Guide:
Lightning and surge protection for LED lighting

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OBO BETTERMANN

THINK CONNECTED.

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Chapter 1. Lightning and surge protection for LED lighting

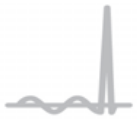
Chapter 1.1 Basic principles:

Due to their light intensity, their energy efficiency and their robustness, LED luminaires are ideally suitable for street lighting and signal and object lighting in industrial and commercial premises. As LED luminaires consume up to 70 per cent less energy than standard lighting, whilst still producing the same luminous power, they can make a significant contribution to the reduction of energy costs over their lifespan of up to 100,000 hours. By comparison: Metal-halide lamps only have a lifespan of up to 20,000 hours. For this reason, the increased purchasing price of LED luminaires amortises within a short time, if protected against advance failure through direct lightning strikes and switching surge voltages.

Chapter 1.2 Risks:

In the field of street lighting, LED luminaires are directly exposed to close and distant lightning strikes and surge voltages, on account of their exposed position. When switching fluorescent tubes or HQI luminaires in buildings, there is the risk of damage or premature ageing on account of the high switching surge voltages of up to 5,000 volts. These loads can lead to a reduction in the luminous intensity or to the destruction of the electronic ballasts. There is the risk of failure and of high repair costs, which extend the amortisation time. Accordingly, suitable surge protection should be used as protection against damage from lightning or surge voltages.

Lightning strike with destruction through fire and surge voltages.



Failure through surge voltages through induction and from the AC network.

Wind, sun, snow and temperatures all place loads on the installation.

Electrical devices of surge voltage category I, e.g. the electronic ballasts or LED drivers, must, according to VDE 0100-443.4 Table 1, be created with a surge voltage resistance of 1,500 volts and, in the case of surge voltage category II, of 2,500 volts. However, interference from lightning and switching operations cause surge voltages of up to several 10,000s of volts, which are considerably above the named rated surge voltage resistances. Modern LED luminaires require external surge protection against surge voltages.

Chapter 2. Street lighting

Chapter 2.1 Damage and repair costs

In the field of street lighting, the replacement of the defective components, alongside the hardware costs, also incurs high costs through the use of elevating platforms and personnel. Upstream surge protection devices reduce the pulses and protect the luminaire.

Whole streets are supplied via central distribution boxes, containing the controllers and protection components. The supply voltage is fed in via buried cables in the connection compartment of the mast. The luminaire is supplied from the connection compartment.

Chapter 2.2 Creation of the earthing systems

In a new installation, the supply cable can be protected against destruction from lightning currents in the earth by an optional earthing line above it. According to the current lightning protection standard DIN EN 62305-3 (German supplementary sheet 2), this earthing line must be located 0.5 metres above the supply cable.

The earthing line compensates potential differences and minimises arcing to the supply cable.

Image 1 shows the earthing line routed above the supply cable.

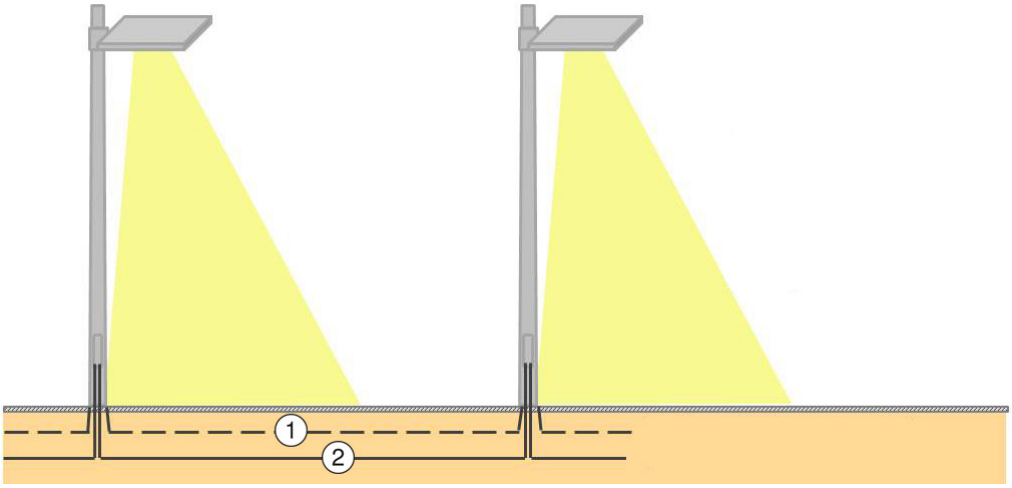


Image 1: Routing of the earthing lines and the supply cables

Legend:

① Earthing line, uninsulated

② Supply cable

Chapter 2.3 Installation location of the lightning and surge protection

The use of surge protection is required for safe operation. According to the American ANSI and IEEE standard, a surge voltage resistance of 20 kV is required for outdoor lighting at a surge current load of 10 kA. However, of decisive importance for the protection action is that the protection level of the surge protection device is below the surge voltage resistance of the lights and the LED driver.

Surge protection devices must correspond to the testing standard EN 61643-11 and must be able to arrest surge currents of several thousand amps multiple times without destruction. According to the testing standard, each protection device requires thermal monitoring and must be isolated safely if there is a defect.

In the luminaire standard "Fpr EN 60598-1: 2012-11 Luminaires – Part 1: General Requirements and Tests", Point 4.32 specifies: "Surge protection devices must meet IEC 61643."

If there is a direct lightning strike in the mast luminaire (Image 2), a large portion of the lightning current will flow directly into the earth, creating a potential difference to the supply cable. Powerful lightning current / combination arrestors can arrest the energy-rich currents.

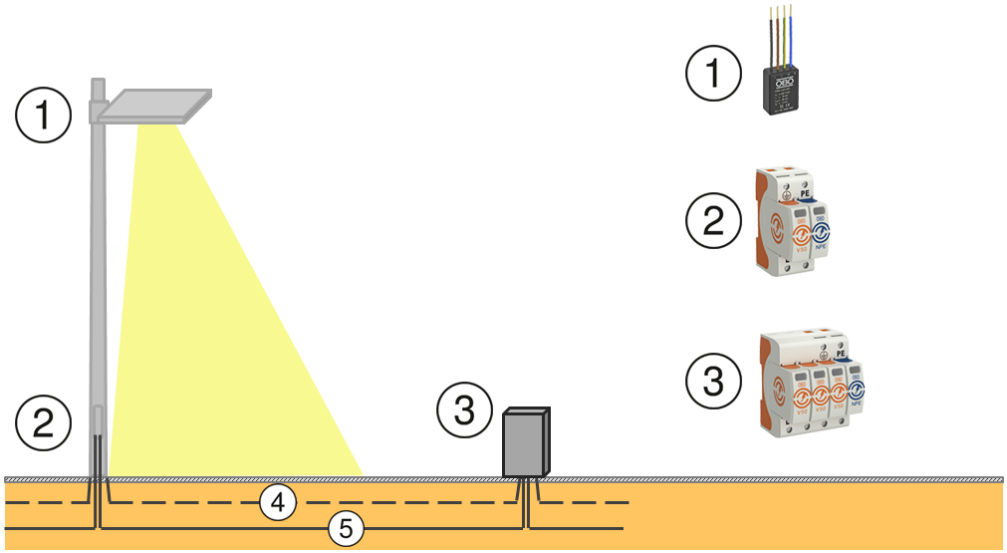


Image 2: Direct and close lightning strike

Legend:

① Lamp head with LED system, type 2
② Connection compartment of the mast luminaire, type 1 + 2
③ Control cabinet with electronics, type 1 + 2
④ Earthing line, uninsulated
⑤ Supply cable

Installation location	Protection device	Description	Article no.
① Lamp head			
Before the LED driver	ÜSM-LED 230	Type 2 surge protection	5092 480
② Mast			
Connection compartment	V50 1+NPE-280	Type 1+2 combination arrestor	5093 522
③ Control cabinet			
Supply	V50 3+NPE-280	Type 1+2 combination arrestor	5093 526

Table 1: Selection of the protection devices

A lightning strike within 1.5 km generates a surge voltage which hits the lighting via the supply cable (Image 3). These surge voltages have less energy than the direct lightning strike, but can still destroy electronic components.

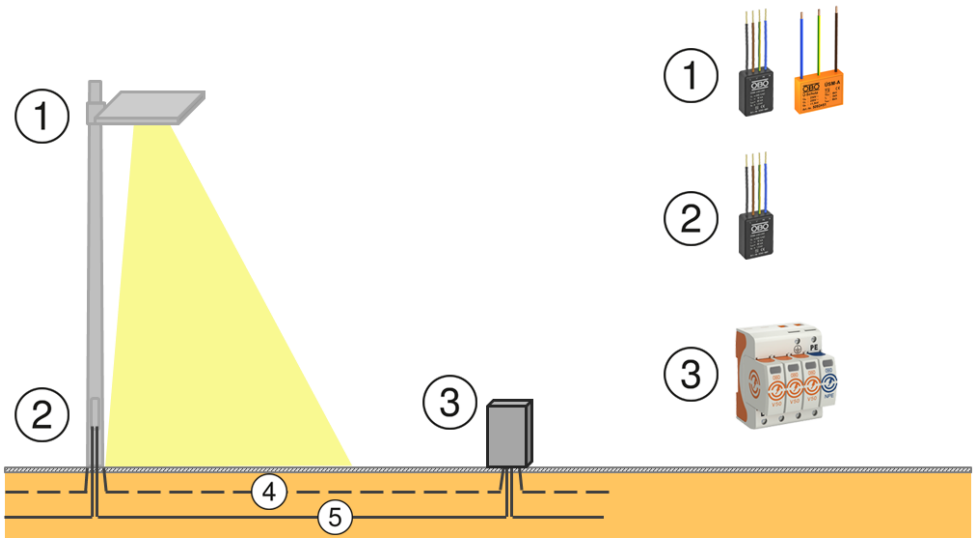


Image 3: Remote strike and inductive coupling

Legend:

① Lamp head with LED system, type 2 or type 3
② Connection compartment of the mast luminaire, type 2
③ Control cabinet with electronics, type 1 + 2
④ Earthing line, uninsulated
⑤ Supply cable

Installation location	Protection device	Description	Article no.
① Lamp head			
Before the LED driver	ÜSM-LED 230	Type 2 surge protection	5092 480
Alternatively: Type 3 protection	ÜSM-A 230	Type 2 surge protection	5092 451
② Mast			
Connection compartment	ÜSM-LED 230	Type 2 surge protection	5092 480
③ Control cabinet			
Supply, 3-phase	V20 3+NPE-280	Type 2 surge protection	5095 253
Alternative: 1-phase	V20 1+NPE-280	Type 2 surge protection	5095 251

Table 2: Selection of the protection devices

Inductive couplings are considerably reduced through a metallic mast and a luminaire with a metallic housing. Here too, surge voltage pulses along cables from the supply network need to be considered. In this case, the surge protection in the mast connection compartment is easily accessible and easy to check.

Chapter 3. Internal lighting

LED lighting systems in industrial plants and administrative buildings are usually destroyed by high voltages, coupled inductively or by switching operations.

A risk analysis according to DIN EN 62305 can be used to determine whether an external lightning protection system is required or not. In a lightning protection system, the supply cables at the entrance to the building must be protected using suitable lightning current arrestors. Independently of this, the surge voltage protection should be installed for the entire lighting system.

In industrial and sports halls, the luminaires are installed at a great height. After damage, the lights or the LED drivers can only be repaired at a high cost. As the minimum lighting strength required at the workstation can lead to accidents or errors, immediate action is required.

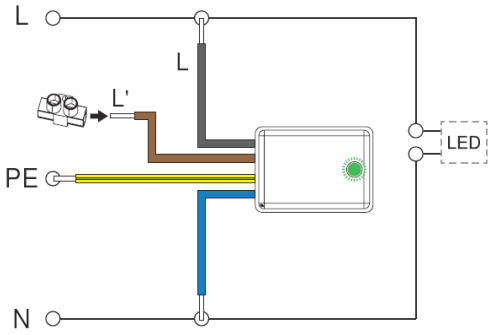
The usually very long supply lines have a high potential for inductive coupling of surge voltages. Surge protection devices must be used in the subdistributor to be supplied. However, the luminaires are often 10 m from this distributor. To protect the LED drivers and the light, a protection device is then required directly in front of the electronic components. If the luminaires are, for example, mounted directly beneath the cable support systems, then the surge protection can also be inserted in a junction box in front of the luminaires. To use the shielding function of the metallic cable support systems, these must be included in the equipotential bonding on both sides.

Chapter 4. Connection

The protection device ÜSM-LED 230 can be installed in series with or parallel to the luminaires. The differing connection can be used to maximise availability (parallel connection) or to switch off the luminaire if there is a defect on the protection device (serial connection).

Chapter 4.1 Parallel connection

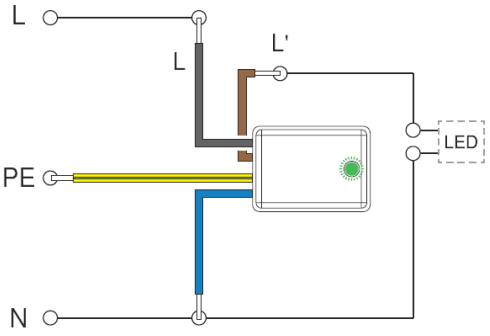
The surge protection device is located upstream of the LED luminaire.



Failure behaviour: The display on the ÜSM-LED goes out. The surge protection is disconnected. The LED luminaire remains lit without protection.

Chapter 4.2 Serial connection

The surge protection is switched in series to the LED luminaire.



Failure behaviour: The display on the ÜSM-LED goes out. The surge protection and the circuit (L') are disconnected. The failure is signalled by the luminaire going out.

Chapter 5. Conclusion

A suitable protection device upstream of the electronic LED drivers is a safe barrier against surge voltages. This guarantees the lifespan of the LED luminaires, securing the investment.

In the commercial section and in the field of street lighting, with a long lifespan, enormous cost savings are possible, despite the increased procurement price. However, premature failure from surge voltage damage can push the return on investment back into the future. The investments can be protected through suitable protection measures.

The OBO ProtectPlus range offers secure system solutions for lighting systems.

Chapter 6. Literature index

Lightning protection:

- VDE 0185-305-1 (DIN EN 62305-1) - General principles
- VDE 0185-305-2 (DIN EN 62305-2) - Risk management
- VDE 0185-305-3 (DIN EN 62305-3) - Protection of buildings and humans
- DIN VDE 0185-305-4 (DIN EN 62305-4) – Electrical and electronic systems within structures

Earthing:

- DIN 18014: Foundation earther

Low-voltage electrical installations:

- VDE 0100 (IEC 60634)
- VDE 0100-534 (IEC 60634-5-534)
- VDE 0100-410 (IEC 60634-4-41)
- VDE 0100-443 (IEC 60643-4-44)
- VDE 0100-714:2014-02 (IEC 60364-7-714) – External lighting installations

Luminaires:

- VDE 0711-1 (Fpr EN 60598-1)

Notes

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