

The Philips logo is displayed in a white rounded rectangle on a dark blue background. The word "PHILIPS" is written in a bold, blue, sans-serif font.

White paper

Public lighting

Street Lighting

The challenges of surge protection



The need for protection

Voltage surges have a huge destructive impact upon public lighting systems. They wear out LED drivers and distribution panels prematurely, and increase service interruptions to street lighting. Beyond material damage to the luminaires, voltage surges caused by lightning, for example, can trigger or break protective devices in the circuit boards of street lighting distribution panels. So as well as the cost of replacing hardware, the public is left without lighting — a critical safety issue in the case of pedestrian and traffic tunnels, road signs and other public lighting.

The vulnerability of electronic lighting systems to overvoltages is widely recognized in technical literature, and different European regulations and standards specify the need for lighting protection. This white paper explains the causes of lighting overvoltages and how they affect public lighting installations. It also covers the legal and regulatory framework governing protection, and proposes a solution to maximize protection performance and continuity of service.

Public lighting installations are exposed to the environment. Located where continuity of service is essential, it is crucial that these installations are protected against lightning and overvoltages.

Investing a small amount in protection can extend luminaire lifetime, improve public services and greatly reduce overall operating and infrastructure costs.



Building-in protection

What are transient or surge overvoltages?

When analyzing the phenomenon of overvoltages, we consider surge overvoltages and power-frequency overvoltages separately. Although they both represent an increase in voltage above an acceptable limit, their root causes, magnitude, duration and method of protection are radically different.

Surge overvoltages are spikes that can reach tens of kilovolts but last for only a few microseconds. Despite their short duration, their high energy content may cause serious problems to equipment connected to the electricity network — from premature aging to destruction — resulting in service disruptions and costly repairs.

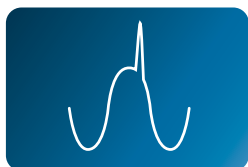


Fig.1 Transient “surge” overvoltage

Voltage surges have several causes. For example, lightning discharges that directly strike the distribution line of a building, or its lightning rod, can induce electromagnetic fields that generate voltage spikes in nearby lighting installations. And very long outdoor distribution power lines are highly susceptible to the direct effects of lightning strikes, with large currents from the lightning being conducted in the power lines. It’s also common for non-weather phenomena to cause voltage spikes in adjacent lines — for instance, switching inside transformer cabinets, or the disconnection of motors and other inductive loads.

Surge overvoltages are voltage spikes of several kilovolts that last for just a few microseconds

Surge overvoltages have two modes of circulation: common and differential. Common-mode overvoltages appear between the live conductors and earth: for example, line-to-earth or neutral-to-earth. Differential-mode overvoltages circulate between live conductors: line-to-line or line-to-neutral. A well-protected luminaire should integrate protection for both modes.

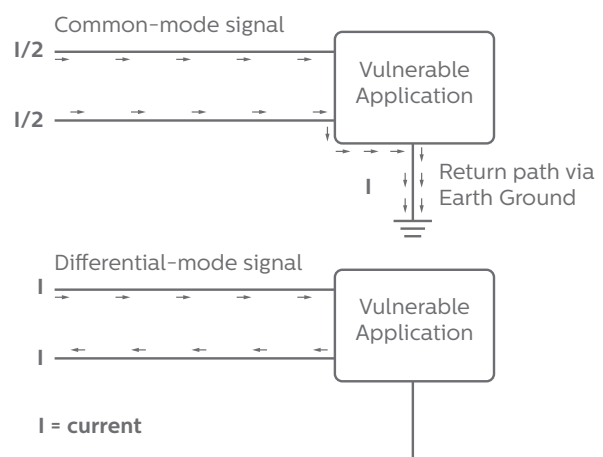


Fig.2 Definition of common and differential-mode currents

Surge overvoltage protection is provided by installing a surge protection device (SPD) on the vulnerable line, and connecting it in parallel or in series. When the SPD is connected in series it acts as a fuse. So when the priority is to protect the electronic components down the line from further damage, as is the case in most Outdoor applications, series connection is preferred. When connected in parallel, the luminaire continues to function even after the SPD is damaged. However the electronic components down the line are no longer protected. So when continuity of functioning (until the next over voltage) is preferred over protection of components down the line, parallel connection can be chosen.

The SPD will get damaged after weathering a number of spikes above a certain voltage level. In the event of a surge overvoltage, the protective device will divert excess energy to earth, thus limiting the peak voltage to a tolerable level for the electrical equipment connected downstream.

Protecting against the effects of surge overvoltages in public lighting

An SPD acts as a voltage-controlled switch. When the network voltage is lower than the activation voltage, the component is passive. On the other hand, when the network voltage exceeds the activation voltage, the SPD diverts the surge energy and prevents it from destroying the equipment. When choosing an SPD, you need to consider the equipment's exposure to the effects of lightning, along with the maximum impulse voltage that the equipment needs to withstand.

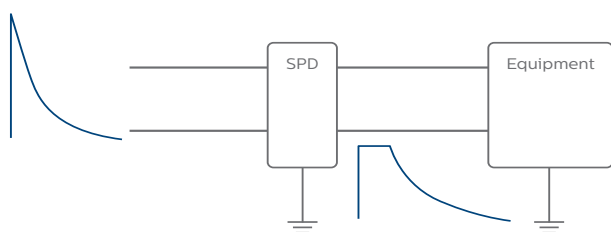


Fig.3 Working principle of a surge protection device (SPD)

In general, the most effective approach to protect large installations of lighting equipment against surge overvoltages is by cascading multiple protective stages. Each stage combines the necessary balance between discharge capacity and voltage protection level. This way, a first stage (typically a 'Type 1' or 'Type 2' SPD) provides robustness, thus diverting most of a spike's energy, while a second stage (typically a 'Type 2' or 'Type 3' SPD) provides 'fine' protection. Thus the peak voltage reaching the equipment always stays below the critical level.

Of the causes of surges mentioned in international protection standards, the ones most likely to affect a public lighting system are:

- direct lightning strikes on distribution lines (conducted through the power lines), and
- lightning strikes near to a building/structure (creating induced surges).

European standards EN 60.364-5-534 and EN 62.305-1 require that protection against these types of electrical disturbance are to be provided by a Type 2 SPD. The protection solution is installed downstream of the main circuit breaker in the distribution panel circuit board, in parallel to the main system. So it diverts the energy of the surge to earth, limiting the voltage peak to a tolerable level for equipment connected downstream.

To guarantee proper protection of a luminaire, the distance between it and its protector circuit must be as short as possible. If the distance between a protected distribution panel and several luminaires is more than 20 meters, using a second protection stage (of Type 2 or 3) is recommended, even if the protection level of the first stage seems to be sufficient (see Fig.4).

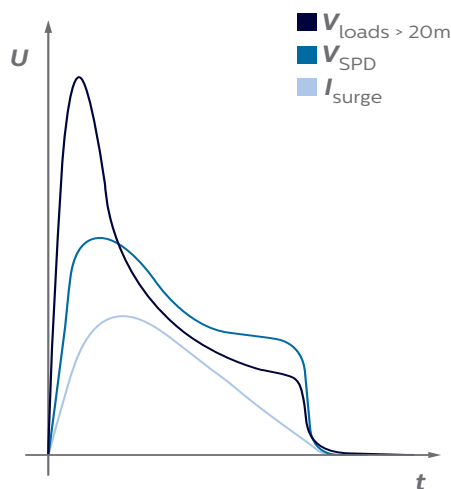


Fig.4 Effect of cable distance on the voltage protection level

Practical approach

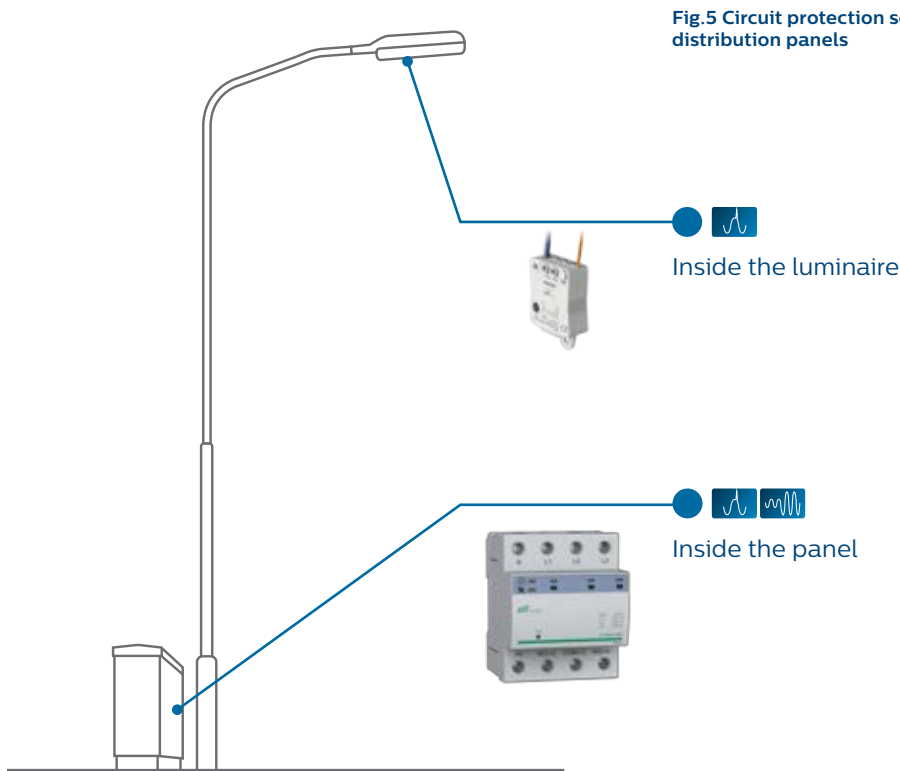


Fig.5 Circuit protection solutions for luminaires and street-lighting distribution panels

Stage 1: Standard protection at luminaire level

IEC61547 states that all luminaires should be protected from overvoltages up to 1 kV in differential mode and 2 kV in common mode. However, Philips has decided to exceed these requirements. All Philips luminaires have a minimum protection of 4 kV, in both common and differential modes. This level ensures acceptable protection for most European street-lighting installations, and therefore makes all Philips luminaires suitable up to Class 4 installations (as defined in EN61000-4-5).

Stage 2: Additional protection of luminaires

When designing installations, the area should be assessed for its vulnerability to lightning strikes and ESD risk. If the vulnerability is high, additional protection until 10kV is recommended. In these cases, Philips recommends the use of a SPD, in addition to the standard protection at luminaire level. The extra protection solution will be offered to Philips' customers as an option upon request. In case of Class II installations the 10 kV option will by default protect the differential mode until 10 kV; for proper protection in common mode PE (protective earth) is needed in the installation and is to be connected to the SPD.

In Class II installations, together with insulated poles, specific weather conditions (dry air with wind) can lead to the potential risk of ESD (Electro Static Discharge) from the housing of the luminaire. In this case protection is not supported by a SPD, but will have to come from either transforming the installation to a Class I installation or from another technical discharge solution in the luminaire.

Stage 3: Distribution panel board protection

In the most vulnerable environments, the V-check 4RC solution offered by our partner Cirprotec can be installed on a DIN rail of 4 modules. It protects not only surge overvoltages (max surge current of 40 kA) but also power-frequency overvoltages. Power-frequency overvoltages are often caused by insulator breakdown in circuitry.

The V-Check 4RC automatically reconnects the power supply after the surge has finished.


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