

# SOLUTION

for LED street lighting systems

Lightning and overvoltage protection



## Why to Protect?

### Protection of Investments

The current requirements on the quality of lighting and energy efficiency bring to light the necessity of using new technologies, in particular that of LED. The manufacturers of LED lamps declare that their service life lasts more than 50,000 hours (in contrast to sodium-vapour lamps, featuring a service life of approx. 25,000 hours, 10,000 hours for discharge lamps, or 1,000 hours for incandescent lamps). However, this feature is counterbalanced by higher investment costs, which can be compensated by not only the lower power consumption of the light source, but also by reduced maintenance costs, where one of the requirements is trouble-free operation. Thus, the use of surge protection devices to achieve higher reliability and a shorter return on investments is no longer an option, but a necessity.

Public lighting installations or lighting systems for large industrial premises are sometimes extensive, with cable lengths about hundreds of metres. This involves the risk of induced overvoltages caused by lightning strikes, operation failures, and switching effects in power distribution and transmission grids.

High-voltage power impulses in extensive installations may reach values that are much higher than the specified withstand voltage of the light source in question. The electronics in the light sources based on the new technology is substantially more sensitive to such disturbances than, for instance, discharge lamps.

**When considering the possibilities of damages to the equipment (installations) caused by lightning, we consider the following causes of damages:**

- S1 – Direct lightning strike to the equipment (installation)
- S2 – Lightning strike within the proximity of the equipment installed, failures and switching phenomena in MV and HV grids near the equipment installed
- S3 – Direct lightning strike to the connected distribution mains; S4 – lightning strike near the connected distribution mains, and switching phenomena and failures in power distribution networks and transmission grids

## What to Use for Protection?

### Surge Protection Devices (SPDs) Specially Designed for LED Lighting Technology

**The types of protective devices (SPDs) are chosen according to the risk that is expected. The following examples illustrate how to resolve individual cases.**

When dealing with the issue of protection from overvoltage, the requirements of the following standards should be taken into account:

EN (IEC) 62305-1 to 4, CLC/TS (IEC) 61643 12, HD-60364-4-443 (IEC 60364-4-44 chapter 443), HD-60364-5-534 (IEC 60364-5-53 chapter 534), EN 60598-1, and IEEE (ANSI) C62.41.2. All SPDs designed by SALTEK intended for the use in various protection solutions meet the requirements of the EN (IEC) 61643 11 standard, in the way required by the EN 60598-1 standard.



# How to Protect?

## Examples, Principles, and Recommendations for the Use of SPDs

### SPD at the connection point of the street lighting system to the distribution mains to the distribution mains

As required by HD 60364-5-534 (IEC 60364-5-53 chapter 534) and IEEE C62.41.2 standards, a SPD has to be installed at the power input of the electrical installation or in the main switchboard. Thus, overvoltages coming from the distribution mains and other distribution systems can be limited, and the requirements on coping with overvoltages from direct lightning strikes into the distribution mains (S3) and from lightning strikes in the proximity of the distribution mains (S4) can be met.

The SPD installed at the power input of the installation is chosen depending on the character of the connected power mains. In the case of an overhead line, it is advisable to use the FLP B+C MAXI V SPD (Fig. 1a). In the case of a cable connection with cable laid in the ground in its entire length starting from the transformer, it is enough to use the FLP 12,5 V SPD (Fig. 1b).

In large industrial buildings with light circuits connected to sub-main distribution boards, the latter are equipped with the SPDs of SLP-275 V (i.e. the SPD type 2 – see Fig. 2). It is advisable to use the SPD a type 1, or type 1+2, such as the FLP-B+C MAXI V, at the power electric input into the building.

At locations with fluctuating voltages or where the voltage may exceed the usually specified tolerance ranges, or in places where the disconnection of a load causes the voltage to increase (e.g. during the night), it is advisable to use varistor-based SPDs with higher  $U_c$  (e.g. the SLP-385 V series), or combined SPDs (with switching and limiting elements connected in series - MOV+GDT technology), such as the FLP B+C MAXI V or SLP-275 VB types. In such cases, the service life of the SPD will be extended and the trouble-free operation at the place of installation will be ensured.

### Protection from overvoltage at locations prone to direct lightning strikes to the lighting system and its structures

If the height of a lamppost exceeds that of the surrounding buildings (Fig. 3), i.e. the light fittings or the structures are situated in the LPZ  $0_A$  zone, the risk of direct lightning strike to such structures becomes imminent (S1).

In regards to street lighting, protection levels LPL III or LPL IV are considered. At locations with high population density levels, where a lightning strike could cause panic or a fire, such as large

Fig. 1a SPD at the connection point of street lighting system to the distribution mains - overhead power line

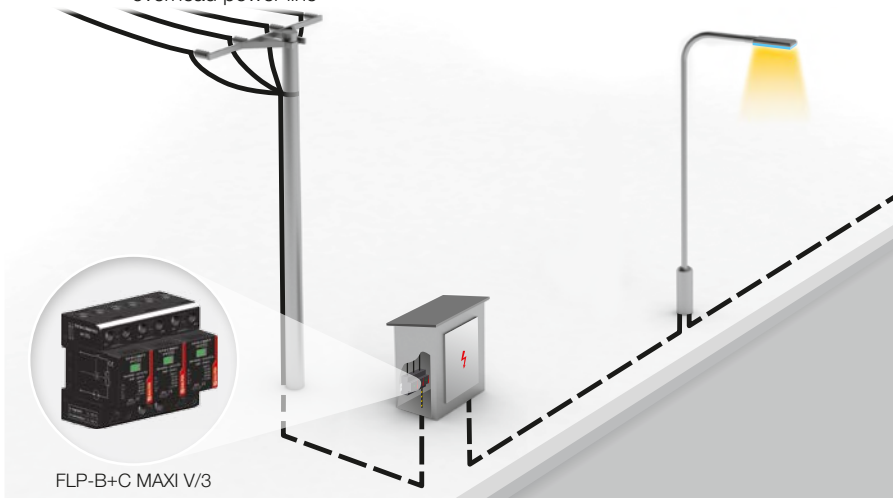


Fig. 1b SPD at the connection point of street lighting system to the distribution mains – cable connection

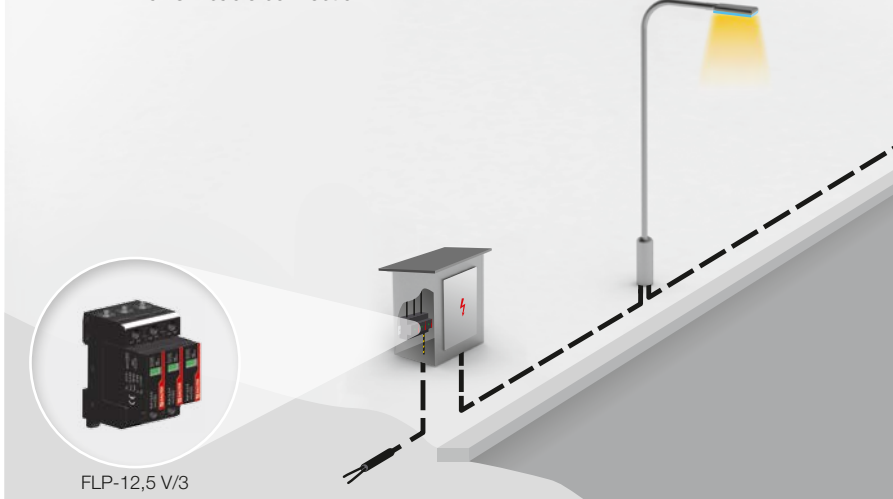
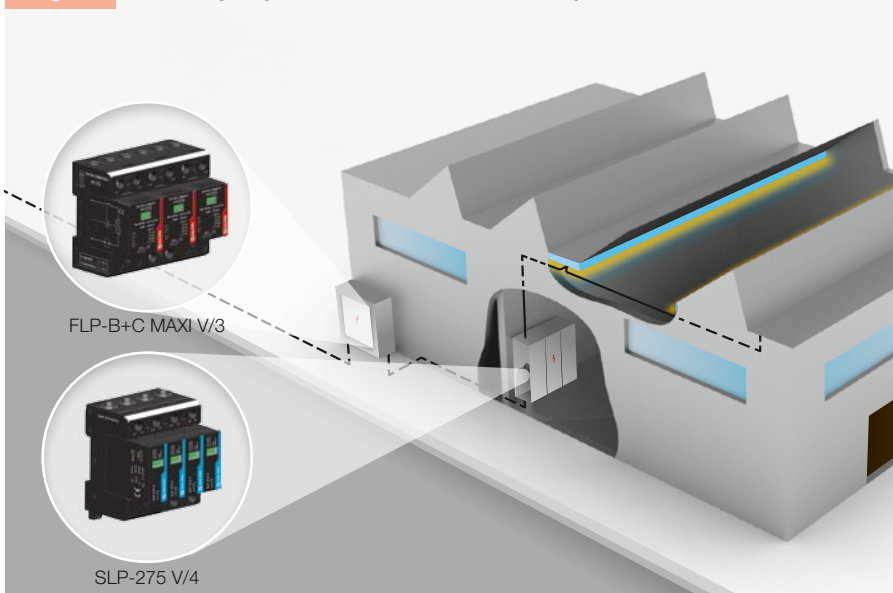


Fig. 2 SPD for lighting circuits installed in a vast building



sport stadiums, a higher level of protection from lightning strikes needs to be considered, e.g. by protecting the lighting system externally from lightning strikes (by a lightning conductor).

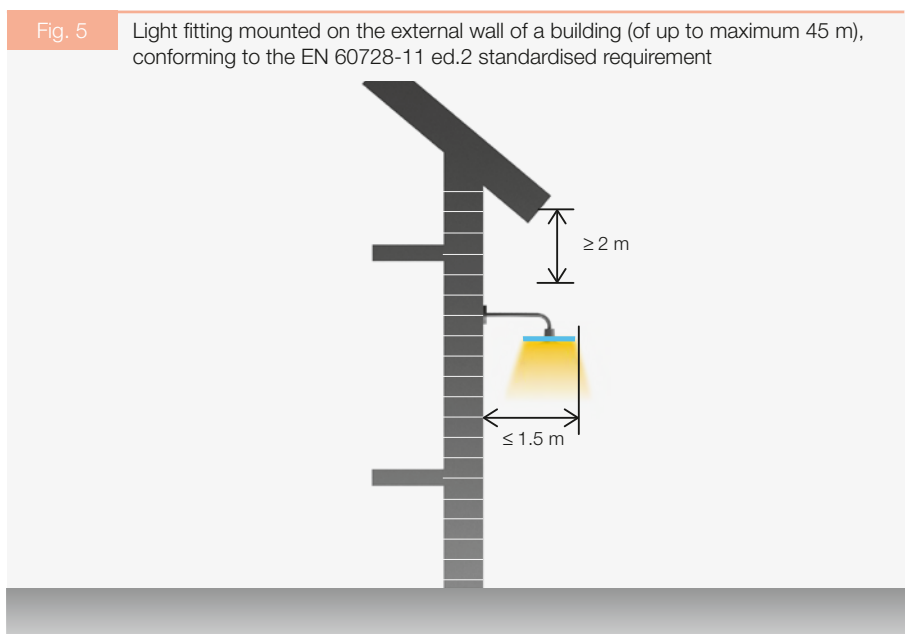
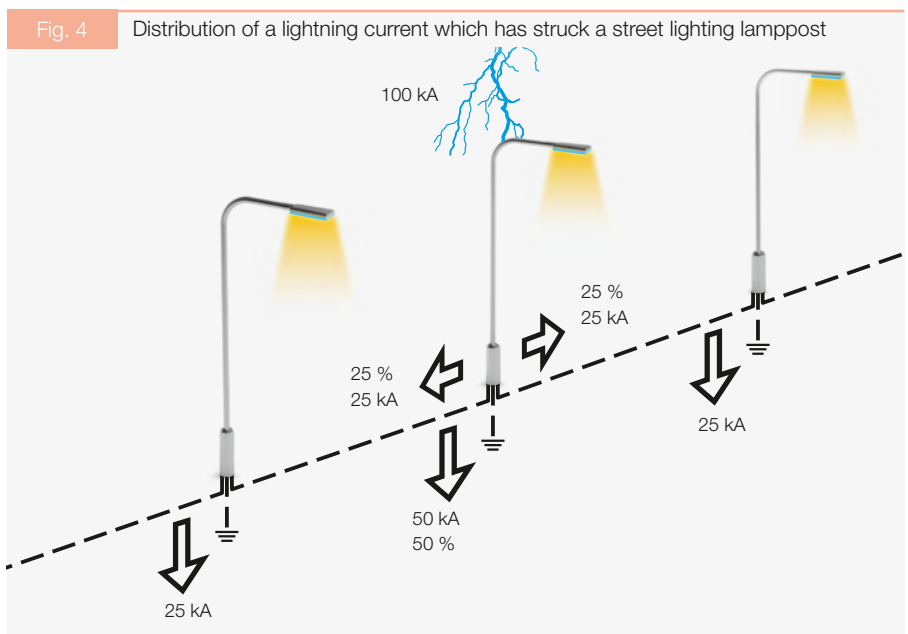
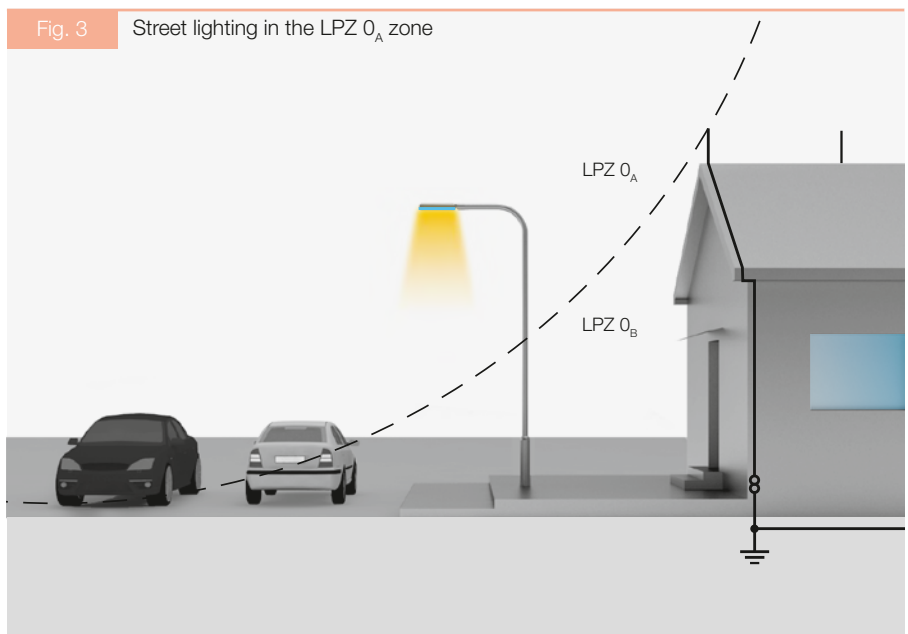
For LPL III and LPL IV levels, the peak current values of 100 kA are considered. These can be simulated by a surge test in the shape of a 10/350  $\mu$ s wave. In such particular cases, each lamppost should be grounded. The worst case scenario considers that only 50 % of the lightning current will be led into the ground via the grounding system, whereby the remaining 50 % would be distributed into the incoming and outgoing cables. Lightning strikes with high parameters may damage the equipment at the lightning strike point, but the lighting system will still be efficiently protected (LED drivers, electronic ballasts, by the LED itself...) in the surroundings (see Fig. 4).

In many situations, street lighting is powered from 3-phase grids, with single-post branches led to each of the light fittings. In such cases, it is enough to install the SPD into the foot of the post, but only to those conductors that supply the light fitting with power, i.e. mostly between the neutral conductors, in which case the FLP 12,5 V/1+1 is most suitable, with its total discharge capacity of 25 kA (10/350  $\mu$ s wave), fulfilling the requirements on the dissipation of lightning strike currents affecting the neighbouring lighting posts. If the cable length of such overvoltage protection to the light source is 10 m or more, then according to the stipulations of the CLC/TS 61643-12 standard, it is necessary to install another SPD to the light source, e.g. the DA-320-LED type. However, even at shorter distances, it is advisable to (IEC) install the SPDs as close as possible to the light source, in spite of the fact that another SPD is already connected in series at the foot of the light post.

### Protection of a lighting system from induced overvoltages

Not only atmospheric overvoltages, but also lighting power cables routed in parallel with high-voltage power lines endanger the sensitive technologies used in modern LED lighting systems. If disturbances in proximity of lighting installations occur (lightning strike S2 or failures and switching phenomena in MV and HV grids running close to the lighting installations) are to be dealt with, in systems where an SPD is used at the installation entry as described in previous section (Fig. 1a, 1b, 2), then the DA-320-LED protective device is to be installed when installing light fittings on a building's exterior facade (Fig. 5) or indoors in the case of a distance of less than 10 m between the light fittings protected with the SPD and connected to one and the same phase conductor (Fig. 6), or in the case of street lighting posts lower than 10 m high with the SPD installed in the foot of the post (Fig. 7).

The SPDs SP-T2+T3-320/Y-CLT-LED are intended for use at locations with a higher



degree of risk, primarily on light fittings in the LPZ 0<sub>B</sub> protection zone. An example of such an arrangement are light fittings mounted on a cross-wire suspension between two buildings with an upstream SPD only at the installation's input (in the terminal cabinet – see Fig. 8), or as a replacement for the DA-320-LED SPD, or in cases of parallel routing with MV or HV power lines, or installations at locations with the occurrence of intense storm activity (more than 25 storm days a year).

The SP-T2+T3-320/Y-CLT-LED SPD is installed also in cases when the post height exceeds 10 m, or when the distance between the light fittings mounted indoors, with an SPD connected to the same phase line, is more than 10 m. If the lighting cabling in large industrial halls is installed near the roof, then it is recommended to avoid parallel routing with the externally mounted lightning protection system (LPS). If such a parallel run cannot be prevented, it is of an advantage to provide each of the light fittings with the SP-T2+T3-320/Y-CLT-LED SPD.

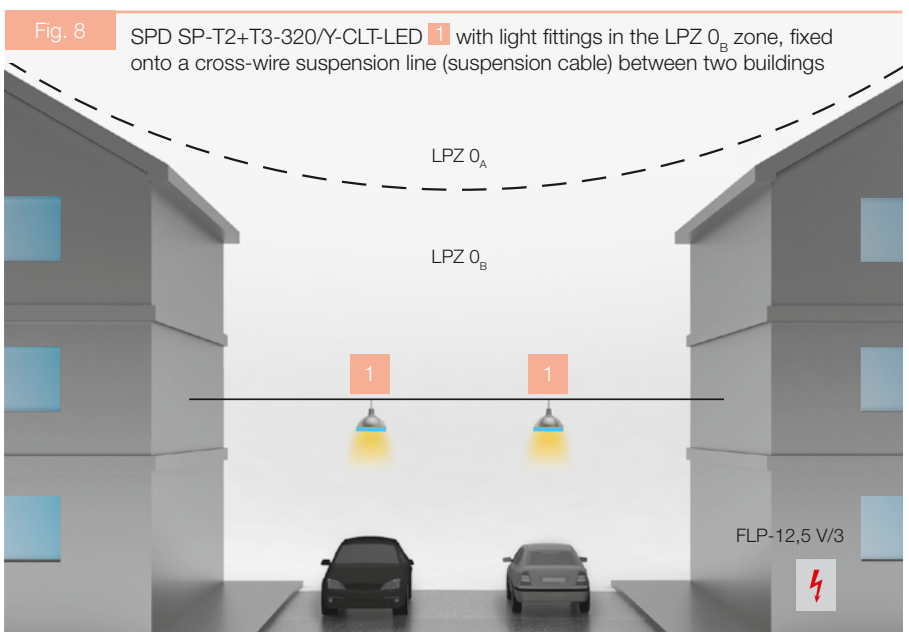
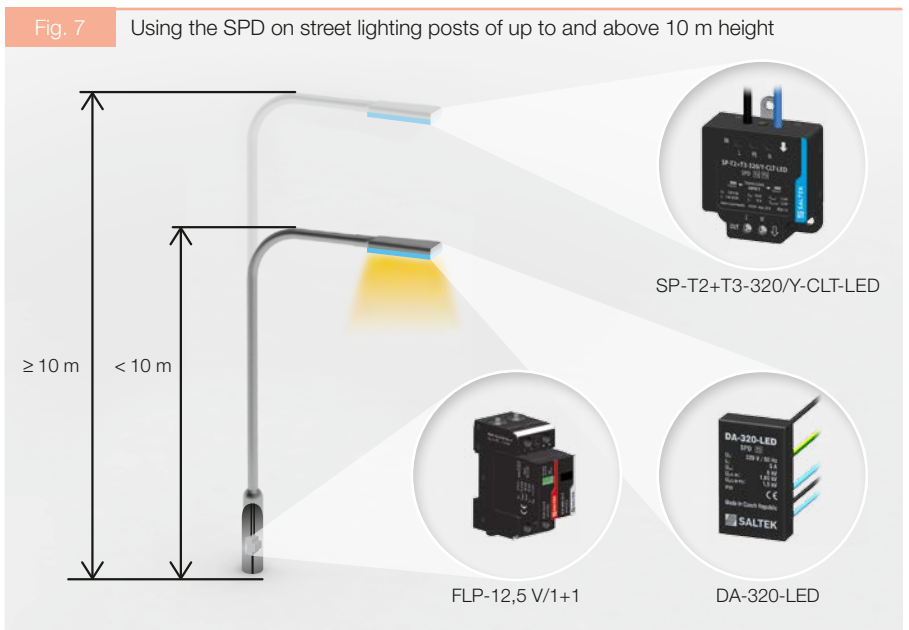
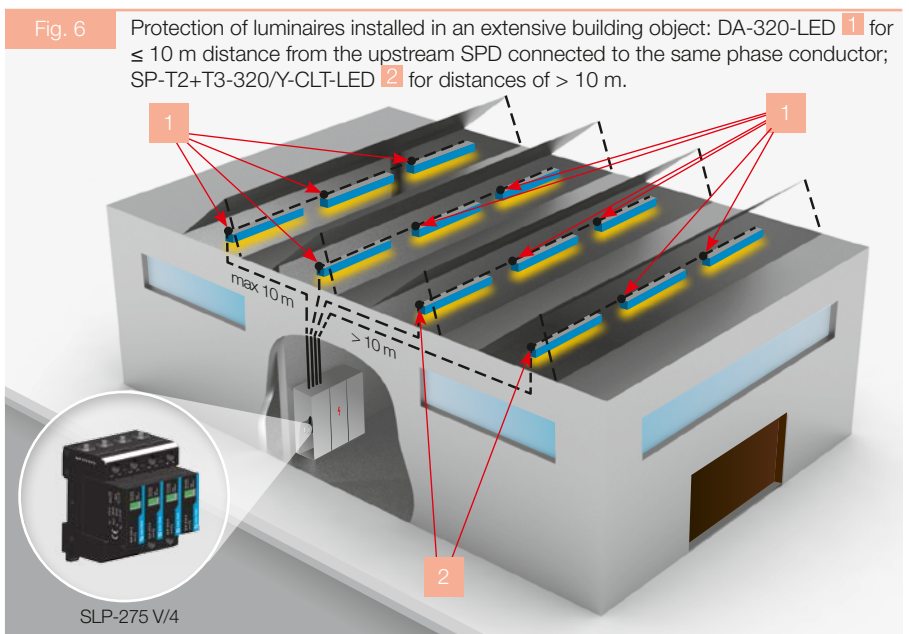
At locations without the risk of direct lightning strike to any part of a street lighting system, it is, in most cases, sufficient to mount the SPD at the input of the installation (e.g. the FLP-B+C MAXI V/3 SPD), and then the SP-T2+T3-320/Y-CLT-LED SPDs at each of the light fitting used. Effects of induced voltage affecting the installed lighting system can be reduced using earthing conductor (line). This conductor is grounded at both ends, i.e. on every lamppost (Fig. 9). An even better solution is to place the lighting cables into metallic tubes, with a galvanic connection between each section of the tube.

### Principles of SPD installation

The same principles of SPD installation as for low voltage installations apply to the street lighting system. These are described in detail in other SALTEK documents, such as the “Manual – Practical Guide for LV power installations”.

#### Basic principles:

- Shortest possible connecting conductors to the SPD (or to the protected equipment in case of a parallel run)
- Avoidance of parallel run of connecting lines with those protected by the SPD
- A joint protective conductor for both the SPD and the protected equipment
- Maintaining adequate (flashover) distance “s” from the external lightning protection system (LPS)
- The SPD must to be installed at a distance of less than 10 m, ideally as close as possible to the protected equipment.
- Do not confuse the input (power supply) and output of SPDs connected in series with the protected equipment.



- Do not exceed the maximum continuous operating voltage ( $U_c$ ) of the SPD
- Use grounding and equipotential bonding in the system installed (grounding e. g. the lampposts of the street lighting system)

## Properties of SPDs intended for use in lighting systems

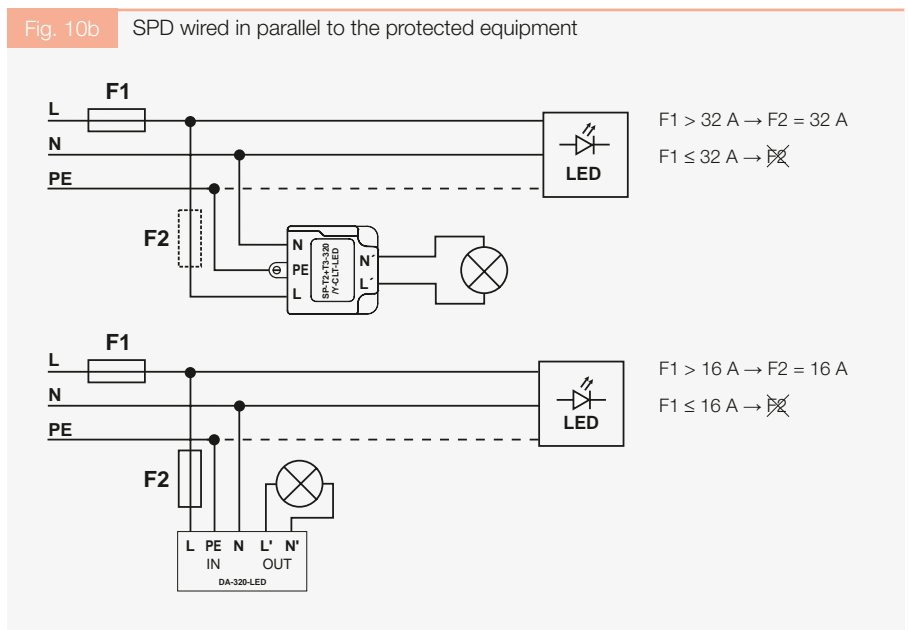
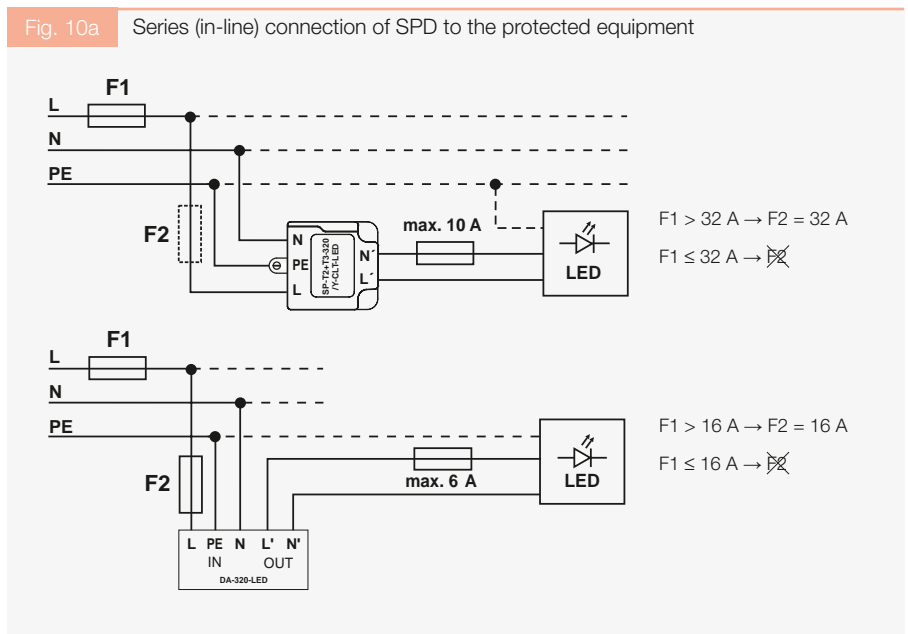
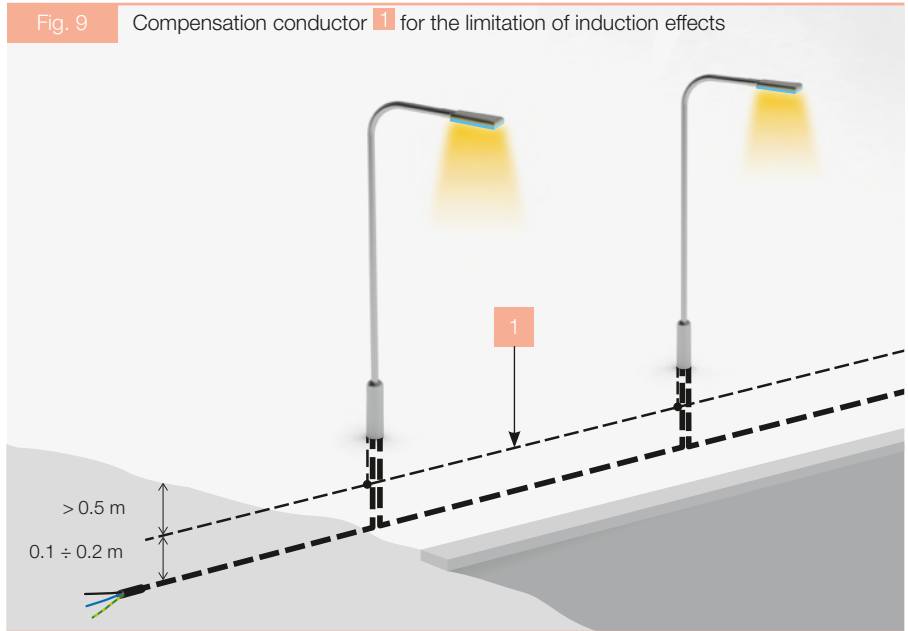
The SPD DA-320-LED and SP T2+T3 320/Y CLT LED SPDs meet the requirements of the IEEE (ANSI) C62.41.2 standard concerning the “C” location (outside of the building). These requirements, however, are determined by the standard mentioned, provided that overvoltage protection is being dealt with also at the starting point of the installation, i.e. at the point of connection to the distribution mains. At the same time, SPDs may be also used for the protection of other electrical equipment that behave similarly to lighting installations.

Concerning its size the DA-320-LED and SP-T2+T3-320/Y-CLT-LED, SPDs are suitable for mounting in light fittings, thus fulfilling the principle of installing the SPD as close as possible to the protected equipment. It is also suitable to mount the FLP-12,5 V or the SLP-275 V SPDs in sub-main distribution boards or at the foot of the lamppost, depending on the risk exposure and the mode of installation used.

The DA-320-LED and the SP-T2+T3-320/Y-CLT-LED SPDs are designed as in-line products with a primary focus on protection. In case the SPD becomes damaged, the light source disconnects itself from the power supply. In so doing, it is possible to easily determine where the failure occurred (Fig. 10a). These SPDs can also be connected in parallel to the protected circuit, and the SPD output is used for the indication of the status of the SPD (Fig. 10b). In addition, failures in SP-T2+T3-320/Y-CLT-LED SPDs are indicated by darkened display openings, to identify the failure in case of a disconnected power supply.

The internal connection of both the DA-320-LED and the SP-T2+T3-320/Y-CLT-LED SPDs is symmetrical, so that no problem arises if the neutral and phase conductors become interchanged, which is the case when it is impossible to follow the colour marking of conductors in light fittings. The internal arrangement can also be used in systems where the light fittings are connected in between the phase conductors (phase-to-phase voltage), provided that the  $U_c$  maximum operating voltage of such a SPD is not exceeded.

The SP-T2+T3-320/Y-CLT-LED SPD is arranged by default to be connected by wires with a lug for the connection of a PE protective conductor, with terminals at its output. Thus, it is not necessary to use another terminals or conductors when connecting the SPD to the light fitting. The only action one needs to take is



to disconnect the wires from the terminal block (Fig. 11), to connect the conductors from the incoming side of the SPD to the terminal block, and to insert the previously disconnected wires into the output terminals of the SPD (Fig. 12). The lug for the PE conductor may also be used to secure the SPD in the inside of the light fitting. The SPDs series SP-T2+T3-320/Y-CLT-LED provide for bespoke solutions of the input/output connection, with various combinations of terminals and conductors, including the PE conductor. An auxiliary adapter made from plastic material makes it possible to attach the SPD to a DIN 35 mm rail (TH 35), provided that the latter is not equipped with a lug to connect the PE conductor.

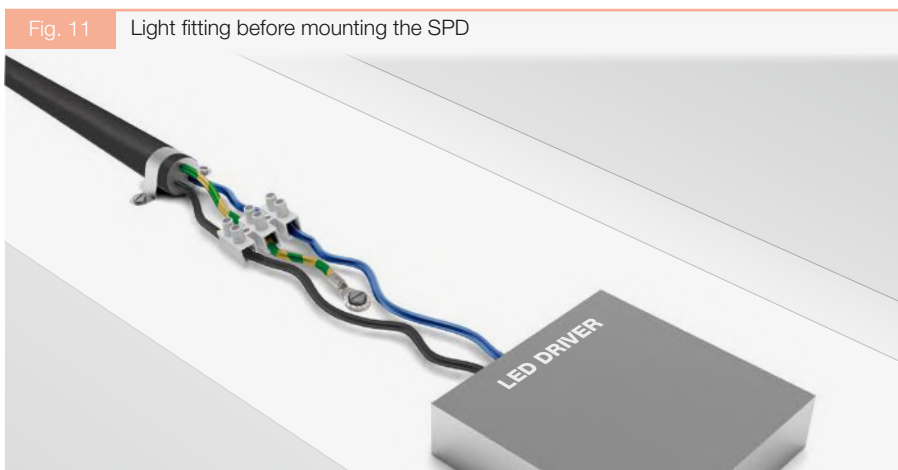


Fig. 11 Light fitting before mounting the SPD

**Using SPDs for light fittings designed as protection class I and II equipment**

Light fittings designed as protection class I equipment have their SPD connected as shown in Fig. 13. If the light fitting is a part of the TN-C grounding system, the SPD may be inserted into the point where the PEN conductor is dissevered (the PEN conductor at the input is connected both to the N and PE terminals).

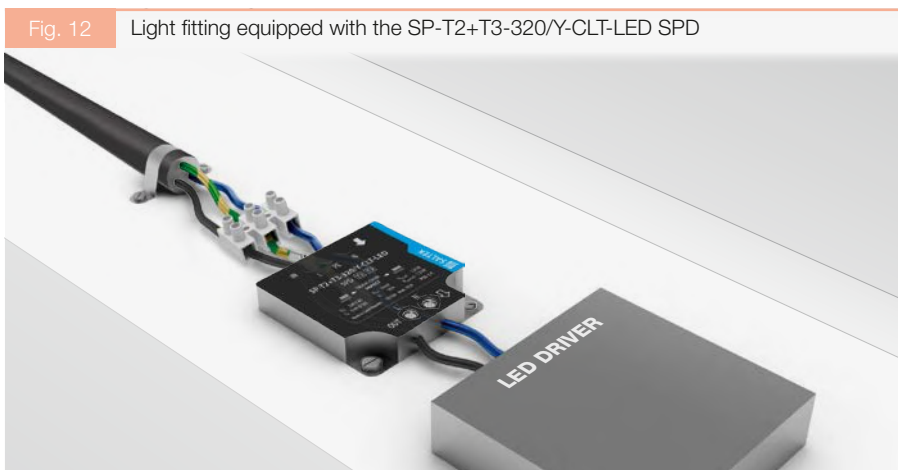


Fig. 12 Light fitting equipped with the SP-T2+T3-320/Y-CLT-LED SPD

In light fittings designed as protection class II equipment, the SPD is installed at the interface between the installation and the protected electrical equipment, while connecting the SPD to the protective earth conductor (PE – Fig. 14).

**Control of the Light Fittings**

Modern street lighting lamps can be controlled and monitored remotely, not only switching them ON and OFF, but also their light intensity, light colour, etc. Communication is based on wireless technology (GSM, WiFi, ...) on communications carried via power-lines, or on using one's own signal lines (RS-485 bus, DALI, Ethernet, ...).

It is advisable to complete the wireless receiver with a surge protection device if the latter forms a part of the protected equipment or is situated near the protected equipment with a SPD on the power supply side.

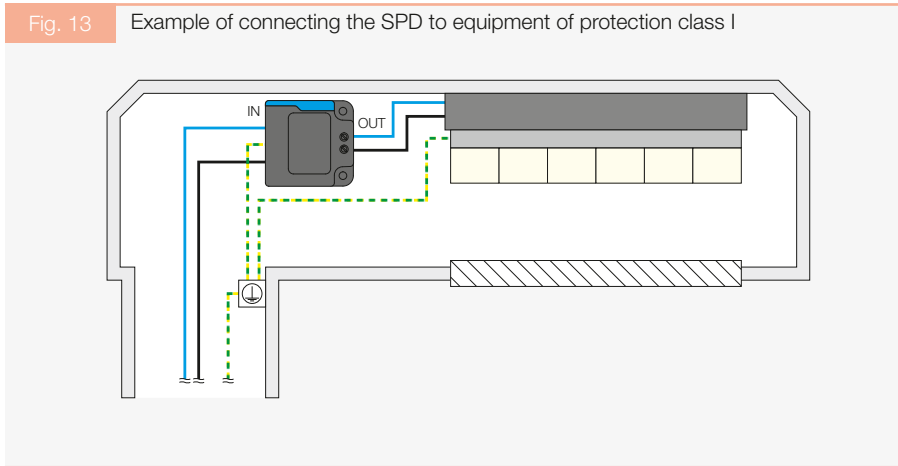


Fig. 13 Example of connecting the SPD to equipment of protection class I

In the case of communications carried via power supply cables, the signal (information) transfer is not affected or limited by the SPDs used.

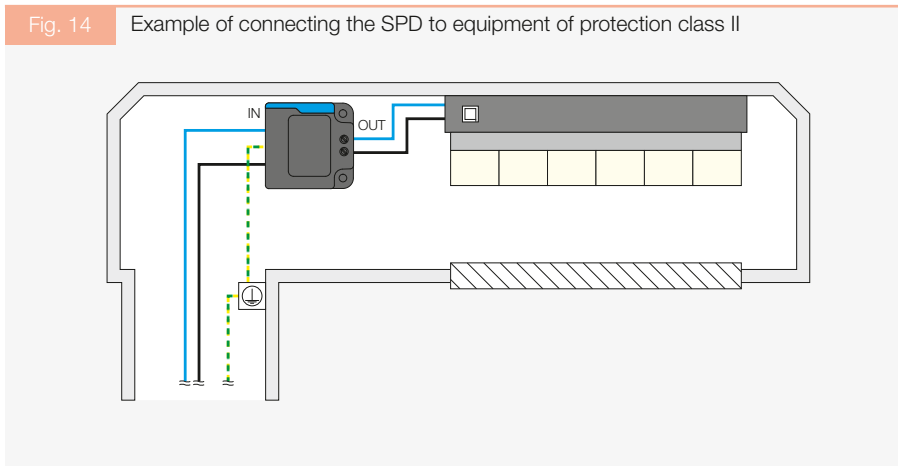


Fig. 14 Example of connecting the SPD to equipment of protection class II

In the case of a self-contained signal line, over-voltage protection is ensured by using the DM (or DL) series of SPDs, depending on the type of communication utilised. It is necessary to know the highest signal voltage when choosing the proper signal line protection, as well as the peak currents in the conductors, the necessary frequency band for signal transfer, and the interrelation between the line conductors and the protective earth (PE conductor).