CITEL

SURGE PROTECTION

FOR

LED lighting systems

Version 5.2

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CITEL

LET THERE BE LIGHT! MODERN LED LIGHTING SYSTEMS

For a long time the sun was the only source of light for mankind. It was only when prehistoric human discovered fire 300,000 years ago that light and life was brought to the once dark caves. Places that had not been reached by any ray of sunlight until then could now be enlightened and discovered. But the light was also ignited and used outdoors: around 260 before Christ, the lighthouse of Alexandria was already sending its light signals to the world, serving as a guide and coordinator for shipping traffic. In the year 378 after Christ there were even indications of the first forms of street lighting. In Antioch, a city in ancient Syria, there were "lights in the streets" that lit the way for people. In the course of time, the streets have thus gradually become a nocturnal habitat. However, the first official illumination of streets did not take place until 2 September 1667 in Paris. Louis XIV was the main driving force behind this, who wanted to better control what happened on the roads.

Nowadays, well-lit streets, grounds or even interiors hardly seem to be a special feature. As an integral part of public safety, electric luminaires naturally provide better vision and orientation in daily life.

Since oil and petroleum lamps from the time of Louis XVI are of course long outdated, LED lights in particular have become established in the modern lighting sector. They are energy-saving, efficient, durable and above all environmentally friendly. In order to meet the growing challenges of sustainable urban development, however, there is an enormous need for light bulb replacement. Especially the lighting of residential streets by the highly criticized mercury vapour lamps will have to be finally replaced by dimmable LED lighting systems in the future (implementing regulation 245/2009 for EU Directive 2005/32/EC). To ensure that the numerous advantages of the luminaires actually pay for themselves, however, it is essential to protect the sensitive control electronics and the LEDs from overvoltages. Lightning strikes, as well as switching operations in the power supply network or in the electrical system can occur within seconds and cause enormous damage.

But how can potential sources of danger be identified? And above all: what measures can be taken to achieve optimum protection?

As a reliable and innovative partner in the field of lightning and surge protection, CITEL not only answers this question with 80 years of experience, but also with a special surge protection concept for your LED lighting – so that your luminaires become almost maintenance-free and can achieve a long life time.

SURGE EVENTS vs. DIELECTRIC STRENGTH

State of the art

Whereas a few years ago the resistance of street luminaires to overvoltages was around 2,000 to 4,000 V, it is now on average around 4,000 to 6,000 V.

However, this is often not enough, as can be seen in Figure 1.

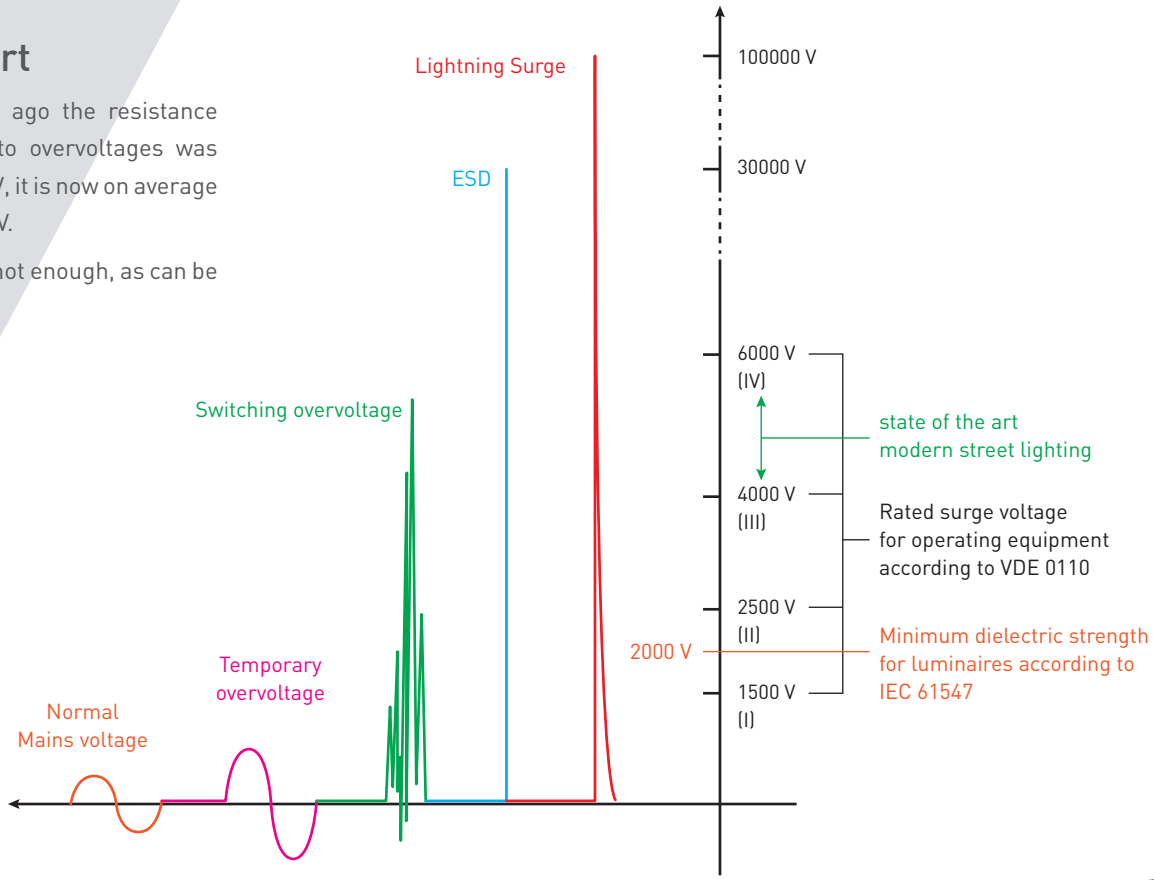


Figure 1:
Overvoltage types and their amplitude

CITEL test laboratory Reims

PASSIVE vs. ACTIVE SURGE PROTECTION (SPD)

There are different protection concepts for effective protection against overvoltages.

Passive protection

Figure 2 shows the design of an unaffected overvoltage. If a luminaire without active surge protection is loaded with such a voltage above its insulation strength, it fails.

Active protection

If an active protective element is installed, it is primarily no longer the maximum voltage that is decisive, but the energy of the interfering impulse. The voltage limitation (Fig. 3) of the protective element protects the LED system from excessive voltages. If the pulse energy exceeds the discharge capability of the protective element, the latter may be overloaded, but the luminaire is still protected in this case. Active protection elements are usually varistors, gas-filled spark gaps or combinations of both. These ensure a longer service life for all components and are very efficient.

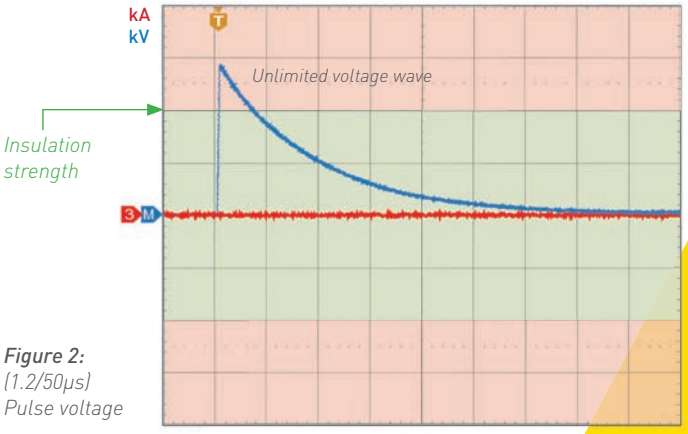


Figure 2: *(1.2/50µs) Pulse voltage*

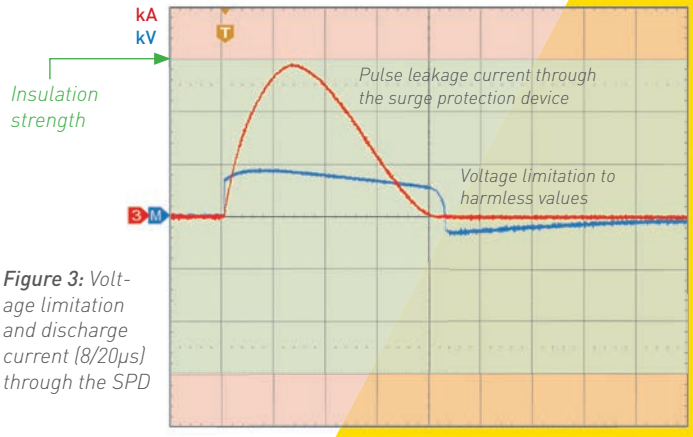


Figure 3: *Voltage limitation and discharge current (8/20µs) through the SPD*

COMPARISON OF ACTIVE SPD ACCORDING TO EN61643-11 vs. PASSIVE DRIVER SOLUTION

The diagram (Fig. 4) shows, in a highly simplified form, the qualitative behavior of surge protection devices (SPDs) and electronic drivers for LED luminaires with integrated protection components in the event of transient pulses.

The performance of surge protective devices is limited by their voltage-limiting mode of operation and their compact design consisting of a few powerful components, mainly by the max. compatible pulse energy or pulse current resistance.

The dielectric strength of LED drivers is determined by the much more complex structure of a wide variety of components, which are in series and parallel. Therefore, their performance is limited by energy- or pulse-current sensitive components (e.g. coils, fuses, contacts, conducting paths) and additionally by voltage sensitive components (e.g. X- or Y-capacitors, optocouplers, IC's, MOSFET).

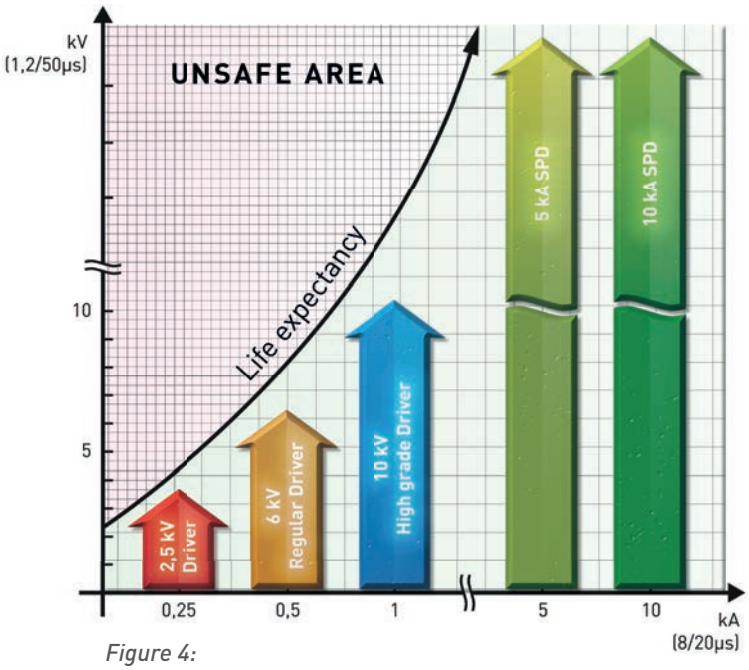


Figure 4:
Safe and unsafe area

Terms from surge protection technology

Active surge protection vs. dielectric strength:

A decisive advantage of active surge protective devices is that they operate relatively independently of the surge level. Important for the selection is the amount of the maximum energy absorption. Therefore, when selecting surge protection, attention should be paid to the type, the installation situation and the risk to the system or persons.

On the other hand, if the insulation strength/dielectric strength of a luminaire without active overvoltage protection is exceeded, there is usually a risk of total or partial failure of the luminaire.

Type 1:
Lightning current arresters, which are used for protection against lightning currents.

Surge protector type 1+2+3:
Combined lightning and surge protection devices which on the one hand can divert high-energy lightning currents, but on the other hand also provide effective protection against rapidly rising overvoltages, such as switching surges and electromagnetic coupling.

Type 2 or type 2+3:
Surge protective devices for protection against switching surges and electromagnetic coupling.

Type 3:
Also called fine protection. Offers only minimum protection directly in or on the terminal and should be used in combination with upstream, high-performance SPDs.

Coordinated protection concept:
This describes the optimum energy distribution between various surge protective devices and the fine protection components in the LED driver. Type 1+2+3 surge protector with integrated Citel VG technology for installation in the central power supply and Type 2+3 in the luminaire circuit coordinated towards the LED driver optimally fulfil this purpose.

Note: Surge protective devices are tested according to IEC 61643-11. As more types are combined, as more tests and parameters are guaranteed by the manufacturer according to IEC 61643-11.

EFFICIENT PROTECTION CONCEPT for LED STREET LIGHTING

The following components are relevant in an effective protection concept against transient overvoltages:

- Street lighting main distribution board
- Fuse box in pylon
- Luminaire

Street lighting main distributor:

High-quality surge protectors type 1+2+3 can be installed in the main distribution board to protect the central power supply where there is a good protective earth connection. This protects the main distribution board and thus the entire street lighting from a total failure.

Indirectly, the luminaires are also protected by centrally limiting a large part of the transient overvoltages from the mains supply. A good potential equalisation between the light spots and the main distribution board increases the protective effect.

Street lighting light points:

The protection of the individual light spots depends on the situation. In principle, it is possible to install a surge protection in the **mast fuse box** or in the **luminaire**. Usually one protective device is sufficient. As the pylon heights usually do not exceed 15m, a good level of protection can also be achieved by installation in the mast fuse box.

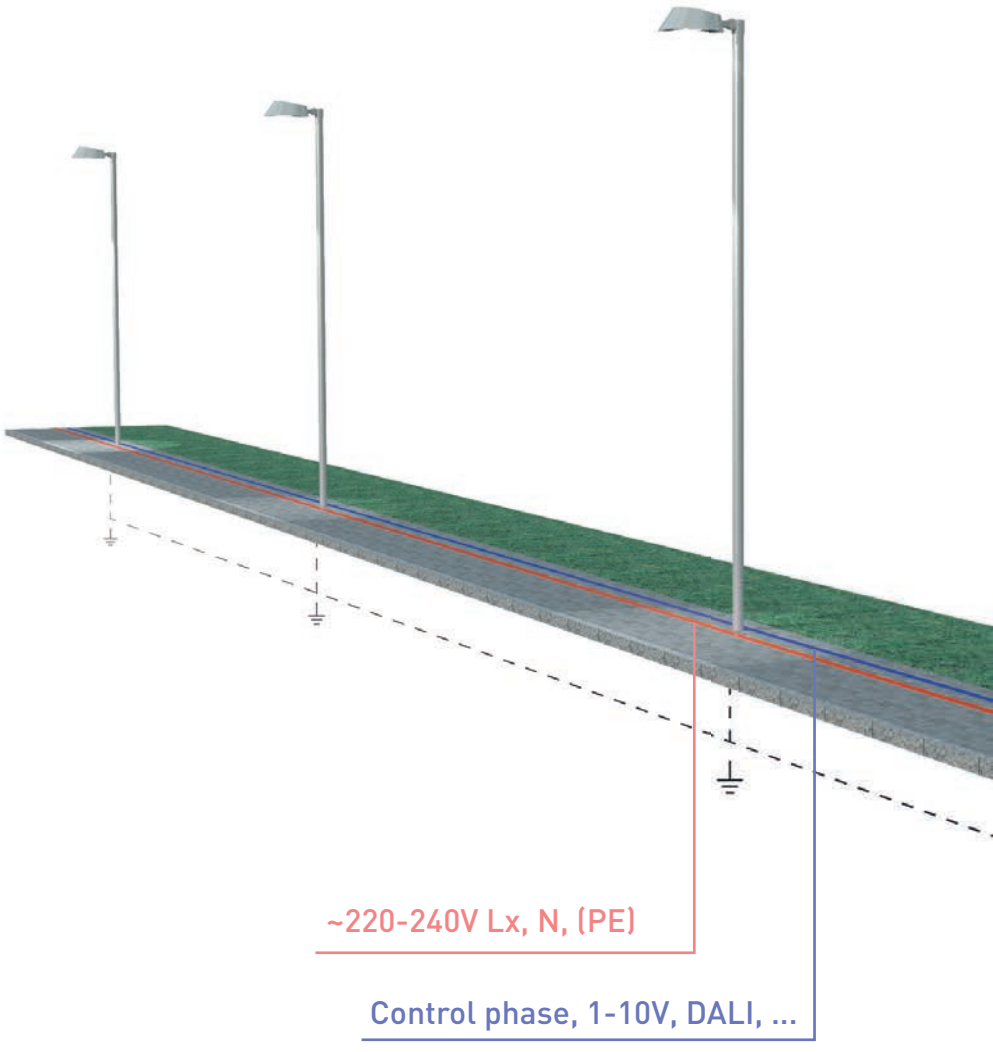
The most sensible solution depends on the local conditions. Thus the following points are relevant:

- Luminaire protection class I or II
- Space conditions in the luminaire or mast fuse box
- Accessibility for maintenance purposes
- Retrofitting or new installation

Especially the question of maintenance and the possibility of retrofitting existing systems speak in favour of an installation in the mast fuse box. The slightly better level of protection and the lower installation effort are more arguments in favour of installation in the luminaire.

For protection class I luminaires, the light point operator always has the option of installing surge protection devices in the luminaire or in the mast fuse box, as a protective conductor is available here and electrical safety is guaranteed in any case.

For protection class II luminaires, surge protection devices according to IEC61643-11 must not nullify the protective insulation. Optimum surge protection against the metal housing or the ground is therefore not possible in a protection class II luminaire. Only a protection between L and N is possible without restrictions.



The installation in the mast fuse box is possible under consideration of the electrical safety according to IEC 60364-4-41 "low-voltage electrical installations - Part 4-41: Protective for safety - Protection against electric shock", if the pylon itself is not part of protection class II. In many lighting installations there is a protective conductor in the mast fuse box, which makes it possible to integrate the mast and a surge protection device into the protective equipotential bonding. The electrical safety, especially the switch-off conditions, are achieved by connecting the protective conductor and the fuse, which is usually located in the mast fuse box. If the impedance of the protective conductor is not good enough, such as in TT networks, it is necessary to install RCD switches in order to achieve the necessary switch-off times according to IEC 60364-4-41. Thanks to the conductive connection of the luminaire to the metal pylon, even luminaires of protection class II can be effectively protected against surges.

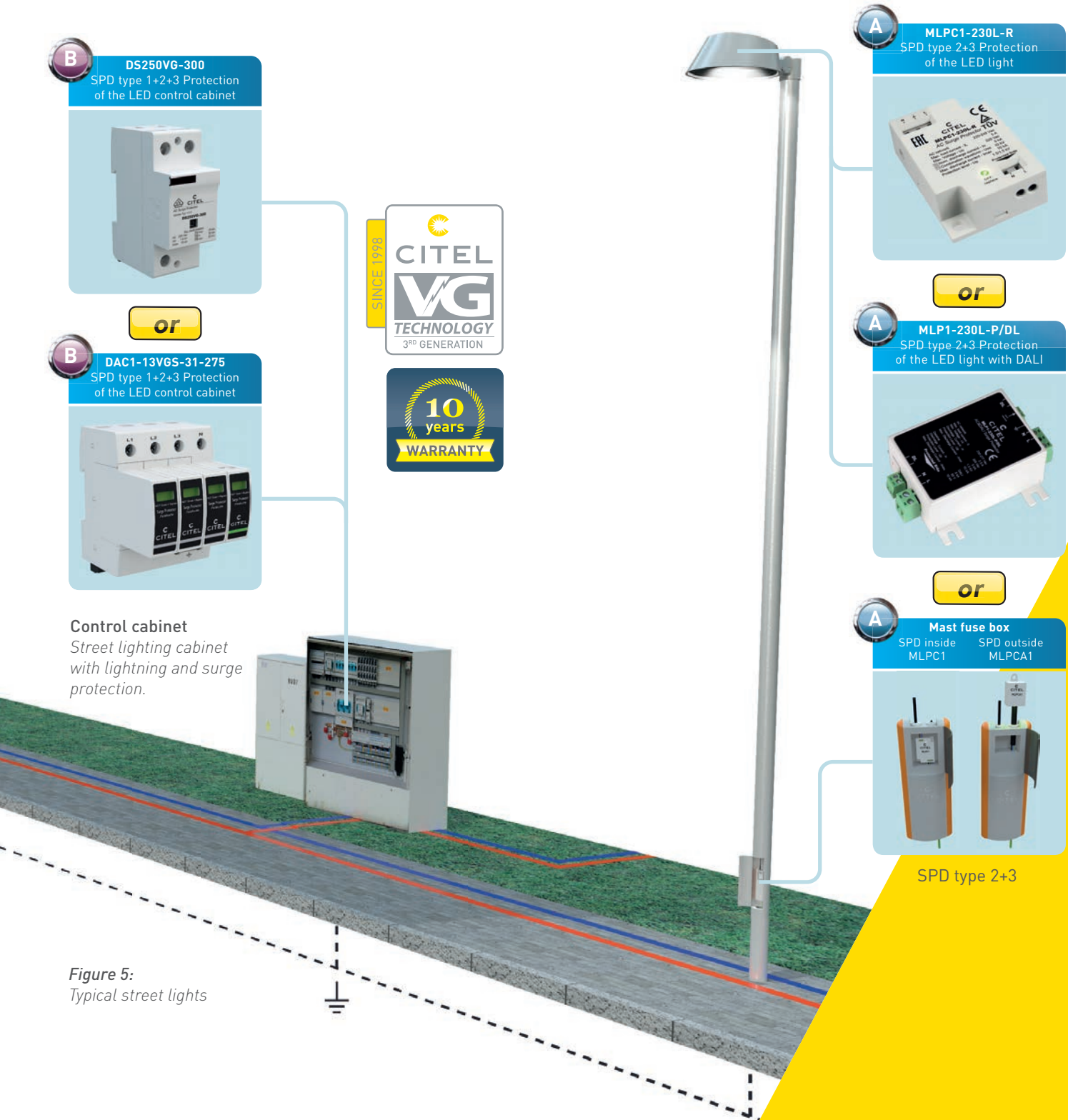


Figure 5:
Typical street lights

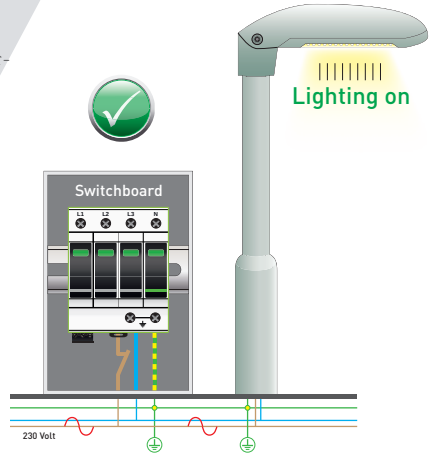
SAFETY AND FAILURE BEHAVIOR OF SURGE PROTECTIVE DEVICES

Surge protective devices are tested according to IEC61643-11, which includes numerous safety-related tests. One of the requirements is the presence of an internal safe disconnector and status signalling. This can be used to detect at any time whether the SPD is still operational.

The disconnector in the surge protection has the task of disconnecting the SPD from the mains in the event of a fault. Depending on the situation, it may be useful to disconnect the circuit of the device to be protected at the same time (Figures 8 and 9), or to signal the fault but continue to supply the system with voltage (Figures 6 and 7).

Failure behavior while maintaining system availability

Figure 6:
Surge protection intact

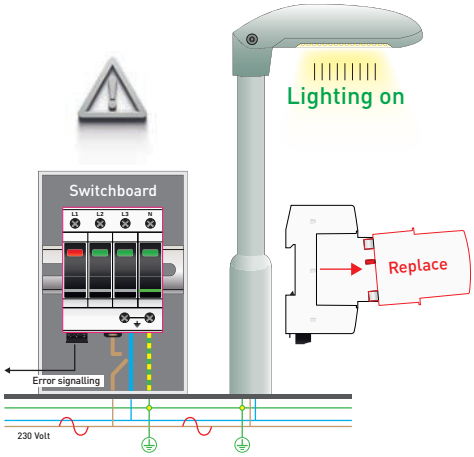


Visual indicator on SPD off

Figure 7:
Surge protection defective

→ SPD is disconnected, power supply of the lights are not

→ Failure is signalled (FS) and detected at the SPD



Visual indicator on SPD on

In a central street lighting control cabinet, it makes little sense to disconnect the system's power circuit in the event of an SPD fault. The streets would be completely dark. SPDs without circuit separation are suitable for this purpose. These only disconnect themselves, indicate the error of the faulty pole and report the error to a control center via a potential-free contact if necessary. The faulty pole can then be easily replaced.

Failure behavior with circuit disconnection

Figure 8:
Surge protection intact

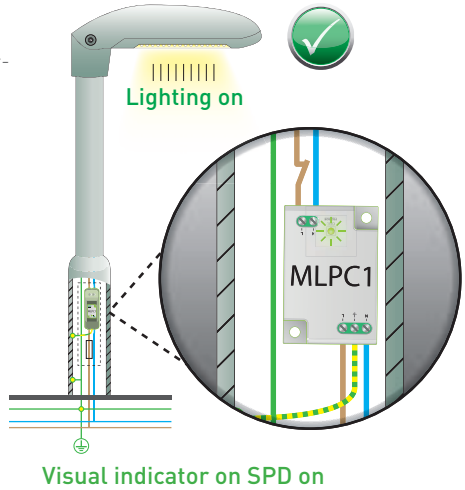
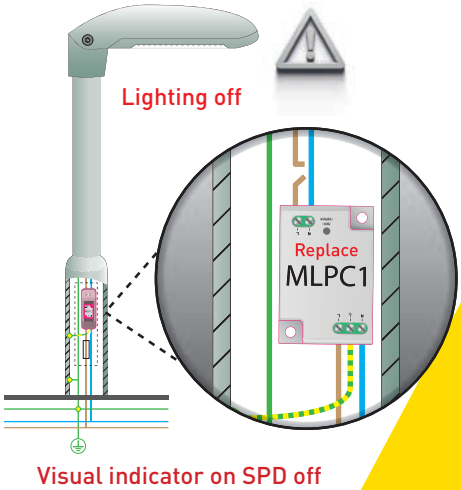


Figure 9:
Surge protection defective

→ Luminaire and SPD are separated

→ Error is visible from outside and at the SPD



For concealed SPDs, e.g. in lamp pylon or luminaires, it often makes sense to switch off the luminaire circuit. This indirectly signals the failure of the SPD to the outside world. The installer can then visually inspect the SPD on site to see if the SPD has triggered.

COORDINATION

1. LED street lighting with SPD in pylon

The term coordination describes the optimal distribution of energy between several SPDs in the same current path. Powerful lightning current arresters or surge protectors should dissipate the main energy already in the central switching point and downstream type 2 SPDs should only limit residual quantities or secondary coupled surges. Fine protection components in LED drivers are thus relieved and their durability is increased.

Citel recommends surge protectors type 1+2+3 with VG technology for the street lighting main distributor. These are coordinated to downstream SPDs even with the smallest cable lengths.

In Figure 10, the coordination between surge protector type 1+2+3 in the main distribution cabinet and SPD type 2 in the mast fuse box is ensured even with the smallest cable lengths.

The coordination between type 2 in the mast fuse box and the LED driver is facilitated by the cable length "$\ell 2$".

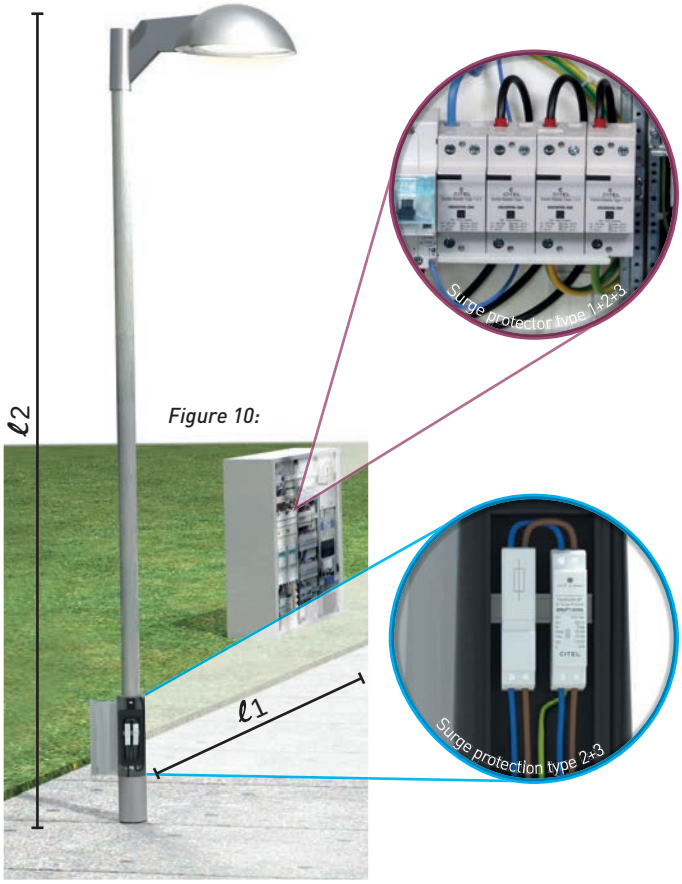


Figure 10:

2. LED street lighting with SPD in the luminaire

In Figure 11, the protection of the lighting spot has been realized by a type 2 SPD directly in the luminaire. The coordination between the surge protector type 1+2+3 in the cabinet and type 2 in the luminaire is again ensured by the Citel VG-Technology.

The coordination between the SPD in the luminaire and the protective components in the LED driver is more critical due to the very short cable length "ℓ3" and is usually checked by luminaire tests in the surge laboratory.

Citel recommends the use of SPDs for lights with indoor drivers or street lights with less than 4kV, which additionally support the coordination.

For this purpose, Citel has developed the MLPCH series with integrated coordination circuit.

MLPCH1-230L-V

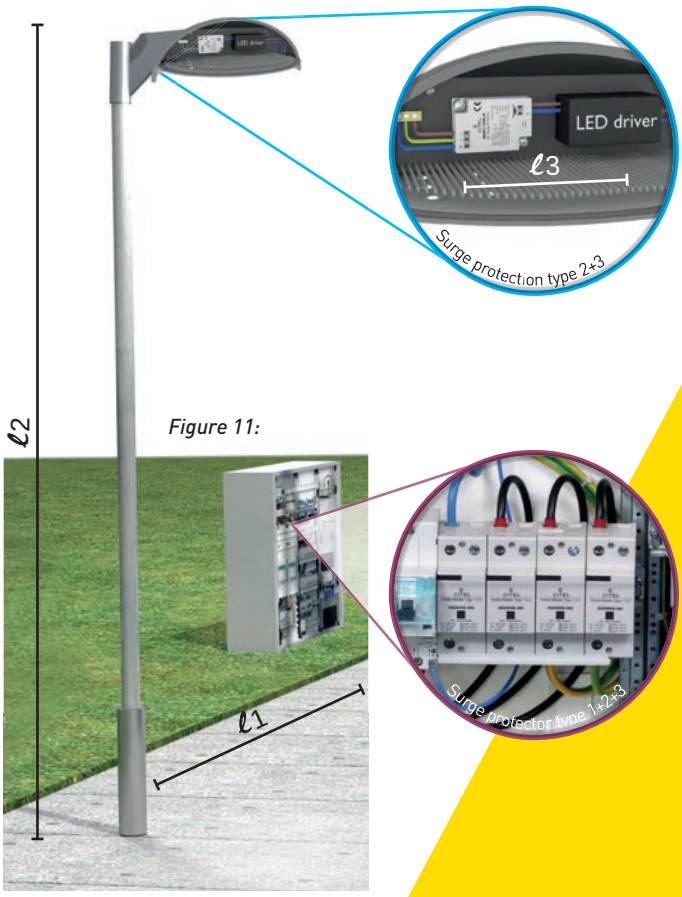
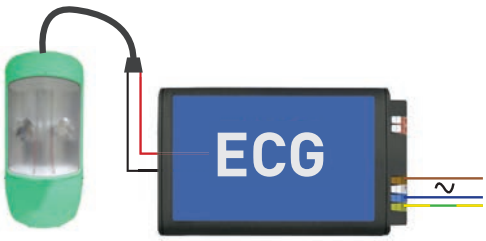


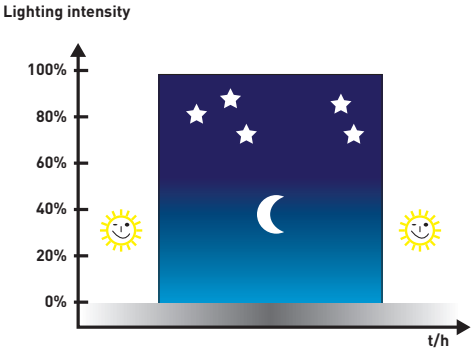
Figure 11:

PROTECTION OF A FACTORY BUILDING TO PROTECT THE LED LIGHTING SYSTEM

DIMMING

without dimming





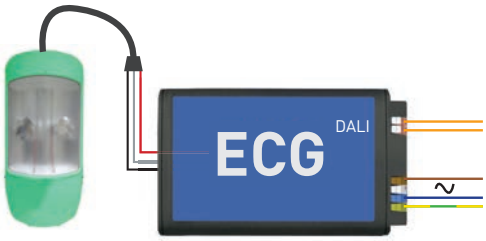
DSLP series

MLPC series

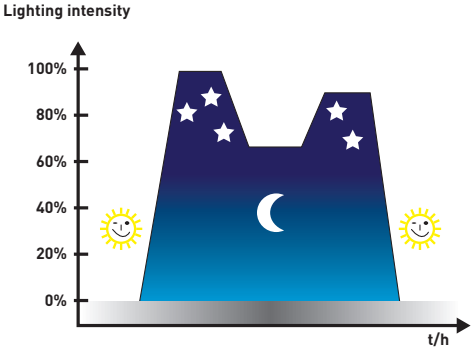
MLPX series

MLPCA series

Dimmable: e.g. via DALI



Variants for 1-10 V and RS485 available



MLP series

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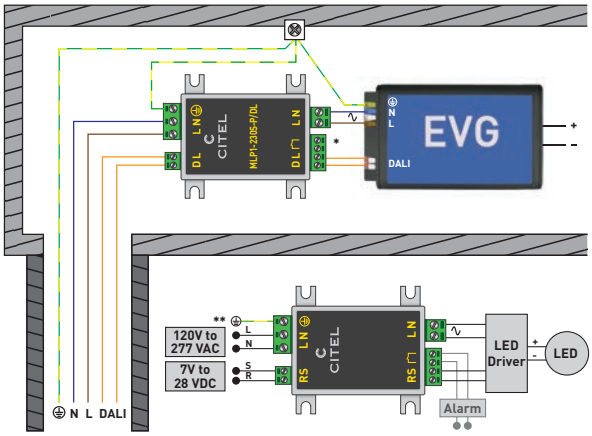
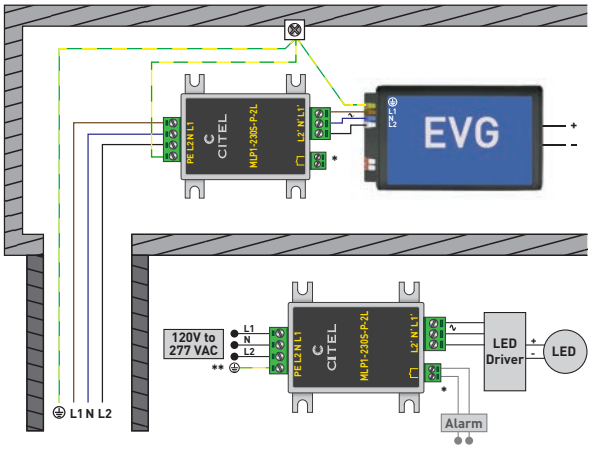
INSTALLATION EXAMPLES FOR LED LUMINAIRES WITH DIMMING

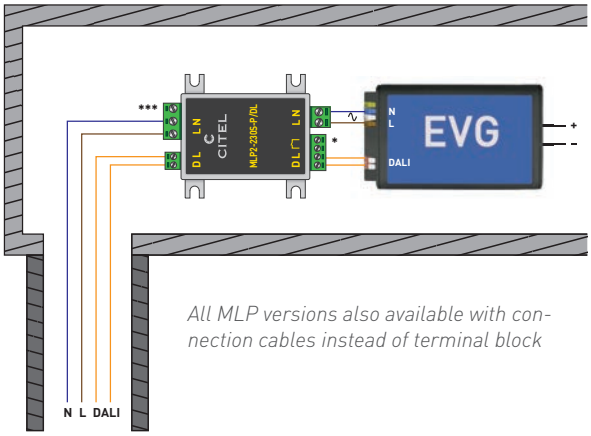
Installation MLP1 with DALI, 1-10V or RS485 for protection class I



Installation MLP1-2L for protection of 2 (control) phases for protection class I

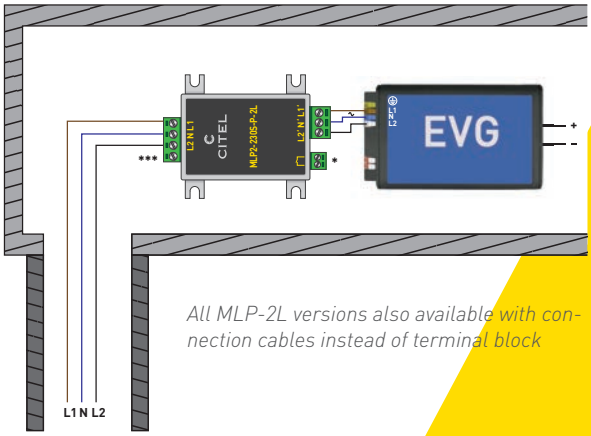


Installation MLP2 with DALI, 1-10V or RS485 for protection class II



All MLP versions also available with connection cables instead of terminal block

Installation MLP2-2L for protection of 2 (control) phases for protection class II



All MLP-2L versions also available with connection cables instead of terminal block

** Remote signaling optional ** Earth connection only for MLP1 devices for protection class I *** Protective earth is not connected*

SPECIAL APPLICATIONS

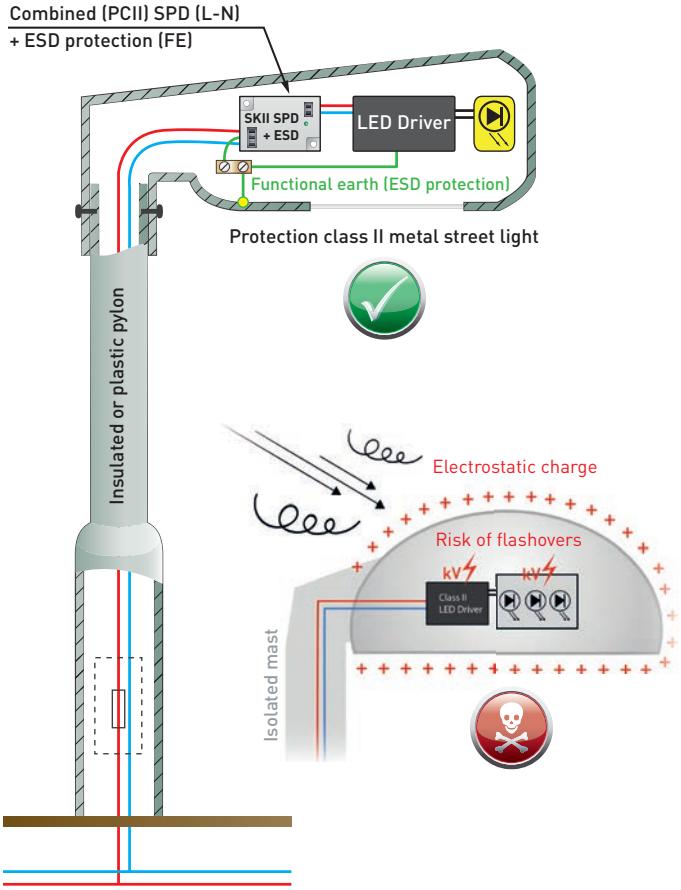
Protection for an insulated PCII luminaire e.g. (GRP) plastic mast

In the case of protection class II luminaires, especially those with an insulated construction, e.g. a GRP pylon or even wire suspensions, electrostatic charging of the luminaire may occur. These charges can generate very high static voltages, which can then discharge uncontrolled in the luminaire and damage the LEDs or drivers.

The drivers commonly available on the market do not usually offer sufficient protection for this phenomenon, since the built-in protective components "mostly capacitors" do not provide any protection against this effect.

With the MLPC2-230L-V/ESP2, Citel has developed a device that ensures protection against switching surges (L-N) as well as against static discharges (lamp body (FE)->N) and also meets the protection conditions of protection class II according to the lamp standard IEC 60598-1.

MLPC2-230L-V/ESP2



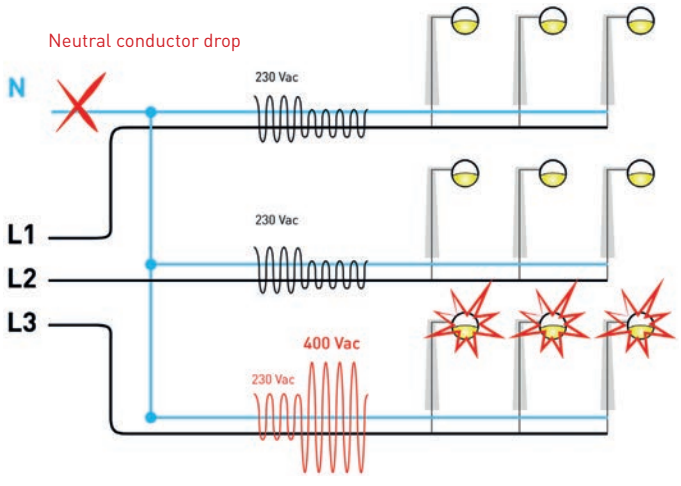
Protection against temporary surges / neutral conductor drop

The MLPVM2-230L-5A is a device which offers protection against switching surges (L-N) and against TOV (TOV = temporary overvoltages).

Temporary overvoltages are not switching or lightning surges (transients) and can be present on the terminal for several seconds. Commercially available surge protection devices only protect against transients, but not against TOV.

In the event of a harmful, temporary overvoltage or undervoltage, e.g. when the neutral conductor drops, the MLPVM2-230L-5A automatically and safely disconnects the terminal device to be protected from the mains to prevent harmful effects. When the mains voltage returns to its normal tolerance range, the MLPVM2-230L-5A automatically reconnects the mains voltage after 10 seconds.

Transient switching surges are also effectively limited by an efficient varistor-based protection circuit.



MLPVM2-230L-5A

SELECTION GUIDE
FOR LED SURGE PROTECTION DEVICES

Selection SPD for LED lighting

Protection class I or II

Class I

Class II

MLP2x
MLPC2x

Dimmable?

YES

NO

MLP1x

With remote signaling?

YES

NO

MLP1x
DAC40CS

For retrofitting outside of cable junction box?

YES

NO

MLPCA

MLPC1 (exterior lighting)
MLPX1 (exterior lighting)
MSB10 (exterior lighting)
MSB6 (interior lighting)
DSLP1 (exterior lighting)
DS98L (exterior lighting)

PRODUCT OVERVIEW

Item	SPD for	Secondary properties	Article designation	Art. No.
A	Power supply 230 Vac	SPD type 2+3, circuit separation, DIN rail mounting, 1TE	DSLP1-230L	352913
		SPD type 2+3, circuit separation, DIN rail mounting, 1TE mechanical optical display	DLPM1-230L	355913
		SPD type 2, DIN rail mounting, pluggable, remote signaling contact, 40 kA, 1TE	DAC40CS-11-275***	821520221
		SPD type 2+3, circuit separation, spring-cage terminal	MLPC1-230L-R	831211
		SPD type 2+3, circuit separation, spring-cage terminal	MLPC1-230L-R/50	831212
		SPD type 2+3, circuit separation, screw terminal	MLPC1-230L-V	831221
		SPD type 2+3, circuit separation, screw terminal	MLPC1-230L-V/50	831222
		SPD type 2+3, circuit separation, spring-cage terminal, IT system	MLPC1-440LY-R	831431
		SPD type 2+3, 4-core rubber sheathed cable 1.5mm², IP65	MLPCA1-230L	835261
		SPD type 2+3, circuit separation, screw terminal	MLPCH1-230L-V	833221
		SPD type 2+3, circuit separation, spring-cage terminal, PCII	MLPC2-230L-R	832211
		SPD type 2+3, circuit separation, connection cable, IP67	MLPX1-230L-W	711214
		SPD type 2+3, circuit separation, connection cable, IP67	MLPX2-230L-W	711217
A	Power supply 230 Vac + protection against static charge	SPD type 2+3, circuit separation, spring-cage terminal, protection against electro static charge	MLPC2-230L-R/ESP2	832217
		SPD type 2+3, circuit separation, screw terminal, protection against electro static charge	MLPC2-230L-V/ESP2	832227
A	Power supply 230 Vac + TOV protection	SPD type 2+3 + protection against temporary overvoltages e.g. neutral conductor drop, circuit separation, spring-cage terminal	MLPVM2-230L-5A	832278
A	Power supply 230 Vac + DALI or 1-10 V	SPD type 2+3, circuit separation, screw terminal	MLP1-230L-P/DL**	721231
		SPD type 2+3, circuit separation, connection cable, IP65	MLP1-230L-W/DL**	711231
		SPD type 2+3, circuit separation, protection class II, screw contact	MLP2-230L-P/DL**	721232
		SPD type 2+3, circuit separation, protection class II, connection cable, IP65	MLP2-230L-W/DL**	711232
A	Power supply 230 Vac + RS485 or DMX	SPD type 2+3, circuit separation, screw contact	MLP1-230L-P/RS**	721251
		SPD type 2+3, circuit separation, connection cable, IP65	MLP1-230L-W/RS**	711251
		SPD type 2+3, circuit separation, protection class II, screw contact	MLP2-230L-P/RS**	721252
		SPD type 2+3, circuit separation, protection class II, connection cable, IP65	MLP2-230L-W/RS**	711252
A	Power supply 230 Vac + control phase	SPD type 2+3, circuit separation, connection cable, IP65	MLP1-230L-W-2L**	731211
		SPD type 2+3, circuit separation, screw contact	MLP1-230L-P-2L**	741211
		SPD type 2+3, circuit separation, protection class II, connection cable, IP65	MLP2-230L-W-2L**	731212
		SPD type 2+3, circuit separation, protection class II, screw contact	MLP2-230L-P-2L**	741212
		SPD type 2+3, 5-core rubber sheathed cable 1.5mm², IP65	MLPCA1-230L-2L	835265
		SPD type 2+3, DIN rail mounting, circuit separation, screw contact, 1TE	DS98L-230G/2L	351933
B	Power supply 230/400 Vac	**VG Technology** Surge protector type 1+2+3, 25/100 kA (10/350µs), 8TE	DS254VG-300/G***	2756
		VG Technology Surge protector type 1+2+3, 12.5/50 kA (10/350µs), 4TE	DAC1-13VGS-31-275***	821730244
C	Power supply 230/400 Vac	**VG Technology** Surge protector type 2+3, 50 kA (8/20µs), 4TE	DAC50VGS-31-275***	821130244

* Further bandwidths and variants available, ** All MLP versions are also available with remote signalling contact, *** S = potential-free remote signaling contact

A Power supply 230 Vac, power supply 230 Vac + DALI, power supply 230 Vac + RS485 and power supply 230 Vac + control phase


MLPC1-230L-V


MLPC1-230L-V/50


MLPC1-230L-R


MLPC1-230L-R/50


MLPC2-230L-R


MLPCH1-230L-V


MLPC2-230L-R/ESP2


MLPC2-230L-V/ESP2


MLPC1-440LY-R


MLPVM2-230L-5A

MLPX1-230L-W

MLPX2-230L-W

MLPCA1-230L
MLPCA1-230L-2L

MLPx-230L-W/DL
MLPx-230L-W/RS
MLPx-230L-W-2L
MLP2-230L-W
MLP2-230S-W
MLP2-230-W


MLPx-230S-P/DL
MLPx-230L-P/RS
MLPx-230S-P-2L
MLP2-230L-P
MLP2-230S-P
MLP2-230-P


DLPM1-230L


DSLP1-230L


DS98L-230G/2L


DAC40CS-11-275

B Power supply 230/400 Vac

DS254VG-300/G

DAC1-13VGS-31-275

C Power supply 230/400 Vac

DAC50VGS-31-275

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