

## Features

### SPD

#### Type 2 Surge arrester range - single phase systems

- Surge arrester suitable for 230V system/ applications
- Protects equipment against overvoltage caused by lightning strikes or switching transients

**7P.21.8.275.1020** Varistor protection L - N

**7P.22.8.275.1020** Varistor protection L - N + spark-gap protection N - PE

Spark-gap protection N - PE avoids earth leakage current

- Visual indication of Varistor status - Healthy/Replace
- Remote signalling contact of Varistor status Connector (07P.01) included
- Replaceable modules
- Complies with EN 61643-11
- 35 mm rail (EN 60715) mounting

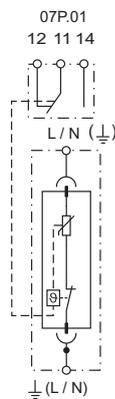
7P.21 / 7P.22  
Screw terminal



### NEW 7P.21.8.275.1020



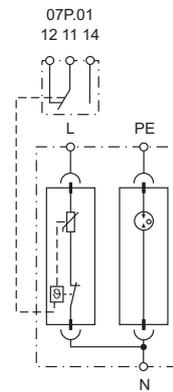
- SPD Type 2 (1 varistor)
- Replaceable varistor module
- Visual and remote signalling of varistor status



### NEW 7P.22.8.275.1020



- SPD Type 2 (1 varistor + 1 spark-gap)
- Combination of replaceable varistor and encapsulated spark gap modules
- Visual and remote signalling of varistor status



For outline drawing see page 6

SPD specification			L-N	N-PE
Nominal voltage	$U_N$	230 V AC	230 V AC	—
Maximum continuous operating voltage	$U_C$	275 V AC / 350 V DC	275 V AC / 350 V DC	255 V AC
Nominal discharge current (8/20 $\mu$ s)	$I_n$	20 kA	20 kA	20 kA
Maximum discharge current (8/20 $\mu$ s)	$I_{max}$	40 kA	40 kA	40 kA
Voltage protection level at 5kA	$U_{P5}$	0.9 kV	0.9 kV	—
Voltage protection level at $I_n$	$U_p$	1.2 kV	1.2 kV	1.5 kV
Response time	$t_A$	25 ns	25 ns	100 ns
Short-circuit proof at maximum overcurrent protection		35 kA <sub>rms</sub>	35 kA <sub>rms</sub>	—
Maximum overcurrent protection - fuse rating		160 A gL/gG	160 A gL/gG	—
Other technical data				
Ambient temperature range		-40...+80 °C	-40...+80 °C	
Protection degree		IP20	IP20	
Max wire size	solid cable	1x1...1x50 mm <sup>2</sup> / 1x 17...1x1 AWG	1x1...1x50 mm <sup>2</sup> / 1x 17...1x1 AWG	
	stranded cable	1x1...1x35 mm <sup>2</sup> / 1x 17...1x2 AWG	1x1...1x35 mm <sup>2</sup> / 1x 17...1x2 AWG	
Wire strip length		14 mm	14 mm	
Screw torque		4 Nm	4 Nm	
Remote status signalling contact specification				
Contact configuration		1 CO (SPDT)	1 CO (SPDT)	
Rated current		0.5 A (AC) - 0.1 A (DC)	0.5 A (AC) - 0.1 A (DC)	
Rated voltage		250 V AC (DC)	250 V AC (DC)	
Max wire size (07P.01)		1.5 mm <sup>2</sup> / 16 AWG	1.5 mm <sup>2</sup> / 16 AWG	
Approvals (according to type)		<b>CE</b>		

## Features

### SPD

Type 2 Surge arrester range - three-phase systems

- Surge arrester suitable for 230/400V system/applications
- Protects equipment against overvoltage caused by lightning strikes or switching transients

**7P.23.8.275.1020** Varistor protection L1, L2, L3

**7P.24.8.275.1020** Varistor protection L1, L2, L3 - N, + spark-gap protection N - PE

**7P.25.8.275.1020** Varistor protection L1, L2, L3 - N, + varistor protection N - PE

Spark-gap protection N - PE avoids earth leakage current

- Visual indication of Varistor status - Healthy/Replace
- Remote signalling contact of Varistor status Connector (07P.01) included
- Replaceable modules
- Complies with EN 61643-11
- 35 mm rail (EN 60715) mounting

7P.23.8 / 7P.24 / 7P.25  
Screw terminal



**NEW** 7P.23.8.275.1020



- SPD Type 2 (3 varistors)
- Replaceable varistor module, 3 pole
- Visual and remote signalling of varistor status

**NEW** 7P.24.8.275.1020

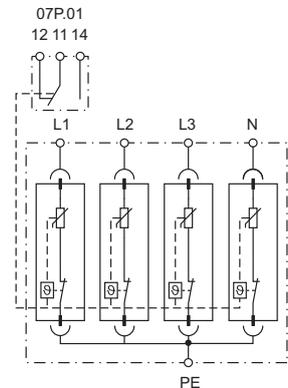
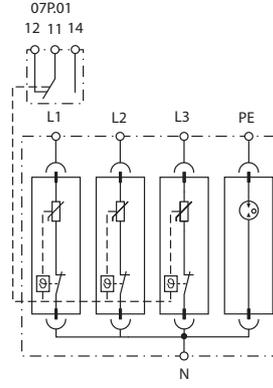
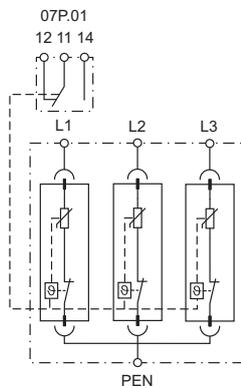


- SPD Type 2 (3 varistors + 1 spark-gap)
- Combination of replaceable varistor and encapsulated spark gap modules
- Visual and remote signalling of varistor status

**NEW** 7P.25.8.275.1020



- SPD Type 2 (4 varistors)
- Replaceable varistor module, 4 pole
- Visual and remote signalling of varistor status



For outline drawing see page 6

SPD specification			L-N	N-PE	
Nominal voltage	$U_N$	230 V AC	230 V AC	—	230 V AC
Maximum continuous operating voltage	$U_C$	275 V AC / 350 V DC	275VAC/350VDC	255 V AC	275 V AC / 350 V DC
Nominal discharge current (8/20 $\mu$ s)	$I_n$	20 kA	20 kA	20 kA	20 kA
Maximum discharge current (8/20 $\mu$ s)	$I_{max}$	40 kA	40 kA	40 kA	40 kA
Voltage protection level at 5kA	$U_{P5}$	0.9 kV	0.9 kV	—	0.9 kV
Voltage protection level at $I_n$	$U_p$	1.2 kV	1.2 kV	1.5 kV	1.2 kV
Response time	$t_A$	25 ns	25 ns	100 ns	25 ns
Short-circuit proof at maximum overcurrent protection		35 kA <sub>rms</sub>	35 kA <sub>rms</sub>	—	35 kA <sub>rms</sub>
Maximum overcurrent protection - fuse rating		160 A gL/gG	160 A gL/gG	—	160 A gL/gG
Other technical data					
Ambient temperature range		-40...+80 °C	-40...+80 °C		-40...+80 °C
Protection degree		IP20	IP20		IP20
Max wire size	solid cable	1x1...1x50 mm <sup>2</sup> /1x 17...1x1 AWG	1x1...1x50 mm <sup>2</sup> /1x 17...1x1 AWG		1x1...1x50 mm <sup>2</sup> /1x 17...1x1 AWG
	stranded cable	1x1...1x35 mm <sup>2</sup> /1x 17...1x2 AWG	1x1...1x35 mm <sup>2</sup> /1x 17...1x2 AWG		1x1...1x35 mm <sup>2</sup> /1x 17...1x2 AWG
Wire strip length		14 mm	14 mm		14 mm
Screw torque		4 Nm	4 Nm		4 Nm
Remote status signalling contact specification					
Contact configuration		1 CO (SPDT)	1 CO (SPDT)		1 CO (SPDT)
Rated current		0.5 A (AC) - 0.1 A (DC)	0.5 A (AC) - 0.1 A (DC)		0.5 A (AC) - 0.1 A (DC)
Rated voltage		250 V AC (DC)	250 V AC (DC)		250 V AC (DC)
Max wire size (07P.01)		1.5 mm <sup>2</sup> / 16 AWG	1.5 mm <sup>2</sup> / 16 AWG		1.5 mm <sup>2</sup> / 16 AWG
Approvals (according to type)		<b>CE</b>			

## Features

### SPD

#### Type 2 Surge arrester range for Photovoltaic applications

- Surge arrester for protection on DC side (420 to 1000 V) of systems in photovoltaic applications
- Protects equipment against overvoltage caused by lightning strikes or switching transients

**7P.26.9.420.1020** 420 V DC

**7P.23.9.700.1020** 700 V DC

**7P.23.9.000.1020** 1000 V DC

- Visual indication of Varistor status - Healthy/Replace
- Remote signalling contact of Varistor status Connector (07P.01) included
- Replaceable modules
- Complies with EN 61643-11
- 35 mm rail (EN 60715) mounting

7P.23.9 / 7P.26  
Screw terminal



### NEW 7P.26.9.420.1020



- SPD Type 2 (2 varistors + 1 spark-gap) for 420 V DC photovoltaic systems
- Combination of replaceable varistor and encapsulated spark gap modules
- Visual and remote signalling of varistor status

### NEW 7P.23.9.700.1020

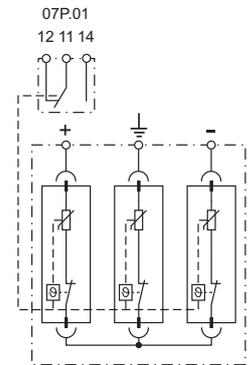
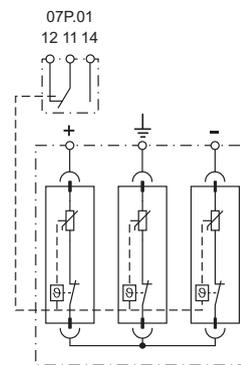
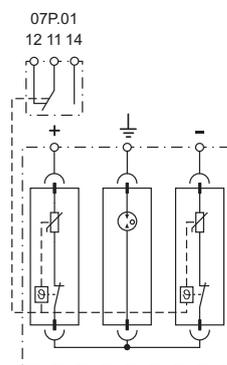


- SPD Type 2 (3 varistors) for 700 V DC photovoltaic systems
- Replaceable varistor modules
- Visual and remote signalling of varistor status

### NEW 7P.23.9.000.1020



- SPD Type 2 (3 varistors) for 1000 V DC photovoltaic systems
- Replaceable varistor modules
- Visual and remote signalling of varistor status



For outline drawing see page 6

SPD specification		Varistor module	Spark-gap module	
PV voltage mid central earthing	$U_{OC\ STC}$	600 V DC		700 V DC
PV voltage earth free systems	$U_{OC\ STC}$	420 V DC		700 V DC
Maximum operating voltage /per module	$U_C$	350 V DC	420 V DC	350 V DC
Nominal discharge current (8/20 $\mu$ s) /per module	$I_n$	20 kA	20 kA	20 kA
Maximum discharge current (8/20 $\mu$ s) /per module	$I_{max}$	40 kA	40 kA	40 kA
Voltage protection level /per module	$U_p$	1.2 kV	1.5 kV	1.2 kV
Voltage protection level of the system	$U_p$	< 2.7 kV		2.4 kV
Response time	$t_A$	25 ns	100 ns	25 ns
Short-circuit withstand capability		100 A 200 V DC	—	100 A 200 V DC
Maximum overcurrent protection - fuse rating		160 A gL/gG	—	160 A gL/gG
<b>Other technical data</b>				
Ambient temperature range		-40...+80 °C		-40...+80 °C
Protection degree		IP20		IP20
Max wire size	solid cable	1x1...1x50 mm <sup>2</sup> / 1x 17...1x1 AWG		1x1...1x50 mm <sup>2</sup> / 1x 17...1x1 AWG
	stranded cable	1x1...1x35 mm <sup>2</sup> / 1x 17...1x2 AWG		1x1...1x35 mm <sup>2</sup> / 1x 17...1x2 AWG
Wire strip length		14 mm		14 mm
Screw torque		4 Nm		4 Nm
<b>Remote status signalling contact specification</b>				
Contact configuration		1 CO (SPDT)		1 CO (SPDT)
Rated current		0.5 A (AC) – 0.1 A (DC)		0.5 A (AC) – 0.1 A (DC)
Rated voltage		250 V AC (DC)		250 V AC (DC)
Max wire size (07P.01)		1.5 mm <sup>2</sup> / 16 AWG		1.5 mm <sup>2</sup> / 16 AWG
<b>Approvals</b> (according to type)				

## Features

### SPD

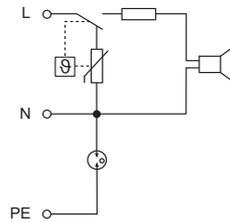
#### Type 3 Surge arrester for incorporation within socket outlets

- Provides easy additional surge protection for existing 230 V sockets
- Protects electric and electronic equipment against pulse overvoltage
- Combined varistor + spark-gap protection (avoiding earth leakage current)
- Acoustical indication of Varistor status (Replace)
- Complies with EN 61 643-11
- 3 wires, 150 mm long, for connection to socket terminals

**NEW** 7P.32.8.275.2001



- SPD Type 3
- Acoustical (buzzing) signalling of varistor fault



For outline drawing see page 6

SPD specification		
Nominal voltage	$U_N$	230 V AC
Maximum continuous operating voltage	$U_C$	275 V AC
Nominal discharge current (8/20 $\mu$ s)	$I_n$	1.5 kA
Test voltage of the combined generator L-N, L(N)-PE	$U_{OC}$	3 kV , 3 kV
Voltage protection level L-N, L(N)-PE	$U_P$	0.9 kV, 1.5 kV
Response time	$t_A$	25 ns
Short-circuit proof at maximum overcurrent protection		6 kA <sub>rms</sub>
Maximum overcurrent protection		16A gL/gG or C16 A
Transient OverVoltage 5s L-N	$U_{TOV}$	335 V
Transient OverVoltage 5s L-PE	$U_{TOV}$	400 V
Transient OverVoltage 200 ms L-PE	$U_{TOV}$	1430 V
Other technical data		
Ambient temperature range		-25...+40 °C
Protection degree		IP 20
Wire length		150 mm
Approvals (according to type)		<b>CE</b>

## Ordering information

Example: 7P series, surge protection device, single phase (1 varistor)

**7 P . 2 1 . 8 . 2 7 5 . 1 0 2 0**

**Series**

**Type**

- 2 = Type 2 surge arresters
- 3 = Type 3 surge arresters

**Circuit**

- 1 = 1 varistor
- 2 = 1 varistor + 1 spark-gap
- 3 = 3 varistors
- 4 = 3 varistors + 1 spark-gap
- 5 = 4 varistors
- 6 = 2 varistors + 1 spark-gap
- 0 = Replaceable module

**Supply version**

- 8 = AC (50/60 Hz)
- 9 = DC (PV applications)
- 1 = N+PE connection

**Supply voltage**

- 000 = 1000 V DC Max (or N+PE connection)
- 275 = 275 V Max (for  $U_N = 230-240$  V AC)
- 420 = 420 V DC Max
- 700 = 700 V DC Max

**Nominal discharge current**

- 020 = 20 kA
- 001 = 1.5 kA

**Remote status signalling**

- 1 = Built-in remote status signalling contact
- 2 = Acoustical fault signalling

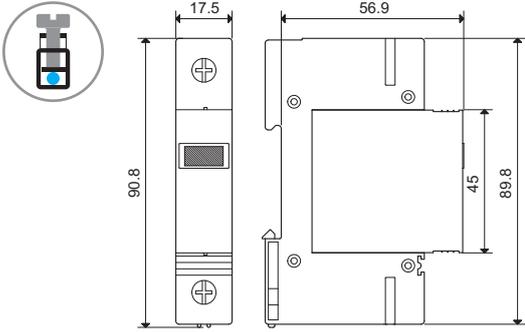
## Replaceable modules



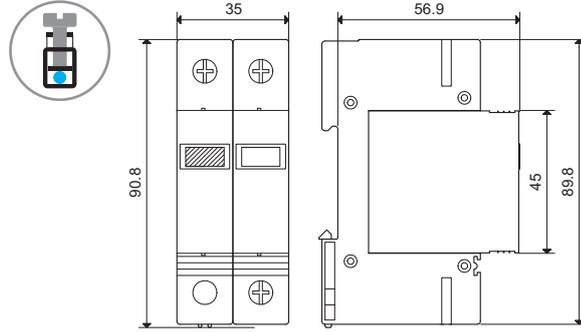
Replacement Varistor and Spark-Gap modules		7P.20.8.275.0020	7P.20.9.350.0020	7P.20.9.500.0020	7P.20.1.000.0020	7P.20.1.000.9020
		Varistor	Varistor	Varistor	Spark-Gap	Spark-Gap
Maximum operating voltage	$U_C$	275 V AC	350 V DC	500 V DC	255 V AC	420 V DC
Nominal discharge current (8/20 $\mu$ s)	$I_n$	20 kA				
Maximum discharge current (8/20 $\mu$ s)	$I_{max}$	40 kA				
Voltage protection level	$U_P$	1.2 kV	1.2 kV	1.8 kV	1.5 kV	1.5 kV
Response time	$t_A$	25 ns	25 ns	25 ns	100 ns	100 ns
Maximum overcurrent protection		160 A gL/gG	160 A gL/gG	160 A gL/gG	—	—

## Outline drawings

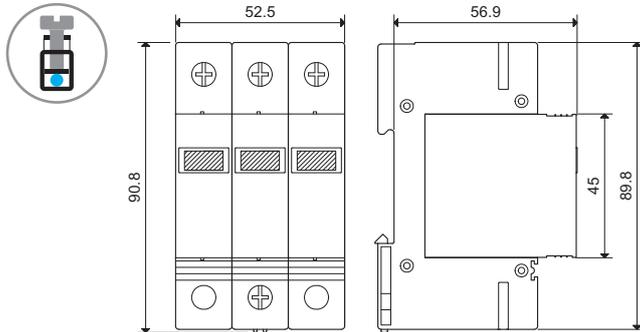
7P.21  
Screw terminal



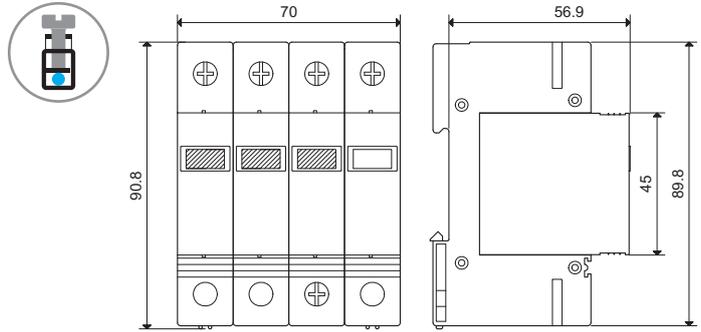
7P.22  
Screw terminal



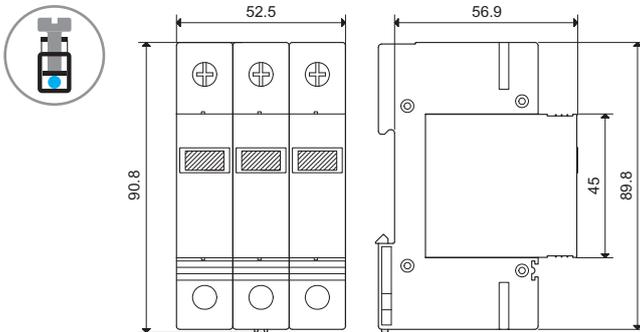
7P.23.8  
Screw terminal



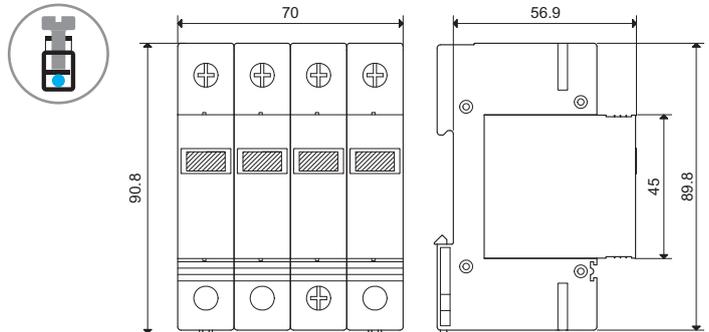
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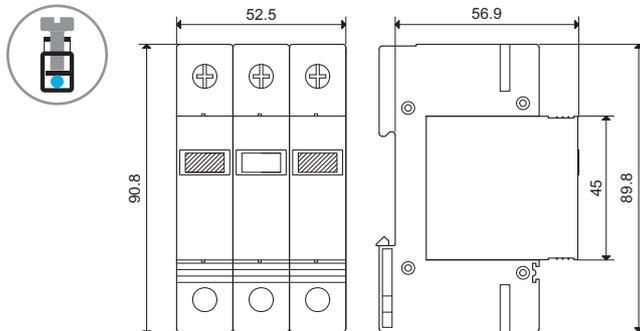
7P.23.9  
Screw terminal



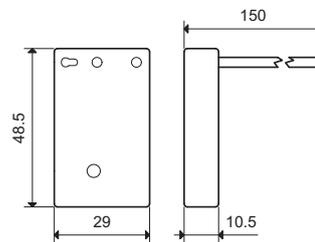
7P.25  
Screw terminal



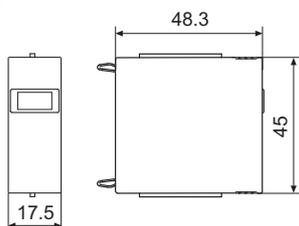
7P.26  
Screw terminal



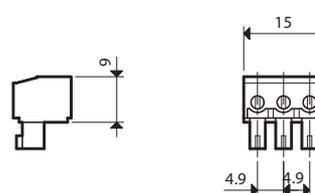
7P.32



7P.20  
Replaceable module

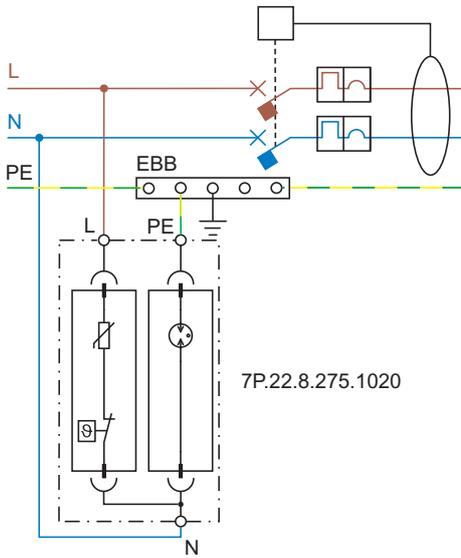


07P.01  
Connector

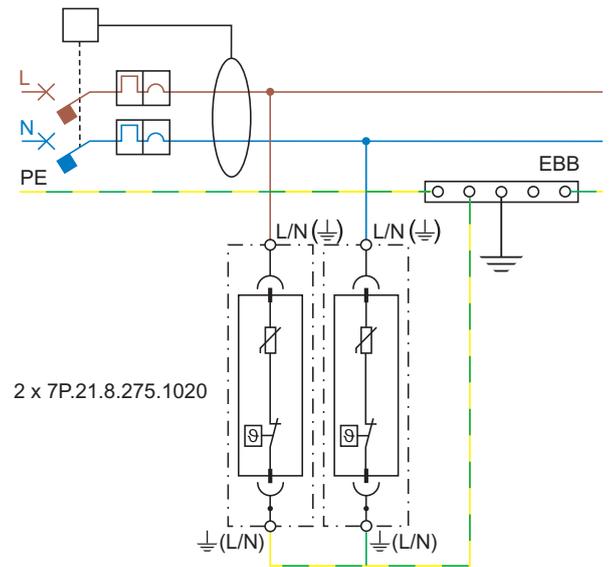


Installation examples - Single phase

TT-SINGLE PHASE SYSTEM - SPD UP-STREAM OF RCD

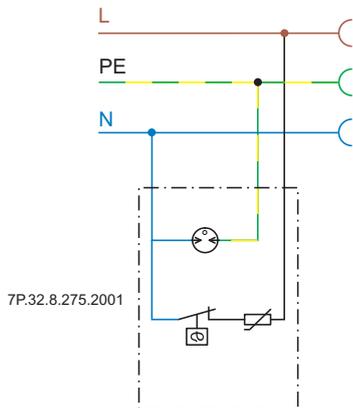


TT or TN-S SINGLE PHASE SYSTEM - SPD DOWN-STREAM OF RCD



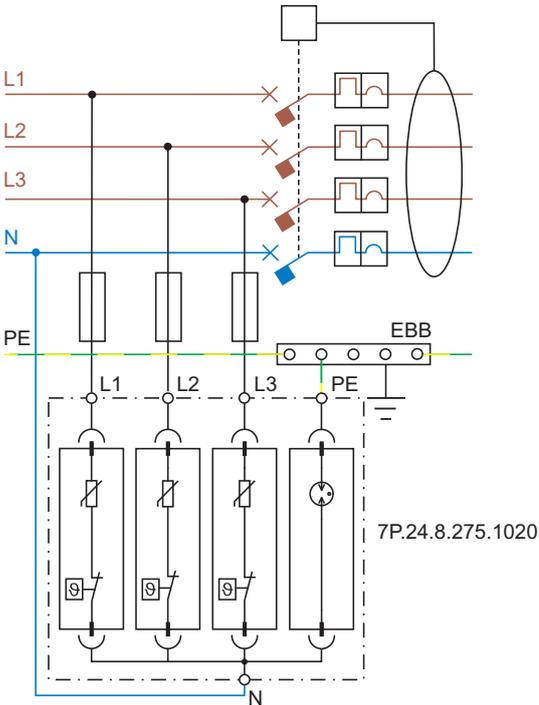
Note: suggested RCD type S

TT or TN-S SINGLE PHASE SYSTEM - INCORPORATED IN SOCKET OUTLET

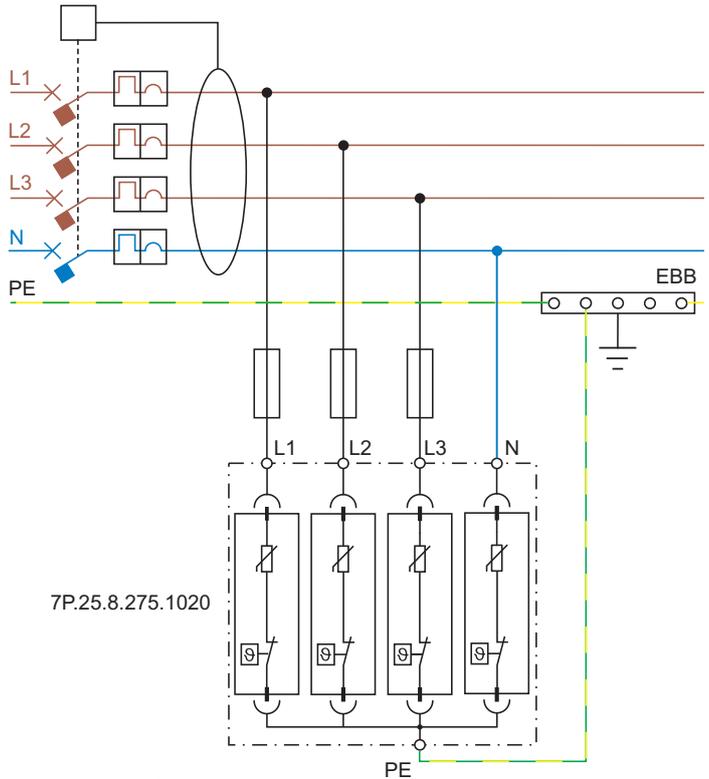


## Installation examples - Three-phase

TT or TN-S THREE PHASE SYSTEM - SPD UP-STREAM OF RCD

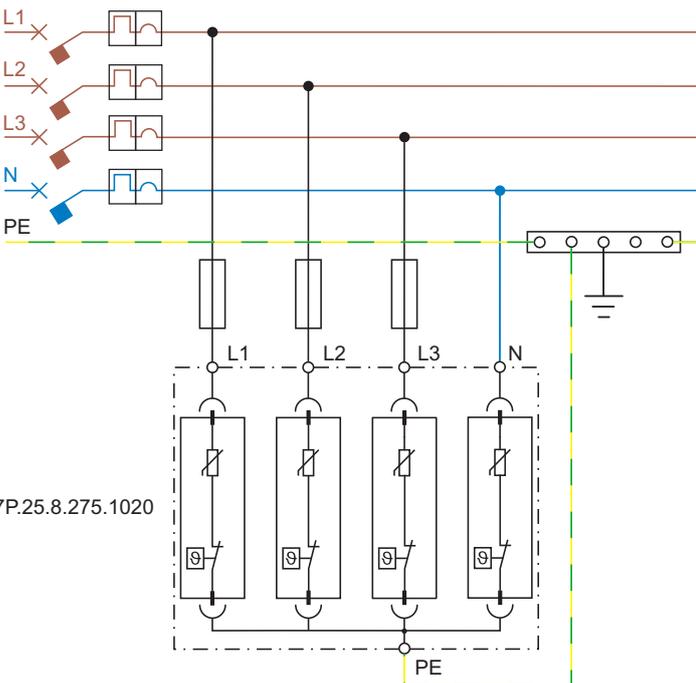


TT THREE PHASE SYSTEM - SPD DOWN-STREAM OF RCD

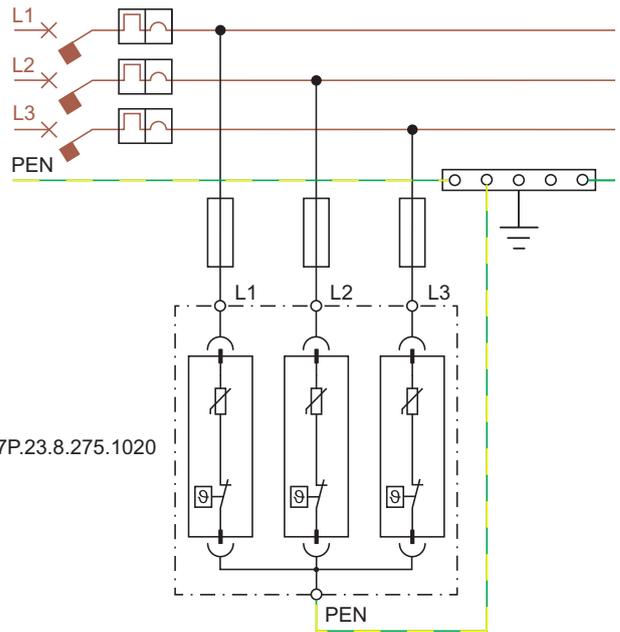


Note: suggested RCD type S

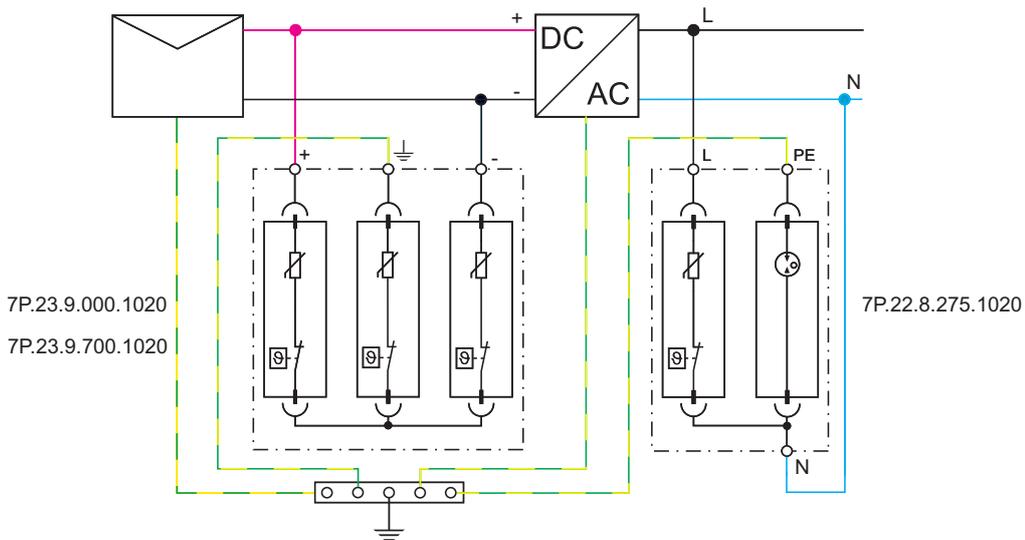
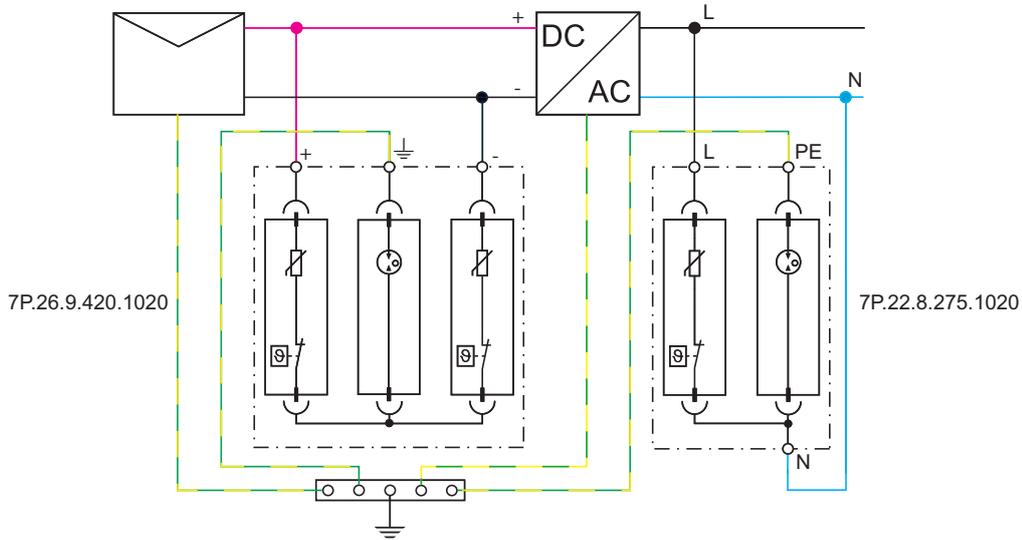
TN-S THREE PHASE SYSTEM - SPD DOWN-STREAM OF OVERCURRENT PROTECTION



TN-C THREE PHASE SYSTEM - SPD DOWN-STREAM OF OVERCURRENT PROTECTION



Installation examples - photovoltaic



## SURGE VOLTAGE PROTECTORS

Surge voltage protectors (such as Finder's Surge Protection Devices, SPD) are intended to be installed in electrical systems, to protect people and machines from surge voltages that can occur on the electrical supply line and which would otherwise have disastrous consequences. These surge voltages can be atmospheric (lightning) or can originate on the electrical system due to, for example: the opening and closing of large loads, short circuits, or the switching of large power factor correction capacitors. The SPD can be described as a switch that is in parallel with the electrical system's supply line - which it is protecting. At the nominal network voltage (e.g. 230 V) the SPD appears as an open switch, having a very high impedance (almost infinite). But, under an overvoltage condition its impedance rapidly falls to near 0 Ω. This effectively applies a short circuit across the supply lines and immediately "drains" the overvoltage to earth. In this way the supply line is protected wherever SPD are installed. When the overvoltage has passed, the SPD impedance rises rapidly and resumes the state of an open switch again.

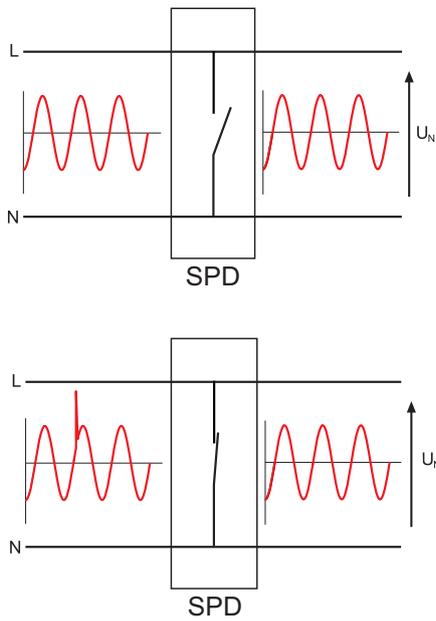


Figure 1: Ideal operation of an SPD

### SPD technologies

Finder surge voltage protectors use either varistors or spark gaps.

**Varistor:** this can be considered as a variable resistance that at nominal voltage has a very high ohmic value. But the resistance rapidly falls to near zero as the voltage surges. In this way the varistor applies a near short circuit which clamps the surge voltage. The varistor is however subject to progressive degradation due to the small leakage current that occurs at the nominal voltage, and with the number of interventions. With every overvoltage that occurs the leakage current rises and accelerates the end of life for the device - which is ultimately indicated by the change from green to red in the signal-window.

**Spark gap:** this comprises two electrodes separated by air, or a gas. When a surge voltage occurs an electrical arc bridges the gap and a surge current flows to limit the surge voltage to a low and constant level. The arc extinguishes only when the surge current falls below about 10 ampere. The gas guarantees a constant level of breakdown voltage since the arc is struck in a protected environment; not exposed to pressure or humidity variations or impurities as would happen if it had occurred in air. There is however, a delay before the device arcs and the surge current is diverted, and this is dependent on the magnitude of the original voltage surge and on its rate of rise. Therefore, the voltage protection level can vary, although it is guaranteed to be less than  $U_p$ .

Component	Symbol	Leakage current	Energy dissipated	Response time	Voltage/Current characteristic
Ideal		0	High	Fast	
Spark gap		0	High	Medium	
Varistor		Very Low	Medium	Fast	

Figure 2: SPD component characteristics.

### Installation (Overvoltage) categories

Choosing the SPD requires the matching of the Rated Impulse Voltage of the SPD with that of the equipment to be protected. This in turn relates to the Installation category (Overvoltage category). Installation categories are described within IEC 60664-1, which for a 230/400 V installation prescribes as follows:

- **Installation category I:** 1.5 kV for "particularly sensitive" equipment (e.g. electronic devices like PC or TV set);
- **Installation category II:** 2.5 kV for "user" equipment subject to "normal" impulse voltages (e.g. household electrical appliances, mobile items);
- **Installation category III:** 4 kV for equipment that are part of a fixed installation (e.g. switchboards, switches)
- **Installation category IV:** 6 kV for equipment installed at or near the origin of main incoming supply mains (e.g. energy meters).

### Lightning Protection Zones and installation considerations

International standards refer to the various Lightning Protection Zones by the letters LPZ followed by an appropriate number.

- LPZ 0A: An external area, where a direct lightning strike is possible and where there is total exposure to the electromagnetic field induced by the lightning.
- LPZ 0B: An external area, but below a lightning conductor providing direct lightning strike protection. There remains total exposure to the electromagnetic field.
- LPZ 1: Area within a building – therefore protected from direct lightning strike. The electromagnetic field will be attenuated, depending on the degree of shielding. This zone has to be protected by SPD type 1 device(s) at its boundary with the LPZ 0A or 0B zone.
- LPZ 2: An area, typically a room, where the lightning current has been limited by preceding surge protectors. This zone has to be protected by SPD type 2 device(s) at its boundary with the LPZ 1 zone.
- LPZ 3: An area within a room where the lightning current has been limited by preceding surge protectors (typically the wiring after a socket or an area within a metal enclosure). This zone has to be protected by SPD type 3 device(s) at its boundary with the LPZ 2 zone.

The correct installation for a Type 2 SPD is for the connections to the local Earth bonding bar to be as short possible. The cable from this equipotential bar to the main equipotential bar must have a minimum section of 4 mm<sup>2</sup>. The phase wiring size remains appropriate to the load.

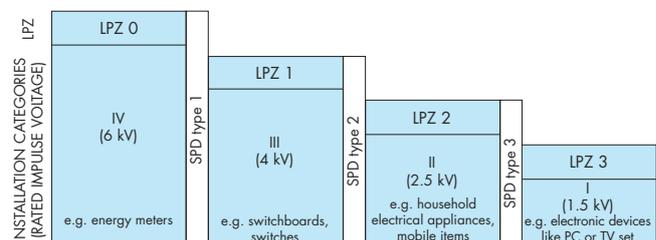


Figure 3: Relation between Lightning Protection Zones, Installation Categories and SPD types

## Finder SPD type 2 devices – Conditions of use, rated values and markings.

SPD type 2 devices are designed to remove the overvoltage from supply circuits that are not likely to be directly hit by lightning. Consequently they can be installed throughout a distributed supply system and also at the incoming of the supply - provided there is a low possibility of direct lightning hits.

The following 4 parameters are marked on the front of a Finder SPD type II device:

**[ $U_c$ ] Maximum continuous operating voltage:** Under this voltage the SPD is guaranteed to appear as an “open switch”. This voltage is normally at least equal to the nominal supply voltage ( $U_N$ ) + 10%. For the Finder SPD,  $U_c$  is specified as 275 V.

**[ $I_n$ 8/20] Nominal discharge current:** The peak current (and waveform shape) through the SPD under conditions prescribed by EN 62305 to represent the surge current as a consequence of a lightning strike to the electric supply line.

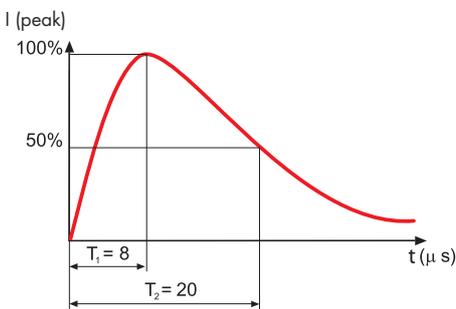


Figure 4: 8/20  $\mu$ s current waveform

**[ $I_{max}$ 8/20] Maximum discharge current:** Peak value of the highest current of a 8/20 $\mu$ s waveform that an SPD can discharge at least once without breaking.

**[ $U_p$ ] Voltage protection level:** This is the highest voltage level seen across the SPD during its intervention. For a Finder SPD this is < 1.2 kV. This means that a 4kV overvoltage would be limited by the SPD to a maximum 1.2 kV. Consequently, electronic devices such as PC, TV, stereo, etc. are protected - as their own internal protection will handle overvoltages up to 1.5 kV.

To better understand this concept; imagine that the SPD is a switch in series a low resistance. In the case of an overvoltage the switch closes and all the current goes through the resistance. According to Ohm's law the voltage developed across the resistance will be this resistance x the current ( $V = R \times I$ ), and will be limited to <  $U_p$ .

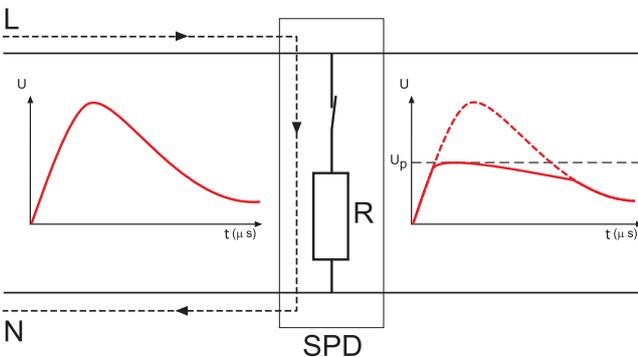


Figure 5: Overvoltage limiting

**Short circuit proof:** A further characteristic, not normally marked on the product but important for its correct installation, is the Short circuit proof at maximum overcurrent protection. This is the maximum short-circuit current that the SPD is able to withstand when it is installed with additional maximum overcurrent protection - such as a fuse rated in accordance with the value stated under the SPD specification. Consequently the maximum prospective short-circuit current of the system at the point of installation of the SPD must not exceed this value.

## Other types of SPD

### SPD type 1

These are used at the incoming of the supply line to the building - in an area exposed to direct lightning. An SPD type I (or class I) has an  $I_{imp}$  rating.

**[ $I_{imp}$ 10/350] Impulse current:**  $I_{imp}$  corresponds to the peak value of a 10/350  $\mu$ s current impulse waveform. This waveform represents a direct lightning strike and is used in tests to prove the performance of SPD type 1 devices.

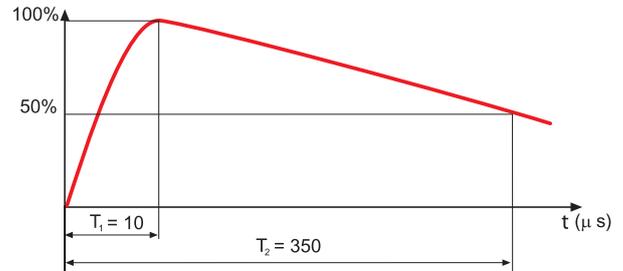


Figure 6: 10/350  $\mu$ s current waveform

Comparison of the waveforms in figures 4 and 6 shows the much higher energy content controlled by the type 1 SPD.

### SDP type 3

SPD type 3 devices are used to protect the end user from overvoltage. They may be installed in supply networks where SDP types 1 and/or 2 already exist. They can be installed in fixed or mobile sockets and have the following characteristic parameters.

**$U_{oc}$ :** test voltage. This is the peak value of the no load voltage of the combined test-generator; this has a waveform of 1.2/50  $\mu$ s (figure 7) and can supply at the same time current with waveform 8/20  $\mu$ s (figure 4).

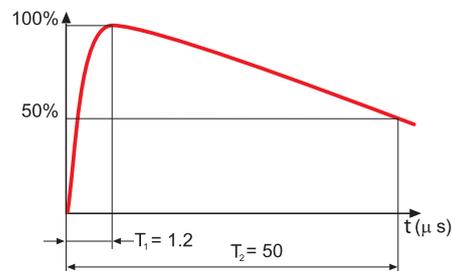


Figure 7: 1.2/50  $\mu$ s voltage waveform

## PROTECTING PHOTOVOLTAIC (PV) SYSTEMS AGAINST LIGHTNING

Photovoltaic systems are generally located external to a building and can be subjected to the direct or indirect effects of lightning. The installation of photovoltaic panels on the roof does not, in itself, increase the risk of direct lightning; however the only practical way to protect against the effects of a direct lightning strike is the use of a lightning protection system (LPS).

The indirect effects of lightning can however, be mitigated by the appropriate use of Surge Protection Devices (SPD). These indirect effects occur when lightning strikes in proximity to the structure and where magnetic induction creates an overvoltage in the conductors – a danger to both people and equipment. In particular, the DC cables of a PV system would be exposed to the high conducted and radiated disturbances caused as a result of the lightning currents. In addition, overvoltages in PV systems are not only of atmospheric origin. It is also necessary to consider overvoltages due to switching on electrical networks connected to them. These overvoltages can also damage both the inverter and the PV panels, and this explains the need to protect the inverter on both DC and AC sides.

### Installation Systems

**[ $U_{OC\ STC}$ ] PV voltage:** corresponds to the SPD maximum operating voltage and must be greater or equal to the maximum no-load voltage of the PV system - depending on the configuration: earth free or mid central earthing.

It is suggested that the maximum no-load voltage of the PV system is calculated on the basis  $1.25 \times N \times U_{OC(module)}$ , where  $U_{OC(module)}$  is the no-load voltage of the single PV module in standard conditions and N is the number of modules connected in series in each array of the PV system.

#### Earth free system

An earth free system installation, typical of smaller systems, is characterized by the DC side floating, without connection to the ground.  $U_{OC\ STC}$  refers to the voltage between positive and negative poles. Class II photovoltaic panels are normally used in earth free system. However, if Class I panels are used, their metallic frame has to be earthed for safety reasons.

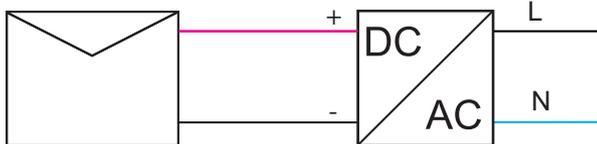


Figure 8: Earth free system installation

#### Mid central earthing

This system is used in larger installations, with high voltages: the ground connection to the mid point reduces by half the maximum voltage with respect to the ground. In this case  $U_{OC\ STC}$  is the voltage between the pole connected to the SPD and the ground.

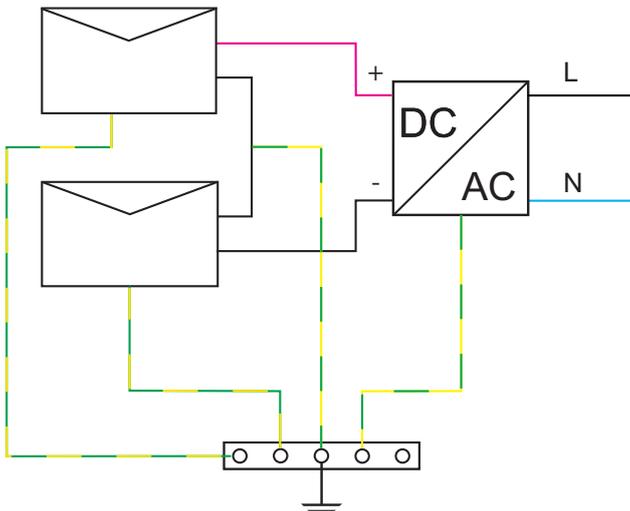


Figure 9: Mid central earthing installation

## Photovoltaic system on a building without a lightning protection system (LPS)

As an example, Figure 10 represents a simplified photovoltaic system placed on a building without lightning rod. In such a system, the protection against lightning must be considered at the following points of installation:

- DC input of the inverter
- AC output of the inverter
- Low voltage supply network

At the DC input to the inverter SPDs specific for photovoltaic systems must be installed, according to the PV system voltage. At the inverter AC output, type 2 surge arresters must be installed suitable for the type of system. At the point of connection to the LV supply network, install type 2 surge arresters suitable to the type of system (TT, TN). In more complex systems, it might be necessary to introduce additional SPDs: one close to the PV panel (if the distance between the PV panel and inverter is greater than 10 m), and finally another at the point where the DC cables enter the building (where the distance between the PV panel and the inverter is greater than 20 m).

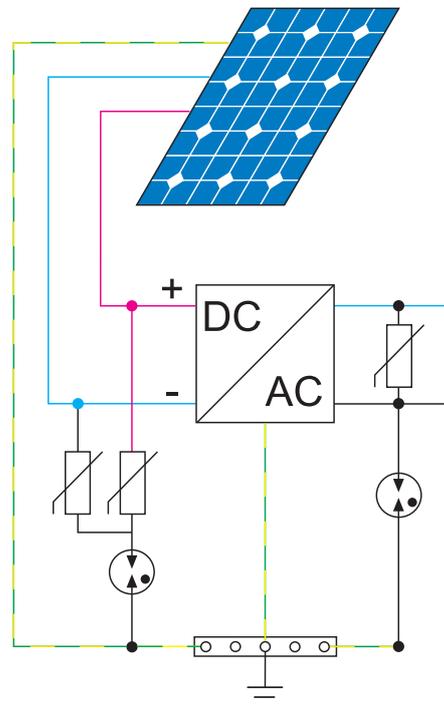


Figure 10: example of a photovoltaic system located on a building without LPS, protected on the DC side by an SPD with  $U_{OC\ STC} = 420\ V$ , and on the AC side by a 7P.22, specific for TT systems.

## Photovoltaic system on a building with a lightning protection system (LPS)

In this case it is good practice to install the photovoltaic panels in the area protected by the lightning rod.

In addition it is necessary to realize a good equipotential bonding system, which must be positioned as close as possible to the entry point of LV supply into the structure. The LPS, the SPD and all metal parts have to be connected to this equipotential system.

SPD protection on the DC side is the same as for systems without LPS, therefore an arrester for PV systems of a suitable voltage  $U_{OC\ STC}$  should be used. The AC side should be protected by a suitable Type 2 SPD on the inverter AC output. And, if the distance between the power distribution point and the inverter output is  $> 5\ m$ , it is also suggested to install an appropriate SPD at the power distribution point.