.

Operational principle of spark gaps

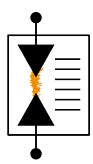


1. Without surge, the spark gap has a high impedance (typically 100 MΩ). The SPD behaves like an open circuit.



2. As soon as a surge occurs, the voltage between the electrodes increase in just a few microseconds.

3. When the voltage reaches thousands of volts, air or gas ionization takes place between the electrodes igniting the electric arc (ignition voltage). Thank to the active operation of the electronic device producing a spark, the electric arc ignites in advance (description on the following page).



4. The discharge current passes through the electrodes. The electrodes are short circuited and energy flows through the SPD.

5. The electric arc is kept in the installation point by the short circuit current of the power supply has to be extinguished as soon as possible (see follow current explanation).

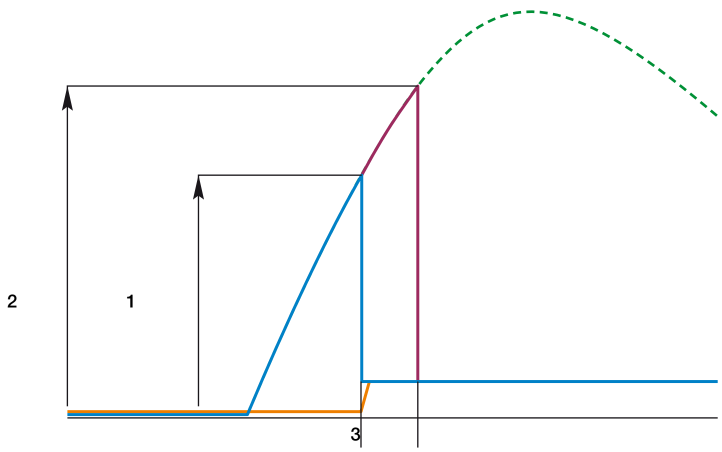
2CTC438041S0201

General information on SPDs
Technologies used

Advanced ignition of the electric arc

The ignition voltage is the maximum voltage reached during the overvoltage discharge operation. An electronic device cuts in so as to obtain a reduced protection level, igniting the arc with a spark before the surge reaches high voltage levels. The low protection level ensures protection of the downstream equipment.

1 - Level of protection with the intervention of the electronic device
2 - Level of protection without the intervention of the electronic device
3 - Advanced ignition of the electric arc



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General information on SPDs
Products Standards, IEC 61643

The new IEC 61643-11:2011 is similar to the EN 61643-11:2012 and is the standard for Low-Voltage Surge Protective Devices. These standards exist since the nineties and have gone through different releases improving them. In the last release not only the evaluation of the product performances is under focus, but the stress on safety evaluation.

Regarding performances, **this new edition recognizes the possibility to evaluate and certify SPD under multiple categories,** option not considered in the previous editions. So in order to certify an SPD under the Type 1 and Type 2 category, two different tests need to be performed to validate the features under each one of them.

Until now, the safety of the SPD was verified reproducing situations that represent the working conditions of the SPD, as for example, the short-circuit test or the temporary over-voltage test. According to the new edition of the standard, **new tests reproducing the potential interruption of the Neutral conductor and the different modes of end of life of the SPD are performed.**

These two additional tests are a real Plus on safety management and they are a guarantee for the final user that the installation will not suffer any stress in case of the end of life of the SPD. The new QuickSafe® range has been specially developed to answer to these new requirements. All this reducing the stress on the back-up protection device.

The new **QuickSafe® technology allows to comply with the end of life tests thanks to a patented internal disconnection system,** this systems disconnects the internal circuit before the internal components (MOVs) go into short-circuit.

The advantage for the customer is that **the product is self-protected up to higher values of current** and this **allows to install back-up protection elements with higher rated current,** as these elements will only intervene in the rear case of a short-circuit on site together with a sudden End of Life of the SPD (this happens when for example the SPD is hit by a current higher than it's Imax).

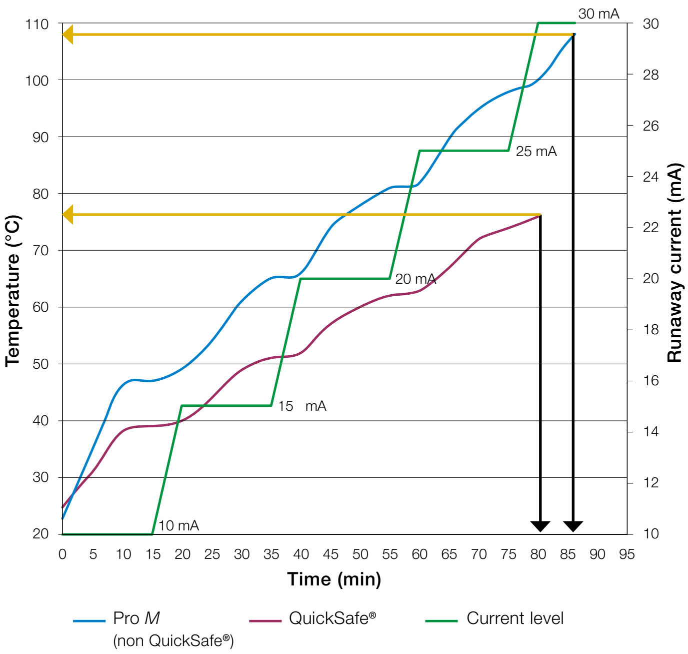
This new technology allows as well to increase the prospective withstand short-circuit current at the point of the installation up to Isccr = 100 kA with a back up protection of maximum rated current of 125 A (for OVR T2 QS and OVR T2-T3 QS) and 160 A (for OVR T1-T2s QS and OVR T2s QS).

In simple words, the new OVR QuickSafe® can be used in 99.9% of standard installations and becomes an easy replacement to any other SPD ranges.

What's new in IEC/EN 61643-11:2012?

- New test procedure which takes into account the failure behavior of protective equipment in the event of an overload, or when the service life has expired
- The Type 1 operating duty test is conducted with a higher current than that specified in the previous standard
- Recognition of the mixed types, as Type 1+2 and Type 2+3, this allows as to certify the product with more than one category.

Thermal Disconnection – Temperatures measured at the disconnection point of the MOV



Here we can see 2 different curves representing the behavior of the actual range (blue curve) and the new QuickSafe® range (red curve), for the same level of current (the green line represent the evolution of the current with the time, as specified by the IEC 61643-11).

- These curves represent the temperature INCREASE that the MOV suffers when being tested under these values of current for the indicated time. These are NOT absolute temperature, but relatives ones
- As you can see with the black arrows, the time to guarantee the disconnection fo the same level of current has been reduced by 6 minutes
- And even better, as you can see with the orange arrows, the maximum reached temperature required to guarantee the disconnection is lower, from 108 to 76 °C.

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General information on SPDs
Products Standards, UL 1449

SPD terminology

8/20 wave:
Current waveform which passes through equipment when subjected to an overvoltage (low energy).

Type 2 surge protective device (SPD)
Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at a branch panel. It has successfully passed testing to the standard with the 8/20 wave (class II test).

Metal oxide varistor (MOV)
A varistor is an electronic component with a "diode like" nonlinear current-voltage characteristic, used to protect circuits against excessive transient voltages. Most commonly composed of metal oxides.

Maximum continuous operating voltage (MCOV, Uc)
The maximum designated root mean square (rms) value of power frequency voltage that may be applied continuously between the terminals of the SPD.

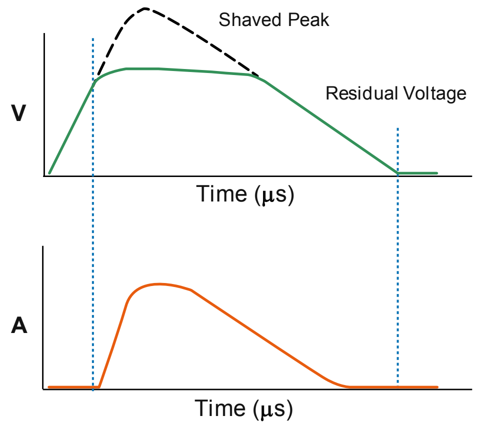
Nominal discharge current (In)
Peak current value of an 8/20 waveform which the SPD is rated for based on the test program.

Maximum discharge current (Imax)
Peak current value of an 8/20 waveform which can be safely discharged by the SPD, with an amplitude complying with the class II operating test sequence. Imax > In.

Short circuit current rating (SCCR)
Maximum symmetrical fault current, at rated voltage, that the SPD can withstand without sustaining damage that exceeds acceptable criteria or creates a hazardous operating condition.

Voltage protection rating (VPR)
The value of the VPR is determined as the nearest highest value, taken from Table 63.1 of ANSI/UL 1449 3rd Edition, to the measured limiting voltage determined during the transient voltage surge suppression test using the combination wave generator at a setting of 6 kV, 3 kA.

Voltage protection level (Up or Ures)
The voltage let through by the SPD while diverting surge current to ground must not exceed the voltage withstand value of the equipment connected downstream.



Notes:
Test wave 8/20 µs according to IEEE # C62.62-200/UL 1449
The first number corresponds to the time from 10% to 90% of its peak value (8 µs).
The second number corresponds to the time taken for the wave to descend to 50% of its peak value (20 µs).

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General information on SPDs
UL 1449

The Underwriters Laboratories (UL) standard for surge protective devices (SPDs) has been the primary safety standard for surge protection since the first edition was published in 1985, and updated to the second edition in 1996.

The objective of UL 1449 has always been to increase safety in terms of surge protection.

Change in the standard's name: From TVSS to SPDs

Prior to UL 1449 3rd Edition taking effect, the devices this standard covers were known as Transient Voltage Surge Suppressors (TVSS), operating on power circuits not exceeding 600 V. With the inception of the 3rd Edition, these devices are now known as Surge Protective Devices (SPDs), and may operate on power circuits not exceeding 1500 V DC.
This new designation moves the UL standard closer to the international designation and to IEC standards. The new edition is now renamed UL Standard for Safety for Surge Protective Devices, UL 1449.

The different type designations of surge protective devices

The new UL 1449 3rd Edition places SPDs into five different Type categories based on installation location within an electrical system.
While Type 1, Type 2 and Type 3 categories refer to different types of SPDs that can be installed at specific locations, Type 4 and Type 5 categories refer to components used in an SPDs configuration.

Type 1 – "Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device."
Type 2 – "Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device."
Type 3 – "Point of utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel."
Type 4 - Component assemblies – "Component assembly consisting of one or more Type 5 components together with a disconnect (integral or external) or a means of complying with the limited current tests."
Type 1, 2, 3 - Component assemblies – "Consists of a Type 4 component assembly with internal or external short circuit protection."
Type 5 – "Discrete component surge suppressors, such as MOVs that may be mounted on a PWB, connected by its leads or provided within an enclosure with mounting means and wiring terminations."

These new categories are by far the major changes applied to UL 1449 3rd Edition. SPDs installation location is now taken into account. The closer an SPD is installed to the equipment, the better the protection is. This is a push in the direction of providing stepped protection including external and internal surge protection.

The measured voltage protection level

One of the last changes found in the new UL 1449 3rd Edition, is the modification in the measured voltage protection level.
The Measured Limiting Voltage (MLV) is the maximum magnitude of voltage measured at the application of a specific impulse wave shape.
When applying a certain surge current on the SPD the measured voltage at the device terminals is the so called "let-through voltage."
In UL 1449 2nd Edition, the let-through voltage was referred to as Suppressed Voltage Rating (SVR) and was calculated with a 0.5 kA surge wave form at 6 kV. The new designation is Voltage Protection Rating (VPR) and is calculated with a 3 kA surge wave form at 6 kV.

All products you will find in this chapter have been certified according to the UL 1449 3rd Edition.

The MLV will allow comparison of different types of SPDs with regards to the let-through voltage. However, it is important to note that the surge current used to measure the let-through voltage is six times higher in the 3rd Edition than in the 2nd Edition. This means that, comparing the obsolete SVR designation with the new VPR ratings will not be valid, as VPR ratings will of course be higher than SVR ratings.

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General information on SPDs
Technologies used

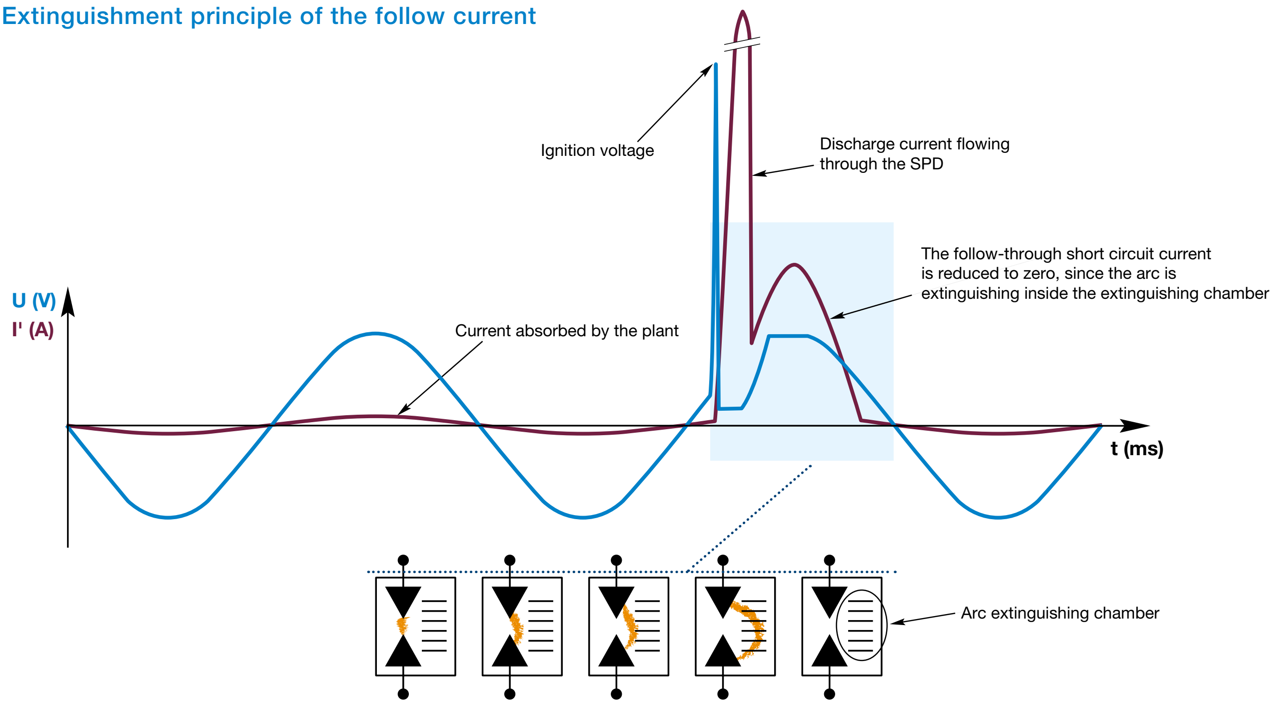
Extinguishing of the electric arc (follow current) in the arc extinguishing chamber

After that the voltage surge has been discharged by the SPD, the mains voltage persists at the electrodes; in the absence of suitable extinguishing systems, the arc would tend to remain (follow-through short circuit). The follow-through current tends to reach the short-circuit current at the installation point of the SPD, generally high at the origin of the system. The arc extinguishing chamber has the function of extinguishing the arc and interrupting the follow-through short circuit, even for high values. The extinguishing chamber cuts the arc in many small ones to be easily extinguished.

The maximum short circuit current that a SPD is able to interrupt without the operation of a disconnector is known as follow current interrupting rating, I_{fi}.

If the SPD is not able to extinguish the arc itself, the current reaches the system short-circuit current intensity I_{sc} and the upstream back-up fuse cuts in.

Extinguishment principle of the follow current



How does a Class 1 OVR T1 SPD work?

1 The discharge reaches the terminals of the SPD and is detected by the electronic device.
2 Thanks to the active intervention of the electronic device, the electric arc is ignited in advance.
3 The electric arc flows through the electrodes and is directed into the arc chamber to be extinguished.
4 The hot ionized gas flows in the special cooling conduits, preventing the risk of fire.

1

2

3

4

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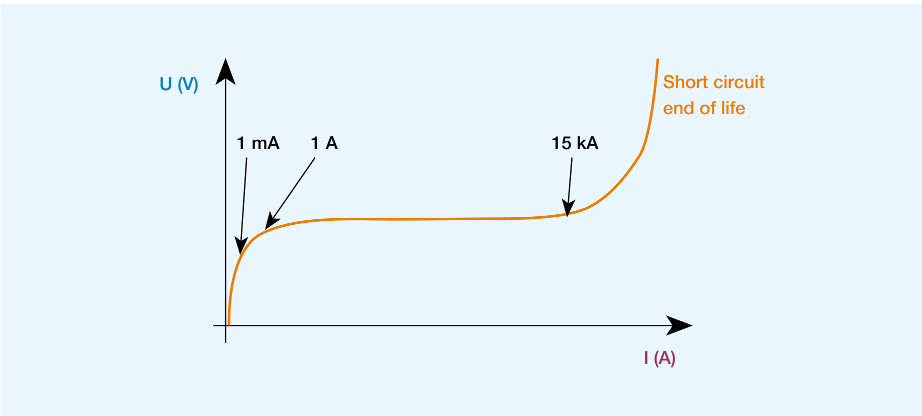
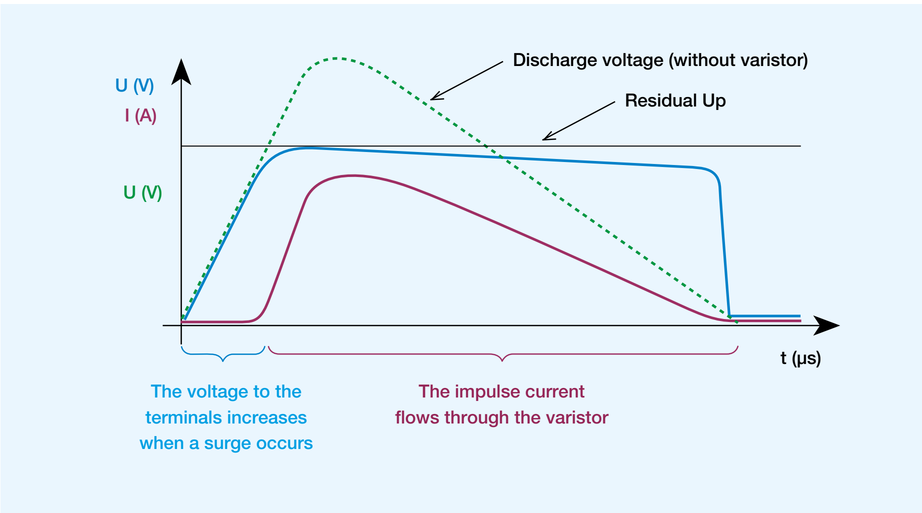
Varistor SPDs

Varistors are components which have their impedance controlled by the voltage, with a characteristic continuous but not linear "U in function of I". SPDs based on varistors, also known as voltage limiting, are characterized by a high impedance when there is no surge present (normally above 1 MΩ). When a surge occurs, the varistor's impedance falls rapidly below 1 Ω within a few nanoseconds, allowing the current to flow. The varistor regains its isolation properties after discharging the surge. A specificity of varistors is that a negligible current is always flowing through them, know as residual current, I_{PE} (100 to 200 µA).



Characteristic continuous U as a function of I for a 15 kA varistor.



Operation of a varistor SPD in case of voltage surge.

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General information on SPDs
Comparison between spark gaps and varistors

The main characteristic of spark gaps is their capacity to manage large quantities of energy from direct lightning strikes, while varistors have a very low level of protection (therefore high-performance) and are fast acting. We will now examine the difference between the two technologies.

	Varistor	Spark Gap
Isolation properties	A varistor, although it presents a very high impedance at rest, always has a minimal continuous current, I_c, flowing through it (e.g. 0.5 NA). This current tends to increase as the varistor wears, until it reaches high levels. For this reason, Varistor SPDs must always be protected against short circuit and cannot be used for N-PE connection upstream of the RCDs. + include an internal protection that guarantees a safe end of life	A spark gap is a true open circuit when at rest, ensuring that there is no current flow at all either in normal operating conditions or when it reaches the end of its life; for this reason a SPD may be installed upstream of an RCD (therefore protecting it from the flow of impulse or discharge current) only if the connection between the active conductors and earth provides for a spark element.
Resistance when conducting	Even in the discharge phase, the resistance remains appreciably greater than zero, limiting the possibility to reduce the surge overvoltage to 3-4 times the rated mains voltage.	When the arc is ignited, the resistance becomes negligible.
Response time	Very rapid, a few nanoseconds	Generally slow, but accelerated by the electronic device.
Ignition / limiting voltage	Low, thanks to the fast response time	Generally high, thanks to the excellent insulating properties of the air, but reduced with the aid of the electronic device.
Extinction of the short-circuit	Varistors are not characterized by a follow-through short circuit current, as their impedance returns to very hight values as soon as the surge ceases.	SPDs with spark gap technology must necessarily be designed in a way that enables the interruption of the follow current (such as an arc extinguishing chamber).
End-of-life	A varistor progressively loses its isolating performance; at the end of its life it can therefore become a low impedance short-circuit.	A spark gap is no longer able to ignite the arc at the end of its life, due to the wear of its electrodes or because the electronic ignition circuit has faded. It therefore becomes a permanently open circuit.
Need for back-up protection	Back up protection is necessary in order to ensure short circuit end of life safety. In case of short circuit end of life of the varistor the thermal disconnector is generally not able to open the circuit.	Back-up protection is to be provided for in all cases to ensure safety in the case of a fault with the SPD and to interrupt the electrical arc if the short-circuit current in the installation point is greater than the SPD's performance for interrupting the short-circuit follow-through current (I_{sc}>I_f).
Power capacity	Less powerful than the spark gap for the same volume.	More powerful than a varistor for the same volume.

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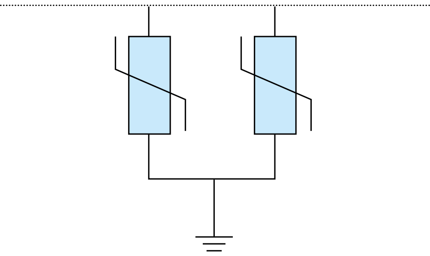
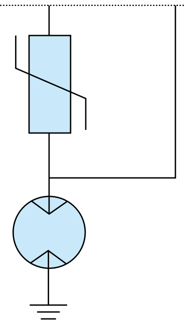
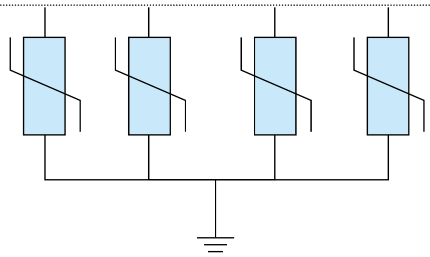
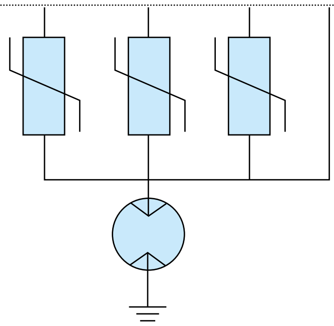
General information on SPDs
Comparison between spark gaps and varistors

From the comparison between varistors and spark gaps it emerges that each has its own benefits and disadvantages. As a consequence, the best results are obtained, where possible, by combining the benefits of both technologies using "combined technology" SPDs.

The Class 2 OVR T2 SPDs are available with combined technology to obtain maximum performance from both types of component.

Poles	Varistor technology, classic set-up	Combined varistor + spark gaps-to-earth technology, optimum solution
1P+N		
3P+N		
	Layouts only possible in TN-S Systems. Common Protection.	Layouts mandatory for TT systems and recommended in TN-S systems. Thanks to the insertion of a spark-gap to earth, the SPDs can be installed upstream of the RCD to protect it and prevent unwanted tripping. Common and differential protection.

The combined varistor + spark gap solutions are suitable for protecting TT and TN-S networks against indirect lightning strikes; ABB therefore offers multi-pole versions for each use.

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General information on SPDs
SPD classes and uses

The effects and consequences of direct and indirect lightning strikes are different, and so two different devices are necessary to completely protect the system.

All SPDs are tested by subjecting them repeatedly to current and voltage impulses. A SPD tested with a 10/350 μs waveform takes the name of Type or Class 1, while a SPD tested with 8/20 μs waveform takes the name Type or Class 2.

Type or Class	Class 1	Class 2	Class 1 and Class 2
Tests	Tested with 10/350 μs impulses.	Tested with 8/20 μs impulses.	Tested both with impulse currents of 10/350 μs waves and discharges of 8/20 μs waves.
Use	Protect against impulse currents from lightning which enter the system directly, for example through the lightning rod or the aerial electricity lines.	Protect against surges induced by lightning hitting the building or surrounding area and from surges resulting from operations on the electricity grid.	Protect against both direct and indirect lightning strikes. Used in small systems containing sensitive equipment (e.g. telecommunications).
Composition	Usually with spark-gaps or power varistor.	Usually with varistors, combined versions (varistor + spark gap) may be installed upstream of the RCD.	Usually combined technology (varistor + spark gap)
Installation point	Installed at the origin of the system.	Installed in all electrical switchboard of the plant, near sensitive equipment.	Installed in a reduced space at the origin of the plant, near delicate equipment.

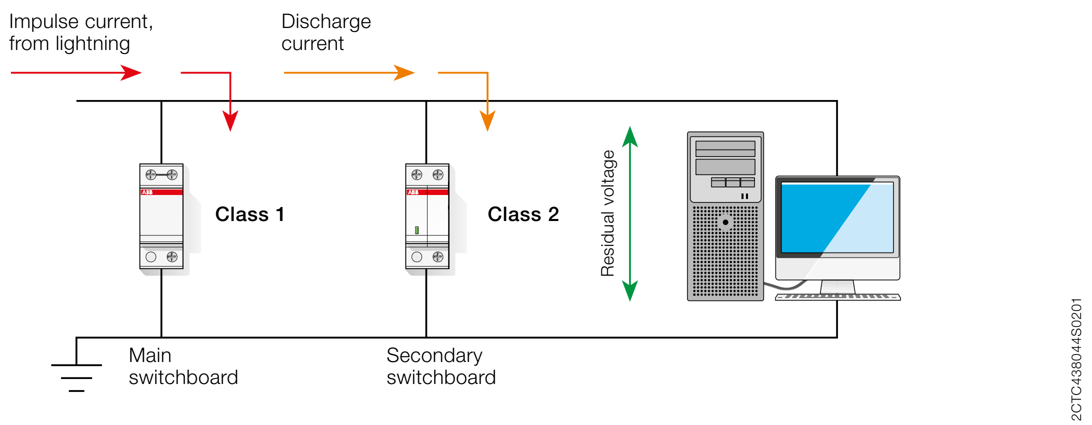
Class 1 and Class 2 SPDs are complementary, ensuring protection from the origin point of the plant right up to the terminal devices.

Class 1 SPDs protect from direct lightning strikes, with the ability to divert a large quantity of energy. They allow only a small part of the impulse current into the system, which must be managed by finer (Class 2) protection devices. A Class 2 SPD must be installed downstream of the Class 1 SPDs to protect sensitive equipment.

The Class 2 SPDs protect against indirect lightning strikes, designed to protect from a large number of discharges, quickly and with a high level of protection. They must be installed near the equipment to be protected.

Example of protecting a system with Class 1 and and Class 2 SPDs

Level of protection
<
Equipment impulse withstand voltage
=
Ensured protection



General information on SPDs
SPD terminology

Surge Protective Device (SPD)
A device designed to limit transitory overvoltage surges and to divert impulse currents away. Also known as limiters, they include at least one non-linear (non ohmic) component.
The european international reference product are EN 61643-11 and IEC 61643-1.

10/350 µs waveform:
Standardized current waveform; it flows through the equipment at the moment it is summited to a direct lightning strike.

8/20 µs waveform:
Standardized current waveform; it flows through the equipment at the moment it is subjected to an indirect lightning strike.

1.2/50 µs impulse voltage
Standardized voltage waveform, it is added to the rated mains voltage.

Type 1 surge protective device (SPD)
Surge protective device designed to divert the energy associated to a direct lightning strike or an operation on the electricity grid. The test parameter is the discharge current represented by a 10/350 µs waveform (test class I).

Type 2 surge protective device (SPD)
Surge protective device designed to discharge the energy associated with an indirect lightning strike or an operation on the electricity grid. The test parameter is the discharge current idem 8/20 µs waveform (test class II).

Type 3 surge protective device (SPD)
Surge protective devices shall be installed as close as possible from the sensitive equipment to protect. Tested with a 1.2/50 - 8/20 current combination wave generator, they ensure a very low protection level.

I_{imp}: impulse current for test class I
This is the discharge current with 10/350 µs waveform that the device is able to divert towards earth or the network at least one time, without deterioration. It is used to classify the surge protection devices in test class 1 (the 10/350 µs waveform corresponds to this definition).

Why is I_{imp} important?

IEC 62305 standard requires a maximum impulse current value per pole of 25 kA. To ensure protection in any installation, the SPD must be correctly sized for the maximum current provided for. Be careful not to confuse the current per pole (25 kA) with the total current (100 kA for a 3P+N network).

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General information on SPDs
SPD terminology

I_n: rated discharge current for test class II
This is the discharge current with 8/20 μs waveform that the Class 2 SPD is able to divert (towards earth) at least 20 consecutive times, without deteriorating.
It is used to determine the SPD's level of protection, U_p. It is at this I_n value the level of protection value (U_p) is measured.

Why is I_n important?

By law, a SPD with I_n of at least 5 kA may be installed in any system, even in areas with high frequency of lightning strikes.
In any case, it is better not to scrimp on the I_n: the higher it is, indeed, the longer the life of the SPD will be.

I_{max}: maximum discharge current for test class II
Peak value of the maximum discharge current with 8/20 μs waveform that a Class 2 SPD is able to withstand at least once.
I_{max} is, in general, much greater than I_n .

Why is I_{max} important?

The difference between I_{max} and I_n indicates when the SPD is working, in nominal conditions, near its limits.
The higher the I_{max} is, for the same I_n, the safer the SPD is working, far away from its performance limits.

U_n: rated voltage
Rated voltage of the mains network between phase and neutral (RMS AC value).

U_c: maximum continuous voltage
Maximum voltage to earth that the SPD is able to permanently support without either cutting in or deteriorating.

U_T: resistance to TOV (Temporary Overvoltage)
Maximum RMS or DC voltage which the SPD can be subjected to which exceeds the maximum voltage for continuous operation U_c for a specific and limited time (generally 5 s).

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General information on SPDs
SPD terminology

Ng: lightning density
Expressed as number of times lightning strikes the ground per km^2 per year.

Protection mode
Common mode (MC): protection between the active conductors (phase and neutral) and earth.
Differential mode (MD): protection between the active conductors.

I_f: follow-through current
Current, supplied by the electrical supply grid, which flows through the SPD following an impulse current.

I_{fi}: rated interruption value of the follow-through current
Presumed short-circuit current that a SPD is able to interrupt on its own.

U_p: voltage protection level
It characterizes the ability of the SPD to limit the voltage between its terminals in the presence of a surge; the value of the protection level, selected from a list of preferential values, is greater than the most elevated residual voltages measured in the Test Class I or II for a current I_n.

Protection level U_p and residual voltage U_{res}

The residual voltage U_{res} is the value of the voltage at the terminals of the SPD when it is subject to the passage of an electric discharge. There is a U_{res} value for each impulse or discharge current value. The only valid value, both from the point of view of design and of the choice of SPD is U_p, the level of protection. The U_p value is obtained by discharging a current of I_{imp} (for Class 1) or I_n (for Class 2). Other residual voltage values have no value in planning and cannot be used as a parameter for choosing the SPD.

The protection voltage U_{prot} is the sum of the level of protection U_p of the SPD and the voltage drops across the connections.

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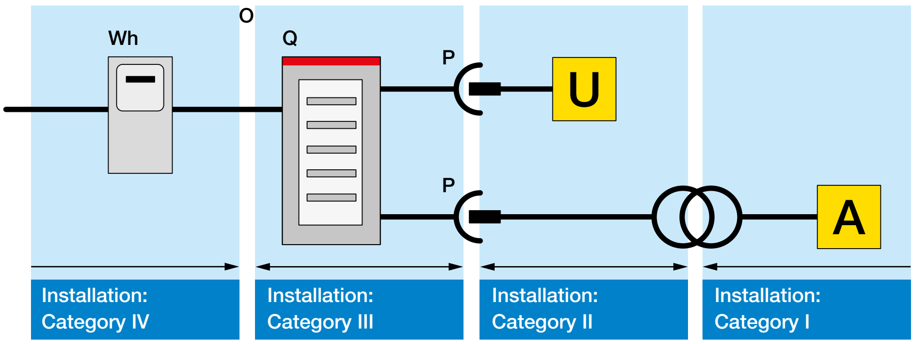
SPD terminology

U_W: equipment impulse withstand voltage

The tolerance of equipment to overvoltage surges is classified according to 4 categories (as indicated in the following table), pursuant to IEC 60664-1 ed.2.



O = origin of the installation; Wh = electricity meter; Q = main electrical switchboard;
P = electric socket; U = end-user electrical equipment; A = electronic equipment

Category	U_n				Examples
	120-220 V	230-400 V	400-690 V	1 000 V	
I	800 V	1 500 V	2 500 V	4 000 V	Equipment containing particularly sensitive electronic circuits: – Servers, computers, TVs, HiFis, videos, alarms etc. – Household appliances with electronic programs etc.
II	1 500 V	2 500 V	4 000 V	6 000 V	Non-electronic household appliances, devices etc.
III	2 500 V	4 000 V	6 000 V	8 000 V	Distribution switchboards, switching devices (switches and circuit breakers, sockets, insulators etc.), conduits and accessories (wires, bars, junction boxes etc.)
IV	4 000 V	6 000 V	8 000 V	12 000 V	Industrial equipment and equipment such as, for example, fixed motors connected permanently to fixed systems, electricity meters, transformers etc.

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General information on SPDs
SPD terminology

The golden rule

The SPD's level of protection U_{prot} must always be less than the impulse withstand voltage U_w of the equipment to be protected.

For example, in a main switchboard (400 V three-phase), protection of category III equipment is ensured if the U_{prot} value is less than 4 kV. An OVR T1 SPD protects the equipment thanks to its low protection level (2.5 kV),

In the secondary switchboards, protection of the category II equipment requires the installation of a Class 2 SPD, or eventually a Class 1, with low U_p protection level (1.5 kV).

For example, for a Type 2 SPD installed near terminal equipment (Category II) in a 230 V single-phase network, the level of protection (U_{prot}) must be chosen so that the sum of the U_p and inductive voltage drops on the connections is less than 2.5 kV.

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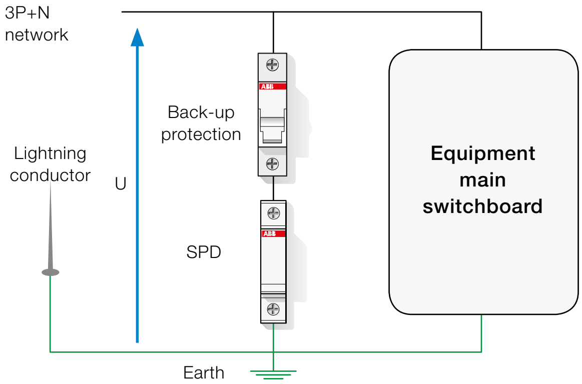
General information on SPDs
SPD terminology

The technical terminology outlined above is referenced in the following designs which illustrate the different stages of operation of Class 1 and 2 SPDs in a standard installation.

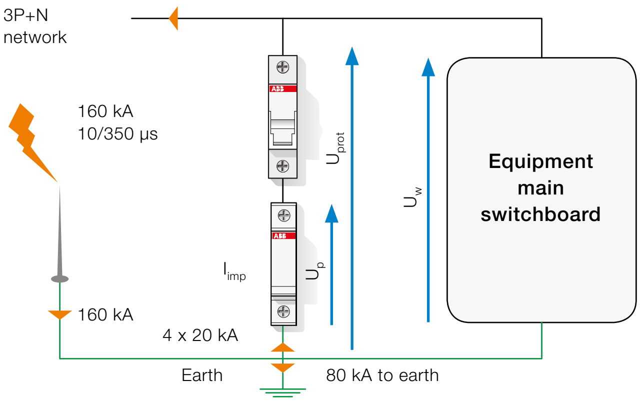
Class 1 SPDs: Standard operation

U: U_n rated network voltage (230 V between phase and earth)
U_C maximum continuous operating voltage of SPD (255 V between phase and earth)
U_T resistance to temporary overvoltage (TOV) of the SPD



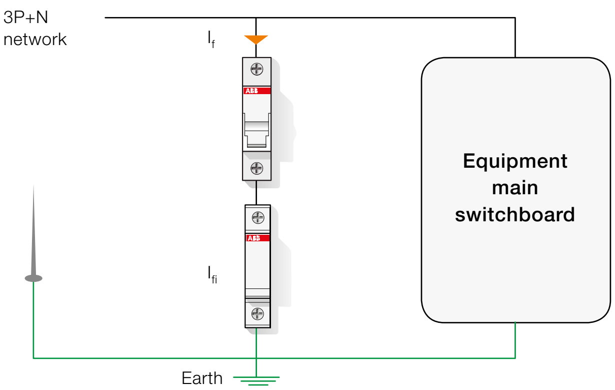
Direct lightning strike on external LPS

I_{imp}: lightning current per pole of the SPD (25 kA).
I_{imp} > discharge current per pole, 20 kA
U_p: level of protection of the SPD, 2.5 kV
U_{prot}: level of protection of the SPD + voltage drops on the connections U_{prot} = 3 kV with short connections
U_w: Impulse withstand voltage of the equipment, 4 kV (category III)
U_w > U_{prot}, the equipment is protected



Extinguishment of discharge follow-through current

I_f: Follow-through short-circuit current
I_{fi}: Rated follow-through current interruption value of the SPD
I_{fi} > I_f, the electric arc is safely extinguished inside the SPD.
Protection against direct lightning strikes has been ensured.
The passage of the lightning current creates an indirect lightning strike in the surrounding area, dealt with class II SPD.



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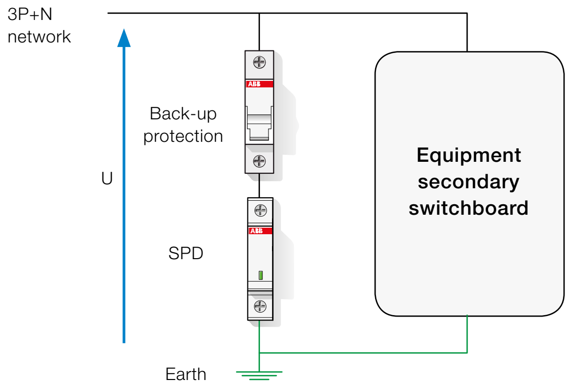
General information on SPDs
SPD terminology

Class 2 SPDs: Standard operation

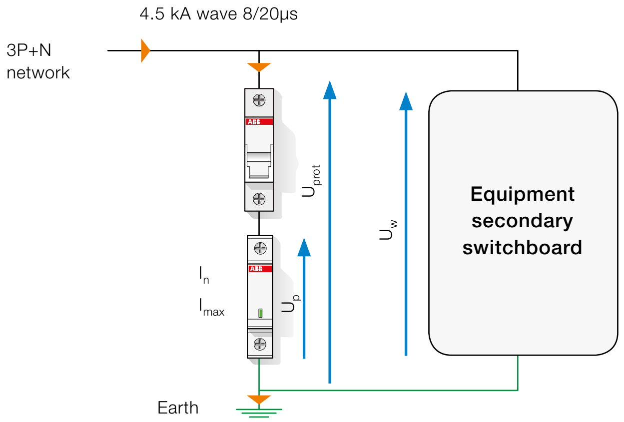
U: U_n rated network voltage (230 V between phase and earth)
U_C maximum continuous voltage of SPD (255 V between phase and earth)
U_T resistance to temporary overvoltage (TOV) of the SPD



Indirect lightning

I_n: nominal discharge current of the SPD (20 kA).
I_{max}: maximum discharge current of the SPD (40 kA).
I_n > discharge current, 4.5 kA
U_p: level of protection of the SPD, 1.4 kV
U_{prot}: level of protection of the SPD + voltage drops on the connections
U_{prot} = 1.9 kV with short connections
U_w: Impulse withstand voltage of the equipment, 2.5 kV (category II)
$U_w > U_{prot}$, the equipment is protected

The SPD's insulation properties are automatically restored after the passage of the discharge.



The product designs are simplified in these two pages. In the case of a 3P+N network the SPD and fuse holder are multi-pole.

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General information on SPDs
Earthing systems

The earthing system describes the connection to earth of the electrical system and its equipment earths.

All devices installed in an electrical supply system must ensure protection of people and equipment.

Four earthing systems exist, differentiated by:

- Connection of the neutral to ground
- Connection of the exposed conductive parts (equipment earthing) to earth or neutral.

Earthing system	Neutral connection	Connection of earths
TT	Neutral connected to earth	Earths connected to an earth collector
TN-C	Neutral connected to earth	Earths connected to neutral
TN-S	Neutral connected to earth	Earths connected to protective conductor
IT	Neutral isolated from earth or connected to earth via an impedance	Earths connected to an earth collector

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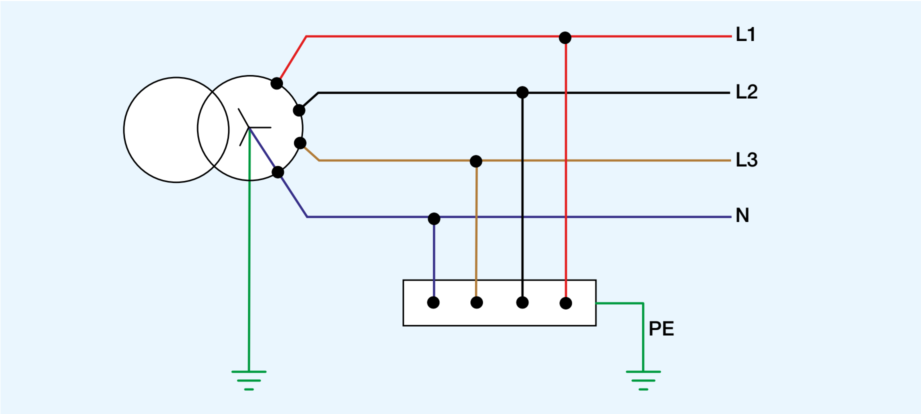
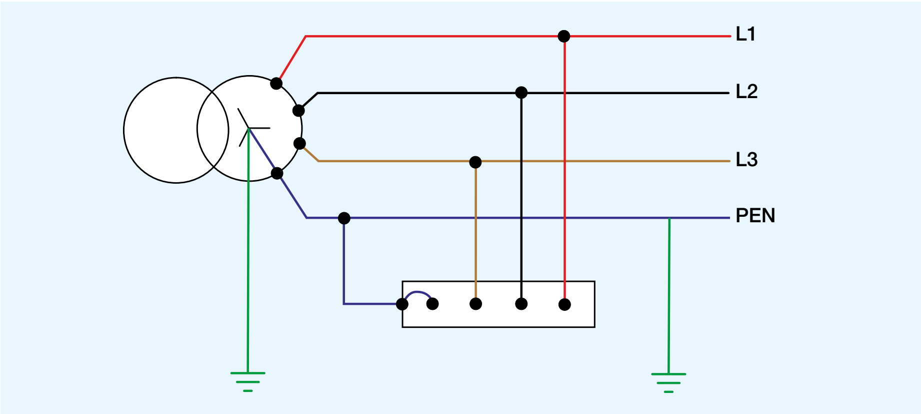
General information on SPDs
Earthing systems



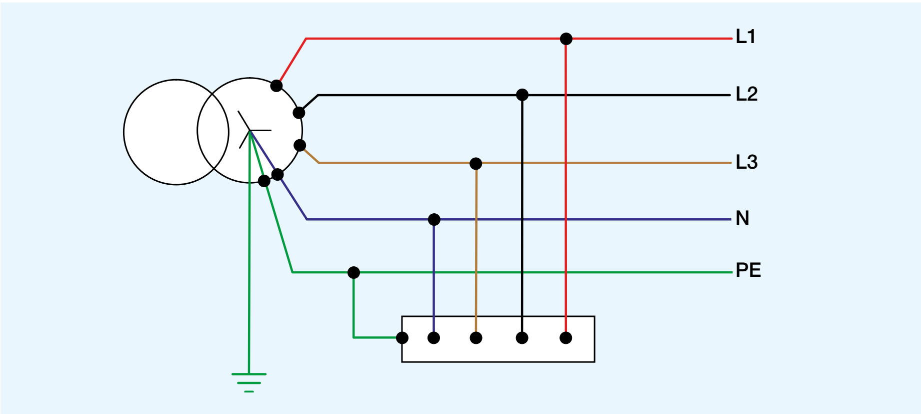
TT System

The electrical supply neutral is connected to earth. The exposed conductive parts of the system are connected to an earth bar (this can be a separate earth bar, or else the bar which the neutral is earthed to).



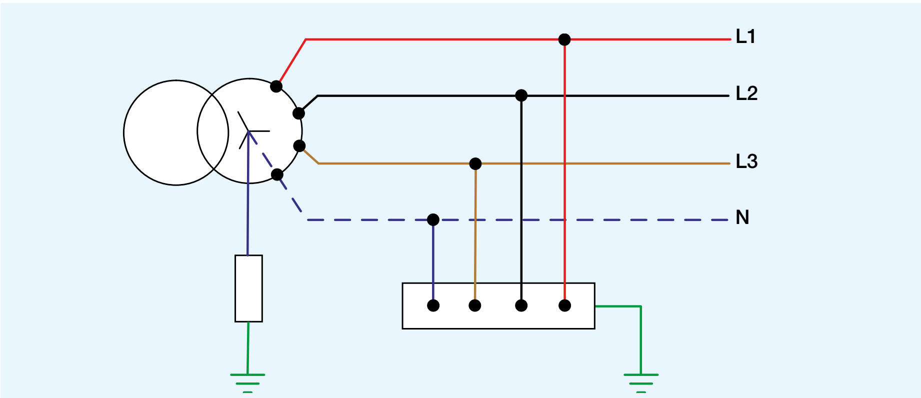
TN-C system

The electrical supply neutral is connected to earth. The neutral conductor and the protective conductor are the same conductor: PEN.



TN-S system

The neutral and the protective conductor are separate and connected to the same earthing system.



IT System
(isolated neutral or else earthed via an impedance).

The neutral may be isolated from earth, or else connected to it via an impedance
(from 1 000 to 2 000 ohms)

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General information on SPDs
Earthing systems

The choice of the earthing system depends on:
– Operational conditions
– Maintenance methods and requirements

Is continuity of service a priority?	
Yes	**No**
Isolated neutral (IT)	Isolated neutral (IT) Neutral connected to earth (TT) Distributed neutral (TN)
This is the safest system for avoiding interruptions to the power supply. Some examples are industrial environments and hospitals.	The choice of system depends on a careful exam of: – Characteristics of the system and complexity of implementing each type of earthing system – Operational and installation costs of each type of earthing system

The earthing system may be imposed by the electricity company:
– TT, for residential customers, small offices and small tertiary service plants
– IT, used in the case where continuity of service is required: hospitals, public buildings.

Earthing systems

System type	Recommended
Large network with few equipment earths	TT
Network located in an area subject to thunderstorms	TN
Grid supply from aerial electricity lines	TT
Backup or emergency generator	IT
Loads with reduced insulation (ovens, kitchens, welding equipment)	TN
Portable single-phase loads (drills, grinders)	TT or TN-S
Machines for handling, hoisting, conveyor belts	TN
Large amount of auxiliary equipment, machine tools	TN-S
Buildings at risk of fire	IT or TT
Construction sites (unreliable earthing)	TT
Electronic/computer equipment	TN-S

ABB's range of SPDs covers all requirements, for all earthing systems.

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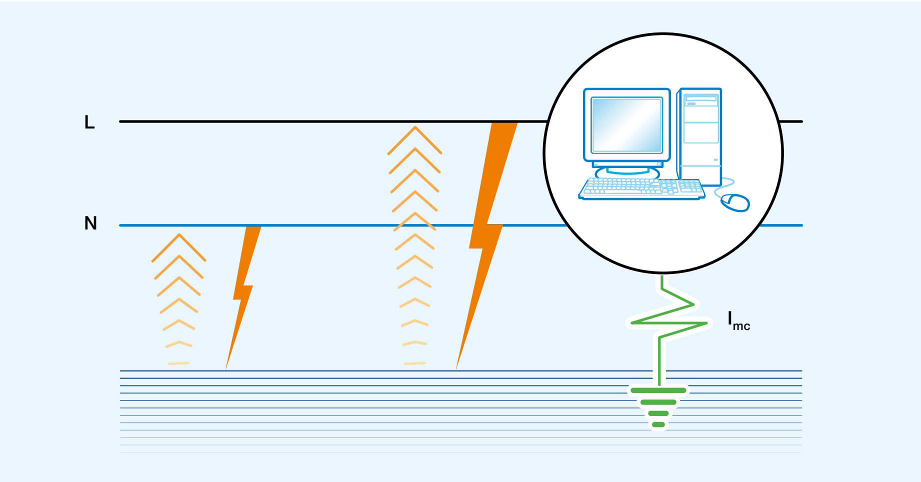
General information on SPDs
Protection methods

Surges in electrical systems are classified by category, may be common, differential, or a combination of both.

Common mode

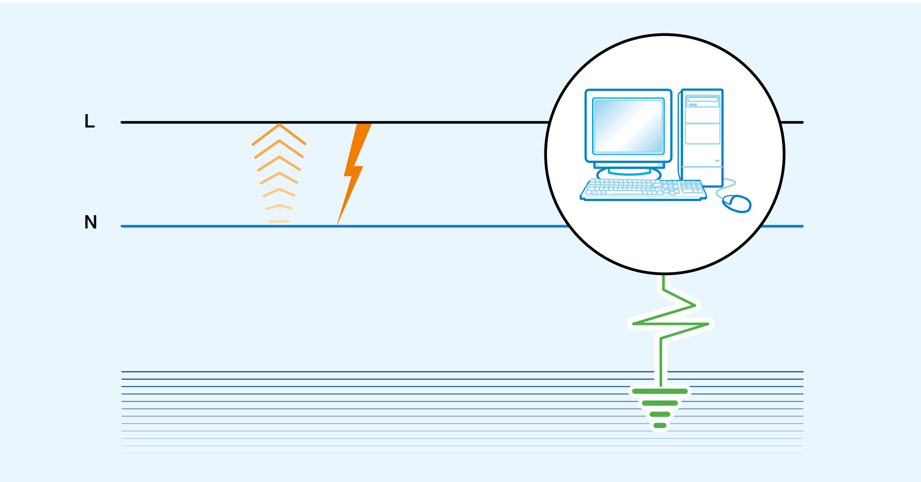
Common mode overvoltages occur between the active conductors and earth, for example phase-earth or neutral-earth.
Active conductor here means both the phase conductors and the neutral conductor. This overvoltage mode destroys equipment connected to earth (class I equipment), but also equipment not connected to earth (class II equipment) located near an earth and with insufficient electrical insulation (few kV). Class II equipment not positioned near an earth is, in theory, protected against this type of aggression attack. These surges are frequent and appear in case of impact on external lightning protection system



Note:
Common mode overvoltages have an effect on all earthing systems.

Differential mode

Differential mode overvoltages occur between the active conductors: phase-phase or phase-neutral. These overvoltages have a potentially damaging effect on all electrical equipment connected to the electrical network, above all sensitive equipment. These surges are less frequent. See explaination in note below.



Note:
Differential mode overvoltages occur in TT earth systems because the cables follow different paths.
They can also occur in TN-S earthing systems whenever there is a noticeable difference between the length of the neutral and the protective (PE) cables.

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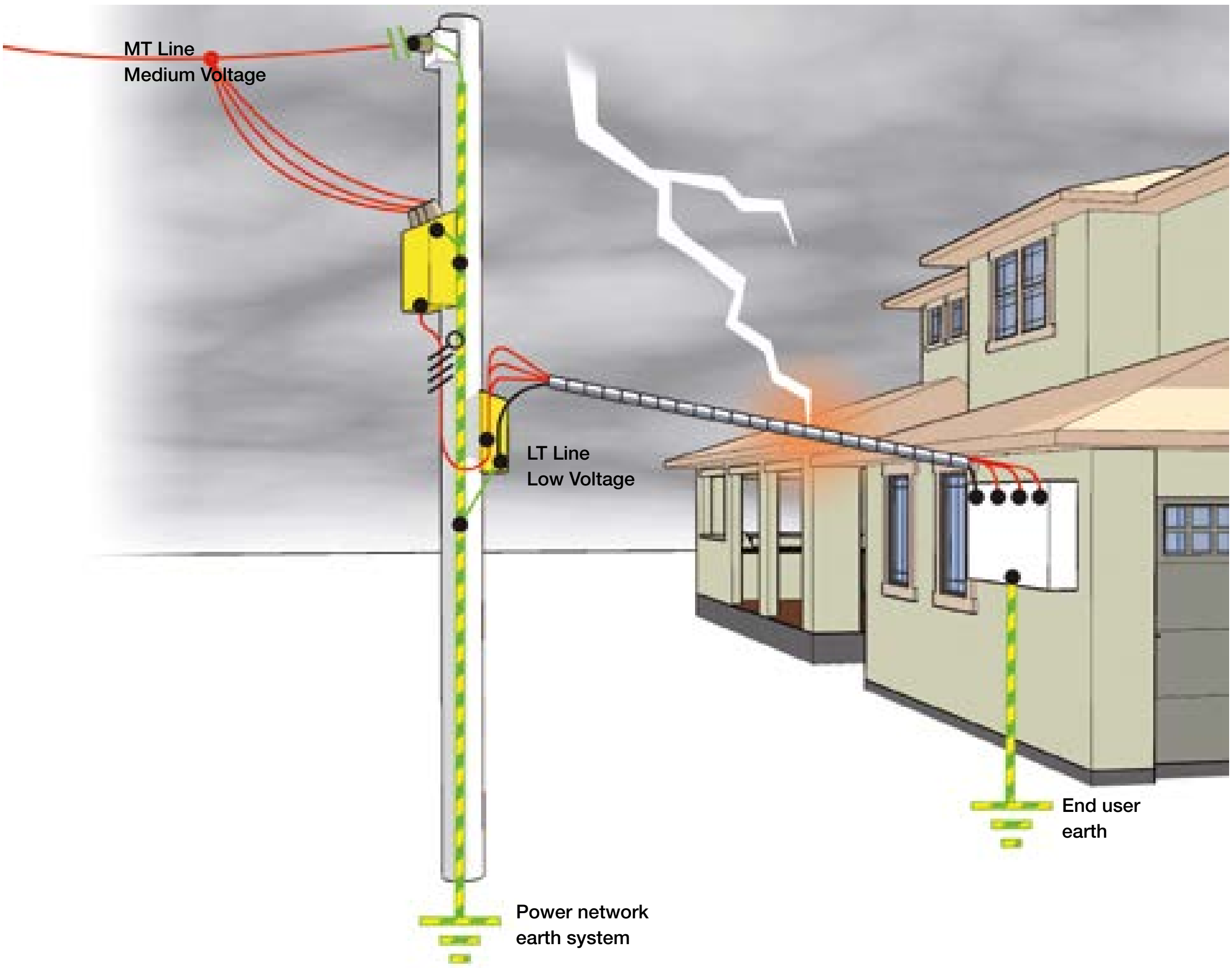
Protection methods

"Surges caused by a lightning strike inevitably generate common mode voltages" and may also generate differential mode voltages.
The solution ensuring maximum safety consists of using protective devices which allow a combination of common and differential mode; most SPDs developed by ABB are made this way.



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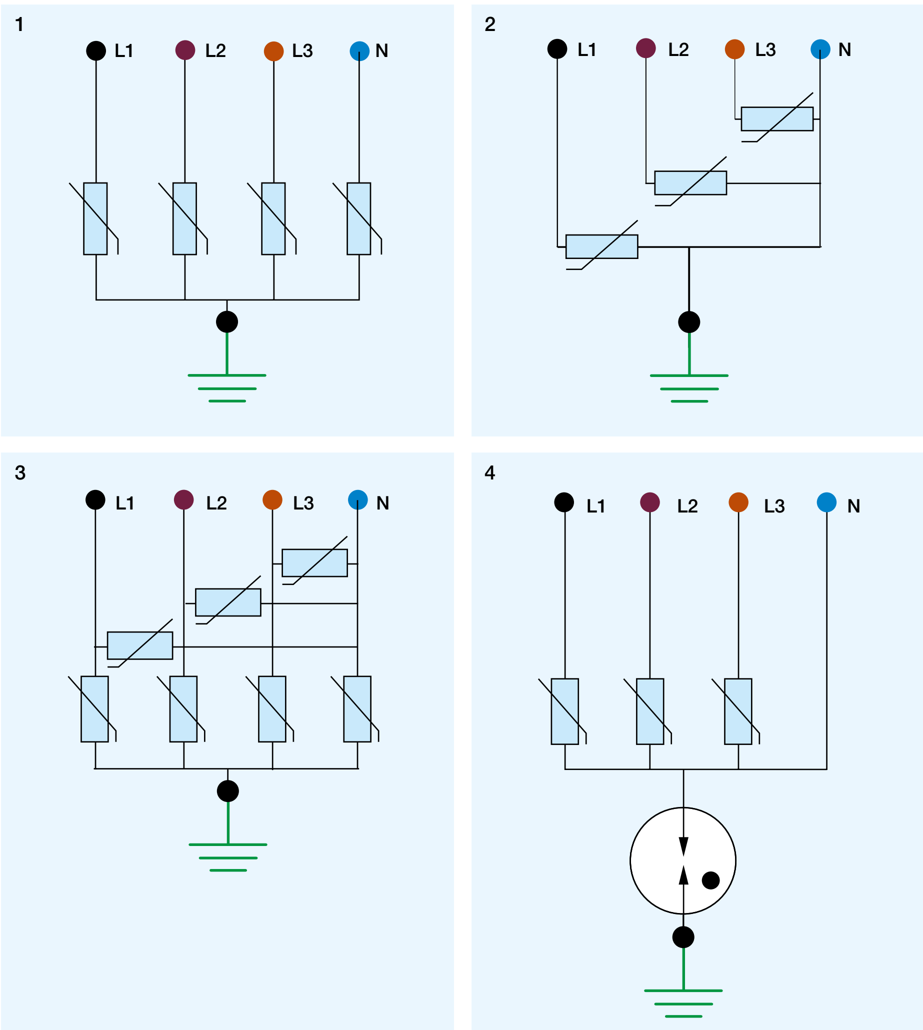
General information on SPDs
Protection methods

Protection from overvoltages in common and differential mode (MC/MD)

Non-linear components, such as varistors and spark gaps, are used to stop overvoltage surges reaching equipment.

The combination of one or more non-linear components allows common mode protection, differential mode, or a combination of both, of the internal electrical scheme or the wiring of the equipment.
Diagrams of electrical connections are given below based on the protection mode.



1. Protection from surges in common mode (MC)
2. Protection from surges in differential mode (MD).
3. Protection from surges in common and differential mode (MC/MD) using seven SPDs.
4. Protection from surges in common and differential mode (MC/MD), with gas spark gap to earth. No current flows to earth at the rated voltage.

1 and 4 schematics are commonly used.

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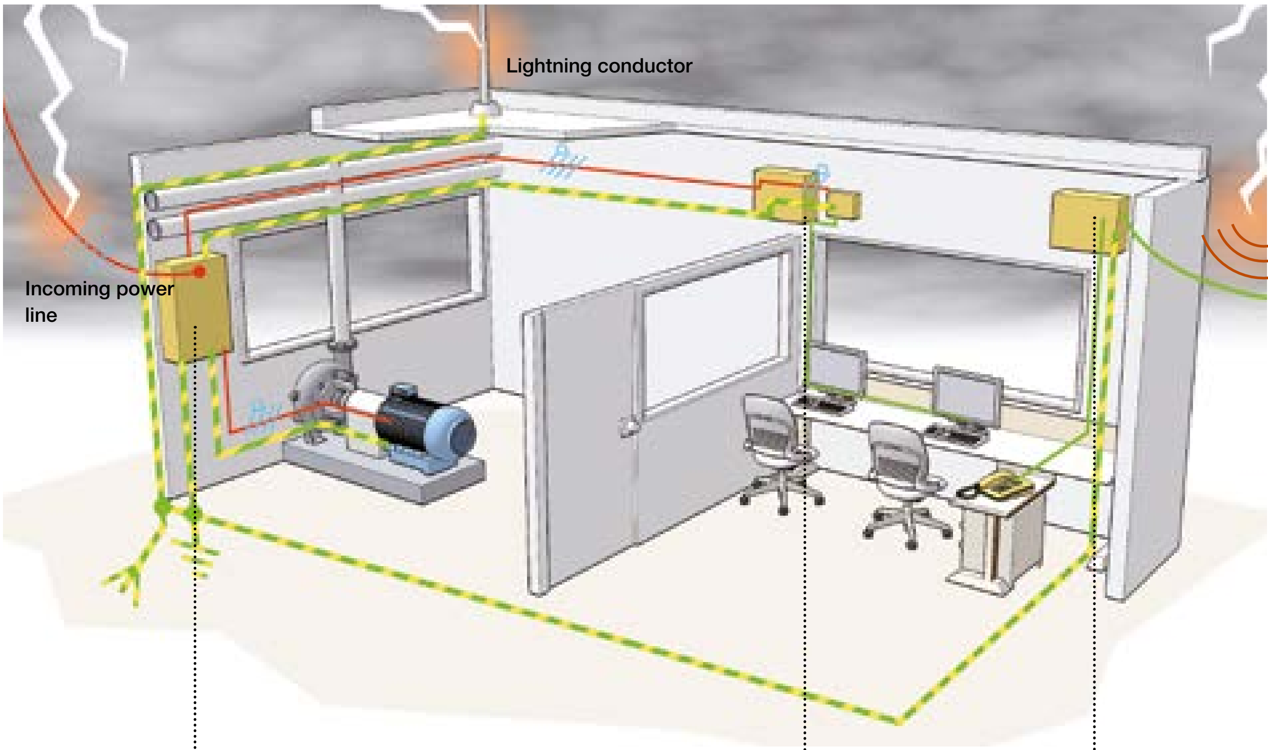
Surge protective devices

Global protection of this installation fitted with a lightning conductor is performed with a Class 1 SPD to protect against direct lightning strikes (OVR T1), by a Class 2 SPD (OVR T2) to protect against indirect lightning strikes and by a dedicated SPD on the data lines (OVR TC)

The Type 1 SPD (OVR T1), installed in the main electrical switchboard at the origin of the system, is able to direct the current of a direct lightning strike to earth or to the network. This is the first level of protection for the electrical supply network. **The behavior of the wiring in the presence of an impulsive phenomenon limits the effectiveness of the upstream SPD to 10 m. It is therefore necessary to use one or more protective devices downstream in order to obtain the required level of protection for the terminal equipment.**
As such, it is appropriate to use a Type 2 SPD (OVR T2) co-ordinated with the protective device at the system origin. This is the second level of protection. Finally, whenever there is a risk of overvoltages on the electrical network, this risk also exists for the auxiliary and data networks. Appropriate protection consists of a SPD designed to protect the telephone or data lines (OVR TC).



Main electrical switchboard
Protection of equipment (machinery)
OVR T1 Type 1 SPD
3N 25 255 TS

Secondary distribution switchboard
Protection of terminal equipment (power supply for computers, etc.)
OVR T2 Type 2 SPD
3N 40 275 s P TS QS

Protection of the telephone network
OVR TC

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Surge protective devices
How to choose a SPD

The choice of the SPD depends on a series of criteria defined in the phase of assessing the risk of lightning strikes, allowing the surge protection requirements to be identified.

When is it necessary to provide for protection?
First of all, the requirements of the standards must be considered; to the analysis of these we can add recommendations based on ABB's industrial experience.
The criteria taken into consideration in this section consist of assessing the risk of a direct lightning strike on or near a building, including the financial aspect caused by equipment which may be damaged and temporary loss of operational capacity. Even in the case that protection is not indispensable, it is as well to note that, considering that a zero risk does not exist, it is always a good idea to provide a protection.

In the case that protection against lightning strikes is recommended, it is sufficient to choose the appropriate product and install it.
The choice of the SPD is based
on different elements:
– The type of lightning strike, direct or indirect
– protection level U_p;
– The discharge capacity: I_{imp} or I_n (10/350 μs or 8/20 μs impulse wave);
– The network's earthing system;
– The operating voltages (U_c and U_T).
– Options and accessories (end-of-life indicator, pluggable cartridges, safety reserve, remote signaling).

Protection against surge for unstable networks
Unlike the developed countries in North and Europe, which have relatively stable AC network power voltage, developing countries in Asia, Latin America and Middle East are still facing overload in existing infrastructure, causing huge surge and sags in voltage, we are talking about "unstable network".
A "stable" network will have some voltage fluctuation up to +/- 10 % of the nominal voltage, "unstable" network can go up to +/- 50 % of the nominal voltage!
For example : a motor connected to a classic 230/400 V (+/- 10 %) system network will see at maximum value 255/440 V, if the same motor was installed on an unstable network, it will see 345/600 V!!
For these applications, protection equipment must be chosen according the maximal continuous operating voltage.
Coming back to the SPDs, they are very sensitive to voltage fluctuations, every time a temporary overvoltage is happening, varistors are prematurely damaged, affecting directly the lifetime of the surge protection.

In the aim to offer Surge Protective Device able to withstand these unstable networks, without reducing lifetime protection, a new dedicated range with special varistors can be used on 230 V and 400 V electrical network:
– Type 2
– 230 V and 400 V electrical network
– Uc 350 V and 600 V
– Imax 40 kA and 80 kA
– One pole, 1N, 3L, 4L, 3N versions
– Same dimension as the classic range.

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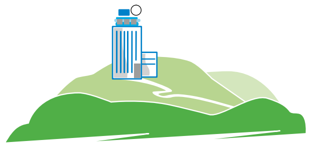
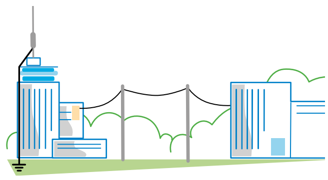
Surge protective devices
How to choose a SPD

Recommendations for the use of SPDs

Environmental criteria

			
Context	**The building has a LPS**	**Ng > 2.5 and aerial electricity lines**	**Building located in a mountainous area**
ABB's installation recommendations	SPD strongly recommended	SPD strongly recommended	SPD recommended
Type of SPD	Type 1	Type 1 or Type 2	Type 1 or Type 2 (70 kA)

			
Context	**Element greater than 20 m height less than 50 m from the building to protect**	**Less than 500 m in a straight line separate the LPS and the main electrical switchboard of the building to be protected**	**Less than 50 m of distance separate the lightning rod from the building to be protected**
ABB's installation recommendations	SPD recommended	SPD recommended	SPD recommended
Type of SPD	T1 or T2	T1 or T2	T1 or T2 (70 kA)

Operational criteria

Selection criteria	**Recommended**	**Particularly recommended**	**Absolutely recommended**
Priority to operational continuity (for cost reasons to avoid operational losses, safety reasons etc.):			
- Industrial plants, offices, banks, airports, police stations, pharmacies, surveillance systems etc.;			●
- Hospitals, old-people's homes, dialysis centers.			●
Protection priority of the equipment			
- High value > 150 000 euros			●
- Medium value > 15 000 euros		●	
- Low value > 150 euros	●		
Frequency of lightning strikes in the region			
- Ng ≤ 2.5		●	
- Ng > 2.5			●
Isolated area			●
Type of electricity supply lines powering the building			
- Aerial lines		●	
- Underground lines	●		

Frequent and repeated overvoltage surges due to lightning strikes cause large economic losses greater than the cost of installing the system to protect against overvoltage surges.

The cost of the protection is often low compared to the cost of the equipment to protect.

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Surge protective devices
How to choose a SPD

Choosing the type of protection according to the supply network

Overvoltages occur in common and differential mode, or only in common mode, depending on the type of earthing system.

	TT	TN-S	TN-C	IT with N	IT without N
Common mode	Yes	Yes	Yes	Yes	Yes
Differential mode	Yes	Yes(1)	No	No	No

1) In the case that there is a considerable difference between the length of the neutral cable and that of the protective cable (PE).

Note:
For each network configuration it is easy to identify the suitable multi-pole protection.

The choice of the operating voltage is fundamental when selecting a SPD

Two voltage characteristics exist for a SPD: U_c and U_T .
It is essential that SPDs, in combination with their switching devices, are able to resist a temporary overvoltage at 50 Hz without any change of their characteristics or operation. For an electrical network (phase/neutral) at 230 V, this overvoltage is defined as follows:

U_C: Maximum continuous voltage
U_T: Resistance to temporary overvoltages (TOV)

U_T for 5 seconds (+ 0/–5%).

It is fundamental that the U_T values are chosen in conformity with the table given below, according to the type of earthing system.

Connection of the SPD	Earthing system of the network conform to IEC 60364-4-44 ed. 2									
	TT		TN-C		TN-S		IT (distributed neutral)		IT (non-distributed neutral)	
	U_c	U_T	U_c	U_T	U_c	U_T	U_c	U_T	U_c	U_T
Between phase and neutral	253 V	334 V	N.A.	N.A.	253 V	334 V	253 V	334 V	N.A.	N.A.
Between phase and PE	253 V	400 V	N.A.	N.A.	253 V	334 V	400 V	N.A.	400 V	400 V
Between neutral and PE	230 V	N.A.	N.A.	N.A.	230 V	N.A.	230 V	N.A.	N.A.	N.A.
Between phase and PEN	N.A.	N.A.	253 V	334 V	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

These represent minimum voltages
N.A.: not applicable.

The table also supplies the U_c values corresponding to the maximum continuous operating voltage which the SPDs must be able to manage in a network at a rated voltage of 230/400 V.

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Surge protective devices
Choice of I_{imp} and I_n for a SPD

The protection performance of a SPD depends on its technical characteristics and rated specifications on its data plate.
The choice is therefore made on the basis of the accepted level of risk.

Over 99% of lightning strikes are less than 200 kA (IEC 62305-1, Annex A, base values of lightning currents); in the case of a lightning bolt of 200 kA, we can consider that the impulse current on each conductor of a three-phase plus neutral network is 25 kA.

Impulse current I_{imp} for Type 1 SPDs

ABB therefore recommends a minimum I_{imp} of 25 kA per pole for Type 1 SPDs, based on the following calculation:

- Maximum direct lightning current I: 200 kA (only 1% of lightning discharges are over 200 kA)
- Distribution of the current inside the building: 50% to earth and 50% to the electrical network (according to International Standard IEC 62305-1, Annex D).
- Equal distribution of the current across each of the conductors (3 L + N):

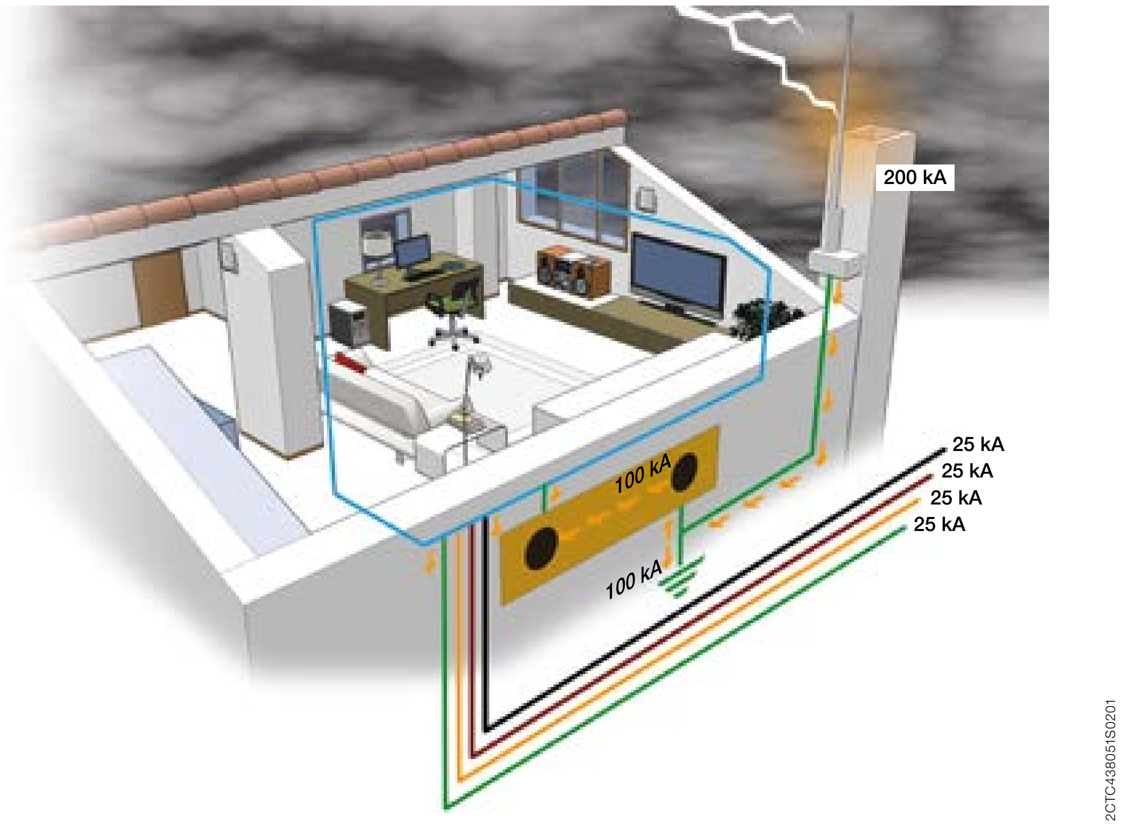
$$I_{imp} = \frac{100 \text{ kA}}{4} = 25 \text{ kA}$$

Rated discharge current I_n for Type 2 SPDs

Note:
ABB defines its Type 2 SPDs on the basis of their maximum discharge current (I_{max}). For a determined value of I_{max} there is a corresponding rated discharge current value (I_n).

	Optimization of I_n for Type 2 SPDs, according to ABB recommendations, on the basis of lightning density data.		
Ng	< 2	2 ≤ Ng < 3	3 ≤ Ng
I_n (kA)	5	20	30
I_{max} (kA)	15	40	70

Note: The lightning current can bring the earth collector to a much higher potential. For example, if the earth resistance is 10 ohms, a discharge current of 50 kA to earth will cause an increase in potential up to 500 kV.



Surge protective devices
Lifetime of Class 2 SPDs

The duration of a Class 2 SPD, that is to say its capability to operate correctly over time, essentially depends on its resilience

(characterized by its rated discharge current I_n), but also by the quantity of lightning strikes in the vicinity of the system each year.

IEC/EN 61643-11 provides for a rather complicated functional test for Type 2 SPDs. To summarize, we can state that a SPD is made to survive at least 20 8/20 μs waveform surges at its rated discharge current I_n undamaged.

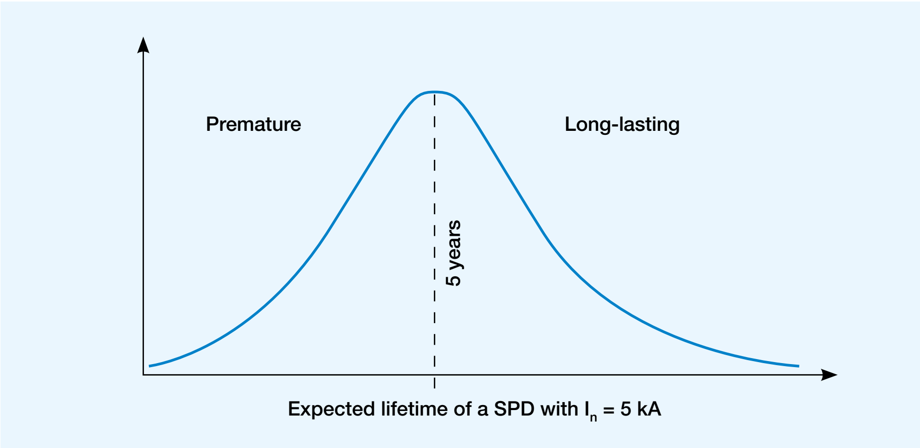
If the collection area for indirect lightning for a building is, let us assume for simplicity, Am = 1 km² and, in the district in which this is installed, the number of lightning strikes per year per km² is Ng = 4 lightning strikes/km²/year and the maximum discharge current expected on the system is 5 kA, a SPD with I_n = 5 kA will have a duration of approximately:

$$\frac{20 \text{ discharges}}{\text{Am x Ng}} = \frac{20}{1 \text{ x } 4} = 5 \text{ years}$$

It is obvious that a SPD with I_n = 5 kA, while fully complying with regulations, would have a very short duration, if compared to the expected life of the installation to which it is connected. If several SPDs are installed in the network, given that 5 years is an average lifespan, some SPDs (premature) could already reach the end of their lives in the first few years of the system's operation.

If several SPDs are to be installed, in order to avoid changing cartridges after less than five years, it is advisable to choose a SPD with a safety margin, that is with a higher rated discharge current. Choosing a SPD with a high rated discharge current I_n saves on maintenance and ensures protection for a longer period.

End-of-life probability of a SPD with rated discharge current of 5 kA.



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Lifetime of Class 2 SPDs

Do not scrimp on I_n

By law, a SPD with I_n of at least 5 kA may be installed in any plant, even in areas with high frequency of lightning strikes. In any case, it is better not to save money by using SPDs with low I_n values; indeed, the higher the I_n, the longer the lifetime of the SPD will be.

The I_n value which gives the best compromise between the cost of the SPD and the cost of subsequent maintenance of the product lies between 15 kA and 20 kA.
Tests in ABB laboratories have determined an average lifespan of at least 20 years for a SPD with I_n 20 kA.

Lifespan of a 20 kA SPD

	I_{max} test		In I_n		Real case		
Overcurrent expected in the system [kA]	**40**	30	**20**	10	**5**	2	1
Number of discharges before end-of-life	**1**	5	**20**	40	**200**	1 000	3 000

The table allows us to see that, in practice, a 20 kA SPD, under the most serious overcurrent conditions at 5 kA, will have an average lifetime of 200 discharges, presumably lasting longer than the average lifetime of the system it is installed in.

ABB also offers Class 2 SPDs with a rated discharge current I_n of 30 kA (with I_{max}=70 kA), with the benefit of doubling the average life and protecting zones with serious risk of lightning strikes (building located in mountainous region, lightning conductor at less than 50 m from the building to protect...)

2CTC438052S0201

Solutions for all uses
Protection from direct lightning strikes in electrical networks
Class 1 SPDs - OVR T1

Type 1 SPDs provide input protection for plants in areas with high levels of lightning strikes, and are typically installed in main distribution switchboards to protect against direct lightning strikes.

Benefits of the ABB OVR T1 range:

Wide range
OVR T1 SPDs are available in multi-pole versions to be used in all applications. There are also single-pole versions to be assembled for maximum flexibility.

High impulse current
The impulse current of 25 kA per pole (10/350 µs wave) satisfies all requirements for overvoltage surge protection.

Signaling contact
It is possible to monitor the operational status of the SPD remotely via a 1 A dry exchange contact.

Co-ordination
OVR T1 SPDs are co-ordinated at zero distance from OVR Class 2 SPDs; they can therefore be installed next to each other without decoupling coils, for combined protection against direct and indirect lightning strikes.

Electronic arc ignition device
The early creation of the electric arc by this electronic device reduces the protection level U_p to an optimum value, 2.5 kV.

Extinguishment of the follow-through current
OVR T1 SPDs contain a dedicated arc chamber for extinguishing the electric arcs following through from discharges. Thanks to this the SPD can open short-circuits up to 50 kA without the back-up fuse having to cut in.

Multi-pole versions with "1+1" and "3+1" schemes
Thanks to the "1+1" and "3+1" designs providing for a spark gap to earth, OVR T1 can be installed upstream of the RCD to protect against and prevent unwanted tripping. Combined-mode protection is provided, both common and differential.

Double terminals
OVR T1 allows an input and output cable to be connected for each pole, with a current up to 125 A. They allow connection distances to be reduced to a minimum and avoid bridges.

Combined Type 1 + Type 2 SPDs using spark gap and varistor technology
These are very compact SPDs which protect both against direct and indirect lightning strikes. They are dedicated to applications where space is very limited (telecoms).

Type 1 + 2 SPDs using varistor
These are dedicated to applications where low U_p is necessary.

2CTC438053S0201

Solutions for all uses
Protection from indirect lightning strikes in electrical networks
Class 2 SPDs - OVR T2

Type 2 SPDs are suitable for installation at the origin of the network, in intermediate panels and by the terminal equipment, protecting from indirect lightning strikes.

Benefits of the ABB OVR T2 range:

Wide range
OVR T2 SPDs are available in specific multi-pole versions for all distribution systems. There are also single-pole versions to be assembled in the field for maximum flexibility. With OVR T2 you can choose between three different rated discharge currents to ensure the maximum lifespan of the installation in all conditions and co-ordinate protection in extended installations.

Multi-pole versions with "1+1" and "3+1" schemes
Thanks to the "1+1" and "3+1" designs providing for a spark gap to earth, OVR T2 can be installed upstream of the RCD to protect against and prevent unwanted tripping. Combined-mode protection is provided, both common and differential.

Reduced protection level, for better protection
For all versions the maximum protection level U_p is 1.5 kV, a value suitable for the protection of all terminal equipment, even the most sensitive.

Back-up protection with fuse or MCB
Fuses or ABB circuit breakers may be chosen as back-up protection for all versions.

Co-ordination
The Class 2 SPDs are co-ordinated starting from a distance of one meter.

2CTC438054S0201

OVR surge protective devices – UL Version
Selection tables

Choosing the correct model

1) Determine the service voltage
Consult qualified personnel if the facility or operation service voltage is unknown.

2) Select the SPD maximum continuous operating voltage (MCOV, Uc)
The MCOV should correspond to the service voltage.
Example: If the service voltage is 480 V Delta, an SPD with 550 V or 660 V MCOV will be required.
Surge protection devices must also provide a level of protection compatible with the withstand voltage of the equipment. This withstand voltage depends on the type of equipment and its sensitivity. The incoming surge protector may not provide adequate protection by itself, as certain electrical phenomena may greatly increase its residual voltage if cable lengths exceed 10 m. A second SPD may be necessary.

3) Select the SPD surge capacity (Imax)
Surge capacity is the amount of energy the SPD can withstand from a single surge event. The higher the surge capacity, the longer the device will protect the system. A second surge protector may be required if the surge capacity of the first is not capable of diverting all surge current to ground. See coordination below.

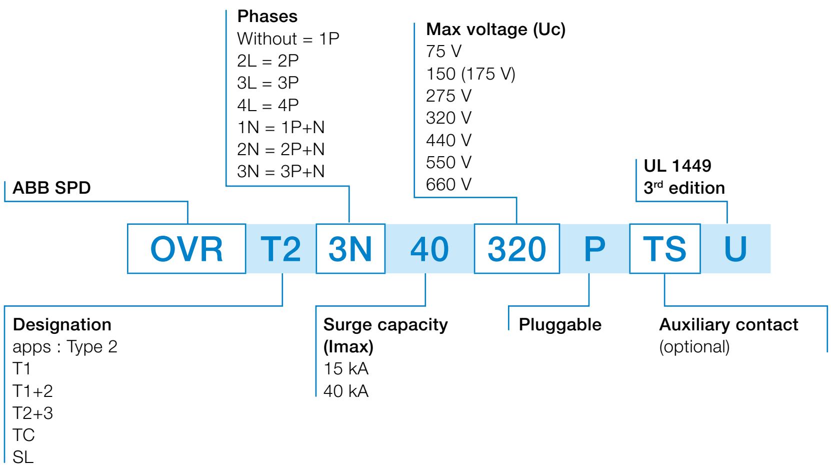
4) Remote monitoring (Optional)
Integrated auxiliary contact for remote monitoring available on models with "TS" designation.
Consult "Selection tables" on next page for help in the selection of SPDs.

Complete facility protection
Installing surge protection at the main distribution panel is only the beginning of protecting the entire operation. As most transient surges are created internally, it is necessary to install surge protection at sub-distribution panels (equipment protection) to be fully protected. Stepping down the Imax level from the service entrance panel toward equipment to be protected is recommended.
For example, if a 40 kA Imax SPD is installed in the main distribution panel, then 15 kA Imax SPDs should be installed in sub-distribution panels for equipment protection.

Coordination
It may be necessary to add a second surge protector, wired to the incoming unit, to achieve the required voltage protection and/or surge capacity. For Type 2 or 4 SPDs, installing this second unit a minimum of 1 m from the first unit will allow the two to work together, achieving the required protection.

Wiring rules
The impedance of the cables increases the voltage across the connected equipment. Therefore, the length of the cable between the surge protector and the equipment should be minimized.
The surge protective device should be installed as close to the equipment to be protected as possible. If this is not possible (the equipment is over 30 m from the panel), then a second surge protector must be installed.

OVR DIN rail SPD - Product type description



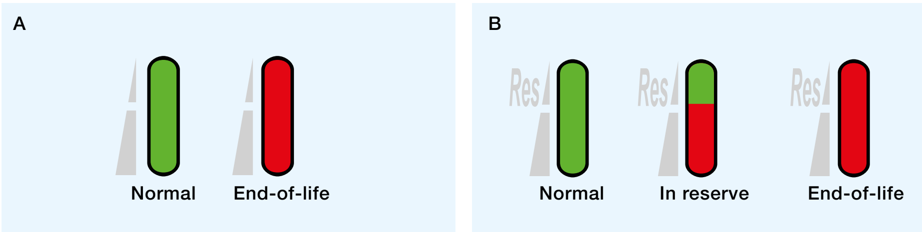
2CTC438023S0201

Solutions for all uses
Protection from indirect lightning strikes in electrical networks
Class 2 SPDs - OVR T2

End-of-life indicator on the SPD (present on all versions)
Indicates the status of the SPD via a mechanical indicator which changes colour from green to red when the device reaches the end of its life.

Safety reserve versions ("s" versions)
Thanks to the back-up function which allows it to continue operating with reduced current capacity, even when approaching the end of its life-cycle, the SPD gives advanced warning that it is approaching the end of its life, allowing its replacement to be planned ahead of time.

A - End-of-life indicator for a SPD without safety reserve
B - End-of-life indicator for a SPD equipped with safety reserve

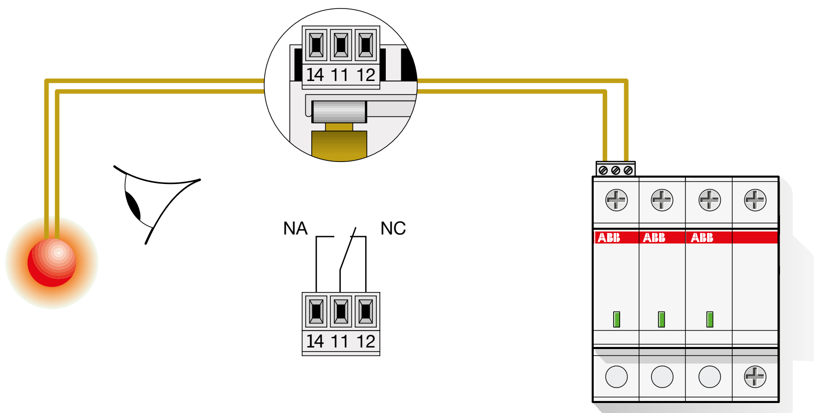


Pluggable cartridges, on "P" versions
ABB SPDs with pluggable cartridges facilitate maintenance operations. If one or more used cartridges need replacing, it is not necessary to disconnect the device. A cartridge at the end of its life can be replaced without having to change either the SPD or all the whole set of cartridges.

Note:
OVR pluggable cartridges contain a device which ensures an incorrect version cannot be inserted when replacing them: phase and neutral cartridges cannot be mixed up.

Signaling contact ("TS" versions)
Allows the operational status of the SPD to be monitored remotely via a 1 A dry auxiliary contact. The monitoring contact is integrated and does not require extra space on the DIN rail. This allows a connection to a Centralized Technical Management (CTM) system.

Technical specifications of the integrated auxiliary contact:
- Changeover contact: 1 NO, 1 NC
- Minimum load: 12 V DC - 10 mA
- Maximum load: 250 V AC - 1 A
- Maximum cable section: 1.5 mm²



2CTC438055S0201

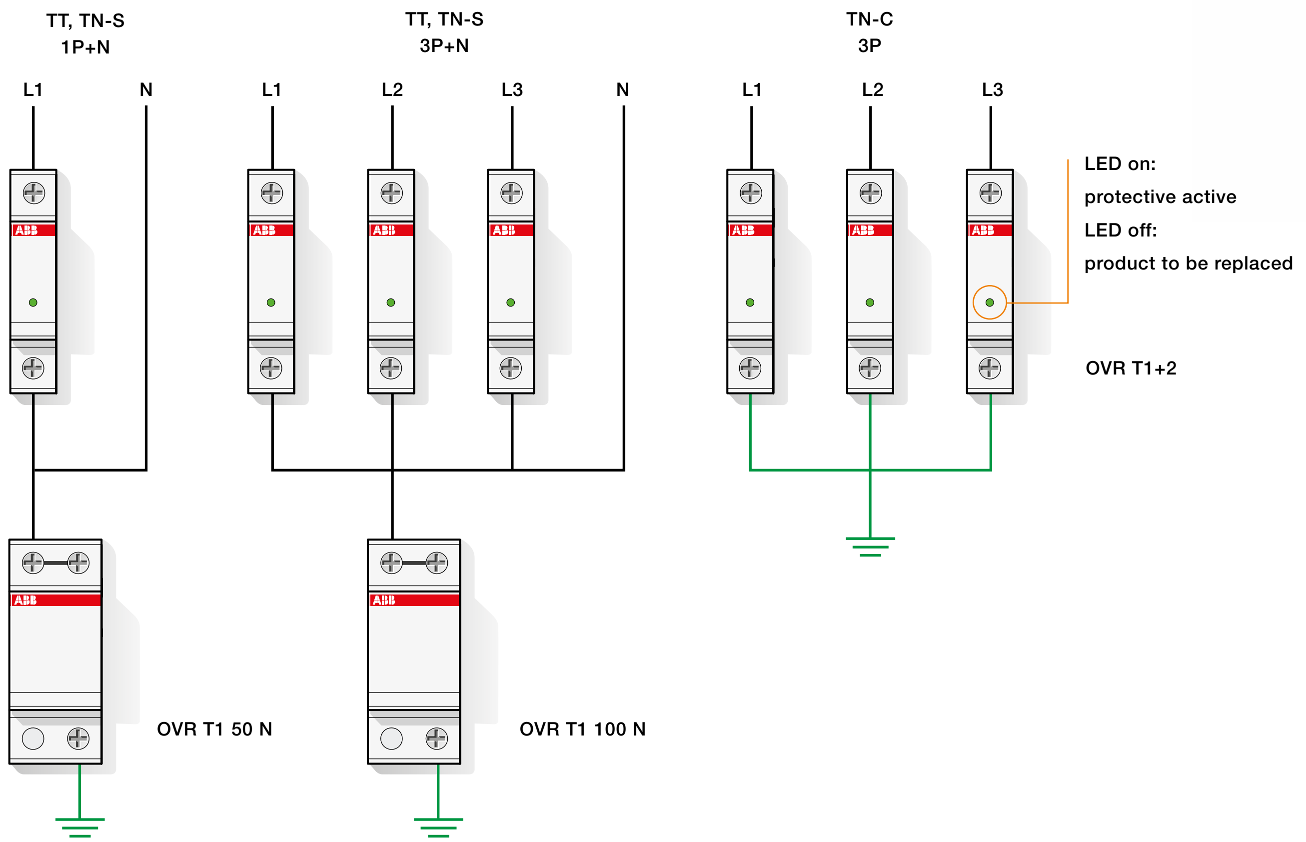
Solutions for all uses
Protection in smaller plants
OVR T1+2: when space is a determining factor

How does it work?
- OVR T1+2 is an integrated solution, equivalent to an automatically co-ordinated Type 1 and Type 2 SPD
- The single-pole module must be combined with the neutral module OVR T1 50 N for single-phase and OVR T1 100 N for three-phase

Where are they installed ?
- Ideal for all smaller plants to obtain simultaneous protection from the main switch to the terminal equipment
- In all distribution systems (TT, TN-C, TN-S)
- Upstream of the RCD, thanks to the spark gap to earth (1+1 or 3+1).

Benefits
- Ideal in all reduced-size plants
- Dual protection: currents from lightning strikes and induced voltage surges
- Optimum level of protection (1.5 kV), high impulse and discharge current per pole
- High operational continuity and low maintenance costs thanks to extinguishment of follow-through currents up to 7-15 kA depending on the version
- Tested in test Class 1 and test Class 2
- Status indicator on the front
- Integrated remote monitoring contact for OVR T1+2 25 255 TS
- Rapid maintenance thanks to the pluggable cartridge format for OVR T1+2 25 255 TS

Recommended connection schemes for OVR T1+2, for both versions:

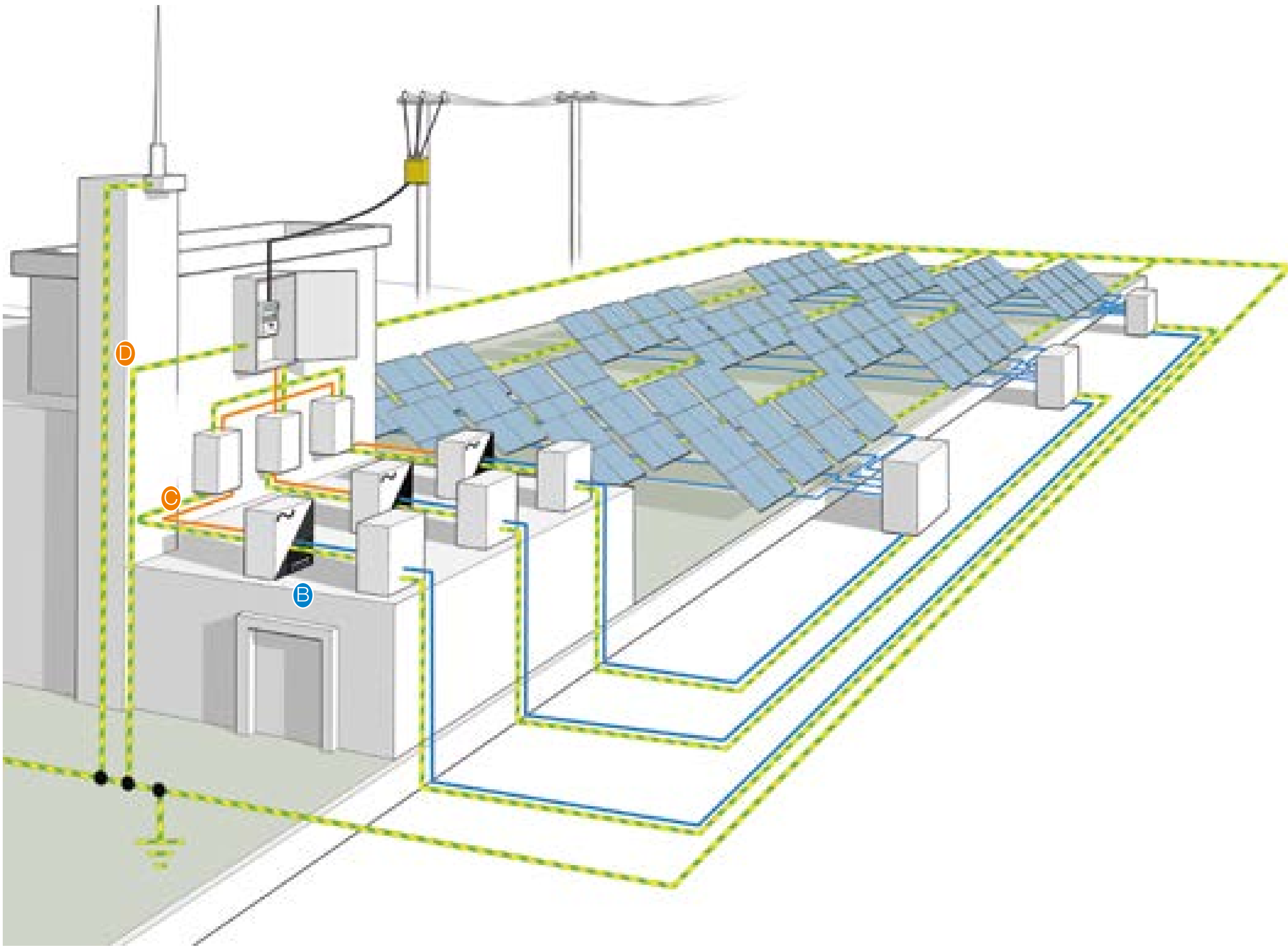


2CTC438056S0201

Solutions for all uses
Surge protection in photovoltaic installations
Production plant

Installed outside, almost always in wide-open areas, photovoltaic installations are particularly subject to atmospheric phenomena and can face damage from surges caused by lightning strikes. For this reason, and given the high value of the components and the high cost of any down time, it is always best practice to fit PV installations with suitable surge protection.

Production plant
- DC side: zones A, B
- AC side: zones C, D
In this example, the plant is composed of multiple strings in parallel and connected to three inverters. The inverters are in turn connected in parallel on the alternating current side.



Protection against direct lightning strikes is ensured by integration of a lightning conductor, connected on the alternating current side. This LPS is selected in order to have a protection area (radius of protection) that covers the switchboard as well as the PV panel, preventing them from damage from direct lightning strikes. A Type 1 SPD is installed in the main switchboard (D) for protection from direct lightning strikes.
Protection against indirect lightning strikes, on the direct current side, is ensured by using OVR PV SPDs for photovoltaic installations. OVR T2 SPDs are used on the alternative current side.

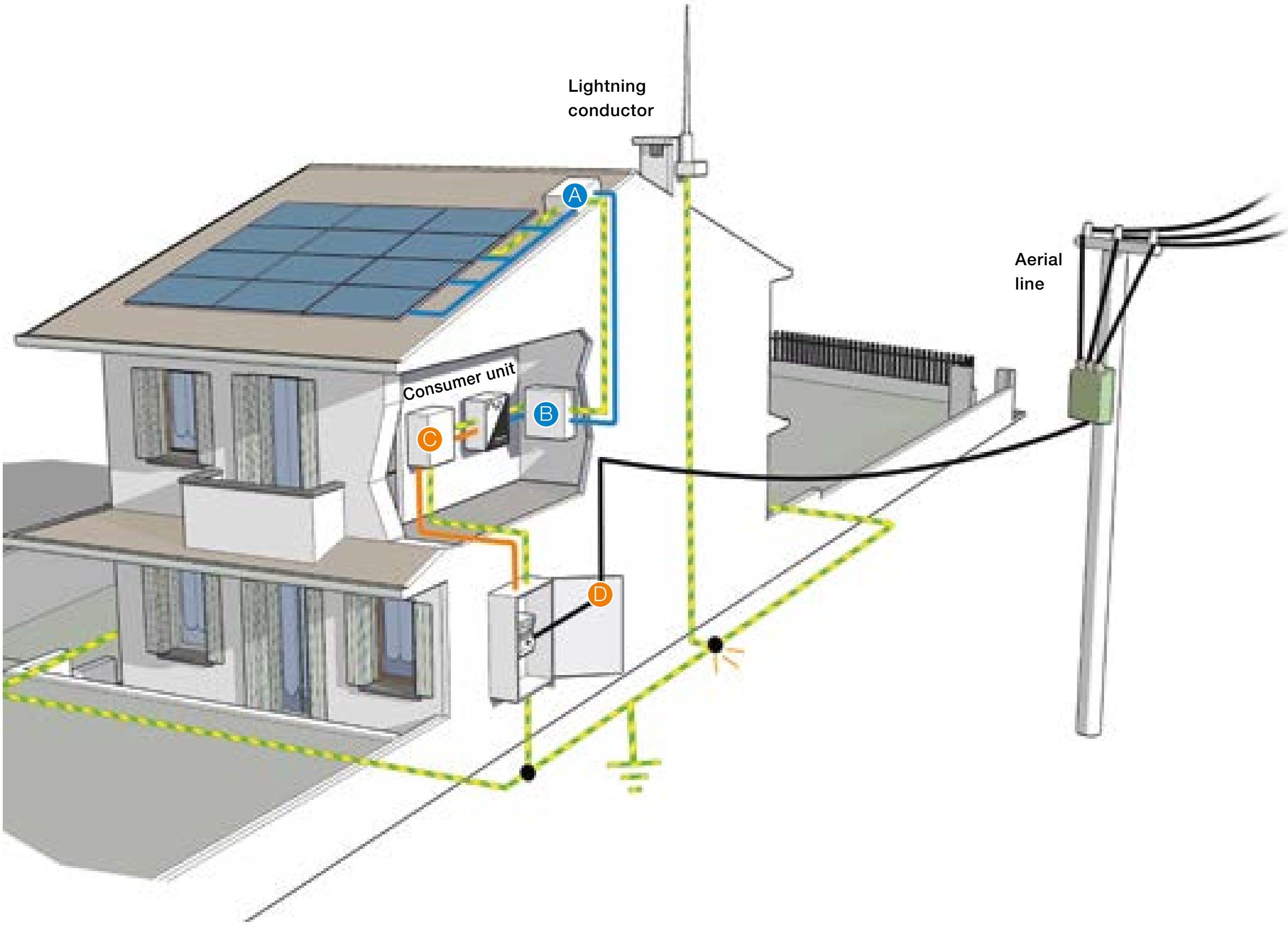
It is necessary to protect both the direct current and alternative current circuits from surges: lightning is not interested in what type of current is flowing in the cables!

2CTC438057S0201

Solutions for all uses
Protecting photovoltaic installations
Domestic plant

Domestic installation - On-site exchange
- DC side: zones A, B
- AC side: zones C, D

This example shows a small domestic plant in a suburban area with one string and a single inverter.
Panels with a combined output power of 1 kW are installed on the roof.



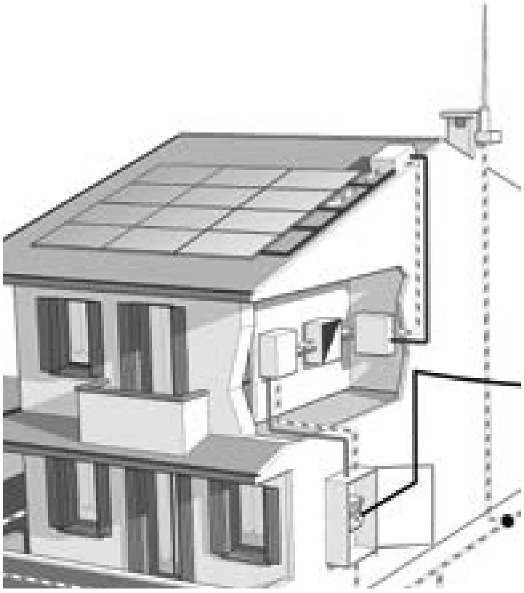
The house is subject both to the risk of lightning striking the building and the aerial LV line. For that reason, a Type 1 SPD has been installed in the main switchboard (D) on the AC side and an ESEAT on the roof.

Protection against direct lightning strikes is ensured both on the DC side by using an OVR PV SPD and on the AC side with an OVR T2 SPD.

In this case, too, it is necessary to protect both the direct current and alternating current circuits from surges: lightning is not interested in what type of current is flowing in the cables!

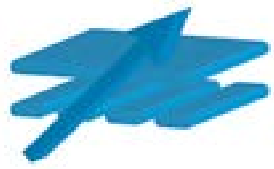
2CTC438058S0201

Solutions for all uses
Protecting photovoltaic installations
Surge protection is effective only when done globally. Protect the four zones.



Zone A
– Field or parallel switchboard
– Protection of panels and strings from surges of atmospheric origin
– Required if distance between A and B is greater than 10 m

Zone B
– Direct current side inverter
– Protection of the inverter from surges of atmospheric origin
– SPD always required



In the table and the drawings, the direct current parts are indicated in blue, while the alternating current parts are indicated in orange

Side	Zone	Description	Protection function	When to protect	Presence of external LPS or aerial supply	
Direct current 	A	Field or parallel switchboard	Protection of panels and strings from surges of atmospheric origin	Required if distance between A and B is greater than 10 m		
	B	Direct current side inverter	Protection of the inverter from surges of atmospheric origin	Always required		
Alternative current 	C	Alternative current side inverter	Protection of the inverter from surges of atmospheric and grid origin	Required if distance between C and D is greater than 10 m		
	D	Delivery point, alternative current-side plant origin	Protection of the electrical installation from surges of atmospheric and grid origin and from direct lightning strikes	Always required	No	
					Yes	

Zone C

- Alternating current side inverter
- Protection of the inverter from surges of atmospheric and grid origin
- Required if distance between C and D is greater than 10 m

Zone D – No lightning conductor

- Delivery point, alternative current side plant origin
- Protection of the electrical system from surges of atmospheric and grid origin
- SPD always required

Zone D – With lightning conductor

- Delivery point, alternating current side plant origin
- Protection of the electrical system from direct lightning strikes and from surges of atmospheric and grid origin
- SPD always required

SPD				Back-up protection			
Version	Remote contact	Type	Code	When to install it	Rating	Fuse or MCB disconnector	
						Type	Code
670 V	-	OVR PV T2 40-600 P QS	2CTB804153R2800	Required only if the prospective short-circuit current at the installation point of the SPD is greater than 300 A (for 600 V DC) and 10 kA (for 1000 V DC and 1500 V DC)	10 A gPV Note: for 670 V and 1100 V. Fuses for 1500 V being tested	E 92/32 PV S802PV-S10 or S804PV-S10	
	1 NO/NC	OVR PV T2 40-600 P TS QS	2CTB804153R2900				
	1 NO/NC	OVR PV T1 6.25-600 P TS	2CTB803953R5700				
1100 V	-	OVR PV T2 40-1000 P QS	2CTB804153R2400				
	1 NO/NC	OVR PV T2 40-1000 P TS QS	2CTB804153R2500				
	1 NO/NC	OVR PV T1 6.25-1000 P TS	2CTB803953R6700				
	-	OVR PV T2 40-1000 P QS	2CTB804153R2400				
1500 V	-	OVR PV T2 40-1500 P QS	2CTB804153R2600				
	1 NO/NC	OVR PV T2 40-1500 P TS QS	2CTB804153R2700				
670 V	-	OVR PV T2 40-600 P QS	2CTB804153R2800				
	1 NO/NC	OVR PV T2 40-600 P TS QS	2CTB804153R2900				
	1 NO/NC	OVR PV T1 6.25-600 P TS	2CTB803953R5700				
1100 V	-	OVR PV T2 40-1000 P QS	2CTB804153R2400				
	1 NO/NC	OVR PV T2 40-1000 P TS QS	2CTB804153R2500				
	1 NO/NC	OVR PV T1 6.25-1000 P TS	2CTB803953R6700				
1500 V	-	OVR PV T2 40-1500 P QS	2CTB804153R2600				
	1 NO/NC	OVR PV T2 40-1500 P TS QS	2CTB804153R2700				
3P+N	If required, see "TS" versions in the System pro *M* compact® catalog	OVR T2 3N 40-275s P QS	2CTB815704R2000	Always required	160A gG		
3P		OVR T2 3L 40-275s P QS	2CTB815704R1800				
1P+N		OVR T2 1N 40-275s P QS	2CTB815704R1400				
3P+N		OVR T2 3N 40-275s P QS	2CTB815704R2000				
3P		OVR T2 3L 40-275s P QS	2CTB815704R1800				
1P+N		OVR T2 1N 40-275s P QS	2CTB815704R1400				
3P+N		OVR T1-T2 3N 12.5-275s P QS	2CTB815710R1900				
3P		OVR T1-T2 3L 12.5-275s P QS	2CTB815710R1800				
1P+N		OVR T1-T2 1N 12.5-275s P QS	2CTB815710R1300				

Solutions for all uses
Protecting photovoltaic installations
Surge protection in PV installations
EN 50539-11 standard

Many indications regarding protection from surges due to direct lightning strikes have been taken from point 9.2.3 of the EN 50539-11 standard. "Guide to the development of photovoltaic power generation systems connected to networks of medium and low voltage".

The protection must be:
- specific
- complete
- safe
- permanent

The protection must be…	Principles of overvoltage surge protection [9.2.3]	ABB's response
Specific	The installation of a SPD protecting the panels and the sensitive electronic equipment (inverter) must be evaluated	OVR PV is the ABB range specifically designed to protect equipment in photovoltaic installations
Complete	SPDs must, in general, provide both differential (+/-) and common mode (+/PE, -/PE) protection	OVR PV is a multi-pole (L, L, PE) module ideal for providing both common and differential mode protection
Safe	The installation of suitable fuse protection upstream of the SPDs is recommended	OVR PV is self-protected up to a short-circuit current of 300 A for 600 V DC, and 10 kA for 1000 V DC and 1500 V DC and, for higher values, must be protected with suitable fuses
Permanent	Since the end-of-life of the SPD is difficult or impossible to detect, it is recommended to install a SPD with integrated remote signaling contact	The TS versions of OVR PV incorporate an end-of-life remote signaling contact The dimensions of the versions with and without contacts are the same.

2CTC438060S0201

OVR PV
Excellent performances with maximum safety. Always.

Born from the experience of ABB, the first company to launch them on a market which continues to choose them, OVR PV photovoltaic SPDs ensure absolute protection in photovoltaic installations. OVR PV SPDs are equipped with a patented thermal disconnector, with DC short circuit interruption performance, specially designed in order to prevent the risks of overheating and fires in photovoltaic installations up to 1500 V.
Thanks to this innovative technology, OVR PV SPDs are self-protected from end-of-life short circuits up to 10 kA DC without the necessity for back-up protection. This performance is ensured by conformity to the standard EN 50539-11.

2CTC438036S0201

Solutions for all uses
Protecting photovoltaic installations
End-of-life, safety begins. Why so many precautions?

Varistors and spark gaps are non-linear components:
at rated voltages they behave like an open circuit, while in the presence of a surges they close the circuit.
In the example below we will try to explain intuitively how a varistor SPD works with a concept borrowed from plumbing: the safety valve.

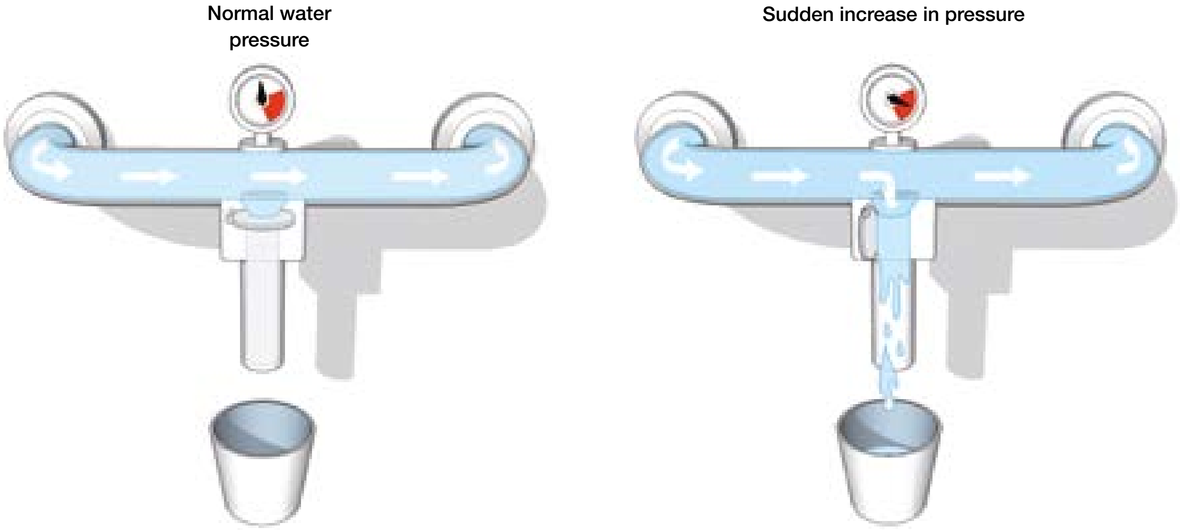
A safety relief valve

– The varistor behaves like a safety valve. When the pressure in the pipe (the voltage) is normal, the valve is closed

– When the pressure suddenly increases, this could cause the pipes (the electrical wires) or the equipment connected to them to break

– The safety relief valve uses the pressure in the pipe to open the safety bleed outlet, letting a little of the liquid (the discharge current) flow out

– When the pressure has returned to normal, the valve re-closes by itself



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Solutions for all uses
Protecting photovoltaic installations
End-of-life, safety begins. Let's discover what it is

After many sudden changes, even with normal pressure … The safety valve starts to leak!

Back to electricity…
- The varistor is no longer able to isolate the network
- Even under normal voltages it conducts a current, to earth or between two phases
- This current is ever as small as the lower the short-circuit current of the system is at the installation point: for PV it can be just a few amps
- In any case the varistor does not have zero resistance
- According to Joule's law: Loss in Watts = Resistance x Current ^{2} therefore…

$$\mathbf{R}\ \text{(large)} \times \mathbf{I}^2\ \text{(small)} \times \mathbf{T}\ \text{(minutes)} = \textbf{heat}!$$

The passage of this current through the varistor is problematic, provoking dangerous overheating!

2CTC438062S0201

Protecting photovoltaic installations
End-of-life, safety begins. Let's discover what it is

The heat generated by a varistor in end-of-life conditions can be sufficient to cause dangerous overheating of the SPD case and even cause the component to catch fire. To keep the system safe, each varistor is accompanied by a thermal disconnector and, if necessary, back-up protection is installed upstream.

The back-up fuse

- The SPD manufacturer must ensure adequate protection and prevent overheating of the varistor at the end of its life. If necessary, additional back-up protection must be provided: in general, fuses are used for PV
- If fitted, the fuse must be quite fast-acting in order to disconnect the varistor from the network at the end of its life before the heat generated has negative consequences
- Since the short-circuit currents are small in PV installations, the fuses must be able to cut in after a few seconds at low currents, so in general they will have a small rating compared to alternating current systems

This is why ABB has developed the specific OVR PV range, which does not require any back-up protection up to 300 A (for 600 V DC) and up to 10 kA (for 1000 and 1500 V DC) short-circuit current (self-protected) while for values above those just indicated it must be protected by a 10 A gR fuse (for 600 V DC and 1000 V DC, tests for 1500 V DC on going).

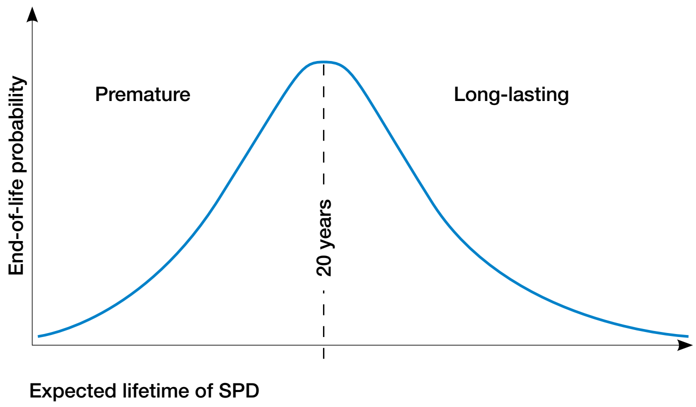
2CTC438062S0201

Solutions for all uses
Protecting installations
End-of-life safety... And when it occurs

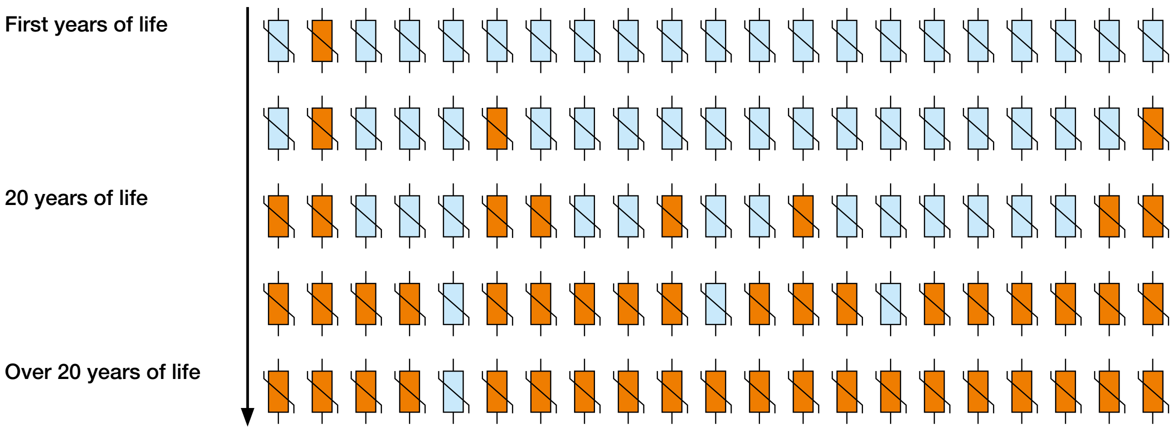
On average, a 40 kA Type 2 SPD has a lifespan of twenty years, but some may last thirty, and others only five! The data refer to the frequency of lightning strikes according to IEC 62305 standards, to SPD lifespan tests according to IEC 61643-11 and to basic statistics.

A statistical question

- The lifespan of a SPD depends on its resilience connected to its rated discharge current In, but also to the number of times lightning strikes near the system each year
- On average, a 40 kA SPD worldwide will reach the end of its life after twenty years
- Given the large number of SPDs installed, statistics tell us that a SPD reaching the end of its life is far from an improbable occurrence; some SPDs (premature) could reach the end of their lives in the first few years of the system's operation...



What happens to each of the SPDs I've installed over the years?



The replacement cartridges allow surge protection to be renewed when one of the SPDs reaches the end of its life-cycle.

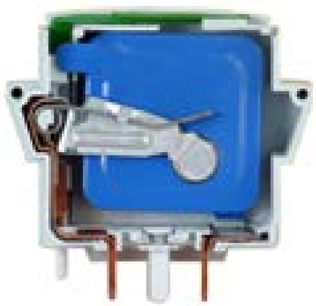
2CTC438007S0201

Solutions for all uses
QuickSafe® technology

In case of an end of life of an MOV in normal conditions, the current passing through the MOV increases progressively creating a quick temperature increase. This phenomenon will slowly damage the MOV itself until it gets into short-circuit. This phenomenon is called a thermal runaway.

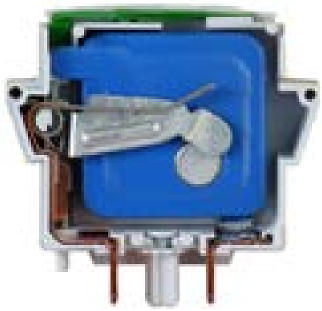
In order to avoid such thermal runaway we have added a thermal disconnection that will detect this temperature increase and will open the circuit.
This disconnection QuickSafe® is directly welded into the surface of the MOV to allow a very fast detection of the raise of temperature, it will react opening the circuit when the temperature achieve the levels considered hazardous for the installation. This disconnection is guaranteed by a metallic arm linked to a spring guaranteeing a quick disconnection.

This is a phenomenon that happens only after thousands of surge protection interventions in average. Most of SPDs get changed during the installation updates before this ever happens. This is the ultimate protection at the very end of life of the SPD.



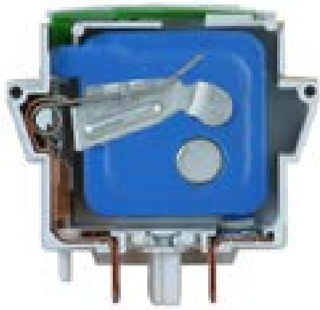
1

Here the disconnection system in Close position. During the test simulating and end of life of the SPD, the SPD has to bear a high voltage that forces a current passing through it. In this example, the passing current is 10 A.



2

Few seconds later, the MOV achieves a temperature that is high enough to melt the special metallic alloy that guarantees the contact and the mechanical position of the metallic arm. This releases the metallic arm pushed far away by the junction spring.



3

The tension in the spring is enough to quickly push up the arm and guarantee the insulation of the MOV. The speed of this movement is a key feature to interrupt the electric arc that will appear between the MOV core and the metallic arm. This movement combined with the characteristics of the MOV will guarantee the complete extinction of the arc.

4

At the end of this movement, the metallic arm will stop without any bouncing. There is no risk of a new electric arc development. At this moment, the MOV has not suffered any thermal runaway, so it is not in short-circuit. The distance between between the MOV electrode and the metallic arm guarantees an insulation voltage of over 6000 V, avoiding any risks for the installation.

2CTC438164S0201

Solutions for all uses
Protecting photovoltaic installations
Expert's corner: What criteria are used to choose the SPDs for PV installations?

Are there international standards?
Since 2010, only the French UTE C 61740-51 was the reference to certify safety in SPDs for PV applications. In 2014 an European regulation shall come out with the EN 50539-11. In agreement with the UTE C, it does introduce the idea of testing the behavior of the SPD in end of life for the safety of the equipment.

If the SPD is rated for alternating current performance, is it ok to use?
Since in theory, but only in theory a SPD can support a peak voltage of $\sqrt{2}$ x V AC, we might be tempted to use a product designed and certified for AC systems in a PV environment for example adapting a 440 V AC SPD for a 600 V DC installation.

This calculation does not take into account the SPD's end of life, a particularly critical case since the SPD must extinguish a DC arc, which is much more difficult compared to an AC arc.
ABB's OVR PV SPDs are specifically designed for direct current and their performance is specified on the product documentation as well as being clearly printed on the product.
On the previous page you can find further information about DC electric arcs and the patented ABB solution to make PV systems safer than ever.

Is it enough for the SPD to be fitted with an integrated thermal disconnector?
The thermal disconnector is a component required by law in all varistor SPDs; it is necessary in any case to be sure that the disconnector has been designed and tested to interrupt a DC short circuit.
The disconnector is the component which ensures SPDs at the end of their lives do not cause fires. ABB knows this very well and so designed a specific one for the OVR PV range.

How can I be sure that the back-up protection is correct?
The IEC guide states that SPD back-up must be co-ordinated. The co-ordination is ensured by special tests carried out by the manufacturer and must be consistent with the maximum short-circuit current of the system, almost always very low.

The tests performed by ABB on the OVR PV range in our laboratory ensure that back-up protection is not required up to 300 A (for 600 V DC) and 10 kA (for 1000 V DC and 1500 V DC) above this value, a 10 A gR fuse must be installed to ensure end-of-life protection (for 600 and 1000 V DC, tests for 1500 V DC on going).

What guarantees does ABB give on the safety of its SPDs for PV systems?
Today, the EN 50539-11 guide is the only protocol in the world to supply clear and unambiguous indications on the tests to be performed to ensure that a SPD is safe for PV applications. EN 50539-11 conformity is today an additional guarantee of the quality and safety of OVR PV.

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Solutions for all uses
Protecting photovoltaic installations
Designed for PV. Designed to always be effective.
The benefits of OVR PV

ABB's OVR PV SPDs are 100 % safe and compatible with all types of PV installations.

The OVR PV SPDs are fitted with a patented thermal disconnector which ensures a safe end-of-life for the SPD in points of the plant with short-circuit current up to 300 A DC (for 600 V DC) and 10 kA (for 1000 V DC and 1500 V DC). Where the short-circuit current is less than 300 A DC (for 600 V DC) and 10 kA (for 1000 V DC and 1500 V DC), OVR PV can be installed without any back-up protection, while if it's above this value then it must be protected with a 300 A (for 600 V DC) and 10 kA (for 1000 V DC and 1500 V DC).

Experience
- The OVR PV range has been designed and tested by ABB specifically for PV applications.

Practicality
- All OVR PV models are multi-pole and have terminals for the two poles and PE
- The wiring system is fast and foolproof, since bars or other accessories are not required.


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Solutions for all uses
Protecting photovoltaic installations
Designed for PV. Designed to always be effective.
The benefits of OVR PV

A spark gap normally behaves like an open circuit, and conducts only when discharging. The nature of the spark gap therefore prevents permanent flow of current to earth.

Insulation

– The spark gap to earth on the OVR PV 40 600 P stops current flowing to the PE
– The number of SPDs which can be installed is unlimited, even when insulation controls are present.

Maximum protection

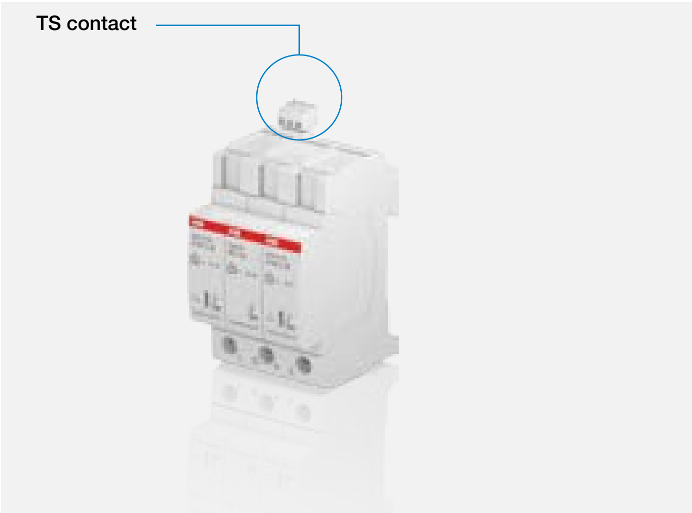
– The OVR PV has an extremely low level of protection: 1.4-2.8 kV for the 600 V version and 3.8 kV for the 1000 V version and 4.5 kV for the 1500 V version.

Pluggable cartridges

– The SPD socket on Base can always be reused
– If a single cartridge reaches the end of its life, it is not necessary to replace the entire product
– Replacements can be made without cutting the power to the switchboard.

Integrated contact

– Available on all versions
– Does not take up extra modules
– Signals the SPD end of life to the remote supervision systems.



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Solutions for all uses
Protecting photovoltaic installations
OVR PV SPDs for PV installations.
Main characteristics

Features

– SPDs designed and manufactured by ABB specifically for the protection of photovoltaic installations
– Self-protected from end-of-life short circuit up to 10 kA for 1000 and 1500 V DC thanks to integrated thermal protection with direct current breaking capacity
– Multi-pole 2P+E (L/L/PE) configuration on all models
– Pluggable cartridges
– Versions with and without end-of-life indication contact

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Solutions for all uses
Protecting photovoltaic installations
Technical information

Problems faced in photovoltaic installations

Due to the presence of unclean water on the electric components used in enclosures dedicated to photovoltaic applications, based on field experience, one can observe few defaults like insulation loss (between +&-) and flashing over electric conductors of opposite polarities. Nevertheless these phenomena remain exceptional.
This phenomenon is primarily related to the couple "water/ direct current voltage".
This following document proposes to give a technical explanation of this phenomenon and to recommend solutions in order to decrease this risk.

Reminder

The photovoltaic installations comprise mainly photovoltaic panels, one or several converters, and one or more connection boxes or electrical power enclosures. Except panels components of the photovoltaic installations are located either inside, or outside buildings. One often meets boxes or enclosures outside or under shelter. In case the boxes and enclosures are located inside the buildings, the buildings are often not heated.
The photovoltaic installations work with continuous voltages up to 1500 V (which is six times the voltage value used in usual electrical supply networks). When the sun is not shining, no current flows in the installations. The current can take the value from few mA to short-circuit current which is around the same level as the maximum nominal current in full sunshine.

Where does the water come from?

The boxes and enclosures containing electric materials can be subjected to particular conditions related to the environment of the photovoltaic equipment (this report is to be expanded for all electrical boxes being subjected to the same environmental conditions). Indeed the equipments installed outdoor or when connected by cables coming from outside, can be subjected to water penetration and/or water streaming inside these equipments. Use of enclosures or boxes which are not dedicated to outdoor use, use of doors or openings poorly closed, untight cables pass etc. so many configurations which are possible reasons to find water around uninsulated live parts.
In addition, the material can be subjected to significant short time temperature variations. Between days and nights, the temperature inside the boxes can approximately undergo temperature variations up to +70°C. This variation involves temperature differences between air and solid parts like cables for example. This creates condensation risks on the cold parts when the favourable hygrometrical conditions are present (the temperature of the solid parts is equal or lower than the temperature of dew point: see appendix 1). One amplifying factor to consider in the specific case of PV installations is the absence of current (or when in the morning, the level of current is very low). This does not allow the cables and other equipments to self maintain at a "warm" temperature (i.e. an SPD does not consume energy).

Which electric property for this water?

Water coming from condensation is pure when the phenomenon of condensation is carried out under extreme conditions of cleanliness (in a laboratory with dedicated condensers). The natural phenomenon of condensation cannot get pure water especially in an industrial electrical environment. The "natural" pollution of the air as well as the obvious surfaces pollution of solid parts contributes to the water pollution decreasing its electrical conductivity. It is obvious that saline environment amplifies this phenomenon.
Thus the simple contact of water with solid parts makes the water conductive. Water presence due to streaming on the electric components is also conducting.

Effect of both water and direct current in electric enclosure

Impure water on metal materials in the presence of oxygen implies irremediably a corrosion phenomenon. This natural corrosion phenomenon is able to modify the mechanical characteristics of the parts and can involve some mechanical malfunctions. The presence of direct current, in conjunction of moisture and metallic parts also creates another phenomenon called electro-erosion or electrolysis. Electrolysis between conducting parts is as more active as the current is high. Thus electrolysis is more or less fast according to the degree of impurity of water in "contact" with both polarities of the source as well as the voltage value applied. This phenomenon is not existing or is very rare in case of alternative voltage like usual networks having a sinusoidal voltage 230/400 V for example.
These phenomena were reproduced in laboratory after salty water spraying (Salt concentration 1%). It is to note that the photovoltaic currents are statistically weak when presence of water by condensation is occurring for example. That supports the slow and random degradation process of the equipments.

Aggravating effects that could be related to specific PV configuration

High voltage and weak current.
Polluted industrial environment.
Installation subjected to extreme climatic conditions.

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Solutions for all uses
Protecting photovoltaic installations
Technical information

Recommandation in case

The phenomena described previously are neither taken into account in electrical products Standards nor in electrical installation Standards. It is advisable to implement the best engineering practices. To avoid the presence and the stagnation of water coming from condensation or water streaming on the electric components it is necessary to design the installation according to the rule book, that is to say:

– Mandatory
  - to use boxes or enclosures for outdoor use if needed (IP65 minimum)
  - not to use completely tight boxes or enclosures (Box sealed for water is not sealed for moisture)
  - to protect against rain and spray the boxes and the enclosures
  - to follow the best practices of wiring (see appendix 2).
    . not to cable through top of the boxes or top of the enclosure
    . to make "drop traps" with cables
    . to cable the equipment bottom up to avoid any water stagnation (when possible and if absence of water cannot be sure
  - to expressly be more vigilant for sites located in high pollution areas or near to the sea.

– Depending on situation
  - to use natural ventilation technical
  - to use devices avoiding condensation like:
    . mechanical ventilation devices
    . thermoregulation devices, i.e. heating resistances
    . air-conditioning devices
    . air dryers (i.e. passive dehydrator bags or mechanical air dryers).
  - to cable the equipment bottom up to avoid any water stagnation (when possible and if absence of water cannot be sure (see appendix 2)
  - to clean or to evacuate water regularly (automatically or manually).

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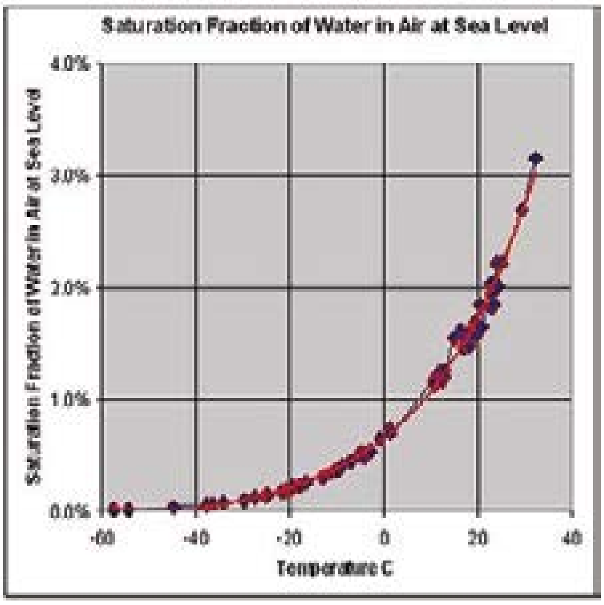
Appendix 1 - Dew point

The dew point is the temperature to which a given parcel of humid air must be cooled, at constant barometric pressure, for water vapor to condense into liquid water. The condensed water is called dew when it forms on a solid surface. The dew point is a saturation temperature.

The dew point is associated with relative humidity. A high relative humidity indicates that the dew point is closer to the current air temperature. Relative humidity of 100% indicates the dew point is equal to the current temperature and the air is maximally saturated with water. When the dew point remains constant and temperature increases, relative humidity decreases.

The dew point is an important statistic for general aviation pilots, as it is used to calculate the likelihood of carburetor icing and fog, and to estimate the height of the cloud base.



This graph shows the maximum percentage (by mass) of water vapor that can exist in air at sea level across a range of temperatures. The behavior of water vapor does not depend on the presence of other gases in air. The formation of dew would occur at the dew point even if the only gas present were water vapor.

At a given temperature but independent of barometric pressure, the dew point is a consequence of the absolute humidity, the mass of water per unit volume of air. If both the temperature and pressure rise, however, the dew point will rise and the relative humidity will lower accordingly. Reducing the absolute humidity without changing other variables will bring the dew point back down to its initial value. In the same way, increasing the absolute humidity after a temperature drop brings the dew point back down to its initial level. If the temperature rises in conditions of constant pressure, then the dew point will remain constant but the relative humidity will drop.

For this reason, the same relative humidity on a day when it's 80°F, and on a day when it's 100°F will imply that a higher fraction of the air on the hotter day consists of water vapor than on the cooler day, i.e., the dew point is higher.

At a given barometric pressure but independent of temperature, the dew point indicates the mole fraction of water vapor in the air, or, put differently, determines the specific humidity of the air. If the pressure rises without changing this mole fraction, the dew point will rise accordingly; Reducing the mole fraction, i.e., making the air less humid, would bring the dew point back down to its initial value. In the same way, increasing the mole fraction after a pressure drop brings the relative humidity back up to its initial level. Considering New York (33 ft elevation) and Denver (5,130 ft elevation), for example, this means that if the dew point and temperature in both cities are the same, then the mass of water vapor per cubic meter of air will be the same, but the mole fraction of water vapor in the air will be greater in Denver.

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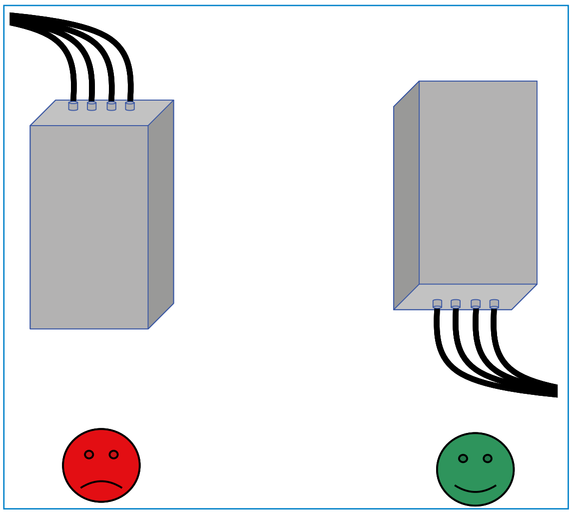
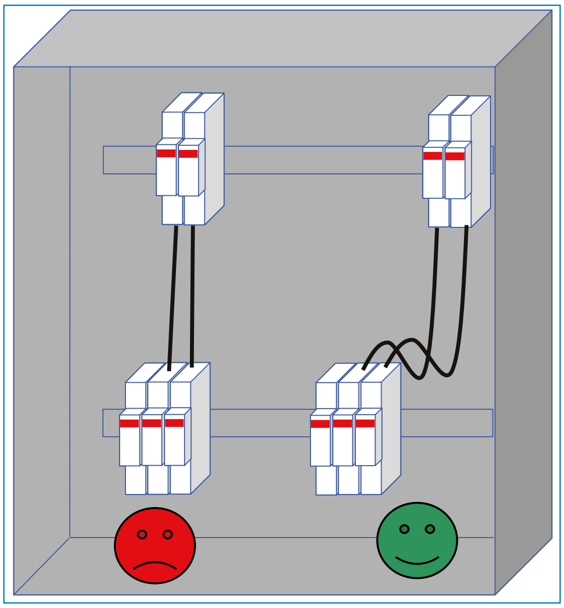
Appendix 2 - Cabling rule book

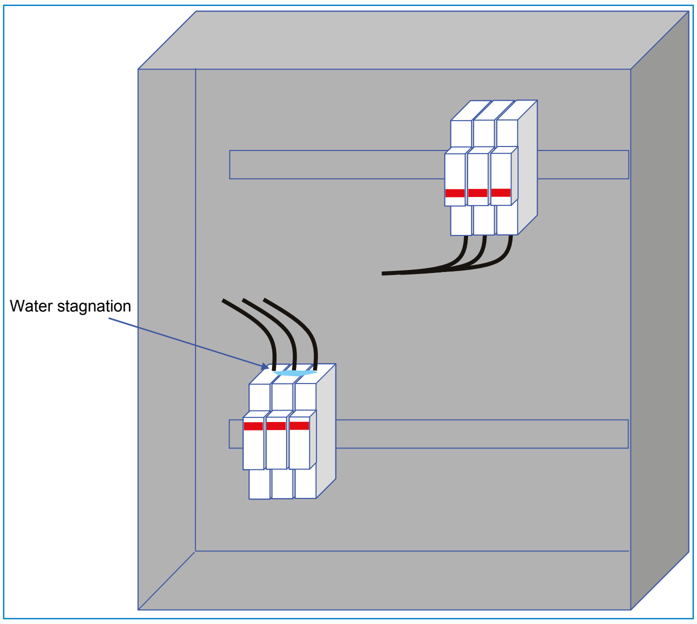
Bottom cabling of enclosure



Water trap



Upside down mounting to avoid water stagnation



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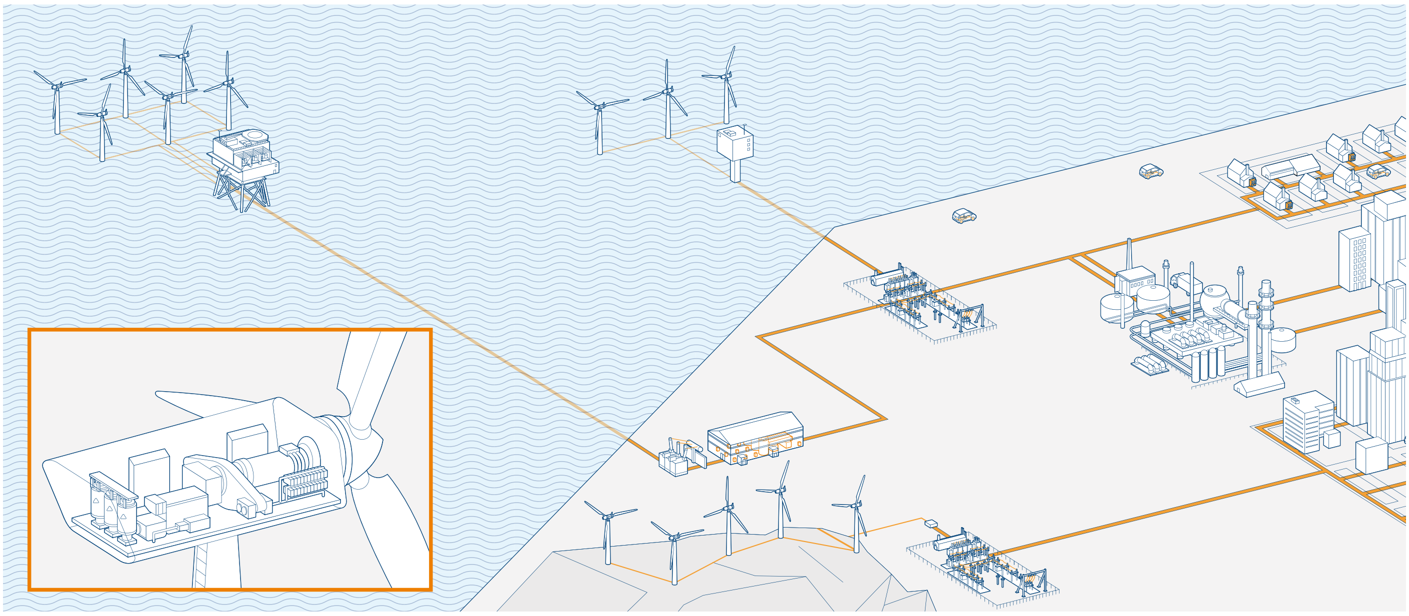
Solutions for all uses
Protection wind turbines

Based on the experience we have gained over the last decades, ABB provides state-of-the-art low-voltage surge protection devices (SPDs), medium and high-voltage surge arresters (SAs) and earthing and lightning protection (ELP) materials to protect against the impact of direct lightning and transient overvoltages caused by the secondary effects of lightning. Thanks to this wide product-range, ABB offers complete solutions for protection of wind-power installations.



Earthing, lightning and overvoltage protection

With its wide product range, ABB can offer:

- Surge arresters for medium voltage (MV) networks such as the POLIM family and the MWK / MWD range
- Surge protection devices (SPDs) for low voltage (LV) systems with the OVR modular range, the Lovos-W and POLIM-R surge arresters
- Earthing components, designed to withstand mechanical damage and the thermal electromechanical stresses from the earth fault and leakage currents expected within an installation.

Wind power

Wind turbines provide electrical power from a renewable energy source to the public power networks. Because of their height (over 100 meters) and exposed location wind turbines are prone to direct lightning flashes entering through the blades, the nacelle or the lines.

Transient overvoltages due to the lightning current can cause severe damage to the wind turbine installation and to the equipment. They can also create expensive downtime that can be avoided by installing a complete lightning protection system (LPS).

This LPS should include both external and internal lightning and overvoltage protection and should be designed, installed in compliance with IEC 62305, protection against lightning and with the IEC 61400-24 for wind turbines.

The risks associated with lightning can be assessed in a global risk analysis, according to IEC 62305-2 and IEC 61400-24. The risk analysis will define a lightning protection level (LPL), and will propose the right protection measures to be applied.

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Solutions for all uses
Protection wind turbines

Products for MV (medium voltage) and LV (low voltage) applications

MWK / MWD and POLIM-C
MV surge arresters with a particular high mechanical and electrical strength. Suitable for protecting medium voltage AC networks against both, lightning and switching overvoltages, as well as Very Fast Transients (VFT). Designed for the protection of transformers, cables, wind generators. For indoor and outdoor application.

POLIM-R
LV surge arresters with very high electrical energy handling capability. Suitable for application in AC and DC systems against both, lightning and switching overvoltages as well as Very Fast Transients (VFT). Designed for the protection of converters. For indoor installation only.

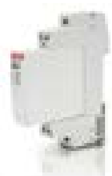
Lovos-W
A new generation of LV surge arresters developed in cooperation with customers world wide. They ensure the surge protection of wind turbines from the direct effect of lightning and transient overvoltages. The Lovos-W is having a dry contact designed for wind turbines. This remote indication is to identify the status of the surge arrester and its location in the installation.

OVR WT SPDs
A dedicated surge protection device is needed to protect wind turbines generators and converters.
The OVR WT SPDs can withstand the high pulse with modulation (PWM) peak transient overvoltages generated by the converters for a long and safe surge protection (Urp characteristics).

OVR Type 1 SPDs
Wind turbines exposed to lightning surges shall be protected with Type 1 and Type 1+2 surge protection devices (SPDs). With a high impulse current discharge capacity (limp), they are located at the service entrance of the LV side of the wind installation to avoid the destruction of the equipment.

OVR Type 2 SPDs
Most of the equipment sustain repetitive transient surges. Generated by indirect lightning strikes or by industrial environment, these transient overvoltages deteriorate and drastically reduce the lifespan of sensitive and costly equipment used in the turbines electrical network.

OVR Plus autoprotected
All surge protection devices shall be installed with a dedicated backup disconnector in case of end of life of the device. The OVR Plus Type 2 range with its integrated MCB disconnector increase safety to the equipment of the LV side of the turbines.



OVR TC dataline protection
To prevent data losses and to bring a complete surge protection of data, signals and telecom lines, dataline surge protection devices should be installed. The OVR TC brings an easyway to protect those lines with RJ11 and RJ45 base elements.

Furse Earthing
A lightning protection system (LPS) forms part of a wind turbine installation. The earthing and the good interconnection of the LPS to the earthing system is a must to safely dissipate the lightning current.

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Solutions for all uses
Protection wind turbines

Dedicated surge and lightning protection devices for a specific application

Different types of drive train

In wind turbines configuration, two main types of drive train are usually used: variable speed Doubly-fed or full converter version.

Doubly-fed drive train

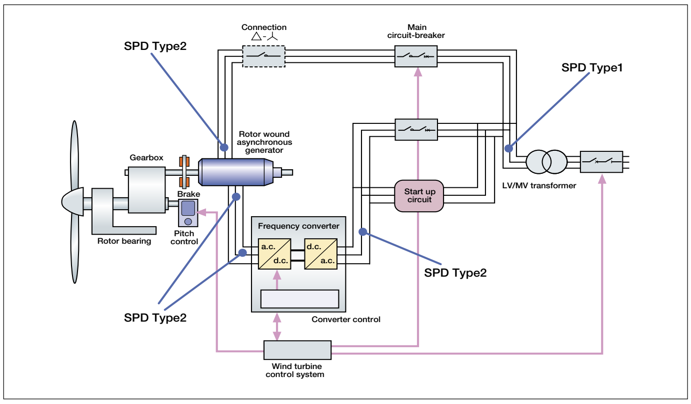

Figure 1

In a variable speed doubly-fed configuration, according to the diagram of Figure 1, it is advisable to place an SPD Type I into the main switchboard at the entrance of the turbine for the protection against transient overvoltages of atmospheric origin and against the surge current from the grid. If the SPD Type I does not have an effective protection level (Up) lower than the maximum withstand voltage (Uw) of the equipment to be protected or the distance from the equipment to be protected is longer than 10 m, it is recommended to install an SPD Type II near the generator for the additional protection of the stator windings and another one near the converter on the grid side for a better protection.
It is also recommended to install, between the converter and the rotor windings, SPDs Type II suitable for protection in the presence of transient overvoltages superimposed on the PWM (pulse with modulation) control voltage (Figure 3).

Full converter drive train

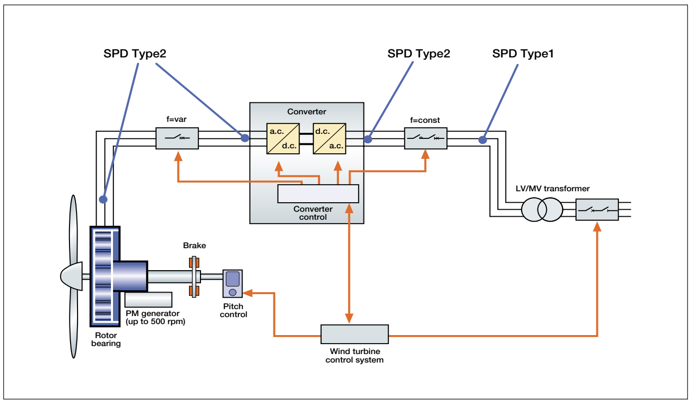

Figure 2

In this configuration, according to the diagram Figure 2, it is recommended to place an SPD Type I into the main switchboard at the entrance of the turbine for the protection against transient overvoltages of atmospheric origin and against the surge current from the network. If the SPD Type I does not have an effective protection level (Up) lower than the maximum withstand voltage of the devices to be protected (Uw) or the distance from the devices to be protected is longer than 10m, it is recommended to install an SPD Type II near the converter on the grid side for a better protection.
It is also recommended to install between the converter and the synchronous generator, SPDs Type II suitable for protection in the presence of transient overvoltages superimposed on the PWM (pulse with modulation) control voltage (Figure 3).

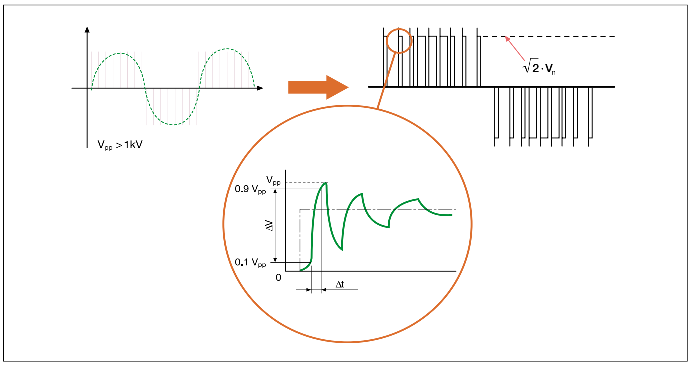

Figure 3

Pulse with modulation (PWM)

Actual variable-speed wind turbines are equipped with PWM (Pulse With Modulation) controlled inverters using IGBT or IGCT in order to regulate their output voltage and frequency. These technologies, if not filtered properly, generate peak transient overvoltages surperimposed on the PWM control voltage. These peaks, of several kV, will be seen by a standard SPDs as transient overvoltages due to lightning, creating unwanted triggering of the surge arresters with a high frequency and therefore reducing considerably their life time. That's why it is necessary to use SPDs with a specific withstand to these PWM, the peak repetitive voltage withstand characteristics (Urp).

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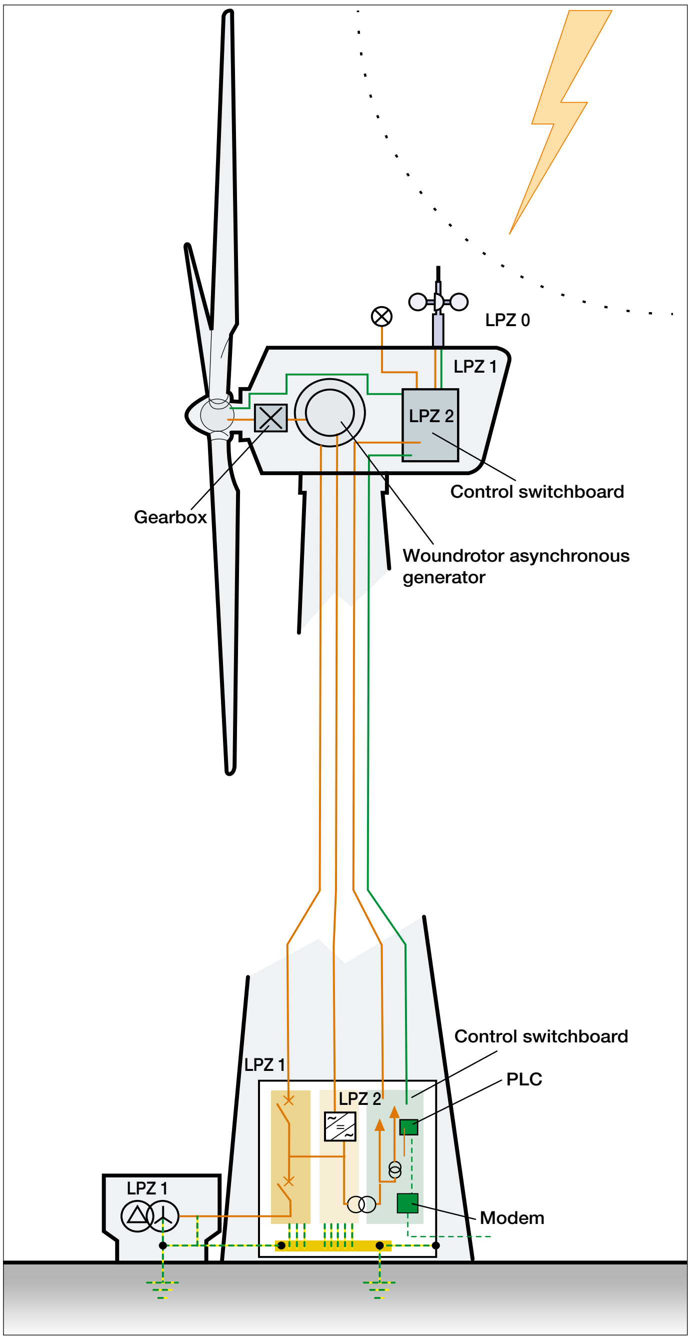
Solutions for all uses
Protection wind turbines

Lightning protection zones concept (LPZs)
The IEC standard introduced the concept of lightning protection zones (LPZs) to help in selecting the correct surge protection to the right location (IEC 62305-4). This concept ensure the gradual reduction by stages of the energies and surge current caused by direct lightning or transient overvoltages caused by lightning. This logic of coordination in the protection is what we call the “stepping protection”.
It consists in dividing a structure in several volumes: the protection zones. The objective is to ensure that the LPZ gives enough protection to the equipment inside a define zone, which means that the protection level (Up) of the installed SPD is in relation with the maximum voltage withstand (Uw) of the equipment. To do so, SPDs are installed at the protection zone boundaries. Each time an SPD is installed, a new protection zone is created.

Furse earthing
An effective earthing system is a fundamental requirement of any structure or system for operational and/or safety reasons. Without such a system, the safety of a structure and the equipment contained within it are compromised.

Earth Termination
The earth termination network connects the LPS down conductor network to the base of the structure and provides the means through which lightning current is dissipated to the general mass of earth.
Earthing components must have both a low resistance to earth and have excellent corrosion resistance, as they will be buried in the ground for many years.
The range of Furse earthing products including earth rods, conductors, clamps and inspection pits, are all designed and manufactured in line with the IEC and BS EN standards, to ensure they meet the demands of earth termination systems.
Additionally many earthing system conductors and steel rebar are connected by the use of exothermic welded joints creating a connection of virtually pure copper, with a greater cross sectional area of the conductors being welded and therefore high quality, corrosive resistant joints.



Doubly-fed drive train turbine example

External zones	
LPZ 0	Exposed area to lightning flash and which can be subjected to full or partial lightning current. This zone is divided in two: LPZ0A and LPZ0B
LPZ 0_A	Unprotected zone outside the building where items are subjected to direct lightning flash and therefore may have to handle to the full lightning current and lightning electromagnetic field.
LPZ 0_B	Zone protected against direct lightning flash by external air terminal and where the threat is the full lightning electromagnetic field.

Internal zones (zones inside the building which are protected against direct lightning flashes)	
LPZ 1	Zone subject to partial lightning or surge currents. Type I SPDs shall be installed at the boundary between LPZ OA and LPZ 1 to block the entrance of lightning currents through power lines (i.e. main distribution board of an installation).
LPZ 2...n	Zone where the surge current is limited by current sharing and where the surge energy is reduced by additional surge protection like SPDs. Type 2 SPDs are installed at the boundaries of each zone, i.e. LPZ 1 and LPZ 2, LPZ 2 and LPZ 3, etc..., to divert the remaining surge currents and limit overvoltage (i.e. sub-distribution boards of an installation).

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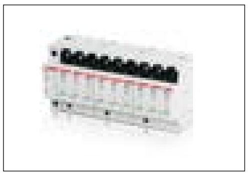
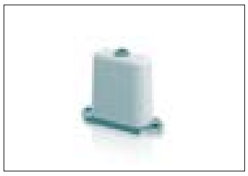
Solutions for all uses
Protection wind turbines

Lightning and overvoltage protection of full converter drive train turbine

Example on a full converter drive train turbine with power converter installed at the tower base and the LV/MV transformer outside the turbine



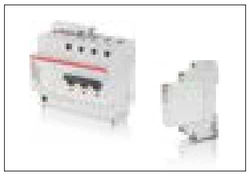
1 2 SPD OVR WT for generator protection in nacelle and converter on the generator side in the tower base



2 Polim-R surge arresters for converter protection on the grid side in the tower base

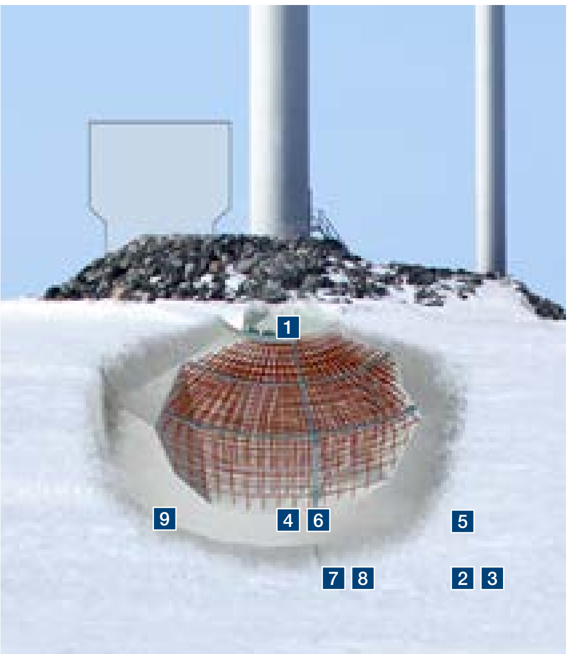
3 Lovos-W for protection of the LV side of the transformer

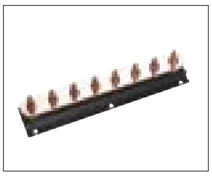
3 MWD surge arresters for protection of the MV side of the transformer and grid lines



4 5 6 7 SPD Type 2 & dataline for protection of pitch, yaw and control systems

Earthing of wind turbines





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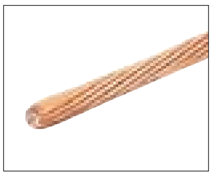

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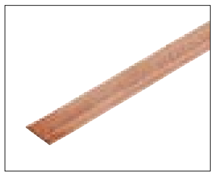
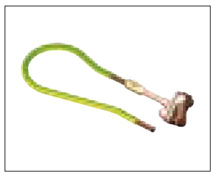


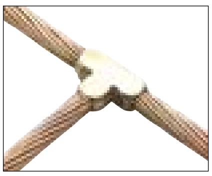
3 TC030/50

4 CR705

5 RB305 + CG370 + ST300



6 PC116



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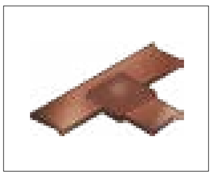

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Solutions for all uses
Protection wind turbines

Technical data

	System voltage	Class of protection	Impulse current I_{imp} 10/350 - kA	Max. discharge current I_{max} 8/20 - kA	Nominal current I_n - kA	Type
Generator						
Full Converter, Stator	up to 1000 V	I+II	2	40	20	**OVR WT 3L 690 P TS**
Doubly Fed, Stator	690 V	I+II	5	-	20	**POLIM-R...1**
		I+II	2.5	100	5	**LOVOS-W 40**
		II	-	40	20	**OVR T2 40 660 P TS U**
Doubly Fed, Rotor	690 V	I+II	2	40	20	**OVR WT 3L 690 P TS**
Converter						
Generator side	up to 1000 V	I+II	2	40	20	**OVR WT 3L 690 P TS**
Grid side	690 V	I+II	5	-	20	**POLIM-R...1**
		I+II	2.5	100	5	**LOVOS-W 40**
		II	-	40	20	**OVR T2 40 660 P TS U**
Main power panel						
LV Side	690 V	I	25	-	25	**OVR T1 25 440-50**
		I+II	15	-	20	**POLIM-R...2**
		I+II	5	140	5	**LOVOS-W 60**
		II	-	40	20	**OVR T2 40 660 P TS U**
Transformer						
MV Side outdoor	up to 44 kV	LD2	-	-	10	**MWK**
MV Side outdoor	up to 7.5 kV	LD2	-	-	10	**POLIM-C N**
MV Side indoor	up to 44 kV	LD2	-	-	10	**MWD**
LV Side indoor / outdoor	690 V	I+II	15	-	20	**POLIM-R...2**
		I+II	5	140	5	**LOVOS-W 60**
Pitch, Yaw & other auxiliary systems						
Power circuit	690 V	II	-	40	20	**OVR T2 40 660 P TS U**
	400 V	II	-	40	20	**OVR T2 40 440 P TS U**
Command circuit	230/400 V	II	-	40	20	**OVR T2 40 320 P TS U**
	48 V	II	-	40	20	**OVR T2 40 75 P TS U**
Data Circuit	12, 24 V, 48 V	C2	-	10	5	**OVR TC xx V P**
Control System						
Command circuit	230/400 V	II	-	40	20	**OVR T2 40 320 P TS U**
	48 V	II	-	40	20	**OVR T2 40 75 P TS U**
Data Circuit	12, 24 V, 48 V	C2	-	10	5	**OVR TC xx V P**
Communication		C2	-	10	5	**OVR TC xx V P**

Technical data

	Dimension	Weight (Kg)	Description	Type
Earth bar	400 mm x 90 mm x 90 mm	1.8	6 way earth bar mounted on base	**LK245-6**
Conductors	70 mm² cross section	0.62 per meter	70 mm sq stranded bare copper cable	**CB070**
Conductors	50 m	0.67 per meter	25 mm x 3 mm bare copper tape supplied in 50 mtr coils	**TC030/50**
Earth rods clamp	/	0.39	Rod to cable clamp 16-20 mm dia to 70 mm sq cable	**CR705**
Earth rods	1200 mm length	2.44	3/4" UNC x 1200 mm lg copperbond earth c/w coupling & driving stud	**RB305 + CG370 + ST300**
Earth points	500 mm	0.84	Earth point with pre-welded tail for connection to steel rebar	**PC116**
Conductive agregate	/	20	FurseCEM conductive agregate	**CM025**
Cable to reinforcing bar	/	/	Furseweld exothermic to connect 70 mm sq cable to steel rebar	**CRE3-3-70**
Cable to cable	/	/	Furseweld exothermic to connect 70 mm sq cable to cable	**CC2-4-7070**
Tape to tape	/	/	Furseweld exothermic to connect 25 x 3 copper tape to copper tape	**BB14-4-253253**

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Notes

note2

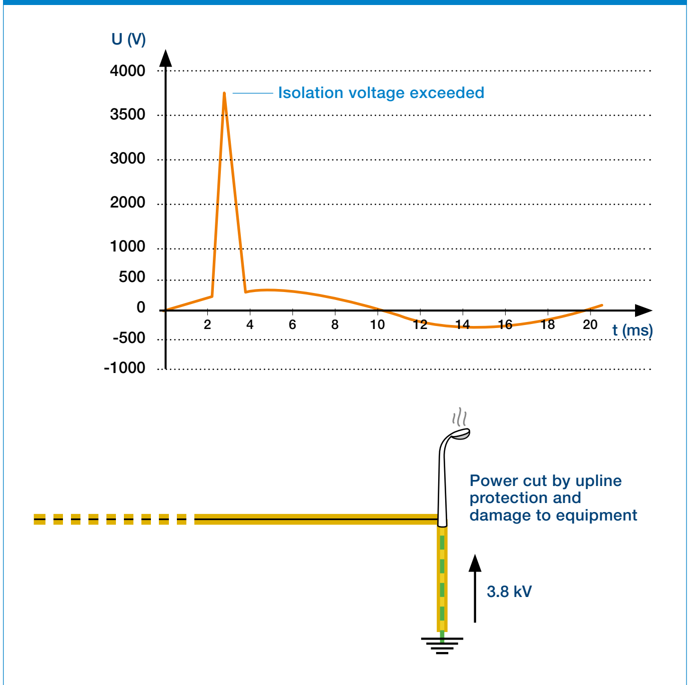
Solutions for all uses
Street lightning

Why protect lighting networks against overvoltages and lightning strikes?

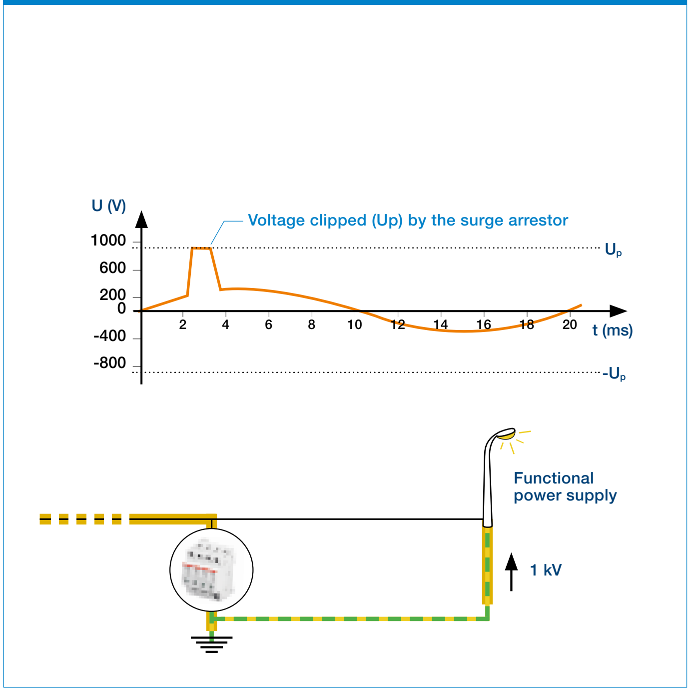
Public street lighting, especially since the advent of LED technology, is highly sensitive to transient overvoltages of industrial origin, or of natural origin caused by lightning.
This may cause electrical disturbances due to the AC network (switching operations) or the lightning surge.
As LED electric lighting is usually connected to power networks via long cables, this disturbance phenomenon is amplified.
Moreover, earthed equipment (class II) is much more exposed to the risk of voltage surge caused by lightning, referred to as rising earth potential. These surges can destroy the power circuits and LED components.

Protection provided by OVR surge protective devices therefore serves to:
- prevent lighting outages
- reduce network maintenance costs
- facilitate access for surge arrestor inspection and maintenance
- protect electrical devices against lightning strikes.

Representation of a transient voltage surge on an AC network without ABB surge protective devices



Representation of a transient voltage surge on an AC network with ABB surge protective devices



What ABB solutions offer

- **Continuity of lighting service** even in the event of lightning strike
- **Budget savings** by **protecting public lighting equipment** against high voltage surges
- **Cost reductions** and less maintenance required
- Easier inspection of equipment with **display of state** of surge arrestor
- **Rapid replacement** due to equipment at base of post
- **Compact products** that adapt to current installations, even the narrowest.

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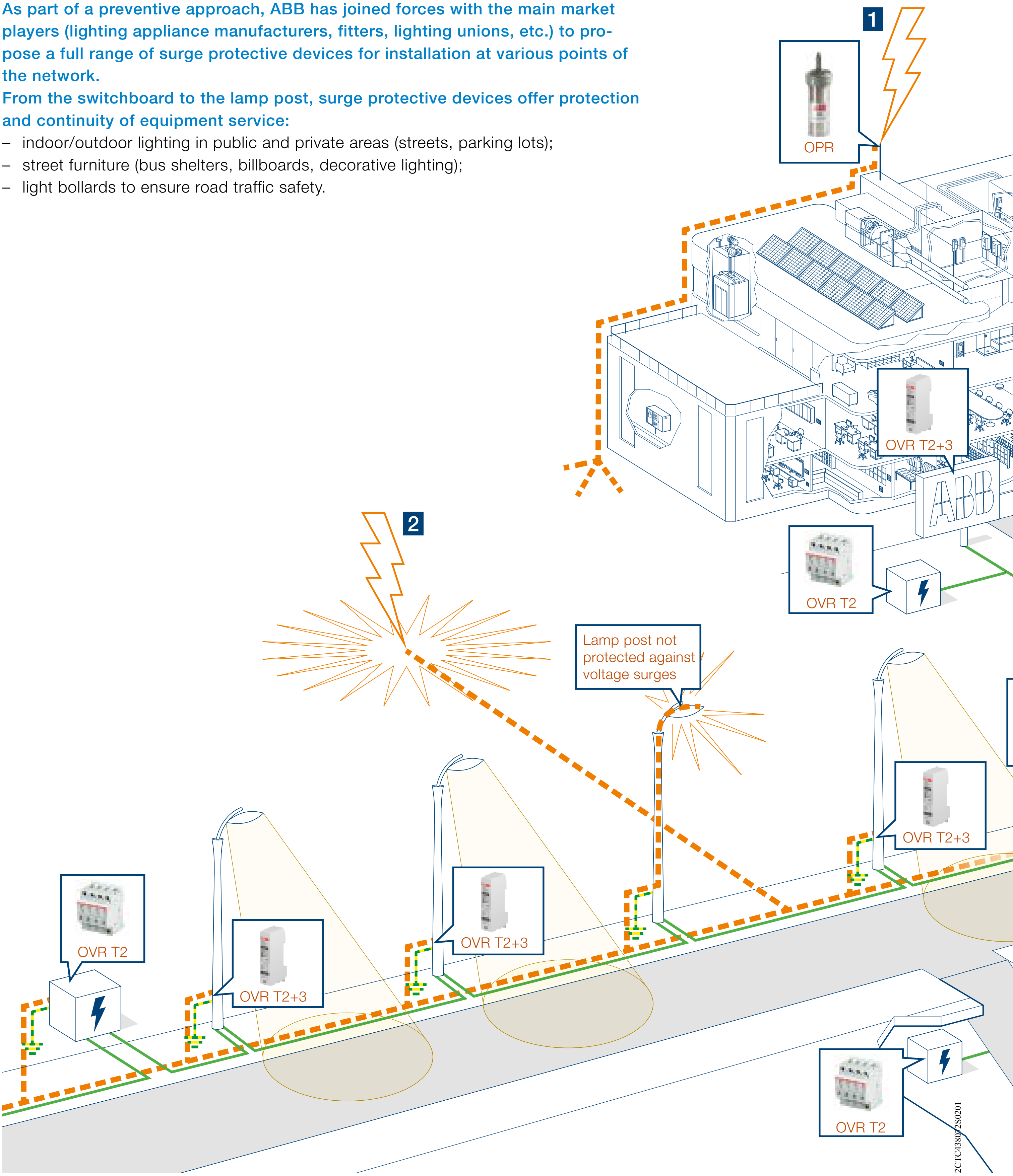
Solutions for all uses
Street lightning

As part of a preventive approach, ABB has joined forces with the main market players (lighting appliance manufacturers, fitters, lighting unions, etc.) to propose a full range of surge protective devices for installation at various points of the network.
From the switchboard to the lamp post, surge protective devices offer protection and continuity of equipment service:

- indoor/outdoor lighting in public and private areas (streets, parking lots);
- street furniture (bus shelters, billboards, decorative lighting);
- light bollards to ensure road traffic safety.

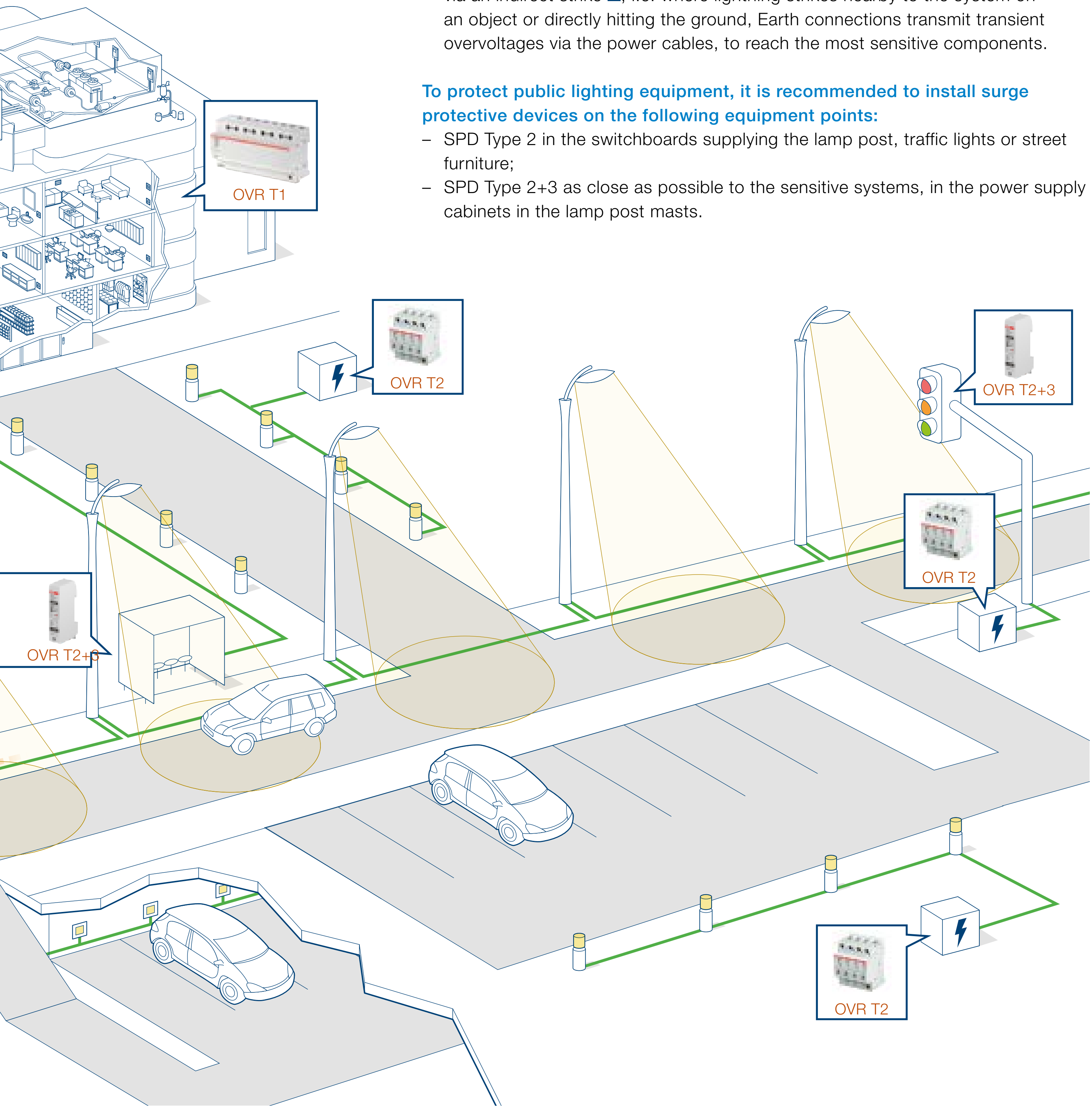


In general, public lighting equipment is powered with a TT or TN-S neutral point system. In the event of lightning strike impact, there is a risk of transmission of transient overvoltages via Earth cables. This phenomenon can occur in two manners:

– via a direct strike **1**, i.e. a direct impact on the metal conductor mast, where the energy will travel to the ground;
– via an indirect strike **2**, i.e. where lightning strikes nearby to the system on an object or directly hitting the ground, Earth connections transmit transient overvoltages via the power cables, to reach the most sensitive components.

To protect public lighting equipment, it is recommended to install surge protective devices on the following equipment points:

– SPD Type 2 in the switchboards supplying the lamp post, traffic lights or street furniture;
– SPD Type 2+3 as close as possible to the sensitive systems, in the power supply cabinets in the lamp post masts.



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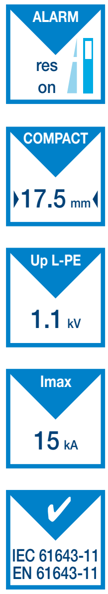
Solutions for all uses
Protection street lightning

ABB proposes a full range of lightning protection products to protect network equipment using OVR's SPDs for transient overvoltages and OPR external lightning protection for direct lightning strikes.

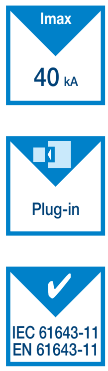
For close equipment protection - SPD Type 2+3

- **The safety system to extend product life**
  The SPD is equipped with two varistors that protect the system against high voltage surges. If one is damaged, the other continues to protect the equipment until the surge arrestor is replaced.
- **Multi-mode protection**
  Its common and differential protection mode serves to limit voltage surges occurring between the live (L), the neutral (N) and the Earth (PE) to protect the system against the effects of lightning.
- **Compact design**
  Easily integrated in all types of lamp posts due to its highly compact design, suitable to small power supply boxes.
- **DIN rail mounting for quick installation**
- **End of life SPD visual indicator**
- **Excellent IP rating and bottom connection**
  No condensation issues.



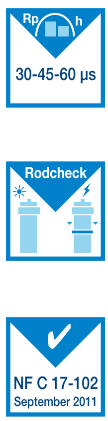
For protection of general power supply cabinets - SPD Type 2

- **Multi-mode protection**
  Its common and differential protection mode serves to limit voltage surges occurring between the live (L), the neutral (N) and the Earth (PE) to protect the system against the effects of lightning.
- **Plug-in cartridge**
  When a cartridge needs replacement, you can replace it without cutting the power or disconnecting wires.
- **DIN rail mounting for quick installation**
- **Auxiliary contact TS**
  Easy inspection of equipment due to NO/NC mechanical contact, end of life indicator.



For protection against lightning strikes - OPR lightning conductor

- **Early streamer emission lightning rod**
  Electronically-assisted formation of an upward leader that rapidly propagates to capture the lightning and direct it to the ground.
- **Total autonomy**
  Requires no power supply, provided by ambient electrical field during a storm.
- **Display of lightning impact**
  Visual verification using the Rodcheck ring, if it has moved from the top to the bottom.
- **Certified compliant with NF C 17-102 (September 2011)**
  Certification of priming device lightning conductors by independent inspection bodies.



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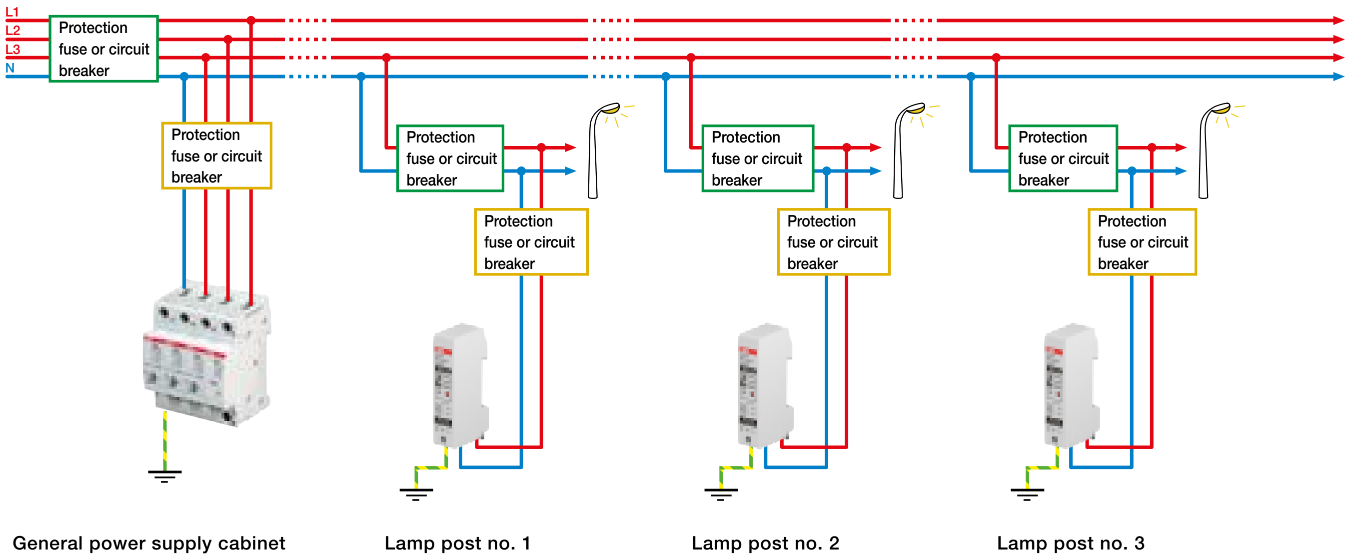
Solutions for all uses
Protection street lightning

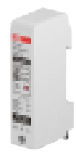
Surge protective device installation diagram



[green box] = Protection obligatory to ensure priority to system safety (power cut-off)

[yellow box] = Protection recommended to ensure priority to continuity of service (system remains energized)

Note: The upstream SPD protection device must be lower than the line protection.



Technical details

Part number		2CTB803873R1100	2CTB804500R0200	2CTB804500Z1200
Designation		OVR T2 N3 40-275 P QS	OVR T2-T3 N1 15-275S SL	OVR T2-T3 N1 15-275S SL
Packing unit	parts	1	1	20
Type of network		TT, TN	TT, TN	
Current type		AC	AC	
Nominal voltage	Un	230 V	230 V	
Type of SPD	Type	2/II	2+3	
Protection mode		Common + differential	Common + differential	
Nominal discharge current	In	20 kA	5 kA	
Maximal discharge current	Imax	40 kA	15 kA	
Voltage protection level	Up	1.25 kV	1.1 kV	
Short-circuit withstand	Icc	100 kA	15 kA	
Connection		Screw terminals	L+N cables 17 cm + screw terminal on PE	
Assembly		DIN rail	DIN rail	
End of life indicator		Mechanical indicator	Mechanical indicator	
Auxiliary contact		Yes	No	
Dimensions (L x H x W)		71.2 x 85 x 64.8 mm	17.5 x 84.5 x 41 mm	
Installation location		Electric cabinet	Power supply box closest to protected equipment	
Response Time		< 25 ns	< 25 ns	
Degree of protection		20	32	
Safety reserve		Optional OVR T2 N3 40-275s P QS (2CTB815704R2200)	Yes	
Back-up protection		Circuit breaker curve B/C < 125 A	Circuit breaker curve B/C < 20 A	
		Fuse gG - gL < 125 A	Fuse gG - gL < 20 A	
Reference standard		IEC / EN 61643-11	IEC / EN 61643-11	

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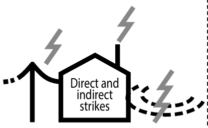
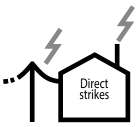
Solutions for all uses
SPDs for electrical switchboards - or easy selection

This table and the "OVR WIZARD" software application are available to make choosing SPDs even quicker and easier.

Alternating current protection

	System				SPD		Breakers (B or C curve) or fuses (gG - gL)
	Class	System	Poles	Remote contact	Type	Code	Size
	In a main switchboard, if there is a lightning conductor or aerial supply and there is delicate equipment connected to the switchboard						
	1+2	TT, TN-S	3P+N	No	OVR T1-T2 3N 12.5-275s P QS	2CTB815710R1900	160A Gg
				Yes	OVR T1-T2 3N 12.5-275s P TS QS	2CTB815710R0700	
			1P+N	No	OVR T1-T2 1N 12.5-275s P QS	2CTB815710R1300	
				Yes	OVR T1-T2 1N 12.5-275s P TS QS	2CTB815710R0100	
		TN-C	3P	No	OVR T1-T2 3L 12.5-275s P QS	2CTB815710R1800	
				Yes	OVR T1-T2 3L 12.5-275s P TS QS	2CTB815710R0600	
		IT	3P	No	OVR T1-T2 3L 12.5-440s P QS	2CTB815710R4700	
				Yes	OVR T1-T2 3L 12.5-440s P TS QS	2CTB815710R3500	
		IT-N	3P+N	No	OVR T1-T2 3N 12.5-440s P QS	2CTB815710R4800	
				Yes	OVR T1-T2 3N 12.5-440s P TS QS	2CTB815710R3600	
	In a main switchboard, if there is a lightning conductor or when the electricity supply is from an aerial line						
	1+2	TT, TN-S	3P+N	No	OVR T1-T2 3N 12.5-275s P QS	2CTB815710R1900	160A Gg
				Yes	OVR T1-T2 3N 12.5-275s P TS QS	2CTB815710R0700	
			1P+N	No	OVR T1-T2 1N 12.5-275s P QS	2CTB815710R1300	
				Yes	OVR T1-T2 1N 12.5-275s P TS QS	2CTB815710R0100	
		TN-C	3P	No	OVR T1-T2 3L 12.5-275s P QS	2CTB815710R1800	
				Yes	OVR T1-T2 3L 12.5-275s P TS QS	2CTB815710R0600	
		IT	3P	No	OVR T1-T2 3L 12.5-440s P QS	2CTB815710R4700	
				Yes	OVR T1-T2 3L 12.5-440s P TS QS	2CTB815710R3500	
		IT-N	3P+N	No	OVR T1-T2 3N 12.5-440s P QS	2CTB815710R4800	
				Yes	OVR T1-T2 3N 12.5-440s P TS QS	2CTB815710R3600	
	In all switchboards, to protect end-user equipment from the electro-magnetic impulse of lightning strikes						
	2	TT, TN-S	3P+N	No	OVR T2 3N 40-275 P QS	2CTB803973R1100	125A Gg
				Yes	OVR T2 3N 40-275 P TS QS	2CTB803973R0500	
			1P+N	No	OVR T2 1N 40-275 P QS	2CTB803972R1100	
				Yes	OVR T2 1N 40-275 P TS QS	2CTB803972R0500	
		TN-C	3P	No	OVR T2 3L 40-275 P QS	2CTB803873R2400	
				Yes	OVR T2 3L 40-275 P TS QS	2CTB803873R2500	
		IT	3P	No	OVR T2 3L 40-440 P QS	2CTB803873R2800	
				Yes	OVR T2 3L 40-440 P TS QS	2CTB803873R2700	
		IT-N	3P+N	No	OVR T2 3N 40-440 P QS	2CTB803973R1400	
				Yes	OVR T2 3N 40-440 P TS QS	2CTB803973R1500	

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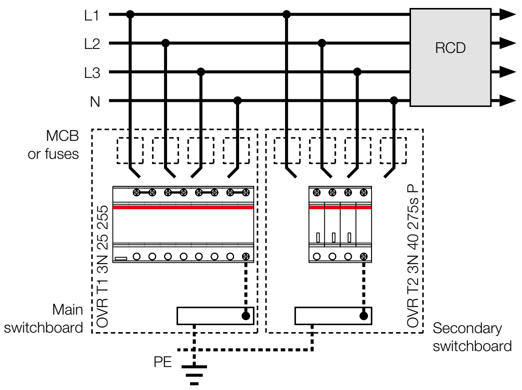
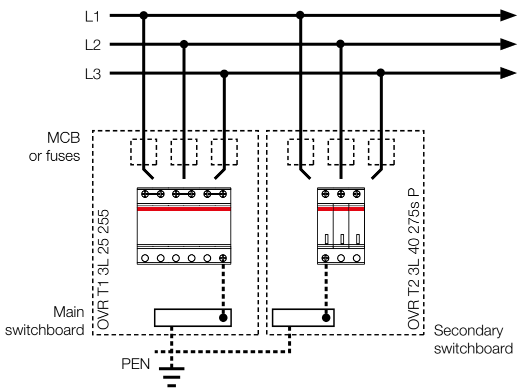
Solutions for all uses
SPDs for electrical switchboards - or easy selection

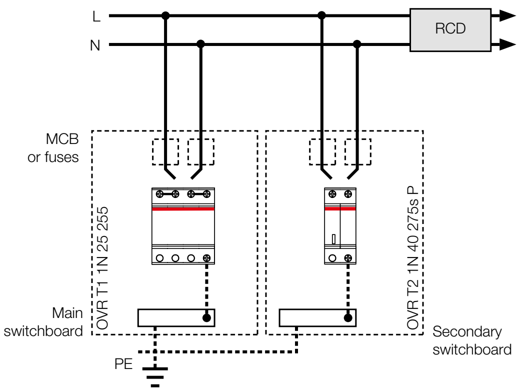
TT and TN-S 3P+N
Systems



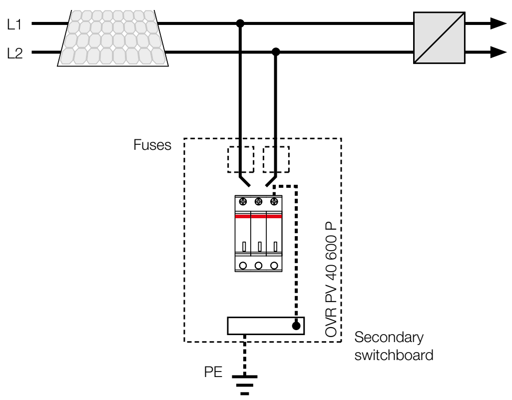
TNC 3P (230 V L-N)
Systems



TT and TN-S, 1P+N
Systems



Photovoltaic



NOTE: In some countries, there is a deviation for the national standard and the IEC 60364-5-53 "Selection and erection of electrical equipment – Isolation, switching and control". In this case, both connections, to the main earthing terminal and to the protective conductor need to be done, and not just one as per the above pictures coming from the IEC. Please check your national standard before defining the electrical connections.

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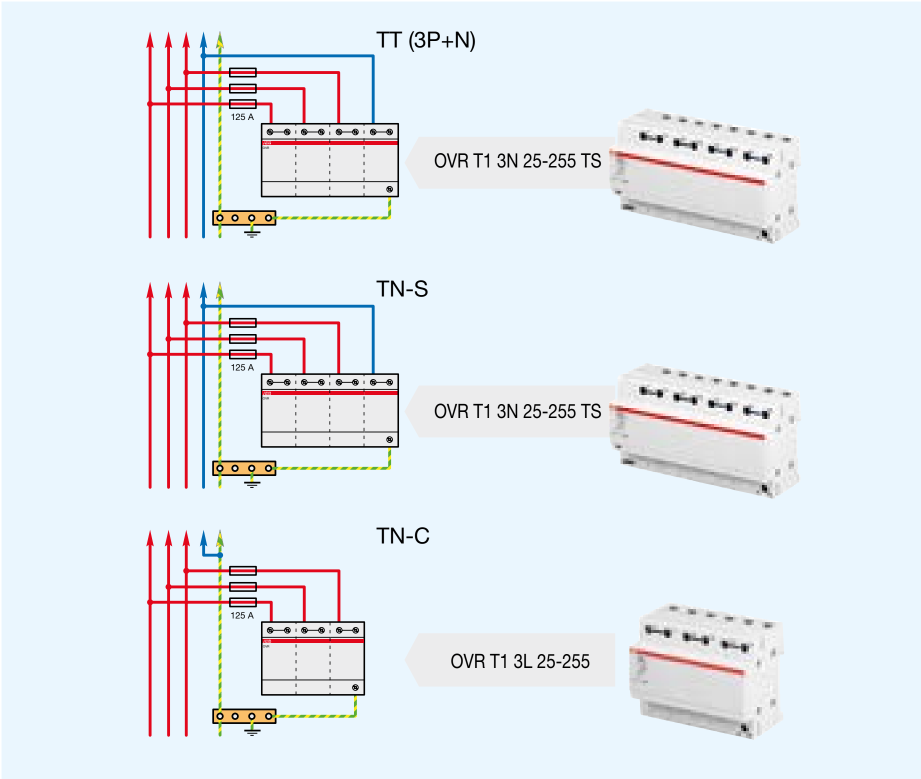
Solutions for all uses
SPDs for electrical switchboards - quick choice

Selection of protection on the basis of the panel, the presence of lightning rods and the earthing system

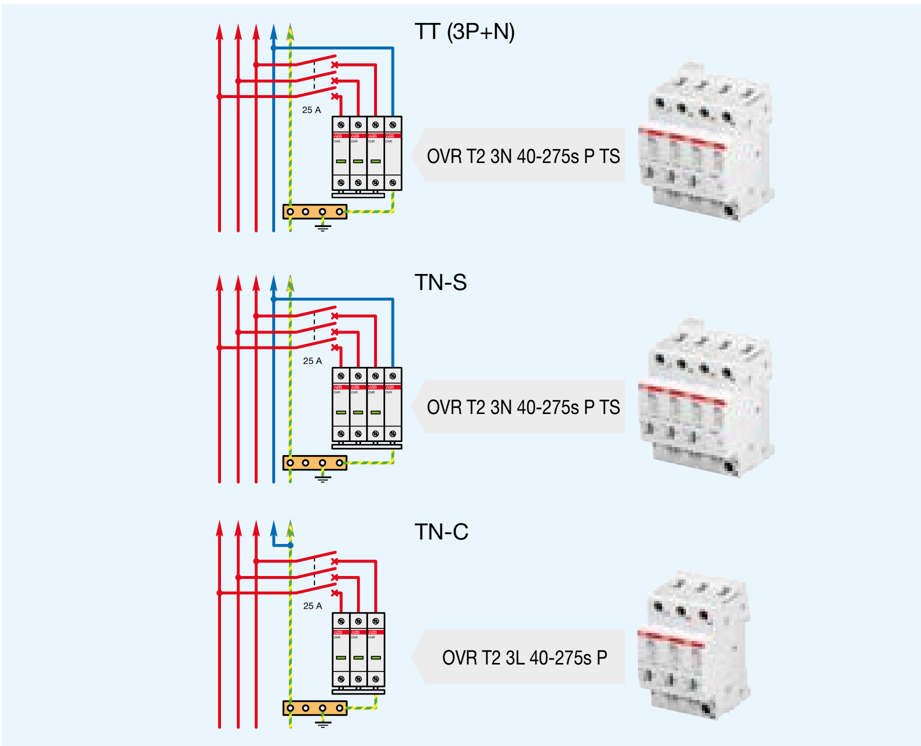
Main electrical switchboard
Presence of external LPS

OVR T1



Main or secondary electrical switchboard
External LPS not present

OVR T2



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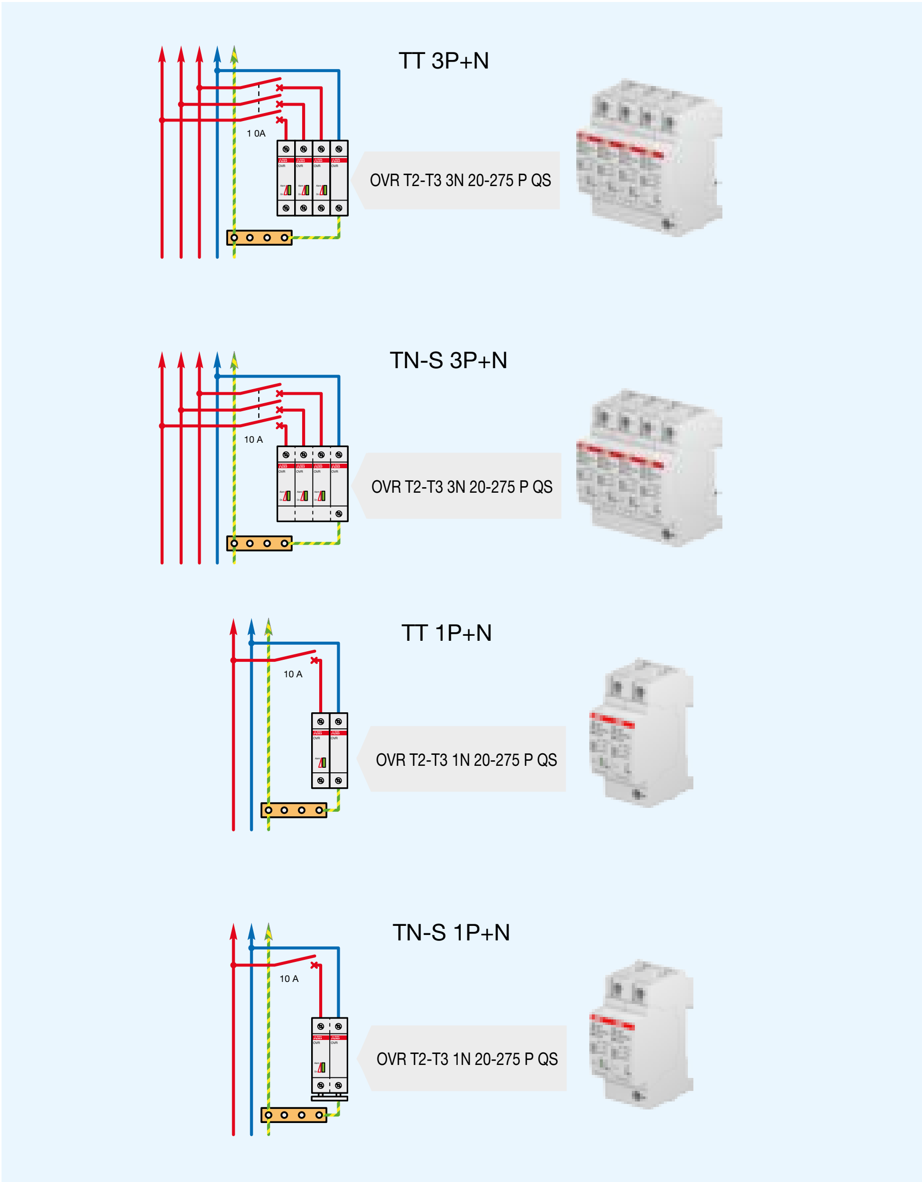
Solutions for all uses
SPDs for electrical switchboards - quick choice

Protection of terminal equipment. Recommended if the terminal electrical switchboard is more than 10 meters from the upstream switchboard



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Solutions for all uses
Protecting telecommunications networks

OVR TC...P with integrated RJ socket:
With RJ45 socket (24 mm width)

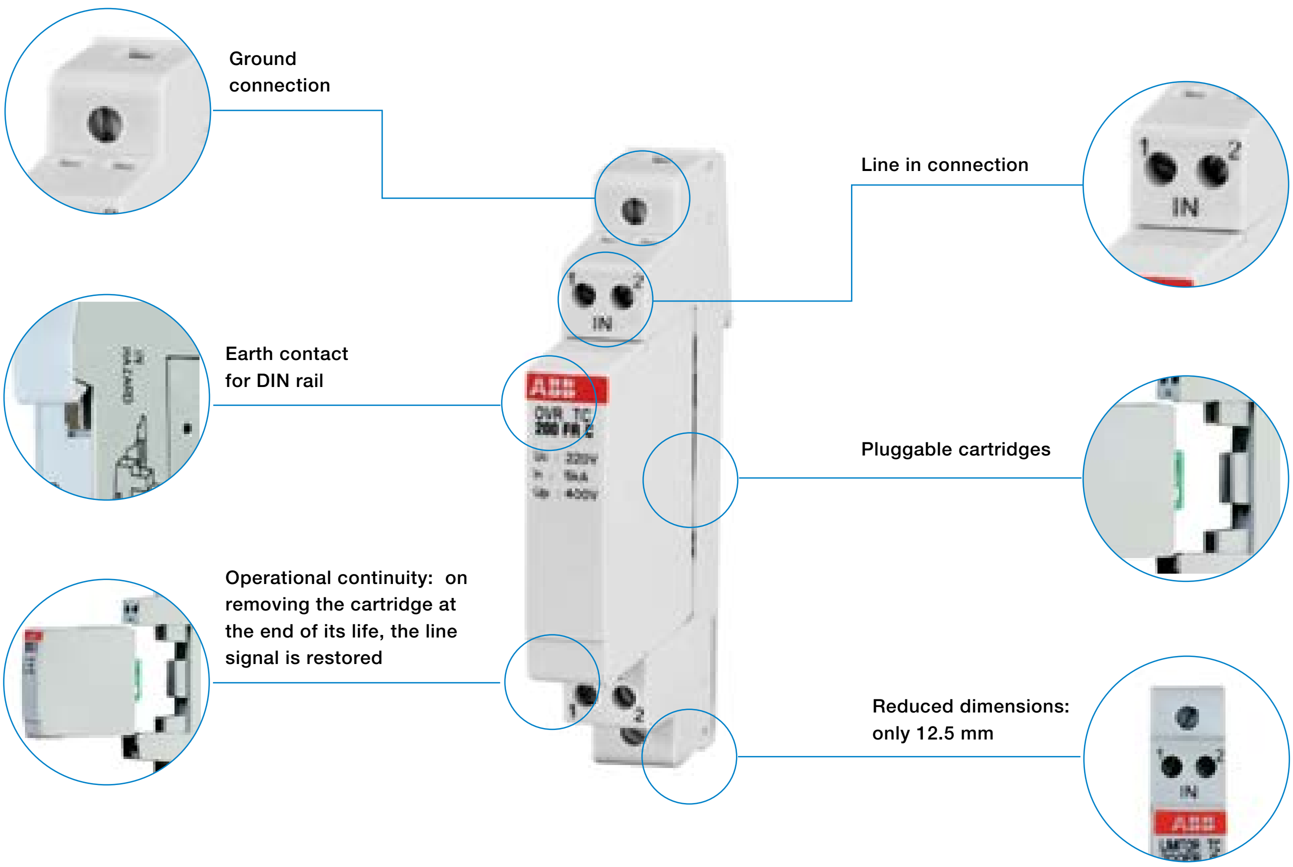
OVR TC SPDs are for fine protection of telephonic equipment, IT devices and BUS systems connected to low-voltage signal lines.

ABB offers a complete range of solutions for protecting telephone and internet through to management and control networks in industrial, service and residential environments.

Main characteristics of the range:
- Pluggable cartridges:
  cartridges can be removed and replaced at the end of their lives, while the base remains reusable. The telecoms line remains active while they are being replaced, thanks to a bypass.
- Reduced dimensions:
  When the cartridge is not plug in the modules with standard two-wire terminal protection are all 12.5 mm wide.
- Bases with integrated RJ45 connectors: these guarantee maximum speed of cabling in the telephone or data patch panel.

It is also wise to provide for the installation of Type 1 or Type 2 SPDs on the power lines to provide effective protection of the telecoms and data equipment.

Benefits of the OVR TC pluggable cartridges range



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Solutions for all uses
Protecting telecommunications networks

Table for choosing protection for Telephone, internet, broadband

Network	Type of connection / application		Type of signal	Max voltage of signal	Max. carrier frequency	Max. downstream speed	Standard connection	Physical medium	Type
PSTN	xDSL	ADSL (Asymmetric DSL)	Digital	180 V	1.1 MHz	8 Mbps	RJ45	1 pair	OVR TC 200 FR P
		ADSL 2+			2.2 MHz	20 Mbps		1 or 2 pairs	1 or 2 x OVR TC 200 FR P
		HDSL			240 kHz	2 Mbps		1 or 2 pairs	1 or 2 x OVR TC 200 FR P
		VDSL			30 MHz	52 Mbps		1 pair	OVR TC 200V P

Network	Type of connection / application		Type of signal	Max voltage of signal	Max. carrier frequency	Max. downstream speed	Standard connection	Physical medium	Type
ISDN	Network-Network	U	Digital	100 V	120 kHz or 1 MHz	160 kbps or 1.9 Mbps	Terminals	1 or 2 pairs	See ISDN table (following page)
	Network-User	Basic rate (T0) (2B+D)		2.5 V (40 V between the pairs)	120 kHz	160 kbps	RJ45	2 pairs	
		2.5 V		2.5 V	1 MHz	1.9 Mbps			
	User-User	Basic rate (S0) (2B+D)		2.5 V (40 V between the pairs)	120 kHz	160 kbps			
		Primary rate (S2) (30B+D)		2.5 V	1 MHz	1.9 Mbps			

Note:
For weak signals, use OVR TC 200 V P (parallel connection)

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Solutions for all uses
Protecting telecommunications networks

Choice of ISDN SPD

Equipment		Application	Access	Input connection	Type	Output connection	Type
NT1*	Network terminal 1	Allows exchange of information between the operator's network and the user's system	Basic	U	OVR TC 200 FR P	T0	OVR TC 48 V P
LT*	Line terminal		Primary	U	OVR TC 200 FR P	T2	OVR TC 6 V P
NT2 (PABX)	Network terminal 2 (Private Automatic Branch exchange)	Private switching exchange: allows internal devices to be connected to the external network	Basic	T0	OVR TC 48 V P	S0	OVR TC 48 V P
			Primary	T2	OVR TC 6 V P	S2	OVR TC 6 V P
TE1 digital	ISDN Terminal	Digital telephone or PC card	Basic	S0	OVR TC 48 V P	Voice or data	/
			Primary	S2	OVR TC 6 V P	Voice or data	/
TA	Terminal adapter	ISDN adaptor for analog terminal	Basic	S0	OVR TC 48 V P	R	OVR TC 200 FR P
			Primary	S2	OVR TC 6 V P	R	OVR TC 200 FR P
TE2 analog	Analog terminal	Analog terminal or modem		R	OVR TC 200 FR P	Voice or data	/

GNT**	Generalized network terminal	Allows communication between the operator's network and the user's system	Basic	U	OVR TC 200 FR P	S0	OVR TC 48 V P
						Z1 or Z2	OVR TC 48 V P
TE2 digital	Specific telephone terminal	Digital terminal adaptable to GNT	Basic	S0 x 5	5 x OVR TC 48 V P	Voice or data	/
TE2 analog	Analog terminal	Analog terminal or modem		Z1 or Z2	OVR TC 48 V P	Voice or data	/

* Connected to NT
** Without NT2

Note: For power supply of NT1 (required for large distances between operator and user) it is recommended the power supply switchboard be protected with OVR T2 1N 40 275s P.

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Solutions for all uses
Protecting telecommunications networks

Field BUS, company networks, management and control systems

Network type	Application		Type of signal	Max signal voltage	Rated current	Max. transmission speed	Standard connection	Physical medium	Type
Line 4 - 20 mA	Long-distance transmission of analog signals		Analog	24 V	20 mA	20 kbps	clamps	1 pair (simplex) or 2 pairs (full duplex)	OVR TC 24 V P
Line 4 - 20 mA HART			Analog + digital						OVR TC 24 V P
RS 232 (24 V)	Serial communication between devices		Digital	± 15 V	~ 100 mA	20 kbps	clamps or SUB-D9 or SUB-D25 or RJ45	4, 8, (RJ45), 9 (SUB-D9) or 25 (SUB-D25) wires	(N wires /2) x OVR TC 24 V P
				± 12 V					(N wires /2) x OVR TC 12 V P
RS 485				-7 … + 12 V		35 Mbps		1 pair	OVR TC 12 V P
				± 6 V					OVR TC 6 V P
10 Base T	Company Ethernet network		Digital	5 V	~ 100 mA	10 Mbps	RJ45	2 pairs	2 x OVR TC 6 V P
100 Base T						100 Mbps			2 x OVR TC 200 V P
Token ring						4, 16, 100 Mbps			2 x OVR TC 6 V P or OVR TC 200 V P depending on the speed
Foundation FieldBUS (H1, H2)	Communications between PCs, actuators, sensors and field equipment		Digital	32 V	10-30 mA	32 kbps - 2.5 Mbps	clamps or SUB-D9 or SUB-D25	1 pair	OVR TC 48 V P
Field BUS Profibus DP		PROFIBUS Field BUS		± 6 V	~ 100 mA	35 Mbps			OVR TC 6 V P
Field BUS Modbus		MODICON Field BUS		-7 … + 12 V	~ 100 mA				OVR TC 12 V P
EIB / KNX (ABB i bus)	Office automation and control systems		Digital	24-34 V	~ 10 mA	9.4 kbit/s	clamps	1 pair	OVR TC 48 V P

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Solutions for all uses
Protecting domestic installations

OVR PLUS is an auto-protected SPD for the TT/TNS single-phase systems and 3 phase + Neutral.
Designed for the home and small offices, thanks to its extremely reduced level of protection it is ideal to protect the most delicate equipment from overvoltages of atmospheric origin or maneuvers:
LCD, LED and plasma televisions, computers, household appliances.

2CTC438076S0201

Solutions for all uses
Protecting domestic installations

Benefits of OVR PLUS SPDs

Universal
Thanks to the nominal current of 5 kA or 20 kA, the device is perfect for protection against indirect lightning strikes in all domestic installations, but also commercial and industrial applications, even in areas with high lightning-strike frequency. Ensures surge protection for many years.

Auto-protected
The integrated back-up miniature circuit breaker ensures automatic disconnection of the device at the end of its life, without the need for additional protection upstream.

No residual current to earth
Thanks to the 1+1 or 3+1 schemes with an N-PE spark gap to earth, it can be installed upstream of the main RCD, protecting it from overvoltage surges and preventing unwanted tripping.

Reduced dimensions
1P+N SPD with I_{Max} 20 or 40 kA and integrated back-up miniature circuit breaker in only two modules (35.6 mm).
3P+N SPD with I_{Max} 20 or 40 kA and integrated back-up miniature circuit breaker in only six modules (106.8 mm).

Mechanical status indicator
The state of the protection is immediately visible on the front of the product. The indication is easy to understand and allows the user to monitor just the status without calling in an electrician as for a standard MCB.

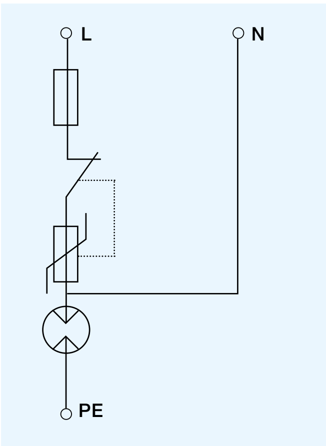
Ease of wiring
Installing OVR PLUS requires just three wires to be connected. No back-up protection needs to be added (it is already integrated) and no remote monitoring contacts need connecting (visual indicator on the front).

Optimum protection level
Thanks to the use of a varistor, the protection level is extremely low (Up=1.3 kV for OVR Plus N1 20) and the device is very fast acting. Safe and fast, the key to safety in domestic installations.

Protection from surges, prevention of unwanted tripping and operational continuity – OVR PLUS brings safety and peace of mind.

Reserve indicators
2 led: OK
1 led: reserve
2 off: to be replaced

OVR PLUS combines a 1P+N "1+1" SPD, thermal disconnector and MCB back-up protection in a single device.



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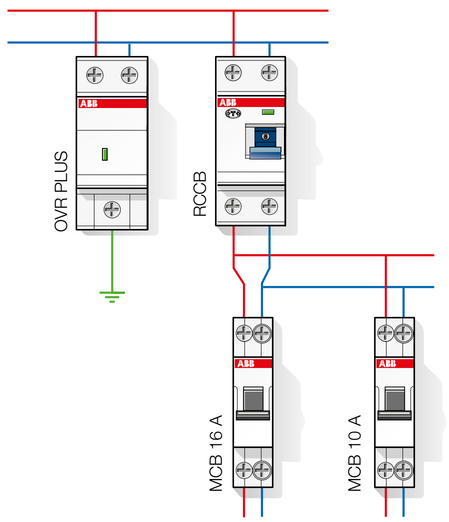
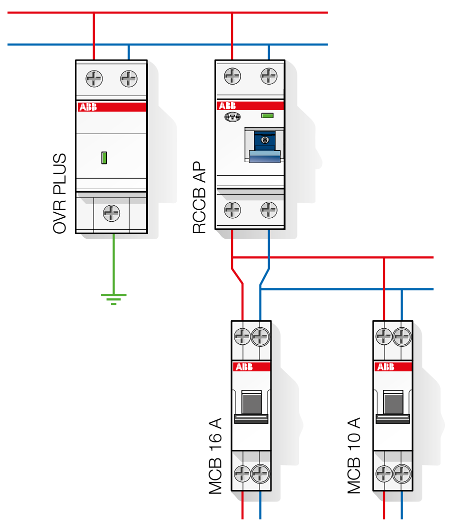
Protecting domestic installations

Practical examples of consumer units with OVR PLUS

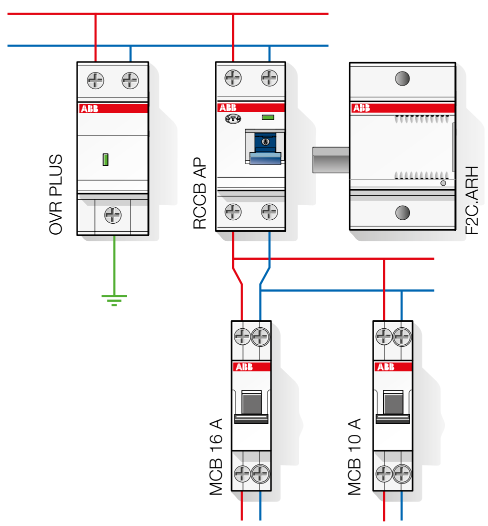
Surge protection and prevention of unwanted tripping



Surge protection and high-performance prevention of unwanted tripping



Surge protection, high-performance prevention of unwanted tripping and absolute continuity of service



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Rules for installation of SPDs
General criteria, tips and tricks

The SPD at the origin of the plant must be installed immediately downstream of the master circuit breaker.

The SPD must be:
- Sized according to the impulse withstand voltage of the equipment to be protected
- Installed near the equipment to be protected
- Co-ordinated with other surge protection devices.

Appropriate steps for limiting voltage surges

Some useful tips for limiting overvoltage surges:
- Avoid connections which enclose a very large area, ensuring that the power and low-voltage cables follow the same path while respecting spacing rules for the two networks;
- Identify the equipment (lifts, lightning rods) which generate surges. Ensure that there is sufficient distance between them and sensitive equipment or that suitable overvoltage protection has been installed;
- Favour the use of shielding for equipment and cables as well as creating an equipotential connection between all the metal parts which access, come out of or are found inside the building, using braiding which is as short as possible;
- Identify the type of earthing system in order to choose the most suitable overvoltage protection; where possible, avoid the use of the TN-C system when there is sensitive equipment inside the plant;
- Select the back-up breakers correctly;
- Favour type-S selective RCDs (DDA 200 A S or F 200 A S) to provide protection against indirect contact in order to avoid unwanted opening of the circuit in the case that the RCD is located upstream of the SPD.

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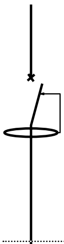
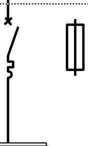
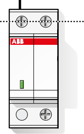
Rules for installation of SPDs
Back-up protection: a question of safety

To prevent the varistor overheating at the end of its life, the SPD must be suitably protected both with a thermal disconnector (integrated) and with a back-up protection. The back-up protection must be quick enough to disconnect the varistor at the end of its life in the case that the thermal disconnector is not able to isolate the network before the heat generated leads to tragic consequences.

SPDs must be combined with suitable upstream back-up protection and with differential protection, depending on the distribution system.

Diagram	Function	Application
	Protection against indirect contact	The RCD is - mandatory for TT systems - Recommended for TN-S, IT and TN-C-S systems - Forbidden for TN-C systems RCDs installed upstream of the SPDs should preferably be type S. To avoid unwanted tripping, where possible the "3+1" scheme (or "1+1 for single-phase networks) is preferable in any case, in which the RCD may be installed downstream of the SPD.
	Back-up protection against faults or end-of-life	The back-up disconnector device can be: - An MCB (type 2 and 3) - A fuse (type 1, 2 and 3) For Class 2 SPDs, the choice depends, apart from on the type of SPD, on the short-circuit current of the system at the installation point.
	Thermal protection	All ABB OVR SPDs are fitted with integrated thermal protection.

All Type 1 and Type 2 OVR 1P+N and 3P+N SPDs can be installed upstream of the RCD. This rule is recommended by standards to avoid the current from lightning strikes passing through the RCD. It allows the RCD to be protected on one hand, and maintains operational continuity on the other hand.
This rule is not possible in many country because of the Power Network operator.

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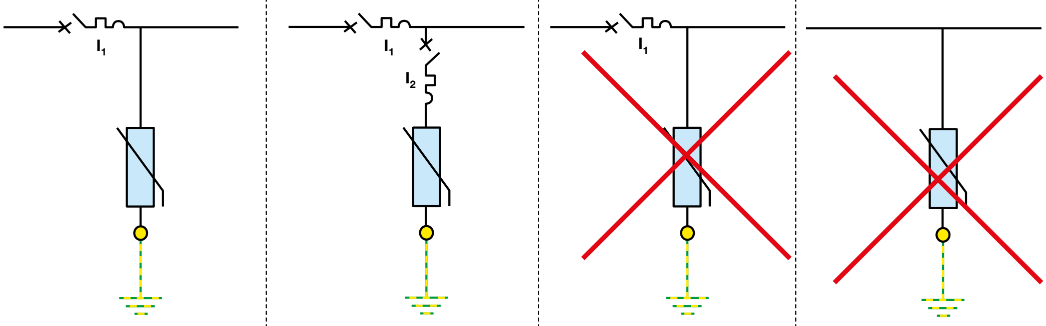
Rules for installation of SPDs
Back-up protection: a question of safety

The SPD can be protected with the line protection, or it may have a dedicated back-up device. The currents I1, I2 and I in the different diagrams are the rated protection currents (fuse or MCB).

Permitted		Not permitted	
Priority to protection I_1 < I of the SPD	**Priority to operational continuity I_1 > I of the SPD and I_2 = I of the SPD**	**I_1 > I of the SPD**	**No protection**



Rated I for the SPD back-up device	**Rated I for the SPD back-up device**	**Rated I for the SPD back-up device**	

Note:
- I_1 and I_2: rated services of the MCB(s) or fuse(s).
- Back-up I of the SPD: rated current of the recommended back-up protection device (see table on next page).

Priority to protection: at the end of the SPD's life, the system downstream goes out of service and the line protection opens. To restore the power supply it is necessary to replace the used SPD (or cartridge).
Priority to operational continuity: at the end of the SPD's life it is isolated from the downstream system (in the same way if the back-up protection or MCB open). The network remains in service without the immediate need to replace the SPD. The downstream system is no longer protected from surges, however, until the SPD is replaced. It is therefore necessary to replace the SPD as quickly as possible.

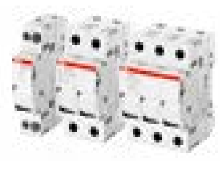
In general it is recommended to prioritize operational continuity by installing back-up protection dedicated to the SPD. A SPD with a safety reserve increases the operational continuity.

2CTC438079S0201

Rules for installation of SPDs
Back-up protection: a question of safety

Maximum rated current of breaker or fuse in function of I_{max} and I_{imp} of the SPD.

Type 1 and Type +2 SPDs

		
	Fuse (gG)	
25 kA per pole (10/350 µs)	125 A or 160 A	

Type 2 SPDs

		Fuse (gG)	**Breaker (Curve C)**
70 kA (8/20 µs)	I_{sc} da 300 A a 1 kA	20 A	30 A (1)
	I_{sc} from 1 kA to 7 kA	40 A	from 32 A to 40 A (2)
	I_{sc} greater than 7 kA	63 A	from 32 A to 63 A (3)
40 kA (8/20 µs)	I_{sc} da 300 A a 1 kA	16 A	25 A (1)
	I_{sc} from 1 kA to 7 kA	25 A	25 A (2)
	I_{sc} greater than 7 kA	50 A	from 25 A a 50 A (3)
15 kA (8/20 µs)	I_{sc} da 300 A a 1 kA	16 A	from 10 A a 25 A (1)
	I_{sc} from 1 kA to 7 kA	16 A	from 10 A a 32 A (2)
	I_{sc} greater than 7 kA	from 25 A to 40 A	from 10 A a 40 A (3)

1) Series S 200 L
2) Series S 200 L, S 200
3) Series S 200 M, S 290

Note:
The cut-out device is also commonly called back-up protection.

ABB has always promoted the use of back-up protection for Class 2 SPDs with relatively low rated currents. What are the benefits of this choice?

The back-up protection solutions have been selected and tested in the lab to supply the maximum operational continuity and maximum safety.
- Operational continuity is obtained with a back-up protection which does not trip out during discharges, which can reach 5 kA for indirect lightning strikes.
- Maximum safety is obtained by disconnecting the SPD as soon as possible when it has reached the end of its life and the thermal disconnector is not able to open the circuit.

The solutions indicated in the table above are therefore the minimum ratings which allow the discharge current to flow and open the circuit rapidly in the presence of a short-circuit current. If there is a short-circuit inside the panel, it is better not to wait to disconnect it!

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Rules for installation of SPDs
Protection distance

The length of the line between the installation point of the SPD and the equipment to be protected assumes great importance in terms of the effectiveness of surge protection.

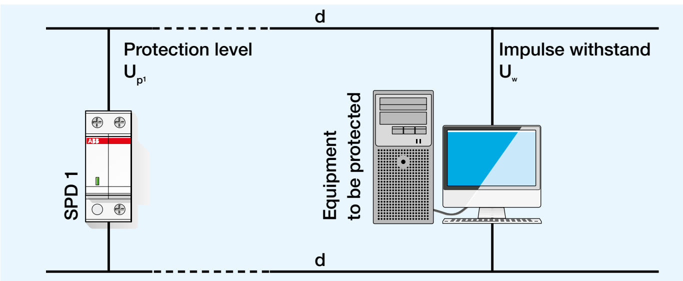
Indeed, if this distance is excessive, the effectiveness of the SPD decreases, as the cable loop behaves like an antenna and is therefore subject both to oscillatory reflection phenomena which can give rise to an increase of the surge voltage (up to 2 times U_p), and to electromagnetic induction phenomena, which increase with the size of the relevant loop.
The protected distance, in other words the maximum length of the conductors between the SPD and the equipment, essentially depends on the protection level U_p, U_{prot} with the voltage drops on the SPD connections and on the impulse withstand voltage U_w of the equipment to be protected. This distance can be calculated, but in any case must be contained, in light of experience in the area, within a maximum radius of 10 m. The installation of a SPD at the origin of the plant may not, therefore, be enough to protect it in its entirety; it is thus necessary to install further SPDs downstream with lower protection levels, co-ordinated with the one upstream, in order to make the whole system safe.

Recommendations for creating effective protection

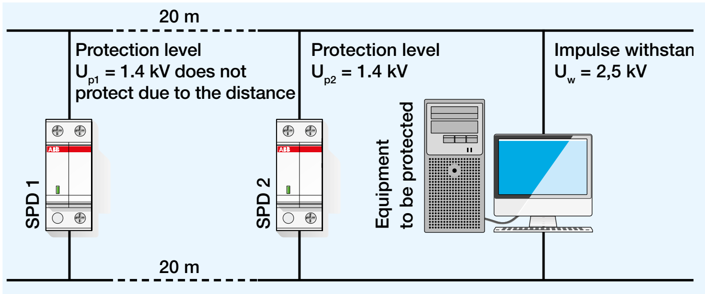
– If the length of the line between the SPD and the equipment to be protected is less than 10 m, the protection is considered 100% effective (this according to the IEC 61643-12, please verify your National standard for further information)

– If the length exceeds 10 meters, the effectiveness of the protection decreases

– According to IEC 61643-12, the upstream protection must be repeated downstream if:
$U_{p1} \times 2 > 0.8 \times U_w$



For example, a SPD with U_{p1} = 1.4 kV, installed in the main distribution switchboard, protects the terminal equipment over 10 m away only if the equipment has an impulse withstand voltage U_w of at least 3.5 kV. If the equipment to be protected has a lower withstand, it will be necessary to install a second SPD at less than 10 m distance or, if possible, move the first one closer.



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Rules for installation of SPDs
Co-ordination principle

After defining the characteristics of the SPD at the origin of the electrical system, it may be necessary to complete the protection with one or more additional SPDs.

The main SPD at the origin may indeed not be sufficient to ensure effective protection for the entire plant. If the length of the cable downstream of the SPD is greater than 10 m, various electromagnetic phenomena can increase the residual voltage of the SPD installed upstream. It is therefore necessary to upgrade the protection with a SPD placed in proximity to the equipment to be protected (at less than 10 m). The SPDs must be co-ordinated on installation (see tables below).

Additional protection must be installed downstream of the SPD present in the main switchboard if:

– The initial SPD does not reach the required level of protection (U_P) on its own; for example if sensitive equipment is connected to a switchboard protected by a Class 1 SPD.

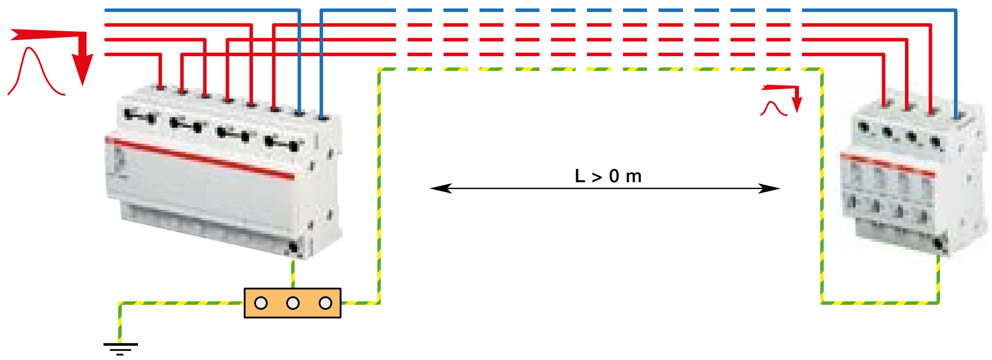
– The initial SPD is at more than 10 m from the equipment to be protected.

Note:
Co-ordination of the Type 2 SPDs is performed by considering the respective maximum discharge currents I_{max} (8/20 μs), starting at the main switchboard at the origin of the system, and working towards the equipment to be protected, keeping track of the progressive reduction of I_{max}.
For example, 70 kA followed by 40 kA. All Type 2 ABB SPDs are automatically co-ordinated with one another, respecting a minimum distance of 1 m.

SPDs coordination tables and minimum cable length

Type 1
limp = 25 kA
(10/350)
I_{fi} = 50 kA

Type 1
limp = 25 kA
(10/350)
I_{fi} = 7 kA



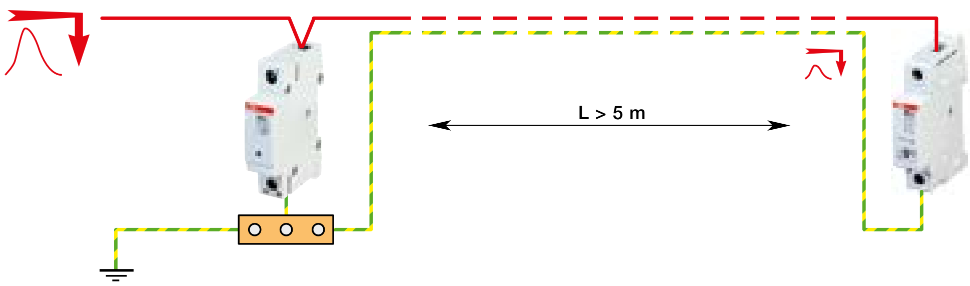
Type 2 s QS
80/40 kA
(8/20)

Type 2 QS
40 kA (8/20)

Type 2+3 QS
20 kA (8/20)

Type 1+2
limp = 15 kA
(10/350)
I_{fi} = 7 kA

Type 1+2
limp = 12.5 kA
(10/350)

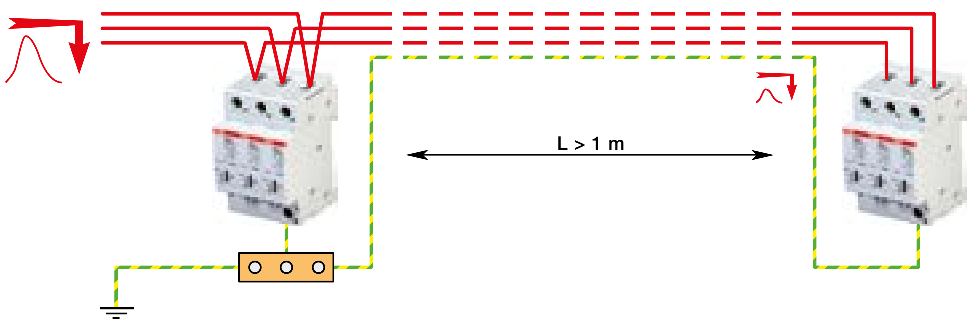


Type 2 QS
40 kA (8/20)

Type 2+3 QS
20 kA (8/20)

Type 2 s QS
80 kA (8/20)

Type 2 s QS
80 kA (8/20)



Type 2+3 QS
20 kA (8/20)

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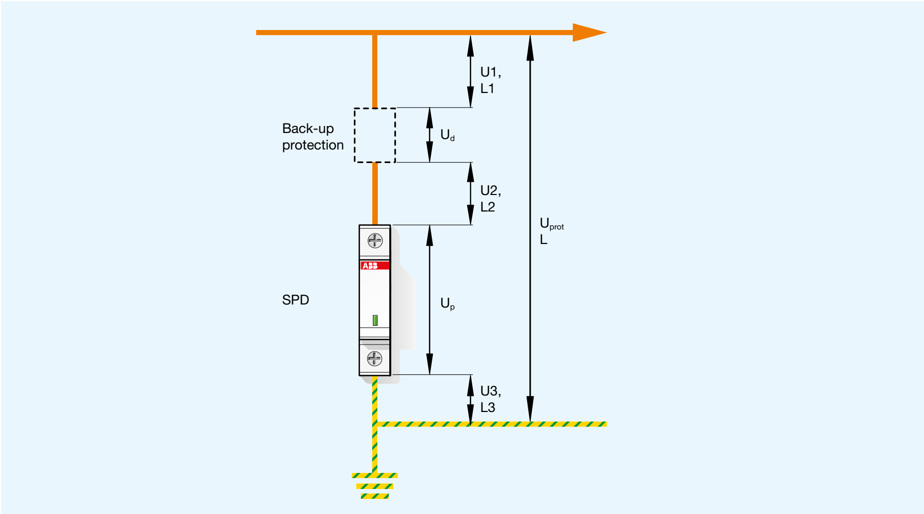
Rules for installation of SPDs
Installation and wiring of SPDs in an electrical switchboard

Connection distance
50 cm rule

A lightning current of 10 kA generates a voltage drop of approximately 1200 V in 1 m of cable due to the inductance of the conductor. Equipment protected by a SPD is therefore subject to a voltage of U_{prot} equal to the sum of:
- Protection level of the SPD U_p
- Voltage at the terminals of the back-up protection U_d
- Voltage in the connections U_1, U_2, U_3

$$U_{prot} = U_p + U_d + U_1 + U_2 + U_3$$

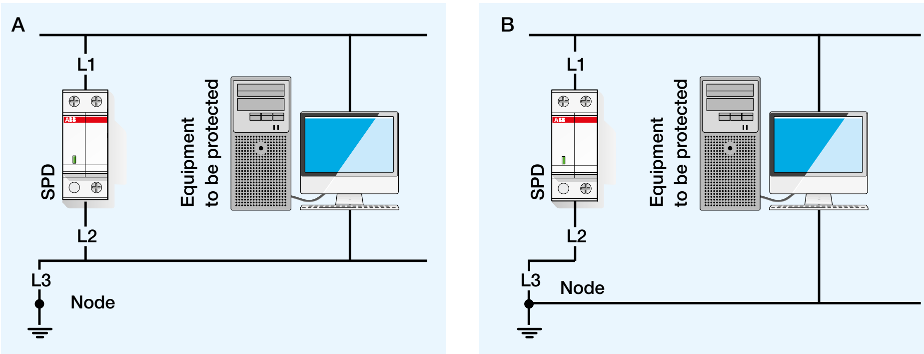
To maintain the level of protection below the impulse withstand voltage (U_w) of the devices to be protected, the total length (L = L1 + L2 + L3) of the connecting cables must be as short as possible (less than 0.50 m).



It is necessary to pay attention to the actual length of the connections, which must be measured from the SPD's terminals to the point at which the cable is taken off as a spur from the main conductor. Here is an example which demonstrates the importance of the lengths of connections (for simplicity the diagram omits the back-up protection).

A: in this case…
L = L1 + L2
The length L3 has no effect on the protection of equipment.

B: in this case…
L = L1 + L2 + L3
If the length of L3 is several meters, considering that every extra meter of wire increases the protection voltage by 1200 V, the protection loses a lot of effectiveness.



The equipment's earth connection must be distributed, starting from the connection of the SPD which protects it.

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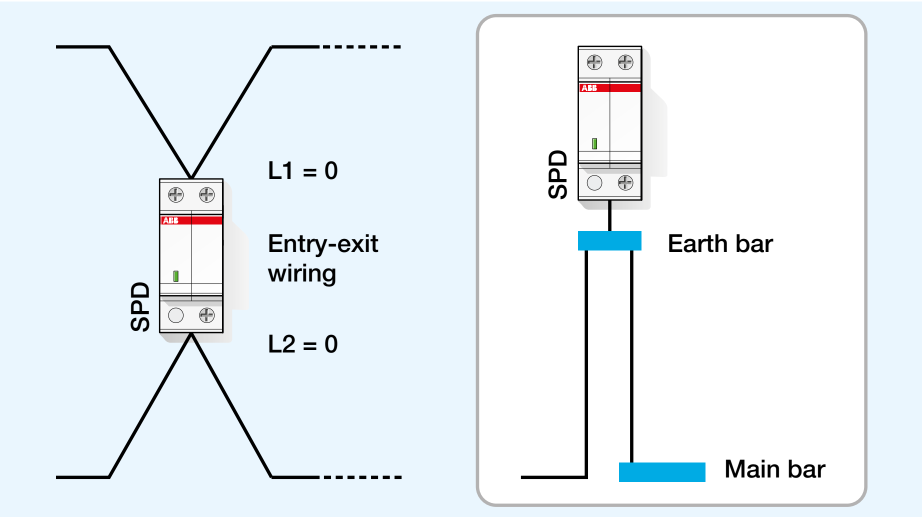
Rules for installation of SPDs
Installation and wiring of SPDs in an electrical switchboard

In the case where the length of the connection (L = L1 + L2 + L3) exceeds 0.50 m, it is recommended to adopt one of the following steps:

1) Reduce the total length L:
- By moving the installation point of the SPD in the switchboard;
- Using V, or "entry-exit" wiring, which allows the lengths of the connections to be reduced to zero (it must, however, be ensured that the rated line current is compatible with the maximum current tolerated by the SPD's terminals);
- In large switchboards, connect the PE coming in to an earth bar near the SPD (the length of the connection is only the spur off from this point, so a few cm); downstream of the connection point, the PE can be taken to the main earth bar.



2) Choose a SPD with a lower level of protection U_p

Install a second SPD coordinated with the first as close as possible to the device to be protected, so as to make the level of protection compatible with the impulse withstand voltage of the equipment.

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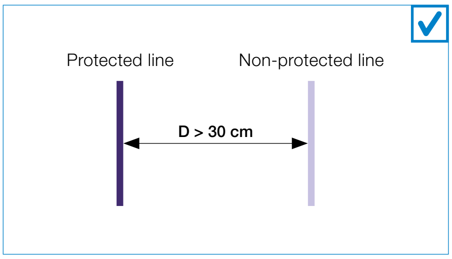
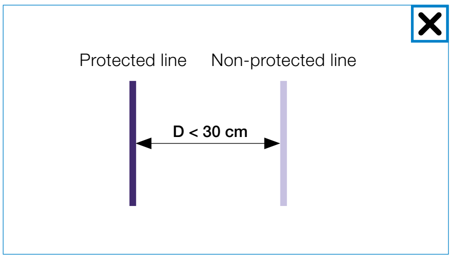
Rules for installation of SPDs
Installation and wiring of SPDs in an electrical switchboard

Electrical lines and connection area
It is necessary to arrange the lines so that the conductors are as close as possible to each other (see figure) to avoid surges induced by inductive coupling of an indirect lightning strike with a large loop contained between the phases, the neutral and the PE conductor.

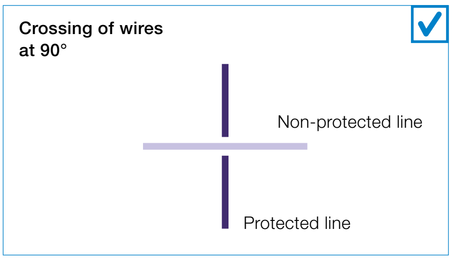
Cabling of protected and non-protected lines
During installation, run the protected and non-protected wiring according to the instructions in the diagrams below.
To avoid the risk of electromagnetic coupling between different types of wires, it is strongly recommended they be kept at a distance from one another (> 30 cm) and that when it is not possible to avoid them crossing, this needs to be performed at a right angle.

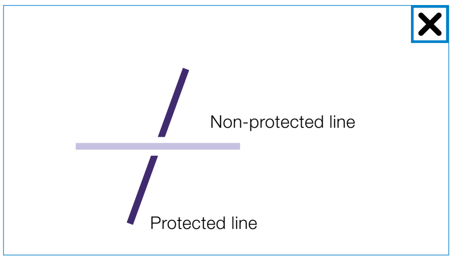
Distance between two wires:

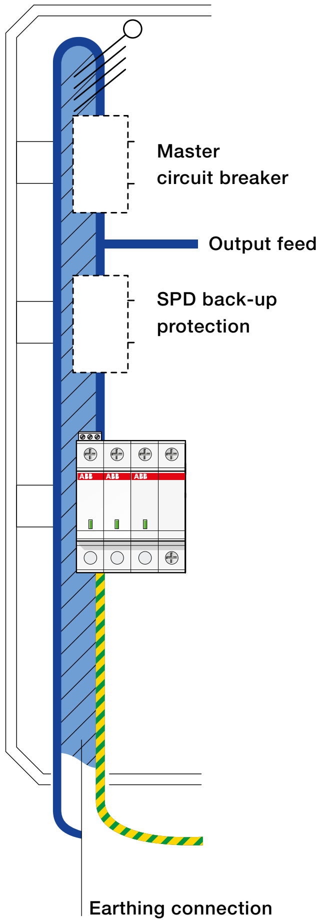




Wires crossing:







Equipotential earthing
It is fundamental to check the equipotentiality of the earths of all the equipment. The equipment's earth connection must also be distributed, starting from the connection of the SPD which protects it.
This allows the connection distances and therefore the voltage U_{prot} to be limited.

Section of the connections

Wiring between active network conductors and the SPD
The cable section must be at least the same as the upstream wiring. The shape of wiring is more important than the section. The recommended section for Main Board is 10 mm² for phase and Neutral and 16 mm² for earth.

Wiring between the SPD and earth
The minimum section is 4 mm² in the case where there is no lightning conductor, and 10 mm² in the case one is installed. It is nevertheless recommended to use a cable with a greater section to leave a safety margin, e.g. 10-20 mm² section.

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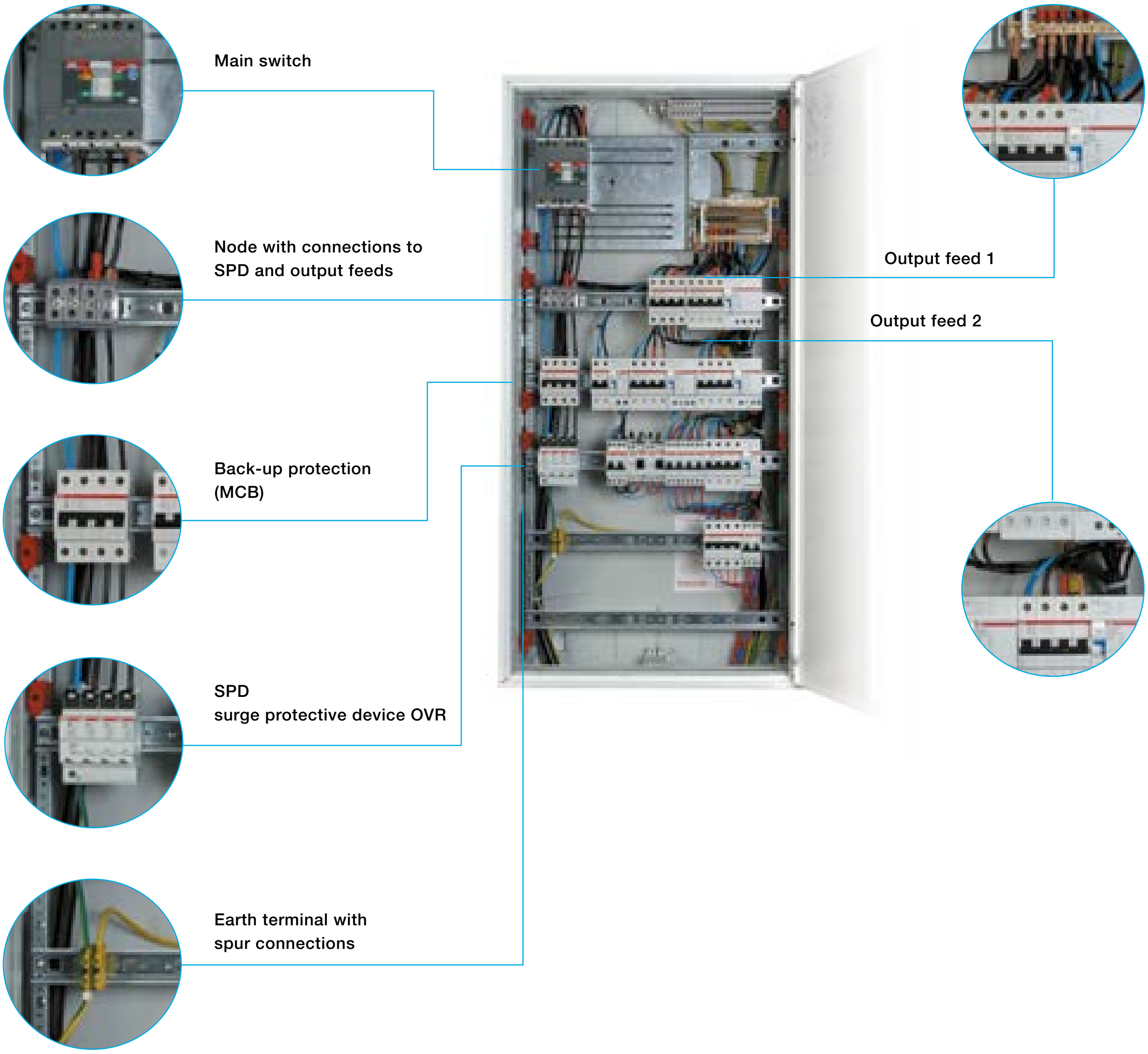
Rules for installation of SPDs

Example of an electrical switchboard protected by ABB surge protection solutions



Rules followed by the installer:
- Connection distances < 50 cm
- Earth terminal in proximity to SPD
- Back-up protection dedicated to the SPD
- Protection installed upstream of RCDs
- Reduction of the loop between the phases, neutral and PE

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Further technical information for the curious

My neighbor has installed a lightning conductor, could it have an effect on my electrical system in the case of a storm?

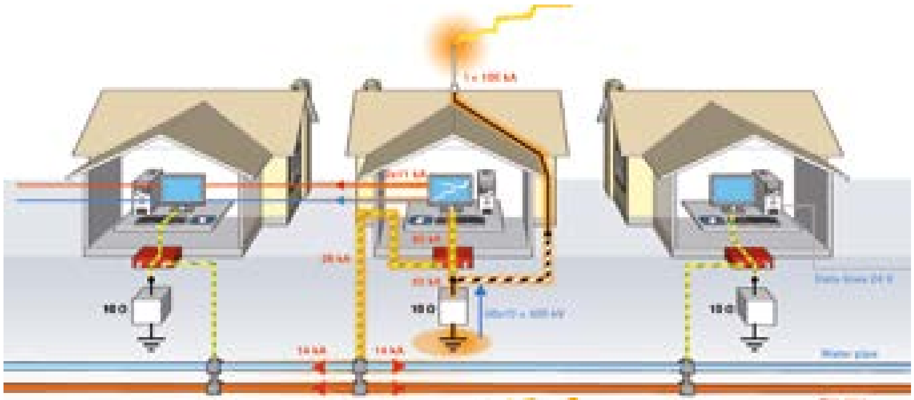
Two phenomena could occur in the case of a direct lightning strike on your neighbor's house:

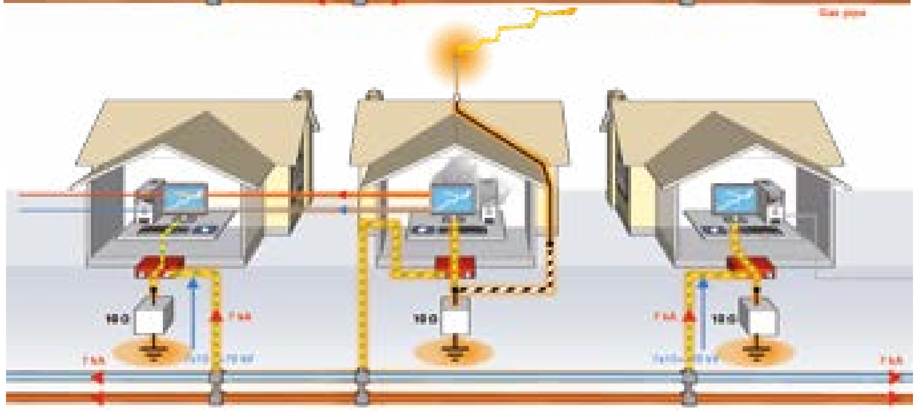
- The first is the conduction of the lightning current to your system through the electrical network or other conductive elements, if they are interconnected.
- The second is the indirect effect resulting from the strong current of the lightning passing through your neighbor's lightning ground system.

If your neighbor has installed a lightning conductor, it is highly recommended to install a SPD on your own installation.

In densely populated areas the electrical connections and the water/gas mains can be common to different buildings. The metal pipes are earthed in different points.
In the case of a direct lightning strike on a lightning rod, about half of the current flows to earth, while the rest flows into the electrical network and the other services entering the building (electrical network, pipes...).
The equipment connected near the lightning rod can be hit by the voltage surge through the electricity network or other services. The presence of a lightning rod in the area therefore increases the risk of suffering from a lightning strike.

Conduction of the lightning current to your electrical system





Indirect lightning strikes resulting from a direct strike in the surrounding area

The passage of the lightning current in the conduit generates a strong surge. A surge can damage the equipment connected to the nearby electrical installations: this is the phenomenon of an indirect lightning strike.

Multiple factors attenuate the effect of an indirect lightning strike: The distance between the two houses, the presence of metallic meshes (e.g. in concrete), shielding of wiring…
A detailed calculation of the effects of the passage of the lightning current inside the building is given on the next page.

If there is a lightning rod nearby it is always preferable to install surge protection.

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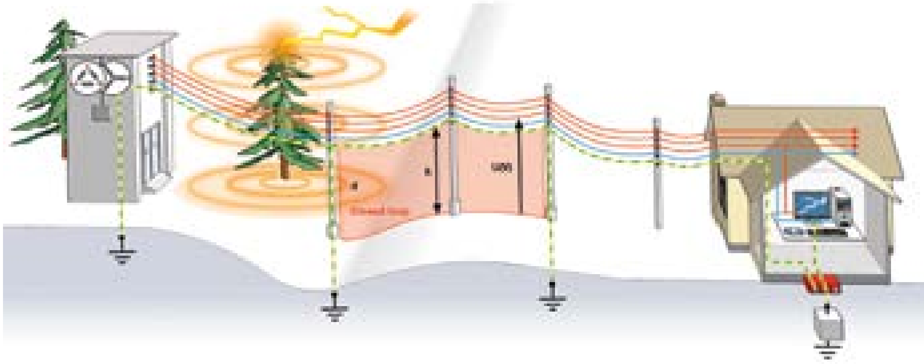
Further technical information for the curious
Example calculations of the effects of indirect lightning strikes

Indirect lightning strike on the aerial electricity lines



Example: k = 1, i = 40 kA, d = 60 m, h = 6 m => U = 120 kV
The voltage surge runs through the aerial electricity lines to arrive on the connected equipment and damaging it.

The lightning provokes a sudden increase in the magnetic field (dB/dt), causing an overvoltage surge in the loops (transformer effect).

The aerial electricity supply lines behave like closed loops (due to the connection to earth of the PE in TNS systems and neutral to earth for TT). The loops generate an overvoltage U when they are struck by the magnetic wave. The formula is :

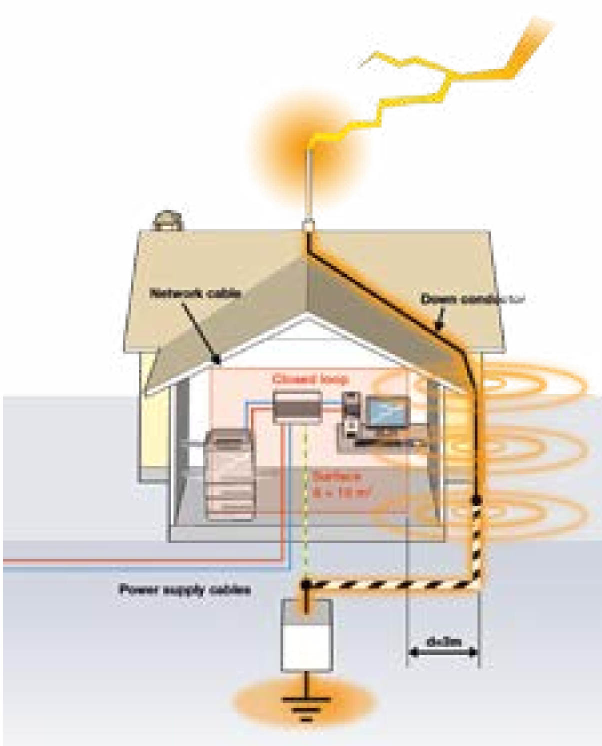
$$U = 30 \times k \times \frac{h}{d} \times I$$

(IEC 61 643-12 Annex C.1.3.)

I = Lightning current
h = Height of the conductor from the ground
k = A factor which depends on the return speed of the discharge in the lightning conduit (k = 1-1.3)
d = Distance from the lightning

Indirect lightning strike due to passage of current through the lightning conductor

The direct lightning strike on the building creates an indirect lightning strike in the surrounding area.
Calculation of overvoltage U with the effect of the indirect lightning strike inside the building:



$$U = \frac{\Delta\phi}{\Delta t} \quad \begin{cases} \phi = B \times S \\ B = f(i, d, \mu ...) \end{cases}$$

$$U = \frac{200 \times S \times \Delta i}{d \times \Delta t}$$

ΔI/Δt: Speedness of the current wave
d= Distance between down conductor and closed loop
S= Surface of the closed loop

Example

ΔI/Δt =15kA/μs
d=3m
S=10m²

$$U = \frac{200 \times 10 \times 15\ (kA)}{3 \times 1\ (\mu s)} = 10\ kV$$

Note: Annex B of IEC 61024-1-2 indicates the calculation for the overvoltage caused by lightning striking a structure.

The effect of the indirect lightning strike is large even in the area surrounding the lightning rod, for example in the neighboring houses.

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Further technical information for the curious
Protection distance

As previously described in the guide, protection is 100% assured up to a distance of 10 m downstream of the SPD. Beyond that distance it is always recommended to repeat the devices in order to protect the equipment, since the residual voltage tends to increase and can become greater than the equipment's impulse withstand voltage. A surge exceeding the impulse withstand voltage value would damage the equipment.

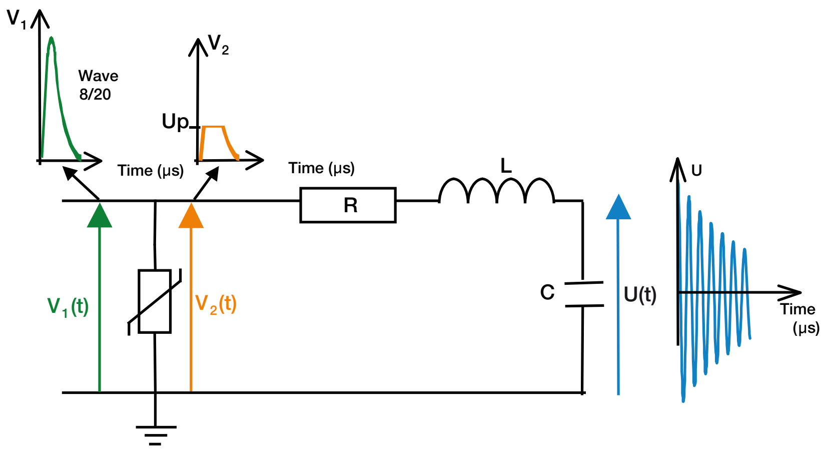
There are two factors which have the greatest influence on the voltage downstream of the SPD:
- The first is the propensity of the electrical network downstream of the SPD to collect the magnetic field variations. The cables downstream of a SPD can be subject to an indirect lightning strike causing surges to occur in the circuit, even if positioned downstream of a SPD!
- The second is linked to the phenomenon of oscillation: the voltage U_p that the SPD limits at its terminals is amplified downstream of the installation. The greater the distance between the SPD and the device requiring protection, the greater this amplification will be. The oscillations can create voltages in the equipment which can reach two times the U_p value. The amplification depends on the SPD itself, the electrical network, the length of the conductors, the discharge gradient (spectral composition of the discharge) and the equipment connected.

The worst case is encountered when the equipment has a high impedance or is internally disconnected from the network (a device turned off at a switch acts as a capacitor).

The phenomenon of oscillation needs only be considered if the distance between the SPD and the equipment is greater than 10 m (IEC 61 643-12 § 6.1.2 & annex K.1.2). Below this distance, protection is 100% guaranteed.

The electrical circuit can be modeled as an RLC circuit (Resistor – Inductor – Capacitor): a diagram of it is shown in the figure

Legend:
V_1: Supply voltages
V_2: Voltage at SPD terminals
U: Voltage at equipment terminals (disconnected from network)



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Impulse voltage downstream of the SPD

The voltage at the terminals of the SPD during a discharge is characterized by the sum (Fourier series) of the sinusoids of approximately a half period and of frequency between 0 and 400 kHz. For frequencies greater than 400 kHz, the amplitude is low enough to be able to consider the effect of the oscillation to be negligible (for the 10/350 µs and 8/20 µs waves).

Behavior of an RLC circuit with a sinusoidal impulse

The voltage u(t) in the equipment in function of the voltage at the SPD terminals (v_2) is governed by the following formula:

$$\frac{d^2u}{dt^2}+\frac{R}{L}\frac{du}{dt}+\omega_0{}^2u=\omega_0{}^2v_2$$

With v_2(t) sinusoidal voltage ($v_2(t)=V_2\cos\omega t$), the voltage in the equipment is:

$$U=\frac{V}{\sqrt{(1-LC\omega^2)^2+R^2C^2\omega^2}}$$

Resonance of the RLC circuit occurs at the angular frequency of:

$$\omega_0=\frac{1}{\sqrt{LC}}$$

And the resonance voltage is:

$$V_2\frac{1}{R}\sqrt{\frac{L}{C}}$$

Influence of the distance between the SPD and the equipment to be protected in the RLC circuit

The phenomenon of resonance can become dangerous when the resonance frequency downstream of the SPD is less than 400 kHz (that is when the circuit is inclined to resonate with the waves which the SPD lets through during a discharge).
In these cases the circuit downstream of the SPD starts to resonate with the waves composing the residual voltage of the discharge. The resonance of the circuit creates surges which can be dangerous to the equipment connected to it.
Despite this, if no delicate equipment is connected downstream of the SPD or if the protection is repeated in proximity to it (at less than 10 meters), protection is ensured.

Distance between the SPD and the equipment to be protected	L (inductance of the downstream cables)	Resonance frequency of the downstream circuit (RLC with C=10nF)	Resonance frequency > 400 kHz = Negligible resonance
1 m	1 µH	1592 kHz	✓
10 m	10 µH	503 kHz	✓
30 m	30 µH	290 kHz	✗
50 m	50 µH	225 kHz	✗
100 m	100 µH	159 kHz	✗

The length of the wires between the SPD and the equipment to be protected must therefore be a maximum of 10 meters to guarantee 100% protection. Above this distance the protection is reduced by the combined effects of the indirect lightning strike (the circuit acts like an antenna) and the resonance of the residual voltage of the discharge.
For this reason the Class 2 SPDs must be installed as close as possible to the equipment to be protected or, if that is not possible, the protection must be repeated.

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Further information for the curious
SPDs and MCBs, two complementary protection devices

SPDs and MCBs are two protection elements for electrical systems. They are both installed on DIN rails and have similar dimensions…
But how valid is the comparison?

From some points of view they are very different. Let's see why:

	OVR T2 SPD	**S200 MCB**
Are 4-phase or 3-phase plus neutral versions preferable for three-phase networks?	The 3N versions (three-phase + neutral) have superior performance: they can be installed upstream of the RCD to protect it and avoid unwanted tripping. Furthermore, no current flows to earth at rated voltage throughout the life of the SPD.	The 4-phase versions are more complete, as they also protect neutral.
Product wiring	It is wired in parallel	It is installed in series, in different points of the installation.
Nominal voltage	This is the voltage between phase and earth, because SPDs are connected between phase and earth.	This is the voltage between phases, or between phase and neutral.
A current in kA?	This is the SPD's rated or maximum discharge current (I_n or I_{max}).	This is the breaking power of the breaker at 50 Hz.
Operation	It cuts in and continues to work. It is tested to function 20 times at its rated discharge current.	When it trips out it must be re-armed, after checking the system.
Co-ordination	The upstream SPD operates first, then those downstream in a cascade. All SPDs work one after the other to reduce the effect of the discharge.	Only the breaker immediately upstream of the fault trips out.
Short circuits are its...	Working tool – the SPD short-circuits phase and earth for an instant. After the discharge it restores its isolation.	Enemy, as soon as a short circuit occurs it opens the faulty circuit.

SPDs and MCBs are two complementary products for protecting electrical switchboards; each product operates very differently, but their aim is the same: safety.

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Practical examples
Example for protecting household equipment

OVR T2 1N 40 275 P QS
Protection of the electrical system

OVR TC 200 FR P
Protection of telephone systems

Protecting household equipment

Type	Order code	Maximum discharge current I_{max} (8/20)	Rated discharge current I_n	Rated voltage U_n	Protection level U_p
OVR T2 1N 40-275 P QS	2CTB803972R1100	40 kA	20 kA	230 V	1.25 kV
OVR TC 200FR P	2CTB804820R0500	10 kA	5 kA	200 V	400 V

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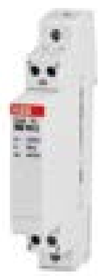
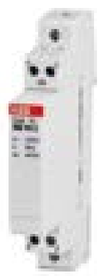
Practical examples
Example for protecting equipment in the office



OVR TC 48 V P - ISDN
Protection of telephone lines



OVR TC 24 V P
Protection of entry-phone systems

OVR T1-T2 3N 12.5-275s P TS QS
Protection against direct lightning strikes

OVR T2 1N 40-275 P QS
Protection of system

Protecting equipment in the office

Type	Order code	Impulse current I_{imp} (10/350) per pole	Maximum discharge current I_{max} (8/20)	Rated discharge current I_n	Rated voltage U_n	Protection level U_p
OVR TC 24V P	2CTB804820R0200	/	10 kA	5 kA	24 V	35 V
OVR TC 48V P	2CTB804820R0300	/	10 kA	5 kA	48 V	70 V
OVR T1-T2 3N 12.5-275s P TS QS	2CTB815710R0700	25 kA	/	30 kA	230 V	1.3 kV
OVR T2 1N 40-275 P QS	2CTB803972R1100	/	40 kA	20 kA	230 V	1.25 kV

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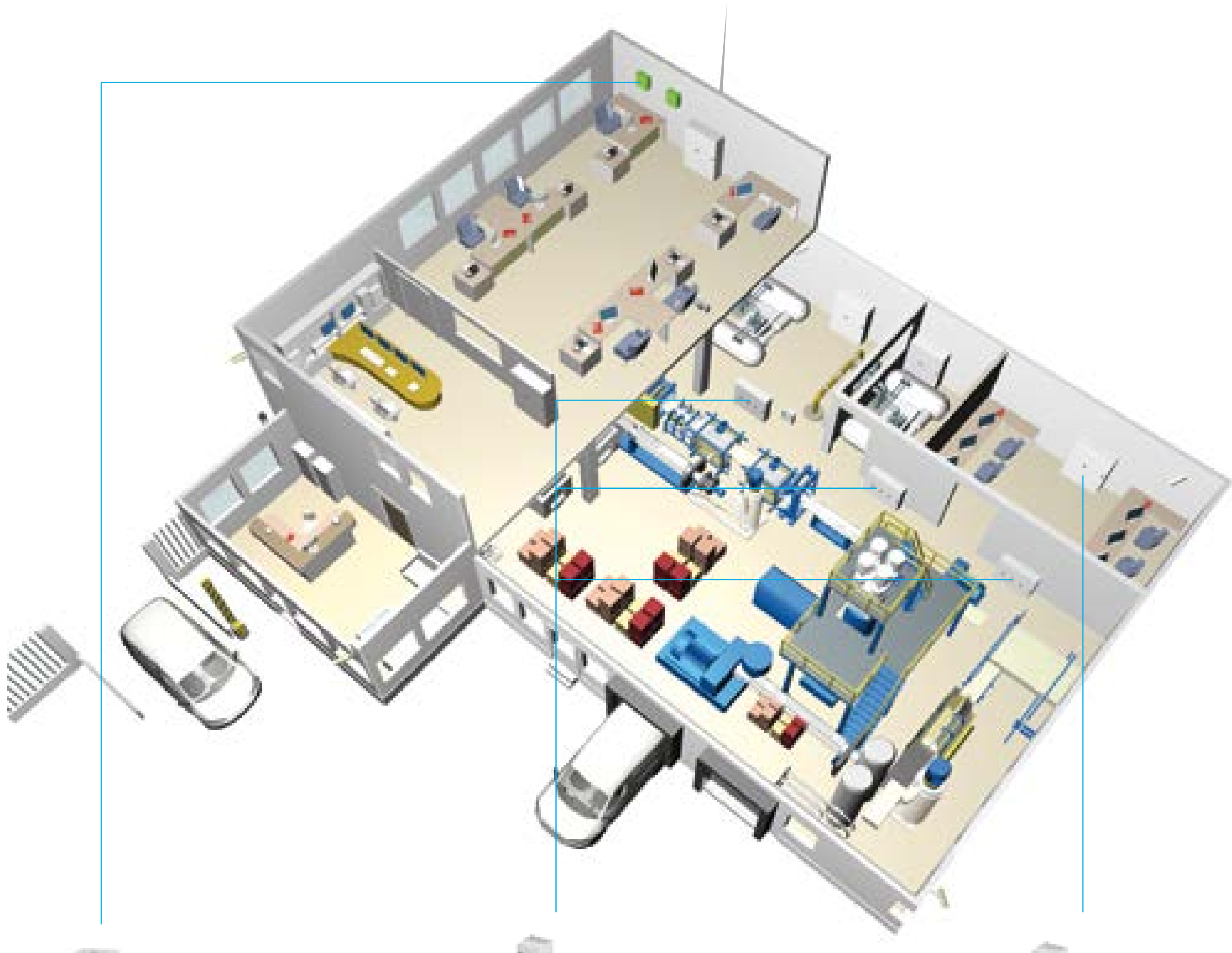
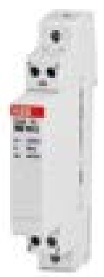
Practical examples
Example for protecting equipment in an industrial scenario





OVR TC 48 V P - ISDN
Protection for telecommunications and data lines

OVR T2 3N 40-275 P TS QS
Protection against indirect lightning strikes

OVR T1-T2 3N 12.5-275s P TS QS
Protection against direct lightning strikes

Protecting equipment in an industrial scenario

Type	Order code	Impulse current I_{imp} (10/350) per pole	Maximum discharge current I_{max} (8/20)	Rated discharge current I_n	Rated voltage U_n	Protection level U_p
OVR TC 200FR P	2CTB804820R0500	/	10 kA	5 kA	200 V	400 V
OVR TC 48V P	2CTB804820R0300	/	10 kA	5 kA	48 V	70 V
OVR TC 24V P	2CTB804820R0200	/	10 kA	5 kA	24 V	35 V
OVR TC 6V P	2CTB804820R0000	/	10 kA	5 kA	6 V	15 V
OVR T1-T2 3N 12.5-275s P TS QS	2CTB815710R0700	12.5 kA	/	30 kA	230 V	1.3 kV
OVR T2 3N 40-275 P TS QS	2CTB803973R0500	/	40 kA	20 kA	230 V	1.25 kV

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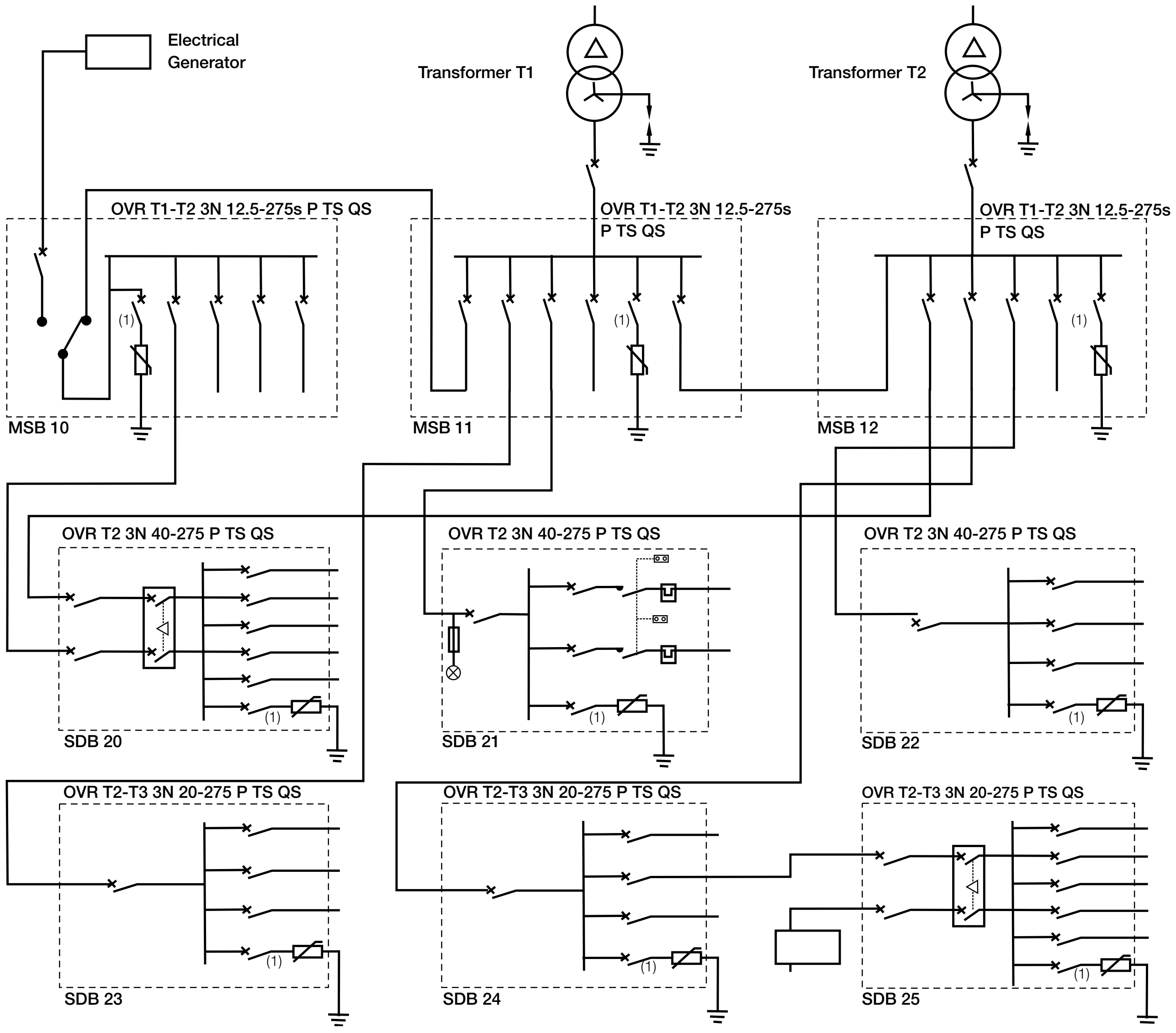
Practical examples
Example for protecting equipment in an industrial scenario



The diagram given above represents an example of an industrial application located in an area in which the lightning density (Ng) is 1.2 lightning strikes/km^2/year:
- The building is protected by an external lightning protection
- The lightning conductor's earth bar is connected to the installation's earthing system
- The earthing system is TNS (main switchboards and secondary distribution switchboard)
- MSBs (Main Switch Boards) 10, 11 and 12 are fitted with OVR T1-T2 3N 12.5-275s P TS QS Type 1-2 SPDs
- SDBs (Secondary Distribution Boards) 20, 21 and 22 are fitted with OVR T2 3N 40-275 P TS QS Type 2 SPDs
- SDBs 23, 24 and 25 are fitted with OVR T2-T3 3N 20-275 P TS QS Type 2-3 SPDs.

[1] The protection device upstream of each SPD may be chosen from the ABB series S 2 MCBs or from the E 9F fuses and E 90 fuse holders.

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Further information
Exploding the myths and reconsidering convictions

Nowadays we use surge protective devices every day, but we still have doubts and curiosities fed by the many urban legends on the subject. Let's look at a few and try to better understand.

"The discharge kilo amperes of a SPD must be coordinated with the short-circuit current of the switchboard"

This belief is due to a misunderstanding. The short circuit current of a switchboard and the discharge current of a SPD are both measured in kilo amperes. However, a short-circuit current normally has a sine wave with a frequency of 50 Hz whilst the discharge current of a SPD has the form of a very brief impulse of just a few microseconds.

Consequently, even the energy content (I_2t) of a short circuit and of a discharge are very different. Once the misunderstanding has been cleared up it is evident that there is no relationship between the I_{sc} of a switchboard and the discharge current of a SPD.

So, how do you choose the discharge current or impulse of a SPD?

It is easier than it seems:

- For a Type 1 SPD there is nothing to choose as the value is imposed by IEC 62 305-1: almost all SPDs have a value of 25 kA per pole and are therefore sized for the worst case provided for by current regulations
- If the risk calculation following the IEC 62305-2 was done a precise current for SPD can be calculated
- For Type 2, the maximum discharge current value foreseen by the standard IEC 62 305-1 is 5 kA, therefore a Type 2 SPD must have at least 5 kA of I_n.

For practical reasons it is nearly always advisable to choose a SPD with at least 20 kA of I_n to ensure an adequate length of working life.

"In a three-phase system with 400 V AC voltage a SPD with a rated voltage of 400 V AC must be installed"

Other misunderstandings. Type 1 and Type 2 surge protective devices are designed to be installed between network and ground, not in series. The "rated voltage" of a SPD is, therefore, that measured between the active conductors (phase and neutral) and the earth conductor.

In a 400 V three-phase network, with or without neutral, this voltage will always be equal to 230 V! The only rare case in which 400 V SPDs are required in a 400 V three-phase network is that of IT systems: in these, indeed, automatic breakage of the power does not happen with a first earth fault. A SPD with 230 V voltage would be subjected to a phase/earth voltage much higher than the nominal voltage and consequently there would be the risk of a failure or fire.

"In a main distribution board it is always best to use a Type 1 SPD"

It depends! In a very large public building or an industrial unit, the risk analysis pursuant to IEC 62 305-2 will probably provide for the installation of an LPS, acronym for "Lightning Protection System", in other words a lightning rod or Faraday cage. In this case the Type 1 SPD will be necessary to protect against damage due to lightning striking the building.

If no LPS is provided for, however, the installation of a Type 1 SPD in the MDB will cause a notable increase in costs without any benefits – it will simply never have to operate!

"To protect a SPD it is necessary to use fuses, breakers are not suitable"

This is also an "Urban legend". Some say that the inductance in series to a circuit breaker reduces the efficiency of the SPD with the discharge current flowing through it. In truth, the SPD product Standard, IEC EN 61643, requires that the manufacturer provide suitable and co-ordinated back-up protection to install upstream from the SPD.

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Further information
Exploding the myths and reconsidering convictions

The sizing is carried out in the laboratory trying numerous, different, combinations of SPD and protective devices. With most of its products ABB offers the possibility of using either fuses or MCBs.
So what about inductance? As we all know, the inductance of a coil depends on the frequency; a few tests in the laboratory are sufficient to show that the inductance of a MCB at the typical frequencies of atmospheric phenomena (many kHz) becomes negligible.

OVR T2 3N 40-275 P QS

"When lightning strikes and the SPD trips, the SPD must always be replaced"
No, SPDs are not "disposable"! Also because, if this was the case, since there can be numerous atmospheric discharges during a thunderstorm, the SPD would be totally ineffective. In reality, SPDs are designed and tested in order to intervene and to go back to being as good as new at least 20 times, if subjected to their rated discharge current.
Given that statistically speaking the discharge current induced by the atmospheric phenomenon is inferior to the rated current, the SPD can trip even hundreds of times before reaching the so-called "end of life". This is the reason why SPDs are installed every day, but changing a cartridge at the end of its life is a rare occurrence.

"A Type 2 SPD is nothing more than a varistor..."
The varistor is a fundamental component of all Type 2 SPDs, but we must not forget that varistors have two characteristics which a SPD must provide a solution to: they end their operative life in short circuit and they conduct a small permanent current.
In order to prevent the short circuit effects at the end of the varistor's life, a small, essential element is provided inside a SPD: a thermal disconnector which isolates the varistor from the network in case of overheating, ensuring a safe end of life for the SPD.
In order to prevent the permanent current to earth, on the other hand, which could involve the risk of indirect contact, in some Type 2 SPDs the N-PE module which is designed to lead the discharge current towards the earth conductor is not realized with a varistor, but with a voltage switching type element (for example, a spark gap), able to permanently prevent the current flow towards the PE.
All ABB OVR T2 1N and 3N SPDs are realized with this technology.

"The remote signaling contact tells me the SPD has intervened"
No, the signaling contact switches only when the SPD has reached the end of its operative life. Very useful in the event of unmonitored distribution switchboards, the information can be used, for example, in order to quickly replace the cartridge at the end of its life and to restore the protection against overvoltage surges.

"A SPD for alternating current can also be used in direct current; it is just a matter of multiplying its rated voltage by the square root of two"
This is the principle for which many SPD for alternating current at 400 V have without warning become SPDs for photovoltaic at 600 VDC
ABB's position on this is very clear: sooner or later the varistors go into short circuit, and interrupting a short circuit in direct current is much more difficult than in alternating current. It cannot, therefore, be absolutely ensured that the thermal disconnector integrated in a SPD designed for alternating current is able to ensure disconnection when the same SPD is installed in a photovoltaic plant: the manufacturer must test it in a laboratory and, in general, must provide for new back up protection, sized for DC applications.

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Notes

note4

Selection tables
OVR surge protective devices - IEC version

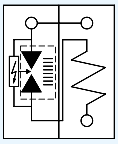
Type 1 SPDs provide input protection for installations in areas with high levels of lightning strikes, and are typically installed in main distribution switchboards. Among their main features:
- High performance, with 2.5 kV protection level and 25 kA per pole lightning current
- High operational continuity and low maintenance costs thanks to extinguishment of follow-through currents up to 50 kA
- Suitable for installation upstream of the RCD ("3 + 1" and "1 + 1" schemes)
- Reduction of the effective protection level U_{prot} thanks to the double terminals allowing "V" cabling up to a rated current of 125 A
- Flexible wiring, with cables and bars
- Flexible application, suitable for everything from service industries to heavy industry.

The single-pole module allows common-mode configurations to be freely installed; combined with the neutral modules, common and differential mode configurations can be obtained. The multi-pole modules integrate the different configurations in a single device.
Type 1 SPDs from the OVR range are automatically co-ordinated with OVR Type 2 SPDs.

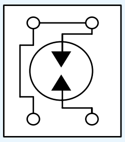
Standards : IEC 61643-11 / EN 61 643-11
Test parameters:
Lightning current with 10/350 µs waveform

Current current per pole (10/350 µs wave)	Follow-through current extinguishment If @ Uc	Level of protection U_p	Protection fuse gG	Distribution system
I_{imp} kA	kA	kV	A	
Without remote contact, Uc = 255 V AC, Un = 230/400 V AC				
25	50	2.5	125	-
25	50	2.5	125	TT, TN-S
25	50	2.5	125	TN-S
25	50	2.5	125	TN-C
25	50	2.5	125	TN-S
25	50	2.5	125	TT, TN-S
25	7	2.5	125	TT, TN-S, TN-C
25	7	2.5	125	TT, TN-S
With remote contact, Uc = 255 V AC, Un = 230/400 V AC				
25	50	2.5	125	TT, TN-S
25	50	2.5	125	TN-S
25	50	2.5	125	TN-C
25	50	2.5	125	TN-S
25	50	2.5	125	TT, TN-S
Without remote contact, Uc = 440 V AC, Un = 400/690 V AC				
25	50	2.5	125	IT, TT, TN
Neutral modules N-PE				
25	0.1	4	125	TT, TN-S, TN-C
50	0.1	2.5	-	-
100	0.1	4.0	-	-

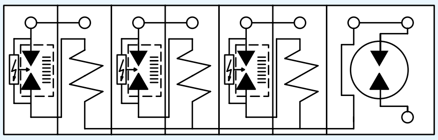
* only for the single-pole module U_n = 230 V AC



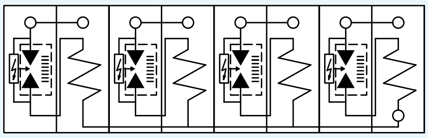
OVR T1 25 255



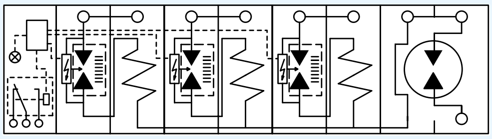
OVR T1 50 N
OVR T1 100 N



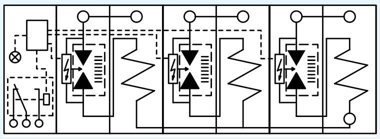
OVR T1 3N 25 255



OVR T1 4L 25 255



OVR T1 3N 25 255 TS



OVR T1 3L 25 255 TS

Poles	Type	Order code	Unit weight kg	Packaging
1*	OVR T1 25-255	2CTB815101R0100	0.25	1
1+N	OVR T1 1N 25-255	2CTB815101R1500	0.50	1
2	OVR T1 2L 25-255	2CTB815101R1200	0.50	1
3	OVR T1 3L 25-255	2CTB815101R1300	0.75	1
4	OVR T1 4L 25-255	2CTB815101R1400	1.00	1
3+N	OVR T1 3N 25-255	2CTB815101R1600	1.00	1
1	OVR T1 25 255-7	2CTB815101R8700		1
3+N	OVR T1 3N 25 255-7	2CTB815101R8800		1
1+N	OVR T1 1N 25-255 TS	2CTB815101R1000	0.50	1
2	OVR T1 2L 25-255 TS	2CTB815101R1100	0.50	1
3	OVR T1 3L 25-255 TS	2CTB815101R0600	0.85	1
4	OVR T1 4L 25-255 TS	2CTB815101R0800	1.10	1
3+N	OVR T1 3N 25-255 TS	2CTB815101R0700	1.10	1
1	OVR T1 25 440-50	2CTB815101R9300		1
N	OVR T1 25 N	2CTB815101R9700	0.25	1
N	OVR T1 50 N	2CTB815101R0400	0.25	1
N	OVR T1 100 N	2CTB815101R0500	0.25	1

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Selection tables
OVR surge protective devices - IEC version

T1+2 type SPDs combine high discharge performance for lightning impulse currents with an extremely reduced level of protection, making them ideal in all small plants: it is possible to obtain both protection against lightning currents and protection of terminal equipment with a single product. Among their main features:

- An integrated solution equivalent to an automatically co-ordinated Type 1 and Type 2 SPD, inside the same distribution switchboard
- High performance, with 1.5 kV protection level and up to 25 kA per pole lightning current
- High operational continuity and low maintenance costs thanks to extinguishment of follow-through currents up to 7-15 kA depending on the version
- Suitable for installation upstream of the RCD ("3 + 1" and "1 + 1" schemes)
- Reduction of the effective protection level U_{prot} thanks to the double terminals allowing "V" cabling up to a rated current of 125 A (25 kA version)
- Quick and easy maintenance thanks to the pluggable cartridge format (25 kA version).

Combined with the OVR T1 50 N and OVR T1 100 N neutral modules, it is possible to create configurations for single-phase and three-phase TT, TN-C and TN-S distribution systems.

T1+2 SPDs from the OVR range are automatically co-ordinated with OVR Type 2 SPDs.

Standards: IEC 61643-11 / EN 61 643-11
Test parameters:
- Lightning current with 10/350 µs waveform
- Discharge current with 8/20 µs waveform

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Selection tables
OVR surge protective devices - IEC version

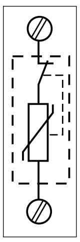
Standards: IEC 61643-11 / EN 61 643-11
Test parameters: discharge current with 8/20 µs waveform

Type 2 SPDs with pluggable cartridges are suitable for installation at the origin of the network, in intermediate switchboards and near the terminal equipment. The whole range has end-of-life indicators. The "s" versions also have an operational safety reserve: when a cartridge reaches its reserve, it is still able to operate, but with reduced performance. Among their main features:
- Installation upstream of RCDs ("3+1" and "1+1" versions)
- Simplified maintenance thanks to the possibility to change the cartridge instead of the whole product and the safety reserve on all "s" versions
- Constant monitoring of the product's status thanks to the integrated signalling contact (TS versions)
- Flexibility in application, from residential to industrial.

All Type 2 SPDs from the OVR range are automatically co-ordinated by respecting a minimum distance of 1 m between upstream and downstream devices.

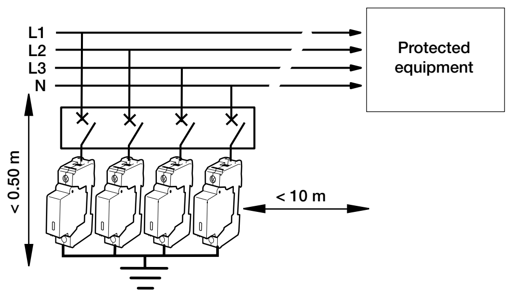
Single-pole Type 2 SPDs with pluggable cartridges

Diagrams



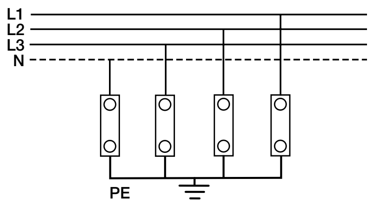
OVR T2 15 / 40 / 70 P

Connection

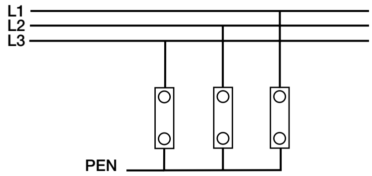


OVR T2 15 / 40 / 70 P

Network types



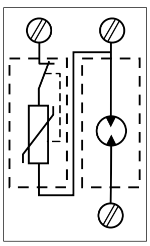
TT-TNS-IT networks



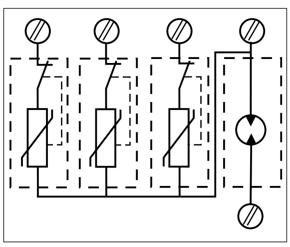
TNC networks

Multi-pole Type 2 1P+N, 3P+N SPDs with pluggable cartridges

Diagrams

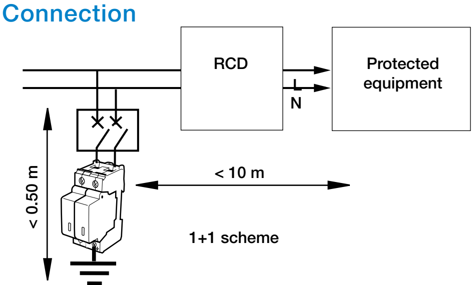


OVR T2 1N 15 / 40 / 70 P



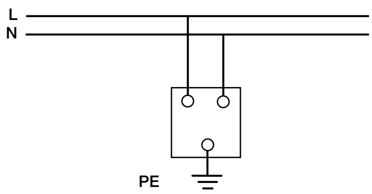
OVR T2 3N 15 / 40 / 70 P

Connection



OVR T2 1N P (all models)

Network types



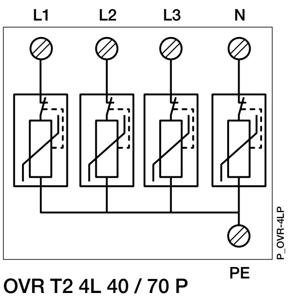
TT-TNS networks

2CTC438167S0201

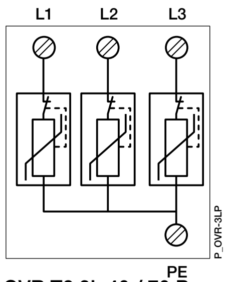
Selection tables
OVR surge protective devices - IEC version

Multi-pole Type 2 3P and 4P SPDs with pluggable cartridges

Diagrams

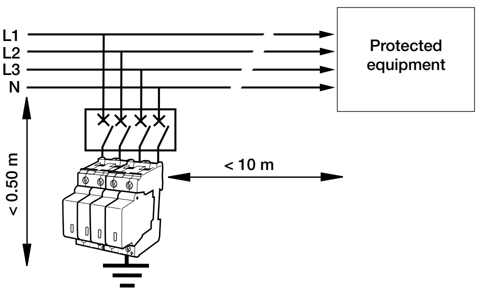


OVR T2 4L 40 / 70 P



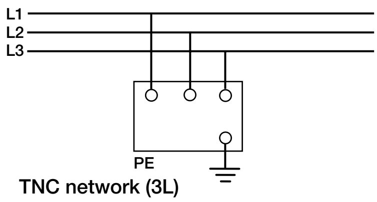
OVR T2 3L 40 / 70 P

Connection

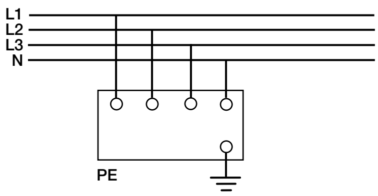


OVR T2 4L P (all models)

Network types



TNC network (3L)



TNS network (4L)

All OVR 1P+N and 3P+N SPDs can be installed upstream of the RCD. This rule is recommended by standards to avoid the current from lightning strikes passing through the RCD. It allows the RCD to be protected, on the one hand, and maintains operational continuity on the other.

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Selection tables
OVR surge protective devices - IEC version

Type 2 and 3 surge protective devices shall be installed as close as possible to the sensitive equipment to protect. As Type 2 they have been characterize by their capacity to safely discharge current with a 8/20 µs wave form and they guarantee the coordination with Type 1 SPDs or other Type 2 respecting coordination distances. As Type 3 they are characterized by their capacity to safely discharge current with 1,2/50 µs wave form, with a very low level of Voltage Protection level..

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Selection tables
OVR surge protective devices - IEC version

Protected lines	Impulse current Iimp 10 / 350 kA	Max. discharge current Imax 8 / 20 kA	Nominal discharge current In kA	Follow current interrupting rating Ifi kA	Voltage protection level Up kV	Nominal voltage Un V	Max. cont. operating voltage Uc V	Type	Order codes
Type 1 - Unpluggable									
Uc 255 V									
1	25	60	25	50	2.5	230	255	OVR T1 25-255	2CTB815101R0100
1	25	60	25	7	2.5	230	255	OVR T1 25 255-7	2CTB815101R8700
2	25	60	25	50	2.5	230 / 400	255	OVR T1 2L 25-255	2CTB815101R1200
2	25	60	25	50	2.5	230 / 400	255	OVR T1 2L 25-255 TS	2CTB815101R1100
3	25	60	25	50	2.5	230 / 400	255	OVR T1 3L 25-255	2CTB815101R1300
3	25	60	25	50	2.5	230 / 400	255	OVR T1 3L 25-255 TS	2CTB815101R0600
4	25	60	25	50	2.5	230 / 400	255	OVR T1 4L 25-255	2CTB815101R1400
4	25	60	25	50	2.5	230 / 400	255	OVR T1 4L 25-255 TS	2CTB815101R0800
1+1	25	60	25	50	2.5	230	255	OVR T1 1N 25-255	2CTB815101R1500
1+1	25	60	25	50	2.5	230	255	OVR T1 1N 25-255 TS	2CTB815101R1000
3+1	25	60	25	50	2.5	230 / 400	255	OVR T1 3N 25-255	2CTB815101R1600
3+1	25	60	25	50	2.5	230 / 400	255	OVR T1 3N 25-255 TS	2CTB815101R0700
3+1	25	60	25	7	2	230 / 400	255	OVR T1 3N 25 255-7	2CTB815101R8800
Uc 440 V									
1	25	60	25	50	2.5	400	440	OVR T1 25 440-50	2CTB815101R9300
Neutral									
1	25	60	25	0.1	4	440	690	OVR T1 25 N	2CTB815101R9700
1	50	100	25	0.1	1.5	230	255	OVR T1 50 N	2CTB815101R0400
1	100	100	25	0.1	2	230	255	OVR T1 100 N	2CTB815101R0500
Type 1+2									
Uc 255-275 V									
1	12.5	80	30	-	1.1	230	275	OVR T1-T2 12.5-275s P QS	2CTB815710R1200
1	12.5	80	30	-	1.1	230	275	OVR T1-T2 12.5-275s P TS QS	2CTB815710R0000
3	12.5	80	30	-	1.1	230 / 400	275	OVR T1-T2 3L 12.5-275s P QS	2CTB815710R1800
3	12.5	80	30	-	1.1	230 / 400	275	OVR T1-T2 3L 12.5-275s P TS QS	2CTB815710R0600
4	12.5	80	30	-	1.1	230 / 400	275	OVR T1-T2 4L 12.5-275s P QS	2CTB815710R2300
4	12.5	80	30	-	1.1	230 / 400	275	OVR T1-T2 4L 12.5-275s P TS QS	2CTB815710R1100
3+1	12.5	80	30	-	1.3	230 / 400	275	OVR T1-T2 3N 12.5-275s P QS	2CTB815710R1900
3+1	12.5	80	30	-	1.3	230 / 400	275	OVR T1-T2 3N 12.5-275s P TS QS	2CTB815710R0700
1+1	12.5	80	30	-	1.3	230	275	OVR T1-T2 1N 12.5-275s P QS	2CTB815710R1300
1+1	12.5	80	30	-	1.3	230	275	OVR T1-T2 1N 12.5-275s P TS QS	2CTB815710R0100
1	15	60	15	7	1.7	230	255	OVR T1+2 15-255-7	2CTB815101R8900
3+1	15	60	15	7	1.5	230 / 400	255	OVR T1+2 3N 15-255-7	2CTB815101R9000
1	25	60	25	15	1.5	230	255	OVR T1+2 25-255 TS	2CTB815101R0300
3	15	60	15	7	1.5	230 / 400	255	OVR T1+2 3L 15-255-7	2CTB815101R9800
3	25	60	25	-	1.5	230 / 240	255	OVR T1+2 3L 25-255 TS	2CTB815101R4300
4	25	60	25	15	1.5	230 / 240	255	OVR T1+2 4L 25-255 TS	2CTB815101R4200
1+1	25	60	25	15	1.5	230	255	OVR T1+2 1N 25-255 TS	2CTB815101R4400
3+1	25	60	25	15	1.5	230 / 400	255	OVR T1+2 3N 25-255 TS	2CTB815101R4500
Uc 440 V									
1	12.5	80	30	-	1.6	400	440	OVR T1-T2 12.5-440s P QS	2CTB815710R4100
1	12.5	80	30	-	1.6	400	440	OVR T1-T2 12.5-440s P TS QS	2CTB815710R2900
1+1	12.5	80	30	-	1.8	400	440	OVR T1-T2 1N 12.5-440s P QS	2CTB815710R4200
1+1	12.5	80	30	-	1.8	400	440	OVR T1-T2 1N 12.5-440s P TS QS	2CTB815710R3000
3	12.5	80	30	-	1.8	400 / 690	440	OVR T1-T2 3L 12.5-440s P QS	2CTB815710R4700
3	12.5	80	30	-	1.8	400 / 690	440	OVR T1-T2 3L 12.5-440s P TS QS	2CTB815710R3500
3+1	12.5	80	30	-	1.8	400 / 690	440	OVR T1-T2 3N 12.5-440s P QS	2CTB815710R4800
3+1	12.5	80	30	-	1.8	400 / 690	440	OVR T1-T2 3N 12.5-440s P TS QS	2CTB815710R3600
4	12.5	80	30	-	1.8	400 / 690	440	OVR T1-T2 4L 12.5-440s P QS	2CTB815710R5200
4	12.5	80	30	-	1.8	400 / 690	440	OVR T1-T2 4L 12.5-440s P TS QS	2CTB815710R4000
Neutral									
1	50	80	30	-	1	230	275	OVR T1-T2 N 50-275s P QS	2CTB815710R2400
1	50	80	30	-	1	400	440	OVR T1-T2 N 50-440s P QS	2CTB815710R5300
Cartridges									
1	12.5	80	30	-	1.1	230	275	OVR T1-T2 12.5-275s C QS	2CTB815710R2600
1	12.5	80	30	-	1.6	400	440	OVR T1-T2 12.5-440s C QS	2CTB815710R5500
1	50	80	30	-	1	230	275	OVR T1-T2 N 50-275s C QS	2CTB815710R2700
1	50	80	30	-	1	400	440	OVR T1-T2 N 50-440s C QS	2CTB815710R5600

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Selection tables
OVR surge protective devices - IEC version

Protected lines	Impulse current Iimp 10 / 350 kA	Max. discharge current Imax 8 / 20 kA	Nominal discharge current In kA	Follow current interrupting rating Ifi kA	Voltage protection level Up kV	Nominal voltage Un V	Max. cont. operating voltage Uc V	Type	Order codes
Type 2 - Unpluggable									
Uc 150 V									
1	–	20	5	–	0.6	120 (±15%)	150	OVR T2 20-150	2CTB804200R0700
1	–	20	5	–	0.6	120 (±15%)	150	OVR T2 20-150 (x20)	2CTB804200R1700
1	–	40	20	–	0.9	120 (±15%)	150	OVR T2 40-150	2CTB804201R0700
1	–	40	20	–	0.9	120 (±15%)	150	OVR T2 40-150 (x20)	2CTB804201R1700
Uc 275 V									
1	–	20	5	–	1	230	275	OVR T2 20-275	2CTB804200R0100
1	–	20	5	–	1	230	275	OVR T2 20-275 (x20)	2CTB804200R1100
3	–	20	5	–	1	230 / 400	275	OVR T2 3L 20-275	2CTB804600R0400
3	–	20	5	–	1	230 / 400	275	OVR T2 3L 20-275 (x6)	2CTB804600R1400
4	–	20	5	–	1	230 / 400	275	OVR T2 4L 20-275 (x5)	2CTB804600R1500
1	–	40	20	–	1.4	230	275	OVR T2 40-275	2CTB804201R0100
1	–	40	20	–	1.4	230	275	OVR T2 40-275 (x20)	2CTB804201R1100
3	–	40	20	–	1.4	230 / 400	275	OVR T2 3L 40-275	2CTB804601R0400
3	–	40	20	–	1.4	230 / 400	275	OVR T2 3L 40-275 (x6)	2CTB804601R1400
4	–	40	20	–	1.4	230 / 400	275	OVR T2 4L 40-275	2CTB804601R0500
4	–	40	20	–	1.4	230 / 400	275	OVR T2 4L 40-275 (x5)	2CTB804601R1500
Uc 440 V									
1	–	20	5	–	1.3	400	440	OVR T2 20-440	2CTB804200R0200
1	–	20	5	–	1.3	400	440	OVR T2 20-440 (x20)	2CTB804200R1200
1	–	40	20	–	1.9	400	440	OVR T2 40-440	2CTB804201R0200
1	–	40	20	–	1.9	400	440	OVR T2 40-440 (x20)	2CTB804201R1200
Type 2 - Pluggable									
Uc 75 V									
1	–	20	5	–	0.3	57	75	OVR T2 20-75 P	2CTB803851R2800
1	–	20	5	–	0.3	57	75	OVR T2 20-75 P TS	2CTB803851R2700
2	–	20	5	–	0.3	57	75	OVR T2 2 20-75 P	2CTB803852R1700
2	–	20	5	–	0.3	57	75	OVR T2 2 20-75 P TS	2CTB803852R1600
Uc 275 V									
1	2	40	20	–	1.25	230	275	OVR T2 40-275 P QS	2CTB803871R2300
1	2	40	20	–	1.25	230	275	OVR T2 40-275 P TS QS	2CTB803871R1700
1	2	40	20	–	1.5	230	275	OVR T2 40-275s P QS	2CTB815704R1200
1	2	40	20	–	1.5	230	275	OVR T2 40-275s P TS QS	2CTB815704R0000
3	2	40	20	–	1.25	230 / 400	275	OVR T2 3L 40-275 P QS	2CTB803873R2400
3	2	40	20	–	1.25	230 / 400	275	OVR T2 3L 40-275 P TS QS	2CTB803873R2500
3	2	40	20	–	1.5	230 / 400	275	OVR T2 3L 40-275s P QS	2CTB815704R1800
3	2	40	20	–	1.5	230 / 400	275	OVR T2 3L 40-275s P TS QS	2CTB815704R0600
4	2	40	20	–	1.25	230 / 400	275	OVR T2 4L 40-275 P QS	2CTB803873R5600
4	2	40	20	–	1.25	230 / 400	275	OVR T2 4L 40-275 P TS QS	2CTB803873R5200
4	2	40	20	–	1.5	230 / 400	275	OVR T2 4L 40-275s P QS	2CTB815704R2300
4	2	40	20	–	1.5	230 / 400	275	OVR T2 4L 40-275s P TS QS	2CTB815704R1100
1+1	2	40	20	–	1.25	230	275	OVR T2 1N 40-275 P QS	2CTB803972R1100
1+1	2	40	20	–	1.25	230	275	OVR T2 1N 40-275 P TS QS	2CTB803972R0500
1+1	2	40	20	–	1.3	230	275	OVR T2 1N 40-275s P QS	2CTB815704R1400
1+1	2	40	20	–	1.3	230	275	OVR T2 1N 40-275s P TS QS	2CTB815704R0200
3+1	2	40	20	–	1.5	230 / 400	275	OVR T2 3N 40-275 P QS	2CTB803973R1100
3+1	2	40	20	–	1.5	230	275	OVR T2 3N 40-275 P TS QS	2CTB803973R0500
3+1	2	40	20	–	1.5	230	275	OVR T2 3N 40-275s P QS	2CTB815704R2000
3+1	2	40	20	–	1.5	230	275	OVR T2 3N 40-275s P TS QS	2CTB815704R0800
1	6.25	80	30	–	1.8	230	275	OVR T2 80-275s P QS	2CTB815708R1200
1	6.25	80	30	–	1.8	230	275	OVR T2 80-275s P TS QS	2CTB815708R0000
3	6.25	80	30	–	1.8	230 / 400	275	OVR T2 3L 80-275s P QS	2CTB815708R1800
3	6.25	80	30	–	1.8	230 / 400	275	OVR T2 3L 80-275s P TS QS	2CTB815708R0600
4	6.25	80	30	–	1.8	230 / 400	275	OVR T2 4L 80-275s P QS	2CTB815708R2300
4	6.25	80	30	–	1.8	230 / 400	275	OVR T2 4L 80-275s P TS QS	2CTB815708R1100
1+1	6.25	80	30	–	1.8	230	275	OVR T2 1N 80-275s P QS	2CTB815708R1400
1+1	6.25	80	30	–	1.8	230	275	OVR T2 1N 80-275s P TS QS	2CTB815708R0200
3+1	6.25	80	30	–	1.8	230 / 400	275	OVR T2 3N 80-275s P QS	2CTB815708R2000
3+1	6.25	80	30	–	1.8	230	275	OVR T2 3N 80-275s P TS QS	2CTB815708R0800
Neutral									
1	–	80	30	–	1.4	230	275	OVR T2 N 80-275 P QS	2CTB803973R1900
1	–	80	30	–	1.8	230	275	OVR T2 N 80-275s P QS	2CTB815708R2500
Cartridges									
1	–	40	20	–	1.25	230	275	OVR T2 40-275 C QS	2CTB803876R1000
1	–	40	20	–	1.5	230	275	OVR T2 40-275s C QS	2CTB815704R2600
1	–	80	30	–	1.4	230	275	OVR T2 N 80-275 C QS	2CTB803876R0000
1	–	80	30	–	1.8	230	275	OVR T2 80-275s C QS	2CTB815708R2600
1	–	80	30	–	1.8	230	275	OVR T2 N 80-275s C QS	2CTB815708R2800

(x5) packaging of 5 pieces. (x6) packaging of 6 pieces. (x20) packaging of 20 pieces.

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Selection tables
OVR surge protective devices - IEC version

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Follow current interrupting rating Ifi kA	Voltage protection level Up kV	Nominal voltage Un V	Max. cont. operating voltage Uc V	Type	Order code
Type 2 - Pluggable									
Uc 350 V									
1	2	40	20	–	1.5	230	350	OVR T2 40-350 P QS	2CTB803881R2300
1	2	40	20	–	1.5	230	350	OVR T2 40-350 P TS QS	2CTB803881R1700
1+1	2	40	20	–	1.7	230	350	OVR T2 1N 40-350 P QS	2CTB803982R1100
1+1	2	40	20	–	1.7	230	350	OVR T2 1N 40-350 P TS QS	2CTB803982R0500
3	2	40	20	–	1.5	230 / 400	350	OVR T2 3L 40-350 P QS	2CTB803883R2400
3	2	40	20	–	1.5	230 / 400	350	OVR T2 3L 40-350 P TS QS	2CTB803883R2500
3+1	2	40	20	–	1.7	230 / 400	350	OVR T2 3N 40-350 P QS	2CTB803983R1100
3+1	2	40	20	–	1.7	230 / 400	350	OVR T2 3N 40-350 P TS QS	2CTB803983R0500
Neutral									
1	–	80	30	–	1.4	230	275	OVR T2 N 80-275 P QS	2CTB803973R1900
1	–	80	30	–	1.4	230	350	OVR T2 N 80-350 P QS	2CTB803983R1900
Cartridges									
1	–	40	20	–	1.5	230	350	OVR T2 40-350 C QS	2CTB803886R1000
1	–	80	30	–	1.4	230	350	OVR T2 N 80-350 C QS	2CTB803886R0000
Uc 440 V									
1	2	40	20	–	1.8	400	440	OVR T2 40-440 P QS	2CTB803871R1200
1	2	40	20	–	1.8	400	440	OVR T2 40-440 P TS QS	2CTB803871R0500
1	2	40	20	–	2	400	440	OVR T2 40-440s P QS*	2CTB815704R4100
1	2	40	20	–	2	400	440	OVR T2 40-440s P TS QS*	2CTB815704R2900
3	2	40	20	–	1.8	400 / 690	440	OVR T2 3L 40-440 P QS	2CTB803873R2800
3	2	40	20	–	1.8	400 / 690	440	OVR T2 3L 40-440 P TS QS	2CTB803873R2700
4	2	40	20	–	1.8	400 / 690	440	OVR T2 4L 40-440 P QS	2CTB803873R5100
4	2	40	20	–	1.8	400 / 690	440	OVR T2 4L 40-440 P TS QS	2CTB803873R5300
3+1	2	40	20	–	2.1	400 / 690	440	OVR T2 3N 40-440 P QS	2CTB803973R1400
3+1	2	40	20	–	2.1	400 / 690	440	OVR T2 3N 40-440 P TS QS	2CTB803973R1500
3+1	2	40	20	–	2	400 / 690	440	OVR T2 3N 40-440s P TS QS*	2CTB815704R3700
1	–	120	60	–	2.5	400	440	OVR T2 120-440s P TS	2CTB803951R1300
1	6.25	80	30	–	2.4	400	440	OVR T2 80-440s P QS*	2CTB815708R4100
1	6.25	80	30	–	2.4	400	440	OVR T2 80-440s P TS QS*	2CTB815708R2900
3	6.25	80	30	–	2.4	400 / 690	440	OVR T2 3L 80-440s P QS*	2CTB815708R4700
3	6.25	80	30	–	2.4	400 / 690	440	OVR T2 3L 80-440s P TS QS*	2CTB815708R3500
4	6.25	80	30	–	2.4	400 / 690	440	OVR T2 4L 80-440s P QS*	2CTB815708R5200
4	6.25	80	30	–	2.4	400 / 690	440	OVR T2 4L 80-440s P TS QS*	2CTB815708R4000
3+1	6.25	80	30	–	2.4	400 / 690	440	OVR T2 3N 80-440s P QS*	2CTB815708R4900
3+1	6.25	80	30	–	2.4	400 / 690	440	OVR T2 3N 80-440s P TS QS*	2CTB815708R3700
Neutral									
1	–	80	30	–	1	400	440	OVR T2 N 80-440s P QS*	2CTB815708R5400
1	–	80	30	–	1.4	400	440	OVR T2 N 80-440 P QS	2CTB803973R2000
Cartridges									
1	2	40	20	–	1.5	400	440	OVR T2 40-440s C QS*	2CTB815704R5500
1	2	80	40	–	2.4	400	440	OVR T2 40-440 C QS	2CTB803876R0400
1	6.25	80	30	–	1.8	400	440	OVR T2 80-440s C QS*	2CTB815708R5500
1	6.25	80	30	–	1.8	400	440	OVR T2 N 80-440 C QS	2CTB803886R0100
1	6.25	80	30	–	1	400	440	OVR T2 N 80-440s C QS*	2CTB815708R5700
Uc 600 V									
1	2	40	20	–	2.3	400	600	OVR T2 40-600 P TS QS	2CTB803881R0500
3	2	40	20	–	2.3	400 / 690	600	OVR T2 3L 40-600 P TS QS	2CTB803883R2700
4	2	40	20	–	2.3	400 / 690	600	OVR T2 4L 40-600 P TS QS	2CTB803883R5300
Uc 760 V									
3	–	40	15	–	2.9	400 / 690	440	OVR T2 3L 40-400/690 P	2CTB803853R4500
3	–	40	15	–	2.9	400 / 690	440	OVR T2 3L 40-400/690 P TS	2CTB803853R4600
Cartridges									
1	–	40	20	–	2.9	400 / 690	440	OVR T2 40-400/690 C	2CTB803854R1100

* Products available end 2015.

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Selection tables
OVR surge protective devices - IEC version

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Follow current interrupting rating Ifi kA	Voltage protection level Up kV	Nominal voltage Un V	Max. cont. operating voltage Uc V	Type	Order code
Type 2-3 - Pluggable									
Uc 275 V									
1	2	20	5	–	0.9	230	275	OVR T2-T3 20-275 P QS	2CTB803871R2400
1	2	20	5	–	0.9	230	275	OVR T2-T3 20-275 P TS QS	2CTB803871R2500
1+1	2	20	5	–	1.4	230	275	OVR T2-T3 1N 20-275 P QS	2CTB803972R1200
1+1	2	20	5	–	1.4	230	275	OVR T2-T3 1N 20-275 P TS QS	2CTB803972R1300
3	2	20	5	–	0.85	230 / 400	275	OVR T2-T3 3L 20-275 P QS	2CTB803873R3400
3	2	20	5	–	0.85	230 / 400	275	OVR T2-T3 3L 20-275 P TS QS	2CTB803873R3500
3+1	2	20	5	–	1.4	230 / 400	275	OVR T2-T3 3N 20-275 P QS	2CTB803973R1200
3+1	2	20	5	–	1.4	230 / 400	275	OVR T2-T3 3N 20-275 P TS QS	2CTB803973R1600
Neutral									
1	–	80	30	–	1.4	230	275	OVR T2 N 80-275 P QS	2CTB803973R1900
Cartridges									
1	–	20	5	–	1.4	230	275	OVR T2 20-275 C QS	2CTB803876R1200
1	–	80	30	–	1.4	230 / 400	275	OVR T2 N 80-275 C QS	2CTB803876R0000
Uc 440 V									
1+1	2	20	5	–	1.4	400	440	OVR T2-T3 20-440 P QS	2CTB803871R1100
1+1	2	20	5	–	1.4	400	440	OVR T2-T3 20-440 P TS QS	2CTB803871R1300
3+1	2	20	5	–	1.4	400 / 690	440	OVR T2-T3 3N 20-440 P QS	2CTB803973R1300
Neutral									
1	–	80	30	–	1.4	400	440	OVR T2 N 80-440 P QS	2CTB803973R2000
Cartridges									
1	–	20	5	–	1.4	400	440	OVR T2 20-440 C QS	2CTB803876R0600
1	–	80	30	–	1.4	400	440	OVR T2 N 80-440 C QS	2CTB803886R0100
Type 3 - Unpluggable									
Combination wave Uoc 6 kV									
1+1	–	10	3	–	0.9	230	275	OVR 1N 10 275	2CTB813912R1000
3+1	–	10	3	–	0.9	230 / 400	275	OVR 3N 10 275	2CTB813913R1000
Type 2 - Autoprotected									
1+1	–	20	5	–	1.3	230	275	OVR PLUS N1 20	2CTB803701R0700
1+1	–	40	20	–	1.6	230	275	OVR PLUS N1 40	2CTB803701R0100
3+1	–	20	5	–	1.3	230 / 400	275	OVR PLUS N3 20	2CTB803701R0400
3+1	–	40	20	–	1.5	230 / 400	275	OVR PLUS N3 40	2CTB803701R0300

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Selection tables
OVR surge protective devices - IEC version

SPDs for photovoltaic installations with pluggable cartridges

The production of energy with solar panels is one of the most promising of the renewable energy sources.
For solar panels, often located in isolated areas and with a generally large surface area, lightning represents a major risk, to be evaluated both for the direct effects of lightning on the panel and for the voltage surges generated in the system.
The OVR PV range allows the DC side of each PV installation to be effectively protected.
Among their main features:

- Self-protected from end of life short circuit: no back-up protection required up to 100 A DC thanks to the integrated thermal protection with direct current breaking capacity
- Pluggable cartridges, for easy maintenance without the need to disconnect the line
- Remote warning contacts for monitoring the operational status (TS versions)
- No follow-through short-circuit current
- No risk if polarity is reversed

Selection table

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Short circuit withstand Isccr/Iscpv kA	Voltage protection level Up kV	Nominal voltage Un V	Max. cont. operating voltage Uc V	Type	Order code
Type 1 - Pluggable - Photovoltaic applications									
Uc 600 V DC									
2	6.25	–	6.25	0.3 (Iscpv)	1.9	600	670	OVR PV T1 6.25-600 P TS	2CTB803953R5700
Cartridges									
2	6.25	–	6.25	0.3 (Iscpv)	1.9	600	670	OVR PV T1 6.25-600 C	2CTB803950R1000
Uc 1000 V DC									
2	6.25	–	6.25	0.3 (Iscpv)	2.5	1000	1100	OVR PV T1 6.25-1000 P TS	2CTB803953R6700
Cartridges									
2	6.25	–	6.25	0.3 (Iscpv)	2.5	1000	1100	OVR PV T1 6.25-1000 C	2CTB803950R1100
Type 2 - Pluggable - Photovoltaic applications									
Uc 670 V DC									
1+1 DC		40	20	10 kA	2.8/1.4	600	670	OVR PV T2 40-600 P QS	2CTB804153R2800
1+1 DC		40	20	10 kA	2.8/1.4	600	670	OVR PV T2 40-600 P TS QS	2CTB804153R2900
1+1 DC		40	20	10 kA	2.8/1.4	600	670	OVR PV T2 40-600 P QS BULK (30)	2CTB804153Z2800
1+1 DC		40	20	10 kA	2.8/1.4	600	670	OVR PV T2 40-600 P TS QS BULK (30)	2CTB804153Z2900
Cartridges									
		40	20	10 kA	2.8/1.4	600	670	OVR PV T2 40-600 C QS	2CTB804153R3100
		40	20	10 kA	2.8/1.4	600	670	OVR PV MC C QS	2CTB804153R3500
Uc 1100 V DC									
1+1 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P QS	2CTB804153R2400
1+1 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P TS QS	2CTB804153R2500
1+1 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P QS BULK (30)	2CTB804153Z2400
1+1 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P TS QS BULK (30)	2CTB804153Z2500
2+2 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P TWIN QS	2CTB804153R3000
2+2 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P TS TWIN QS	2CTB804153R2300
2+2 DC		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 P TS TWIN QS BULK (18)	2CTB804153Z2300
Cartridges									
		40	20	10 kA	3.8	1000	1100	OVR PV T2 40-1000 C QS	2CTB804153R3200
Uc 1500 V DC									
1+1 DC		40	10	10 kA	4.5	1500	1500	OVR PV T2 40-1500 P QS	2CTB804153R2600
1+1 DC		40	10	10 kA	4.5	1100	1100	OVR PV T2 40-1500 P TS QS	2CTB804153R2700
1+1 DC		40	10	10 kA	4.5	1500	1500	OVR PV T2 40-1500 P QS BULK (30)	2CTB804153Z2600
1+1 DC		40	10	10 kA	4.5	1500	1500	OVR PV T2 40-1500 P TS QS BULK (30)	2CTB804153Z2700
Cartridges									
		40	10	10 kA	4.5	1500	1500	OVR PV T2 40-1500 C QS	2CTB804153R3300
Type 1+2 - Pluggable - Wind turbine applications									
Uc 690 V									
3	2	40	20	–	6	400 / 690	690	OVR WT 3L 690 P TS	2CTB235402R0000
Cartridges									
1	2	40	20	–	6	400	440	OVR T2 40 440 C	2CTB803854R0400

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Technical features

Electrical features

Network type		PV installations
Type		2
Response time	ns	25
Residual current	mA	< 1
IP rating		IP20
Integrated thermal protection		300 A (for 600 V DC) and 10 kA (for 1000 and 1500 V DC)
Back-up protection Isc < 100 A DC Isc > 300 A DC		 Not required 10 A gR fuse

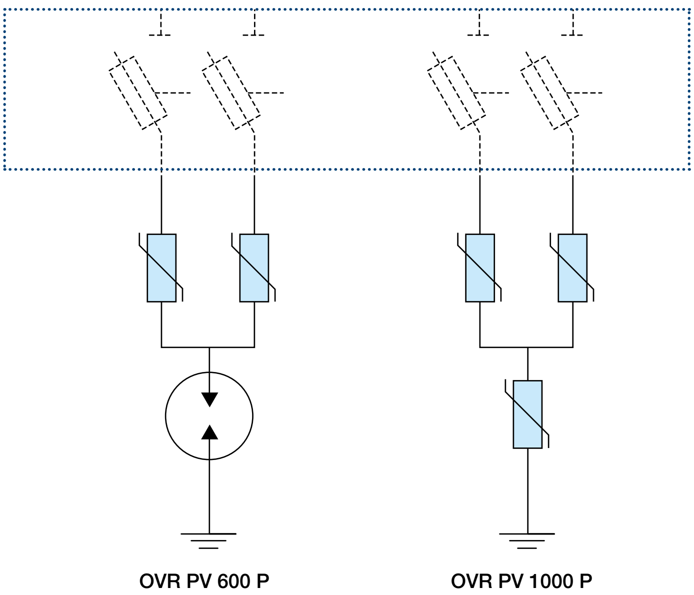
Mechanical features

L/PE terminals rigid flexible	 mm^2 mm^2	 2.5…25 2.5…16
Tightening torque	Nm	2.80
Status indicator		Yes
Remote signalling contact Type Minimum capacity Maximum capacity Cable section	 mm^2	for "TS" versions 1 NO/NC 12 V DC-10 mA 250 V AC-1 A 1.5

Other features

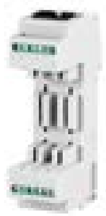
Operating temperature	°C	- 40...+80
Storage temperature	°C	- 40...+80
Maximum altitude	m	2000
Case material		PC RAL 7035
UL94 fire resistance		V0
Reference standards		EN 50 539 - 11 UTE C 61-740-51

Diagrams



Back-up fuses, only required if I_{SC} > 300 A (for 600 V DC) and 10 kA (for 1000 and 1500 V DC)

Selection tables
OVR surge protective devices - IEC version



OVR TC SPDs are for fine protection of telephonic equipment, IT equipment and BUS systems connected to low-voltage signal lines.
Among their main features:
- Cartridges can be removed and replaced at the end of their lives, while the base remains reusable. The telecoms line remains active while they are being replaced, thanks to a bypass.
- Reduced dimensions: the modules with standard three-wire terminal blocks are all 12.5 mm wide.
- Bases with integrated RJ45 connector: these ensure maximum speed of wiring up the telephone or data patch panel

It is also wise to provide for the installation a Type 1 or Type 2 SPDs on the power lines to provide effective protection of the telecoms and data equipment.

Selection table

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Short circuit withstand Isccr/Iscpv kA	Voltage protection level Up kV	Nominal voltage Un V	Max. cont. operating voltage Uc V	Type	Order code
Dataline protection - Pluggable									
Uc 7 V DC									
1 pair	–	10	5	–	0.015	6	7	OVR TC 6V P	2CTB804820R0000
Cartridges									
1 pair		10	5	–	0.015	6	7	OVR TC 06V C	2CTB804821R0000
Uc 14 V DC									
1 pair	–	10	5	–	0.02	12	14	OVR TC 12V P	2CTB804820R0100
Cartridges									
1 pair		10	5	–	0.02	12	14	OVR TC 12V C	2CTB804821R0100
Uc 27 V DC									
1 pair	–	10	5	–	0.035	24	27	OVR TC 24V P	2CTB804820R0200
Cartridges									
1 pair		10	5	–	0.035	24	27	OVR TC 24V C	2CTB804821R0200
Uc 53 V DC									
1 pair	–	10	5	–	0.07	48	53	OVR TC 48V P	2CTB804820R0300
Cartridges									
1 pair	–	10	5	–	0.07	48	53	OVR TC 48V C	2CTB804821R0300
Uc 220 V DC									
1 pair	–	10	5	–	0.7	200	220	OVR TC 200V P	2CTB804820R0400
1 pair	–	10	5	–	0.4	200	220	OVR TC 200FR P	2CTB804820R0500
Cartridges									
1 pair	–	10	5	–	0.7	200	220	OVR TC 200V C	2CTB804821R0400
1 pair	–	10	5	–	0.4	200	220	OVR TC 200FR C	2CTB804821R0500

(x30) packaging of 30 pieces.

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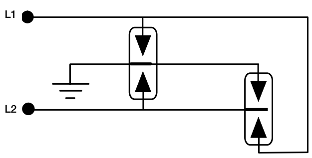
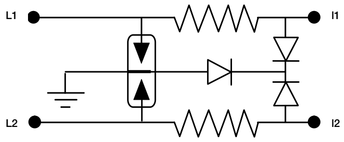
Technical features

Electrical features		
Test class		2
Rated discharge current In (8/20)	kA	5
Maximum discharge current Imax (8/20)	kA	10
Short-circuit current (AC endurance test)	A	10
Rated current In	mA	140
Series resistance	Ω	10
Shielding - earth connection		Connected
Mechanical features		
Signal terminals	mm²	15
Signal conductors bare cable length	mm	6
Signal terminals tightening torque	Nm	0.2
Shielding terminals	mm²	2.5
Shielding conductors bare cable length	mm	7
Shielding terminals tightening torque	Nm	0.4
Status indicator		No
Other features		
IP rating		IP20
Storage temperature	°C	from -40 to +80
Operating temperature	°C	from -40 to +80
Maximum altitude	m	2000
Case material		RAL grey PC
UL 94 fire resistance		V0
Reference standard		IEC/EN 61643-21

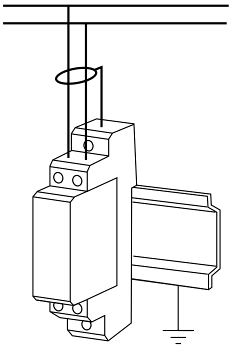
Diagrams



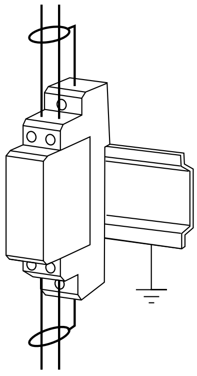


OVR TC 200 V in parallel OVR TC / xx V / 200 FR in series

Connection



OVR TC 200 V



OVR TC 200 FR
OVR TC 48 V
OVR TC 24 V
OVR TC 12 V
OVR TC 06 V

OVR TC 200 V in parallel OVR TC / xx V / 200 FR in series

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Selection tables
OVR surge protective devices – UL Version

List of OVR T2 UL products according to their certification

Type acc. To UL 1449 Ed3

Range	Type	Order code	Type 4 CA	Type 1 CA
T2 U	OVR T2 15-150 P U	2CTB802341R0000		●
	OVR T2 15-320 P U	2CTB802341R0400		●
	OVR T2 40-150 P U	2CTB802341R2000		●
	OVR T2 40-150 P TS U	2CTB802341R2100		●
	OVR T2 40-320 P U	2CTB802341R2400		●
	OVR T2 40-320 P TS U	2CTB802341R2500		●
	OVR T2 40-440 P TS U	2CTB802341R2900		●
	OVR T2 40-550 P TS U	2CTB802341R3300		●
	OVR T2 40-660 P TS U	2CTB802341R3700	●	
	OVR T2 70 N P U	2CTB802341R8000	●	
	OVR T2 1N 15-150 P U	2CTB802342R0000	●	
	OVR T2 1N 15-320 P U	2CTB802342R0400	●	
	OVR T2 1N 40-150 P U	2CTB802342R2000	●	
	OVR T2 1N 40-150 P TS U	2CTB802342R2100	●	
	OVR T2 1N 40-320 P TS U	2CTB802342R2500	●	
	OVR T2 1N 40-440 P TS U	2CTB802342R2900	●	
	OVR T2 1N 40-550 P TS U	2CTB802342R3300	●	
	OVR T2 1N 40-660 P TS U	2CTB802342R3700	●	
	OVR T2 2L 15-150 P U	2CTB802343R0000		●
	OVR T2 2L 15-320 P U	2CTB802343R0400		●
	OVR T2 2L 40-150 P TS U	2CTB802343R2100		●
	OVR T2 2L 40-320 P TS U	2CTB802343R2500		●
	OVR T2 2N 15-150 P U	2CTB802344R0000		●
	OVR T2 2N 15-320 P U	2CTB802344R0400	●	
	OVR T2 2N 40-150 P TS U	2CTB802344R2100	●	
	OVR T2 2N 40-320 P TS U	2CTB802344R2500	●	
	OVR T2 2N 40-440 P TS U	2CTB802344R2900	●	
	OVR T2 2N 40-550 P TS U	2CTB802344R3300	●	
	OVR T2 2N 40-660 P TS U	2CTB802344R3700	●	
	OVR T2 3L 15-150 P U	2CTB802345R0000		●
	OVR T2 3L 15-320 P U	2CTB802345R0400		●
	OVR T2 3L 40-150 P TS U	2CTB802345R2100		●
	OVR T2 3L 40-320 P TS U	2CTB802345R2500		●
	OVR T2 3L 40-440 P TS U	2CTB802345R2900		●
	OVR T2 3L 40-550 P TS U	2CTB802345R3300		●
	OVR T2 3N 15-150 P U	2CTB802346R0000	●	
	OVR T2 3N 15-320 P U	2CTB802346R0400	●	
	OVR T2 3N 40-150 P TS U	2CTB802346R2100	●	
	OVR T2 3N 40-320 P TS U	2CTB802346R2500	●	
	OVR T2 3N 40-440 P TS U	2CTB802346R2900	●	
	OVR T2 3N 40-550 P TS U	2CTB802346R3300	●	
	OVR T2 3N 40-660 P TS U	2CTB802346R3700	●	
	OVR T2 15-150 C U	2CTB802348R2500		●
	OVR T2 15-320 C U	2CTB802348R2700		●
	OVR T2 40-150 C U	2CTB802348R3500		●
	OVR T2 40-320 C U	2CTB802348R3700		●
	OVR T2 40-440 C U	2CTB802348R3900		●
	OVR T2 40-550 C U	2CTB802348R4100		●
	OVR T2 40-660 C U	2CTB802348R4300	●	
	OVR T2 70 N C U	2CTB802348R6500	●	

Type acc. To UL 1449 Ed3

Range	Type	Order code	Type 4 CA	Type 1 CA
PV U	OVR PV 40-600 P U	2CTB802340R0800		●
	OVR PV 40-600 P TS U	2CTB802340R0900		●
	OVR PV 40-800 P U	2CTB802340R2000		●
	OVR PV 40-800 P TS U	2CTB802340R2100		●
	OVR PV 40-1000 P U	2CTB802340R3200		●
	OVR PV 40-1000 P TS U	2CTB802340R3300		●
	OVR PV 15-600 P U	2CTB802340R5600		●
	OVR PV 15-600 P TS U	2CTB802340R5700		●
	OVR PV 15-800 P U	2CTB802340R6800		●
	OVR PV 15-800 P TS U	2CTB802340R6900		●
	OVR PV 15-1000 P U	2CTB802340R8000		●
	OVR PV 15-1000 P TS U	2CTB802340R8100		●
	OVR PV 40-600 C U	2CTB802349R0400		●
	OVR PV 40-800 C U	2CTB802349R1000		●
	OVR PV 40-1000 C U	2CTB802349R1600		●
	OVR PV 15-600 C U	2CTB802349R2900		●
	OVR PV 15-800 C U	2CTB802349R3500		●
	OVR PV 15-1000 C U	2CTB802349R4100		●

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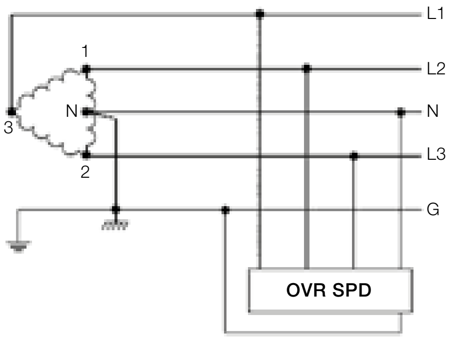
Selection tables
OVR surge protective devices – UL Version

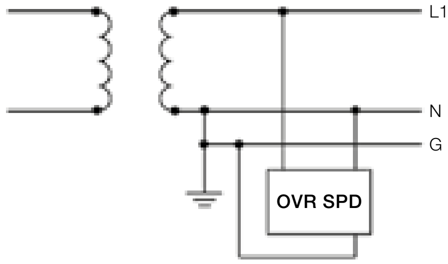
General wiring diagrams - DIN rail devices

Delta



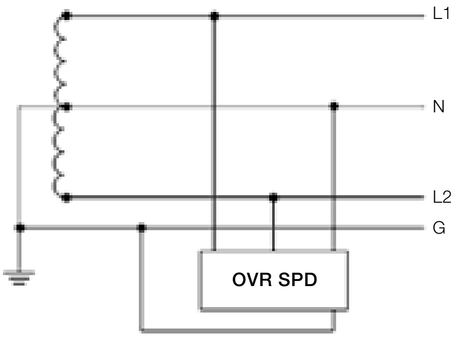
240 / 120 V HLD

Single phase



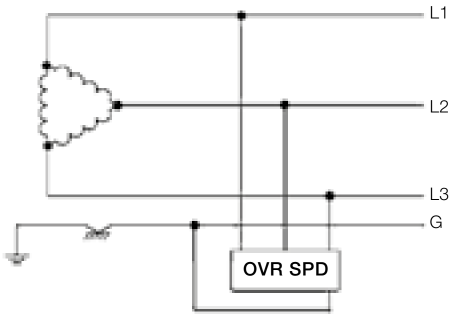
120 V, 240 V, 277 V

Split phase



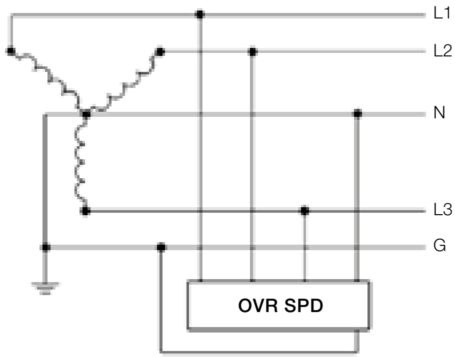
240 / 120 V, 480 / 240 V

Delta



240 V, 480 V, 600 V

Wye



208 / 120 V, 480 / 277 V, 600 / 347 V

NOTE: Multiple pole SPDs shown. Wiring diagrams for reference only.

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Follow current interrupting rating Ifi kA	Voltage protection Rating VPR kV	Nominal voltage Un V	Max. cont. operating voltage MCOV V	Type	Order code
Type 2 - Pluggable - Single Pole networks									
1	–	15	5	–	0.6	120	150	OVR T2 15-150 P U	2CTB802341R0000
1	–	15	5	–	1	277 ±15%	320	OVR T2 15-320 P U	2CTB802341R0400
1	–	40	20	–	0.6	120	150	OVR T2 40-150 P U	2CTB802341R2000
1	–	40	20	–	0.6	120	150	OVR T2 40-150 P TS U	2CTB802341R2100
1	–	40	20	–	1	277 ±15%	320	OVR T2 40-320 P U	2CTB802341R2400
1	–	40	20	–	1	277 ±15%	320	OVR T2 40-320 P TS U	2CTB802341R2500
1	–	40	10	–	1.3	347 ±15%	440	OVR T2 40-440 P TS U	2CTB802341R2900
1	–	40	10	–	1.7	480 ±15%	550	OVR T2 40-550 P TS U	2CTB802341R3300
1	–	40	10	–	1.9	600 ±15%	660	OVR T2 40-660 P TS U	2CTB802341R3700
Neutral									
1	–	70	20	0.1	1.2	230	275	OVR T2 70 N P U	2CTB802341R8000
Cartridges									
1	–	–	–	–	–	120 ±15%	175	OVR T2 15-150 C U	2CTB802348R2500
1	–	–	–	–	–	277 ±15%	320	OVR T2 15-320 C U	2CTB802348R2700
1	–	–	–	–	–	120 ±15%	175	OVR T2 40-150 C U	2CTB802348R3500
1	–	–	–	–	–	277 ±15%	320	OVR T2 40-320 C U	2CTB802348R3700
1	–	–	–	–	–	347 ±15%	440	OVR T2 40-440 C U	2CTB802348R3900
1	–	–	–	–	–	480 ±15%	550	OVR T2 40-550 C U	2CTB802348R4100
1	–	–	–	–	–	600 ±15%	660	OVR T2 40-660 C U	2CTB802348R4300
1	–	–	–	–	–	230	275	OVR T2 70 N C U	2CTB802348R6500

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Selection tables
OVR surge protective devices – UL Version

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Follow current interrupting rating Ifi kA	Voltage protection Rating VPR kV	Nominal voltage Un V	Max. cont. operating voltage MCOV V	Type	Order code
Type 2 - Pluggable - Delta networks									
3	–	15	5	–	1	277 +15%	320	OVR T2 3L 15-320 P U	2CTB802345R0400
3	–	40	20	–	1	277 ±15%	320	OVR T2 3L 40-320 P TS U	2CTB802345R2500
3	–	40	10	–	1.7	480 ±15%	550	OVR T2 3L 40-550 P TS U	2CTB802345R3300
Cartridges									
1	–	–	–	–	–	277 ±15%	320	OVR T2 15-320 C U	2CTB802348R2700
1	–	–	–	–	–	277 ±15%	320	OVR T2 40-320 C U	2CTB802348R3700
1	–	–	–	–	–	480 ±15%	550	OVR T2 40-550 C U	2CTB802348R4100
Type 2 - Pluggable - Single Phase networks									
2	–	15	5	–	1.2	120	150	OVR T2 1N 15-150 P U	2CTB802342R0000
2	–	15	5	–	1.2	277	320	OVR T2 1N 15-320 P U	2CTB802342R0400
2	–	40	20	–	1.2	120	150	OVR T2 1N 40-150 P U	2CTB802342R2000
2	–	40	20	–	1.2	120	150	OVR T2 1N 40-150 P U (x10)	2CTB802342R8000
2	–	40	20	–	1.2	120	150	OVR T2 1N 40-150 P TS U	2CTB802342R2100
2	–	40	20	–	1.2	277	320	OVR T2 1N 40-320 P TS U	2CTB802342R2500
2	–	40	10	–	1.2	347	440	OVR T2 1N 40-440 P TS U	2CTB802342R2900
2	–	40	10	–	1.2	480	550	OVR T2 1N 40-550 P TS U	2CTB802342R3300
2	–	40	10	–	1.2	600	660	OVR T2 1N 40-660 P TS U	2CTB802342R3700
Cartridges									
1	–	–	–	–	–	120 ±15%	175	OVR T2 15-150 C U	2CTB802348R2500
1	–	–	–	–	–	277 ±15%	320	OVR T2 15-320 C U	2CTB802348R2700
1	–	–	–	–	–	120 ±15%	175	OVR T2 40-150 C U	2CTB802348R3500
1	–	–	–	–	–	277 ±15%	320	OVR T2 40-320 C U	2CTB802348R3700
1	–	–	–	–	–	347 ±15%	440	OVR T2 40-440 C U	2CTB802348R3900
1	–	–	–	–	–	480 ±15%	550	OVR T2 40-550 C U	2CTB802348R4100
1	–	–	–	–	–	600 ±15%	660	OVR T2 40-660 C U	2CTB802348R4300
Type 2 - Pluggable - Split Phase networks									
2	–	15	5	–	0.6	120 ±15%	175	OVR T2 2L 15-150 P U	2CTB802343R0000
2	–	15	5	–	1	277 ±15%	320	OVR T2 2L 15-320 P U	2CTB802343R0400
3	–	15	5	–	0.7	120 ±15%	175	OVR T2 2N 15-150 P U	2CTB802344R0000
3	–	15	5	–	1.1	277 ±15%	320	OVR T2 2N 15-320 P U	2CTB802344R0400
2	–	40	20	–	0.6	120 ±15%	175	OVR T2 2L 40-150 P TS U	2CTB802343R2100
2	–	40	20	–	1	277 ±15%	320	OVR T2 2L 40-320 P TS U	2CTB802343R2500
3	–	40	20	–	0.7	120 ±15%	175	OVR T2 2N 40-150 P TS U	2CTB802344R2100
3	–	40	20	–	1.1	277 ±15%	320	OVR T2 2N 40-320 P TS U	2CTB802344R2500
3	–	40	10	–	1.4	347 ±15%	440	OVR T2 2N 40-440 P TS U	2CTB802344R2900
3	–	40	10	–	1.8	480 ±15%	550	OVR T2 2N 40-550 P TS U	2CTB802344R3300
3	–	40	10	–	2	600 ±15%	660	OVR T2 2N 40-660 P TS U	2CTB802344R3700
Cartridges									
1	–	–	–	–	–	120 ±15%	175	OVR T2 15-150 C U	2CTB802348R2500
1	–	–	–	–	–	277 ±15%	320	OVR T2 15-320 C U	2CTB802348R2700
1	–	–	–	–	–	120 ±15%	175	OVR T2 40-150 C U	2CTB802348R3500
1	–	–	–	–	–	277 ±15%	320	OVR T2 40-320 C U	2CTB802348R3700
1	–	–	–	–	–	347 ±15%	440	OVR T2 40-440 C U	2CTB802348R3900
1	–	–	–	–	–	480 ±15%	550	OVR T2 40-550 C U	2CTB802348R4100
Type 2 - Pluggable - Grounded Wye networks									
3	–	15	5	–	0.6	120 ±15%	175	OVR T2 3L 15-150 P U	2CTB802345R0000
4	–	15	5	–	0.6	120 ±15%	175	OVR T2 3N 15-150 P U	2CTB802346R0000
4	–	15	5	–	1.2	277 ±15%	320	OVR T2 3N 15-320 P U	2CTB802346R0400
3	–	40	20	–	0.6	120 ±15%	175	OVR T2 3L 40-150 P TS U	2CTB802345R2100
3	–	40	10	–	1.3	347 ±15%	440	OVR T2 3L 40-440 P TS U	2CTB802345R2900
4	–	40	20	–	1.2	120 ±15%	175	OVR T2 3N 40-150 P TS U	2CTB802346R2100
4	–	40	20	–	1.2	277 ±15%	320	OVR T2 3N 40-320 P TS U	2CTB802346R2500
4	–	40	10	–	1.2	347 ±15%	440	OVR T2 3N 40-440 P TS U	2CTB802346R2900
4	–	40	10	–	1.2	480 ±15%	550	OVR T2 3N 40-550 P TS U	2CTB802346R3300
4	–	40	10	–	1.2	600 ±15%	660	OVR T2 3N 40-660 P TS U	2CTB802346R3700
Cartridges									
1	–	–	–	–	–	120 ±15%	175	OVR T2 15-150 C U	2CTB802348R2500
1	–	–	–	–	–	120 ±15%	175	OVR T2 40-150 C U	2CTB802348R3500
1	–	–	–	–	–	347 ±15%	440	OVR T2 40-440 C U	2CTB802348R3900
1	–	–	–	–	–	277 ±15%	320	OVR T2 15-320 C U	2CTB802348R2700
1	–	–	–	–	–	277 ±15%	320	OVR T2 40-320 C U	2CTB802348R3700
1	–	–	–	–	–	480 ±15%	550	OVR T2 40-550 C U	2CTB802348R4100
1	–	–	–	–	–	600 ±15%	660	OVR T2 40-660 C U	2CTB802348R4300

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Selection tables
OVR surge protective devices – UL Version

Protected lines	Impulse current Iimp 10/350 kA	Max. discharge current Imax 8/20 kA	Nominal discharge current In kA	Short circuit withstand Isccr/Iscpv kA	Voltage protection Rating VPR kV	Nominal voltage Un V	Max. cont. operating voltage Uc V DC	Type	Order code
Type 2 - Pluggable - Photovoltaic applications									
2	–	15	5	1	3	600	670	OVR PV 15-600 P U	2CTB802340R5600
2	–	15	5	1	3	600	670	OVR PV 15-600 P TS U	2CTB802340R5700
2	–	40	10	1	3	600	670	OVR PV 40-600 P U	2CTB802340R0800
2	–	40	10	1	3	600	670	OVR PV 40-600 P TS U	2CTB802340R0900
2	–	15	5	1	4	800	1000	OVR PV 15-800 P U	2CTB802340R6800
2	–	15	5	1	4	800	1000	OVR PV 15-800 P TS U	2CTB802340R6900
2	–	40	10	1	4	800	1000	OVR PV 40-800 P U	2CTB802340R2000
2	–	40	10	1	4	800	1000	OVR PV 40-800 P TS U	2CTB802340R2100
2	–	15	5	1	4	1000	1250	OVR PV 15-1000 P U	2CTB802340R8000
2	–	15	5	1	4	1000	1250	OVR PV 15-1000 P TS U	2CTB802340R8100
2	–	40	10	1	4	1000	1250	OVR PV 40-1000 P U	2CTB802340R3200
2	–	40	10	1	4	1000	1250	OVR PV 40-1000 P TS U	2CTB802340R3300
2	2	40	15	1	4.5	1500	1500	OVR PV 40-1500H P U	2CTB802340R4200
2	2	40	15	1	4.5	1500	1500	OVR PV 40-1500H P TS U	2CTB802340R4300
Cartridges									
–	–	–	–	–	–	600	670	OVR PV 15-600 C U	2CTB802349R2900
–	–	–	–	–	–	600	670	OVR PV 40-600 C U	2CTB802349R0400
–	–	–	–	–	–	800	1000	OVR PV 15-800 C U	2CTB802349R3500
–	–	–	–	–	–	800	1000	OVR PV 40-800 C U	2CTB802349R1000
–	–	–	–	–	–	1000	1250	OVR PV 15-1000 C U	2CTB802349R4100
–	–	–	–	–	–	1000	1250	OVR PV 40-1000 C U	2CTB802349R1600
–	–	–	–	–	–	1500	1500	OVR PV 40-1500H C U	2CTB802349R1700
Dataline protection - Pluggable									
1	–	10	5	–	300	200	220	OVR TC 200FR US	2CTB811814R0000
1	–	10	5	–	15	6	7	OVR TC 06V US	2CTB811814R0100
1	–	10	5	–	20	12	14	OVR TC 12V US	2CTB811814R0200
1	–	10	5	–	35	24	27	OVR TC 24V US	2CTB811814R0300
1	–	10	5	–	70	48	53	OVR TC 48V US	2CTB811814R0400

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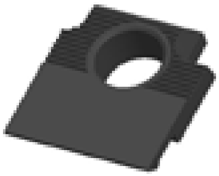
Accessories for OVR
Protection and safety



Accessory for cartridge lock

This accessory can be fitted into the front of the socket of the SPD to guarantee an even higher withstand to vibrations and shocks, it reinforces mechanical lock between the cartridges and the socket (they are already locked by the pins in the back of the cartridge). It's recommended for stressful environments as the nazelle of the wind turbines.

It's sold on packs of 50.

Description	Bbn 3660308 EAN	Type	Order code		Pkg	Weight (1 pce) kg
Accessory for Cartridge Lock	-	SPD accessories	2CTB814355R1200		1	
Accessory for Cartridge Lock	-	SPD accessories	2CTB814355Z1200		50	

Accessory for auxiliary contact lock

This accessory can be fitted into the top of the auxiliary contact module and guarantees an even higher withstand to stressful environments. It reinforces the mechanical lock between the auxiliary contact module and the socket of the SPD. It's recommended in environments where the cables of the auxiliary contact can suffer pulls due to the limited length of the auxiliary cables that restrict any potential movements.

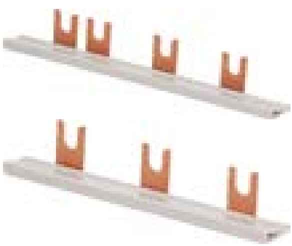
It's sold on packs of 50.

Description	Bbn 3660308 EAN	Type	Order code		Pkg	Weight (1 pce) kg
Accessory for auxiliary contact lock	-	SPD accessories	2CTB814355R2700			

Label for surge protected installations

This label allows the user to identify the panels where surge protection devices are fitted. It's meant to be used in the inside of the panel door and clearly states that the cartridges need to be removed to perform insulation tests.

Description	Bbn 3660308 EAN	Type	Order code		Pkg	Weight (1 pce) kg
Label for surge protected installations	-	SPD accessories	2CTB813860R1500			



Bus bar

For TNC, IT, TNS or TT systems using single pole Type 1 SPDs assembled together, we have 2 different bus bars than can be used, as listed here below.

For TNS, TT (1Ph+N or 3Ph+N) or TNC (3Ph) systems for Type 1+2, Type 2, Type 2+3 SPDs, please refer to the "Busbar and accessories for MCBs S200, SN 201, RCDs F200 and DS 200 series".

Description	Bbn 3660308 EAN	Type	Order code		Pkg	Weight (1 pce) kg
Busbar for Type 1, TT 3+1 configurations	516091	SPD accessories	2CTB815102R0400		1	0.03
Busbar for Type 1, TNC or IT 3-0 configurations	524751	SPD accessories	2CTB815141R0700		1	0.03

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Notes

note1

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Order code classification

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Type classification

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http://new.abb.com/low-voltage/products/system-pro-m/surge-protective-devices-ovr

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