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Light is energy

Overvoltage protection for LED street lighting

Save money with durable and energy-efficient operation

Light is OSRAM

OSRAM

LED technology changes street lighting

Innovative technologies are helping city planners and municipalities save money and energy. LED systems for street lighting are especially efficient and energy-saving.

Municipalities with conventional lighting technology must pay a large share of total energy costs for street lighting. There is still significant savings potential in this area, especially because outdated street lighting is still being used in many places. In the lighting sector, LED systems are regarded as especially efficient and durable, which explains why LED lighting is also penetrating the outdoor applications to illuminate streets, replacing traditional lighting systems.

In addition to economic efficiency, LED systems also offer the opportunity for easy control. For example, the lighting duration and level can be controlled optimally, which allows for appropriate illumination. This is another advantage of LED lighting systems.

Save money and illuminate appropriately

Some LED streetlights are more expensive to purchase, but they pay off very quickly thanks to several advantages:

- Long service life
  up to 100,000 hours of operation are possible
- Low failure rates
  costs for replacement/servicing are reduced
- Low energy consumption
  20 - 60 W LED lights are usually sufficient for street lighting
- Comfortable, dimmable control
  using networks and sensors, the light level can be controlled as needed, so that the light level is reduced at low-traffic times and energy is saved

Energy consumption and environmental requirements

Thanks to the EU regulations for ecological design (especially VO (EG) 245/2009), the introduction of mercury-vapor lamps has been forbidden since April 2015 since they no longer fulfill the energy efficiency requirements. Additionally, the retrofitting of existing streetlights is sustainable and sensible from the economic and ecological points of view.

LED modules
need overvoltage protection

Ecological use of LED modules is only possible if the intended operating time is reached. Economic advantages can be rendered ineffective if the LED modules fail prematurely and have to be replaced.

In contrast to mercury-vapor lamps, light-emitting diodes (LEDs) are only designed for low operating voltages and they are therefore more sensitive to overvoltage. This also applies for the required electronic control gear (LED drivers). Practical experience has shown that LED lights do not survive real overvoltages that occur without protection. Efficient protection of LED lighting systems is therefore essential.

Manufacturers of LED lighting systems frequently design LED drivers for overvoltages between 2 kV and 4 kV. However this protection is not sufficient for street lighting systems.

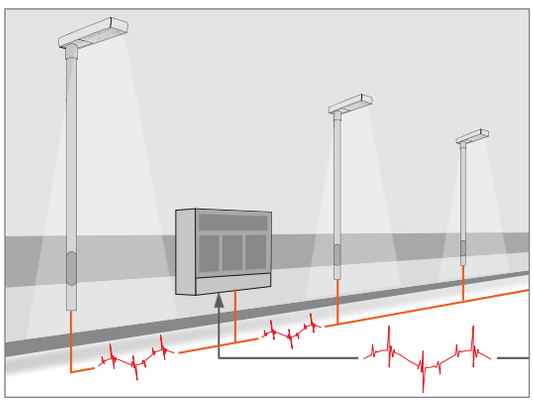
Explanation of terms

LED module
The LED module carries LEDs on a circuit board. The LED driver provides the power supply and controller.

LED driver
The LED driver, also called the LED operating device, supplies the LED module with power. Depending on the model, the light intensity (dimming) can also be controlled. The LED driver is generally installed on the luminaire head directly in front of the LED module.

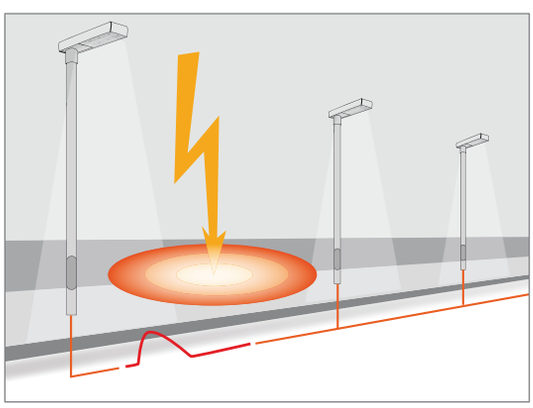
How does overvoltage arise?

Overvoltage is when the rated voltage of the network is exceeded significantly. There can be different causes of overvoltage and it can be triggered by different events:



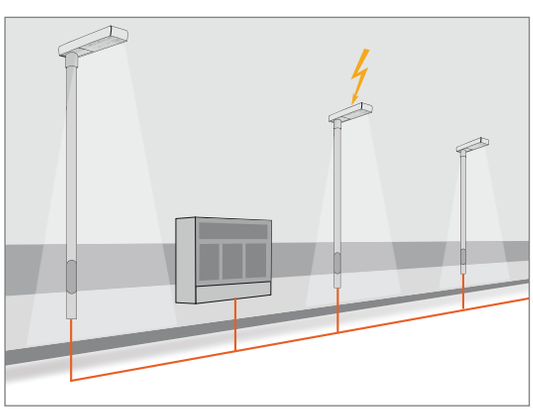
Switching operations/load change on the power grid

Generate overvoltages up to 6 kV and occur much more frequently as compared to lighting strikes (up to several dozen times a year).



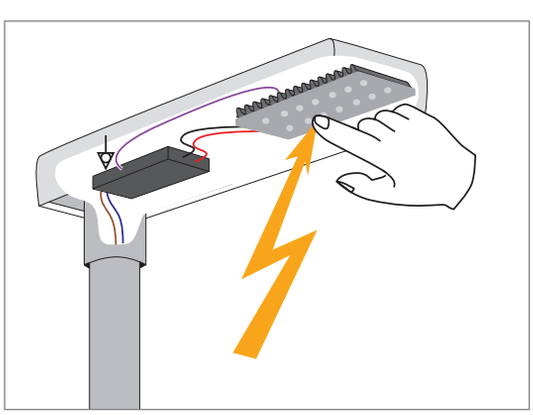
Lightning strikes nearby

Could generate very high overvoltages up to 10 kV depending on the distance from the lightning strike due to inductive and capacitive coupling.



Lightning strikes directly on the streetlights

Create high energy pulses that cannot be conducted away from the luminaire with reasonable effort.



Electrostatic discharge

Arises due to static electricity and happens especially during maintenance work if appropriate ESD protective measures are not taken.

What are the effects of overvoltages?

Slight overvoltages do not necessarily cause the immediate failure of unprotected LED modules or LED drivers, however if overvoltages occur frequently, they can cause the premature aging of the LEDs and thus shorten their service life. This would then limit the economic advantage of LED technology.

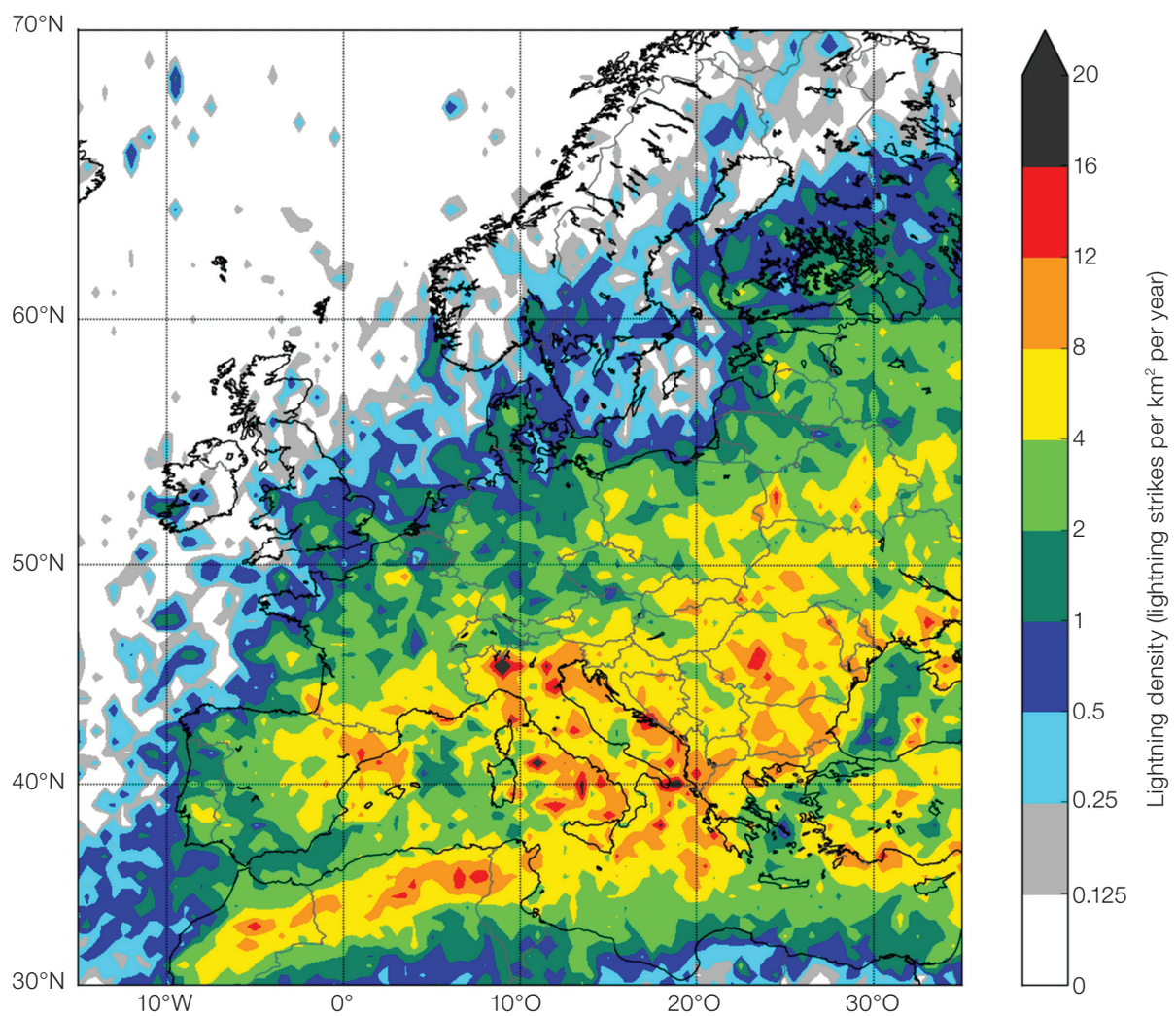
High overvoltages like the ones that can occur in case of lighting strike, by contrast, can cause the direct failure of the LED module or LED driver if effective protective measures are not taken. Overvoltages cause high currents (energy impulses) in the LED driver and LED module. This can have a variety of consequences:

- Partial or complete failure of the LED module
- Faster aging of the LED module and thus reduced service life
- Failure of the LED driver
- Failure of the control interfaces

Regional differences

In Europe, lightning does not strike with the same frequency everywhere. Thus, for example, in Germany there are, on average, between 1.5 and 2.5 million lightning strikes per year with great regional differences. In addition to regional clusters, there are also seasonal clusters. Lightning density increases especially in the hot summer months. Regional differences should be considered during the planning of lightning protection measures (see figure).

OSRAM LED drivers already have an above-average integrated overvoltage protection; this is in many cases sufficient. In regions with higher lightning density, the use of additional lightning protection measures are recommended.



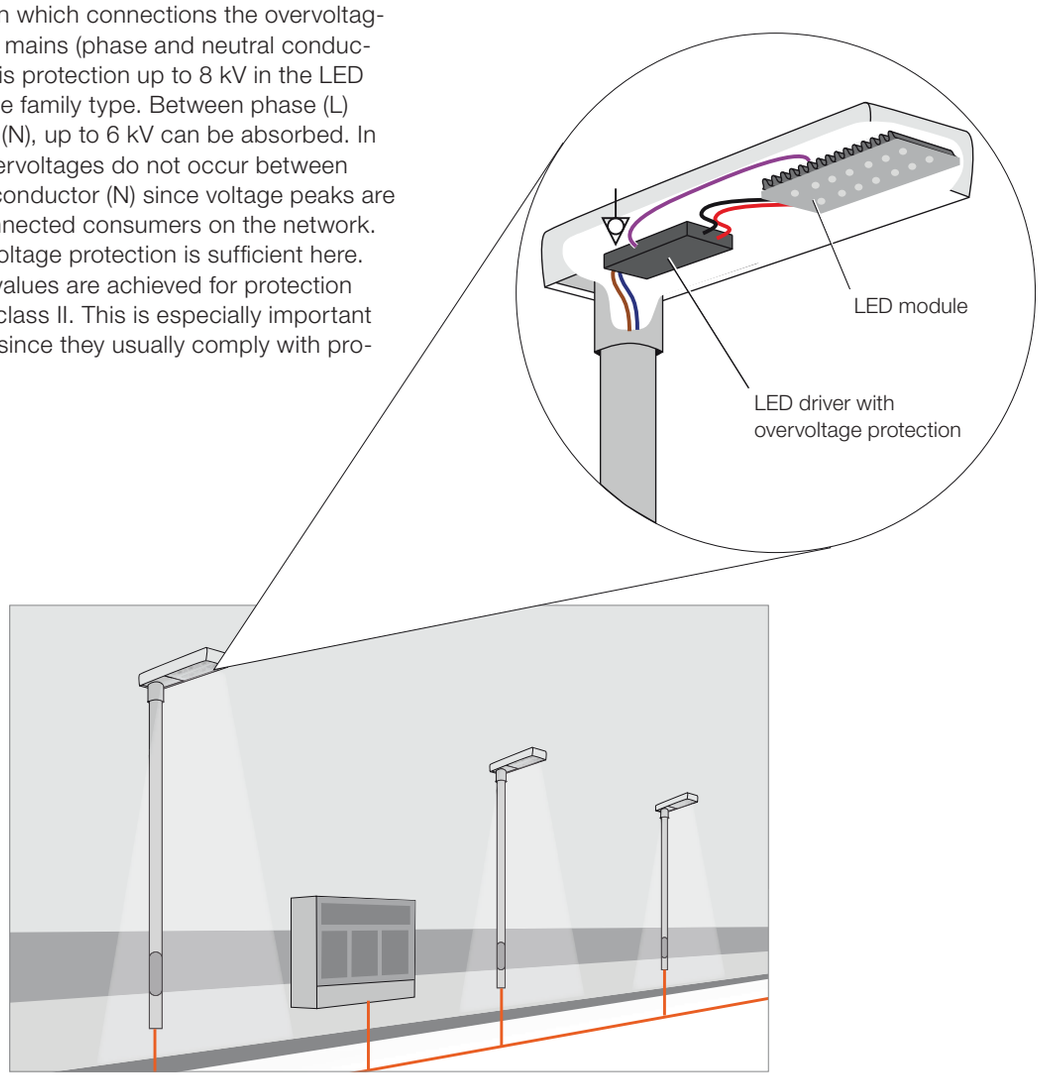
Lightning density map of Europe: for country-specific maps, search the term "lightning density" on the Internet.

Overvoltage protection
but how?

How is it possible to implement the best possible protection against overvoltage? There is no standard solution. Local circumstances must be incorporated in the planning since overvoltages and lightning strikes can vary by region and measures depend on the existing installations.

Overvoltage protection in the LED driver
Basic overvoltage protection should be provided by the LED driver. Standard LED drivers offer overvoltage protection from 2 kV to 4 kV. The OSRAM LED drivers in the OPTOTRONIC 2DIM, 3DIM, and 4DIM series have an integrated efficient overvoltage protection and they can, depending on the product family, absorb overvoltages up to 8 kV.

Crucial here is between which connections the overvoltages occur. Between the mains (phase and neutral conductor) and ground, there is protection up to 8 kV in the LED driver depending on the family type. Between phase (L) and neutral conductor (N), up to 6 kV can be absorbed. In practice, such high overvoltages do not occur between phase (L) and neutral conductor (N) since voltage peaks are absorbed by other connected consumers on the network. Therefore, lower overvoltage protection is sufficient here. The specified voltage values are achieved for protection class I and protection class II. This is especially important for newer installations since they usually comply with protection class II.



EQUI connection, a special feature from OSRAM

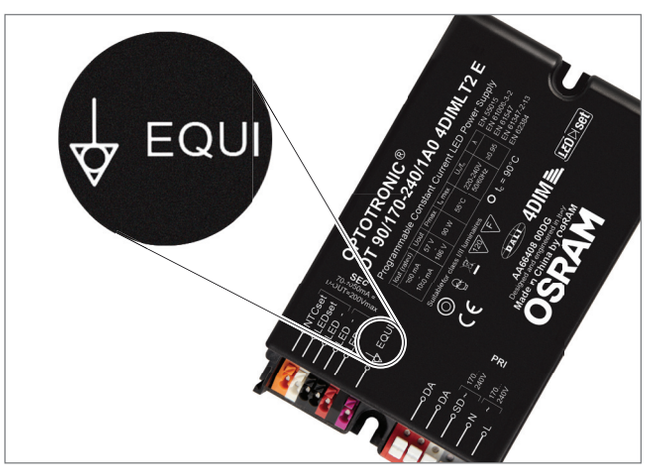
The OSRAM LED drivers in the OPTOTRONIC 2DIMLT2, 3DIMLT+, and 4DIMLT2 series are equipped with an EQUI (equipotential) connection.

EQUI (equipotential) connection:

EQUI

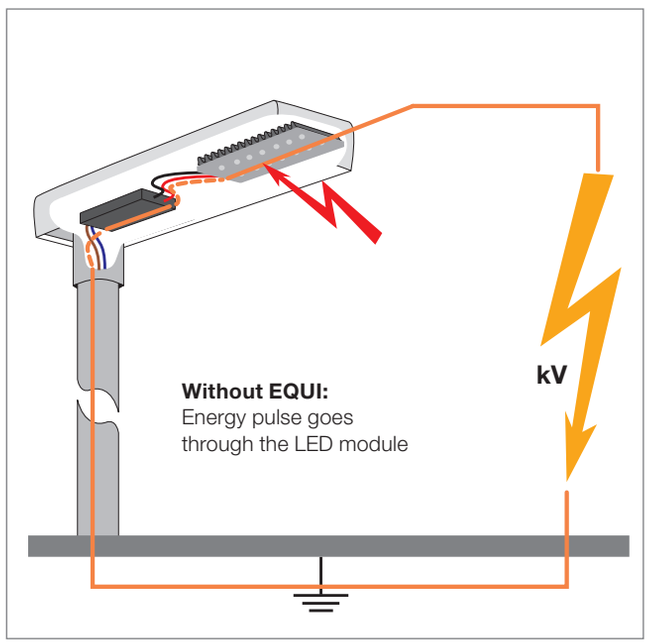
This connection allows the adjustment of different parts of the lighting system to the same potential, thus reducing significantly the overvoltages that occur on the LED module.

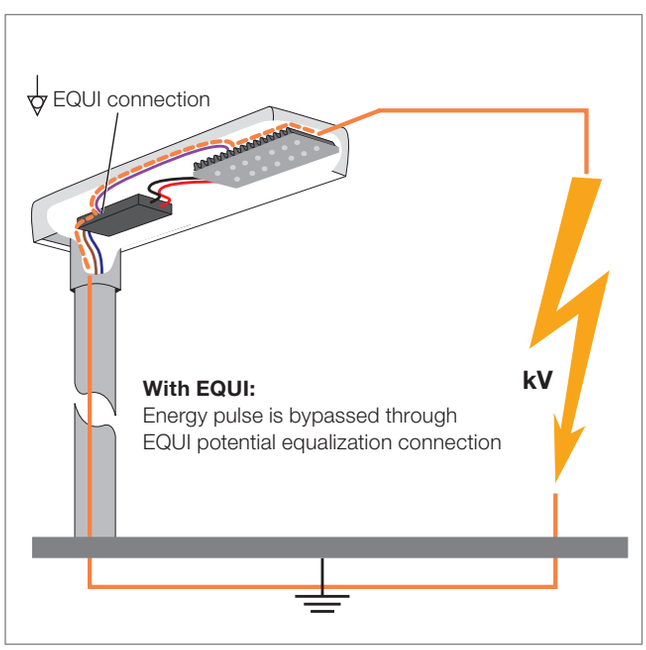
With the EQUI connection concept developed by OSRAM, greater overvoltage protection can be implemented than with standard LED drivers that have no equipotential compensation. In case of an overvoltage pulse, the EQUI connection allows its discharge via the cooling body of the LED module or the metal housing of the luminaire. The surge current no longer flows through the LED module.



Effective basic protection in the LED driver

The basic protection in the OSRAM LED drivers in the 2DIM, 3DIM, and 4DIM series prevents overvoltage damage up to 8 kV depending on the product family. This basic protection is frequently sufficient for areas with low and medium lightning density. In areas with higher lightning density, protection can be improved with additional measures in main distribution cabinet for street lighting and junction boxes in the bottom of the pole.





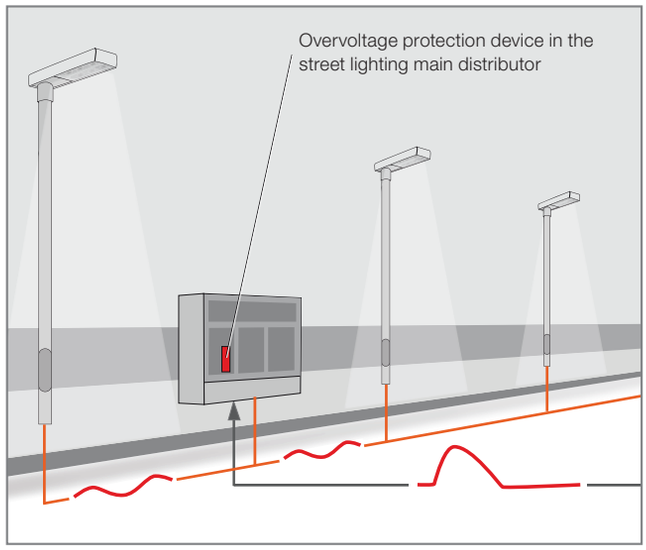
Explanation of terms

Protection class I (SK I)
All electrically-conductive and touchable parts of the light fixture are connected to protective earth of the power grid. In case of a failure, the residual current circuit breaker (FI) or the automatic fuse is triggered and prevents danger to people from live parts.

Protection class II (SK II)
Protection class II luminaire must be double-insulated so that there are two safety barriers. This prevents danger in case of a failure. There is no protective earth connection in these luminaires.

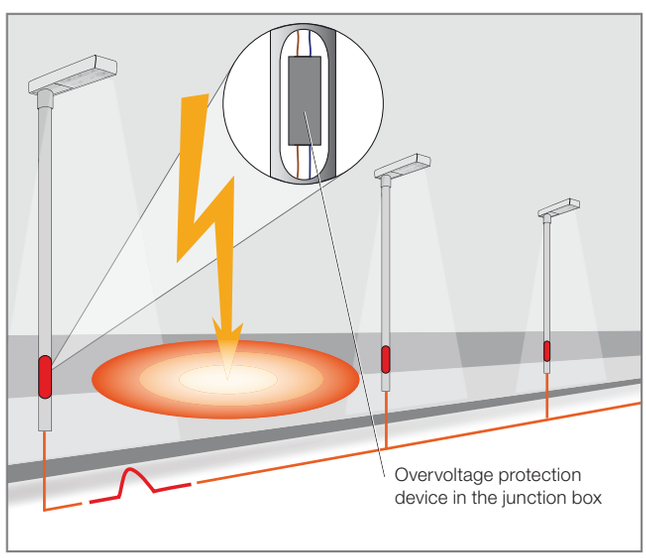
Additional overvoltage protection in the street lighting main distributor

The main distribution cabinet for street lighting is the central element for power supply to the luminaires. This is where power is distributed from the grid to the individual streetlights. Overvoltages that occur on the supply network or direct and indirect lightning strikes on the power grid can be absorbed here with overvoltage protection before they reach the individual lights. The overvoltage protection in the streetlight main distributor is easily accessible for service. In case of failure, replacement is quick and easy. The overvoltage protection devices for main distributors usually consist of voltage-dependent resistors and spark gaps that can reduce or discharge high pulse energy up to a few 10 kA. The integration of a Type 1 & 2 overvoltage device in the main distributor is an investment that makes economic sense.



Additional overvoltage protection in the junction box

The connection of the power supply to the luminaire head is made in the junction box located in the bottom of the pole. Additional overvoltage protection here protects against overvoltages that arise due to direct and indirect lightning strikes on the supply line after the main distribution cabinet. The overvoltage protection in the junction box is easy to access for service and it is therefore easy to fit, maintain, and replace. This additional measure makes sense if there are longer distances to the main distribution cabinet and if there is a higher lightning density to be expected.



Protection against static discharge

Static discharge endangers LED modules especially during installation and service. Therefore, service personnel should adhere to ESD-compliant potential equalization (e.g. work with grounding armbands). If the LED module does not have any integrated ESD protection.

Challenge
for planners and operators

Planners and operators of street lighting systems face the challenge of finding lighting solutions that are as economical as possible, yet simultaneously comply with valid guidelines and standards. Not an easy task. OSRAM LED drivers with overvoltage protection are optimally suited for fulfilling these requirements.

Important standards

For LED lighting solutions in the street lighting sector, there are relevant standards that must be heeded in Europe. Below is a list of the most important standards:

- IEC 60598-1, ED7, ED8
  Luminaires – Part 1: General requirements and tests
- IEC 60598-2-3
  Parts 2-3: Special requirements luminaires for street and road lighting
- IEC 61547
  EMC immunity requirements
- IEC 61000-4-2
  Discharge of static electricity ESD
- IEC 61000-4-3/8
  High-frequency electromagnetic fields
- IEC 61000-4-4
  Electrical fast transients
- IEC 61000-4-5
  Surge immunity test
- IEC 61000-4-6
  Immunity to conducted disturbances, induced by radio-frequency fields

Required in the guidelines IEC standards is overvoltage protection of 1 kV to 6 kV, depending on the necessary availability of the light in the application area. Outdoors, at least 6 kV must be striven for.

Selecting an economically-sensible solution

Basic protection in the LED driver should be provided in any case and be as effective as possible. The benefits when compared with the costs are very great. In many regions, overvoltage protection of 6 kV is already sufficient and no additional measures must be taken.

OPTOTRONIC
LED drivers from OSRAM

The dimmable OSRAM LED drivers in the OPTOTRONIC 2DIMLT2, 3DIMLT+, and 4DIMLT2 series are designed for outdoor areas and are therefore also ideal for street lighting applications. The integrated overvoltage electronics provide protection up to 8 kV depending on the device series.

Overview of OSRAM LED drivers for outdoor areas

OPTOTRONIC	2DIMLT2	3DIMLT+	4DIMLT2
			
Overvoltage protection			
Overvoltage protection L - N	6 kV / 2 Ohm	4 - 6 kV / 2 Ohm	6 kV / 2 Ohm
Overvoltage Protection StepDIM - N		4 - 6 kV / 2 Ohm	6 kV / 2 Ohm
Overvoltage protection L/N-ground	6 kV / 12 Ohm	4 - 6 kV / 12 Ohm	8 kV / 12 Ohm
Functions			
DALI		X	X
0 - 10 V	X		
StepDIM (half-night switch)	X + ext. relay	X + ext. relay	X
AstroDIM	X	X	X
Presence-controlled	X + ext. relay	X + ext. relay	X
MainsDIM (dimming via network voltage reduction)			X
Constant stream of light	X	X	X
Manufacturer-independent LED interface LEDset (Gen2)	X		X
Tuning factor			X

For technical application guides for OSRAM LED drivers, visit www.osram.com/oem-download.

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OSRAM AG

Main administrative office:

Marcel-Breuer-Straße 6
80807 Munich
Phone +49 89 6213-0
Fax +49 89 6213-2020
www.osram.com

OSRAM

E-CHECK Partner-Unternehmen

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