



CITEL



Disruptions of outdoor lighting networks and risks to equipment (LED street lights)

6th edition

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Outdoor lighting networks are especially sensitive to all kinds of electrical interference, whether permanent, temporary or transient. These forms of interference threaten the equipment connected to these networks. Additionally, age or even obsolescence affecting these networks aggravate the issues.

The threats faced are multiple ones: Lightning and its side effects, overvoltages caused by switching, power distribution issues (loss of neutral, connection errors), voltage harmonics. All of these sources of interference are potentially present in outdoor networks, but historically the appliances connected to outdoor lighting networks were sufficiently robust to absorb them without causing any major incidents.

The introduction of highly sensitive electronic technologies into these outdoor networks radically changes the issues, with interference now becoming a major and serious threat. A spectacular illustration of this new problem comes from street lighting which over the past few years has seen major change by massively transitioning to LED technologies.

MAJOR HAZARDS FOR LED OUTDOOR LIGHTING

These new lighting networks combine all of these risks:

- Highly sensitive equipment (electronic drivers, LED components)
- Connection to interference prone networks
- Very long power supply lines
- Large number of appliances installed outdoors
- Extreme user/customer sensitivity to network quality due to the high initial investment involved...

This LED equipment will therefore be subjected to a series of forms of interference which will seriously degrade their performance and their service life (which, it should be restated is the major argument made in favour of migrating to this technology in the first place...)



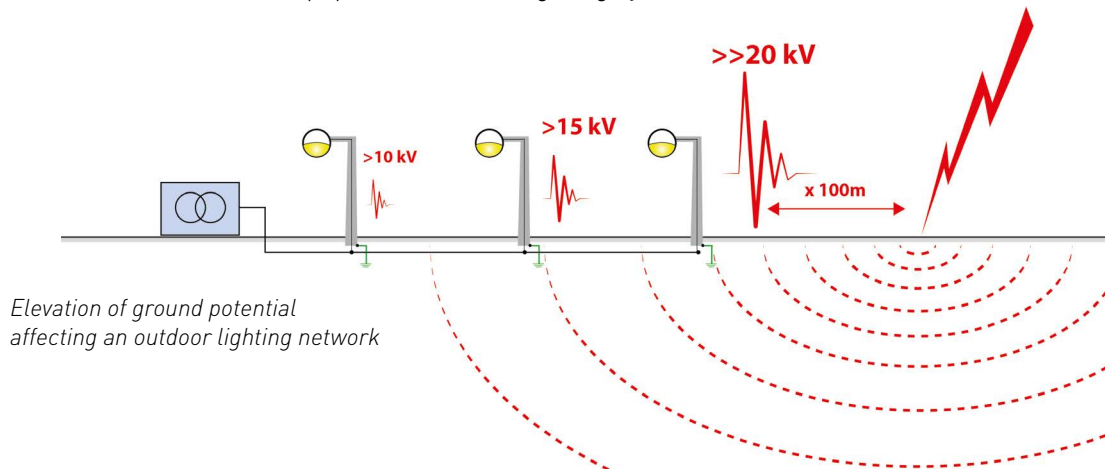
Examples of destruction to LED arrays and drivers due to lightning surges



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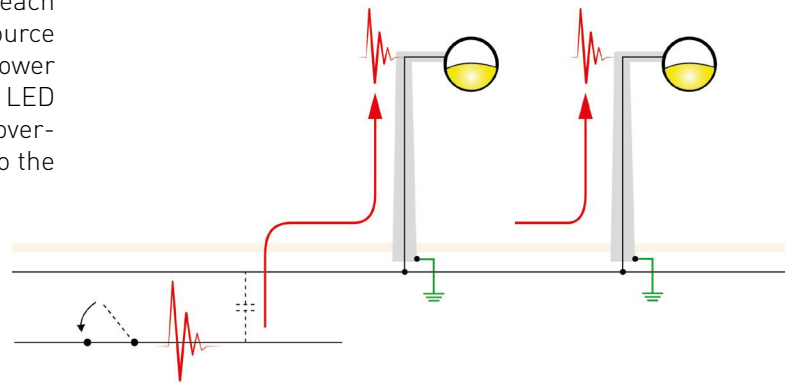
• Transient overvoltages due to lightning

This risk is now a well-known one, caused by the consequences of a lightning discharge that will couple with the power distribution networks: lightning strikes on the overhead line, rise in the ground potential, electromagnetic radiation on the networks. There are many different scenarios that will create very high amplitude transient overvoltages (of many kilovolts), that are fatal to sensitive equipment like LED lighting systems.



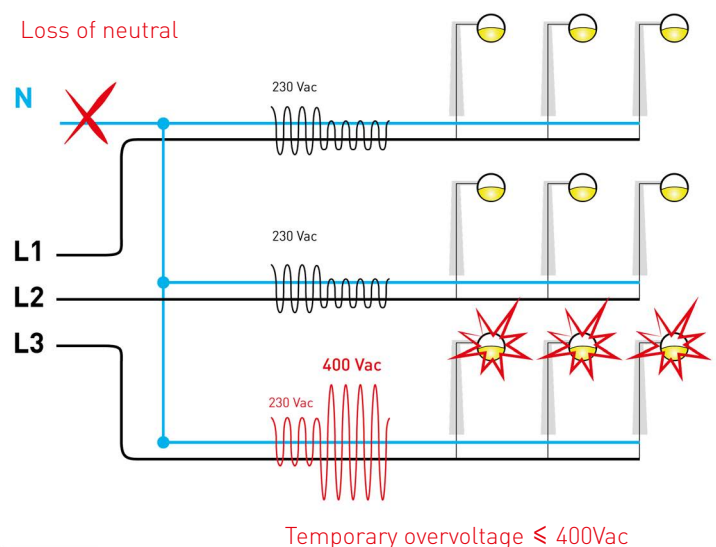
• Switching overvoltages

Electric power networks are full of inductive loads that will generate transient overvoltages that may reach many kilovolts. For lighting networks a major source of switching overvoltages are the ferromagnetic power supplies used by discharge lamps that coexist with LED lighting. Every time the lights are lit, this will inject overvoltage pulses into the system that will propagate to the fragile LED equipment.



• Connection error / temporary overvoltages / Neutral failure

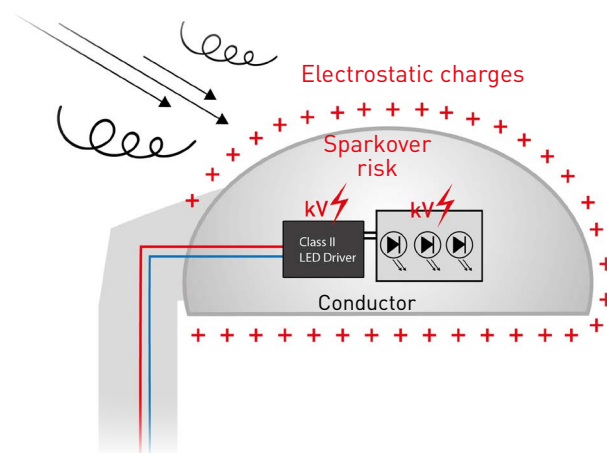
A connection error (phase/phase connection) or a neutral failure on the supply network will generate almost twice as much voltage to the equipment: these temporary overvoltages are devastating for the connected equipment.



• **Electrostatic charges**

These phenomena are not linked to the quality of the electric power supply network but rather to the way LED lights are made. They are however, proven causes of failure in these systems.

Most of the outdoor lighting systems used in France are built to Class II standards (protected against indirect contacts by double insulation or reinforced insulation): the metal casing containing the appliances is not directly connected to the protective ground nor is it indirectly connected to it (via a conductive mounting): a typical example is a light on a wooden or fibre pole. Consequently, there is a risk that the metal casing can become electrostatically charged by the wind (through friction with dust particles), with no possibility to discharge this build-up. This electrostatic charge may reach high amplitudes (in kV) until, in time, it will under certain conditions, cause arcing with internal components



PROTECTIVE SOLUTIONS FOR OUTDOOR LED LIGHTING

• **Surge Protectors**

CITEL as the market leader for surge protection devices, proposes versions suited to be used in luminaires (whether installed in the junction box at the pole base or built-into the light unit head), as well as a number of different layouts that can be used to adapt to the various configurations.

The use of surge protection devices is therefore strongly recommended to avoid failures and to improve the service life of LED lighting networks, but it may also be mandatory: The need to use a surge protector is included in the 2016 version of NF C17-200 french standard (Rules for outdoor low voltage installations, including lighting) and based on a simplified risk analysis.

In addition to surge protection devices built-into the lighting unit, on the low voltage network, other surge protection devices will also have to be installed in the control cabinet as well as on the control networks when applicable.



Surge protector for LED lantern



Surge protector for the mast or pole entry



• Protection against temporary overvoltages and loss of Neutral

To protect against this highly aggressive phenomena, some surge protection devices are designed to “sacrifice” themselves (using their controlled end of life mode) and disconnect the terminal equipment, thereby ensuring their protection. Other solutions:

- Using drivers that have an enhanced resistance to temporary overvoltages.
- Using systems to protect against industrial frequency overvoltages (CITEL MLPVM2, VM230).

• Protection against electrostatic charges

Eliminating any electrostatic charge risk from Class II lights should be covered by construction. However, corrective or additional action may be taken using dedicated discharge devices(ESP-230), sometimes included in surge protection (CITEL MLPC2-230L-R/ESP2).

CONCLUSION

The technological changeover affecting equipment installed on outdoor lighting networks raises a major issue in terms of reliability: to ensure the reliability of these systems and a relevant service life, essential challenges to be met to ensure the spread of such systems, these issues need to be properly taken into account and specific protective actions taken.

CITEL proposes a very large range of effective protection solutions to match the various topologies and risks assessed.

Surge Protectors for LED lighting



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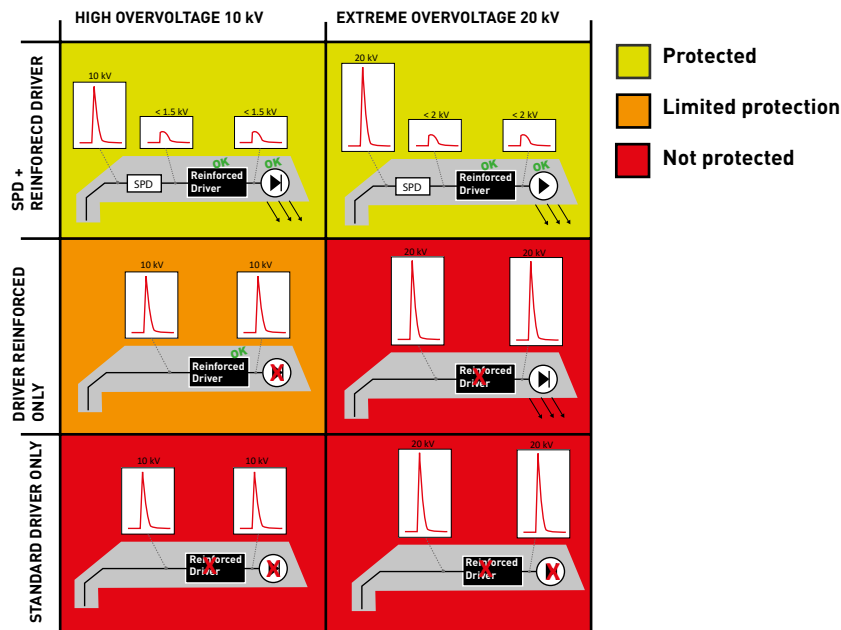
• Overvoltage protection and “reinforced” drivers

Whereas the first generations of electronic drivers equipping LED lights offered reduced impulse withstand (2.5 to 6 kV), new (“reinforced”) driver versions now achieved levels of 10 kV, de-facto improving their resistance to transient overvoltages caused by lightning or switching.

Nevertheless, implementing a surge protection device upstream of the reinforced driver is still necessary as:

- The driver increases its robustness through greater internal insulation but does not provide any additional protection for LED components located downstream.
- Incidental overvoltages may exceed 10 kV and can therefore damage these reinforced drivers.

The table below sets out the scenarios depending on the amplitude of the transient aggression and the various light configurations:



FRENCH STANDARD NF C17-200

In France, the installation rules that apply to outdoor lighting networks are set out in standard NF C17-200.

The September 2016 version of this standard includes paragraph 534-1 (Protection against transient overvoltages) which defines the rules for using surge protection devices.

Standard NF C17-200 requires performing a risk assessment to determine whether protection against transient overvoltages is required for equipment connected to an outdoor low voltage network (like street light networks).

Three criteria are used for this risk assessment:

- The total length of the outdoor network deployed
- The electrical robustness of the appliances connected to the network (shock resistance category)
- The lightning strike impact level for the installation area (Nsg parameter = lightning strikes per year per km²)

Implementing a surge protector is necessary when the total length of the power supply network from the control cabinet to the last electrical equipment exceeds:

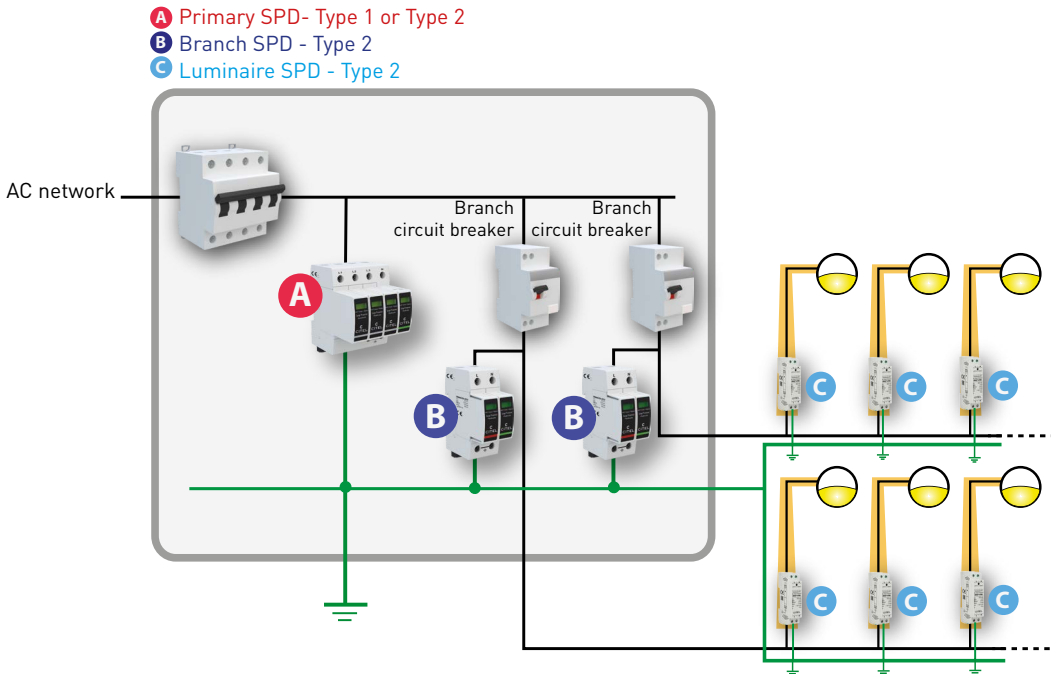
- 2500 m / N_g for category 3 electronic equipment (4 kV impulse withstand) or higher,
- 200 m / N_g for category 2 electronic equipment (2.5 kV impulse withstand),
- 30 m / N_g for category 1 electronic equipment (1.5 kV impulse withstand).

If this risk assessment is not performed, the installation needs to be equipped with protection against transient overvoltages.



SURGE PROTECTORS FOR STREET CABINETS

The cabinet where lighting network control appliances are installed must be made secure against transient overvoltages. Surge protection devices must be installed on the network entrance and on the lines out to the lights. Depending on the risk and the network configuration, a number of models are available.

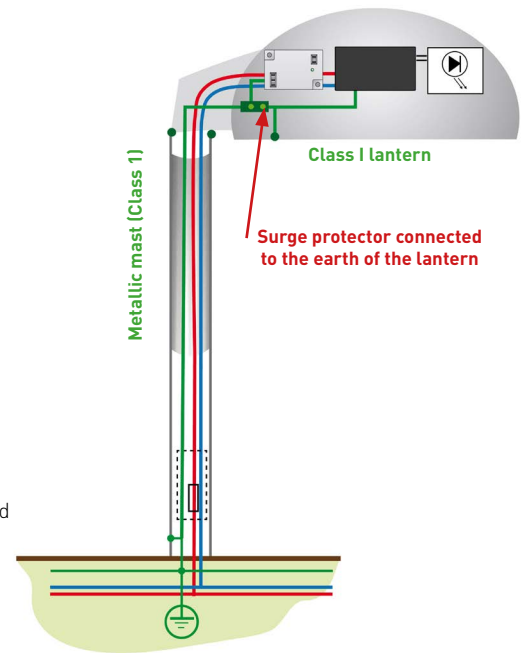


Range	DAC1-13VG	DAC50VG	DSL/PLPM
AC network	230V single phase 230/400V 3-phase + neutral	230V single phase 230/400V 3-phase + neutral	230V single phase
Typical use	Maximun risk - Direct strike risk - Overhead AC line distribution	Low or medium risk - Underground AC line distribution	Always
SPD Type	Type 1 + 2 + 3	Type 2 + 3	Type 2
Discharge currents	Iimp 12.5 kA @ 10/350µs/pole	I _{max} 40 kA @ 8/20µs/pole	I _{max} 10kA @ 8/20µs/pôle
U_p (L-N/N-PE)	1.25/1.5 kV	1.25/1.5 kV	1.5/1.5 kV
IP rating	IP20	IP20	IP20
Failsafe conditions	SPD disconnection from AC line - Failure indication and remote signalling	SPD disconnection from AC line - Failure indication and remote signalling	AC line cut off and signaling
Connectique	Screw terminal for 35 mm ² max	Screw terminal for 25 mm ² max	Screw terminal for 1.5 mm ² max
Monting	DIN Rail	DIN Rail	DIN Rail
References for TN/TT AC system power supply : - single phase 230 V - 3-phase+neutral 230/400V	DAC1-13VGS-11-275 DAC1-13VGS-31-275	DAC50VGS-11-275 DAC50VGS-31-275	DSL/PL1-230L / DL/PLM1-230L





SURGE PROTECTORS FOR CLASS I LANTERNS

These surge protection devices are designed to be built-into Class I lights and offer effective protection in common and differential modes. A number of sizes, layouts and functions are available.



VG diagram
MLPC and MLPX ranges are available with VG technology guaranteeing optimised coordination with the driver and maximum service life.

CITEL model	MLPM1	MLPC1	MLPX1	MSB6
Network	230V single phase	230V single phase	230 V single phase	230 V single phase
VG Technologie	no	Optional ⁽⁵⁾	Optional ⁽¹⁾	no
Max. line current	5 A	5 A	10 A	NA (parallel connection)
Currents In/Imax	5 kA / 10 kA	5 kA / 10 kA	5 kA / 10 kA	3 kA / 6 kA
Up (MC/MD)	1.5/1.5 kV	1.5/1.5 kV	1.5/1.5 kV	1.5/1.5 kV
IP rating	IP20	IP20	IP67 ⁽¹⁾ / IP20 ⁽²⁾	IP20
Security end of life	AC line cut off and mechanical indication	AC line cut off and signaling	AC line cut off and signaling	AC line cut off and signaling by buzzer ⁽¹⁾ ou LED ⁽²⁾
Connectors	Spring ressort opposed	Screw terminal opposed ⁽¹⁾ Common screw terminal ⁽²⁾ Spring ressort opposed ⁽³⁾ Common spring ressort ⁽⁴⁾	Wires	Wires
Mounting	Fixing lug	Fixing lug	Fixing lug	On terminal
Dimensions	60.6 x 42.2 x 18.7 mm	59 x 40 x 20.5 mm	37 x 30 x 20 mm	35 x 25 x 11 mm
Part number	MLPM1-230L-R	MLPC1-230L-V ⁽¹⁾ MLPC1-230L-V/50 ⁽²⁾ MLPC1-230L-R ⁽³⁾ MLPC1-230L-R/50 ⁽⁴⁾ MLPC-VG1-230L-V ⁽¹⁾ MLPC-VG1-230L-R ⁽⁴⁾	MLPX1-230L-W MLPX1VG-230L-W ⁽¹⁾	MSB6-400 ⁽¹⁾ MSB6-400/LD ⁽²⁾
				




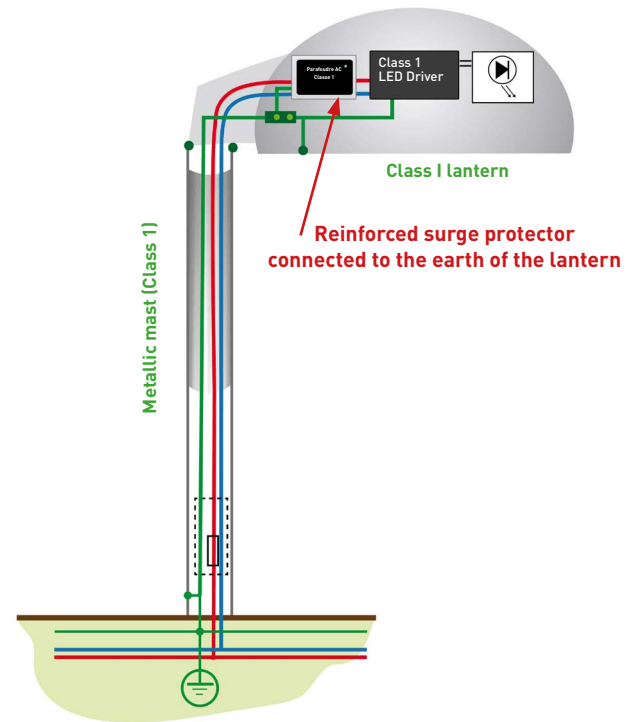
REINFORCED SURGE PROTECTION DEVICES FOR CLASS I LANTERNS

MLP1/20kA Series

These surge protection devices are designed to be built-into Class I lights and have the reinforced discharge current level (I_{max} 20 kA) required in installations exposed to extreme lightning strike conditions.

CITEL model	MLP1/20 kA
Network	230V single phase
Max. line current	5 A
Currents I_n/I_{max}	10 kA / 20 kA
U_p (MC/MD)	1.5 kV/1.5 kV
IP rating	IP20
Security end of life	AC line cut off and signaling
Connectors	Removable screw terminal
Mounting	Fixing lug
Dimensions	66 x 49 x 30 mm
Part number	
Standard version	MLP1-230L-P/20K
Remote indication	MLP1-230LS-P/20



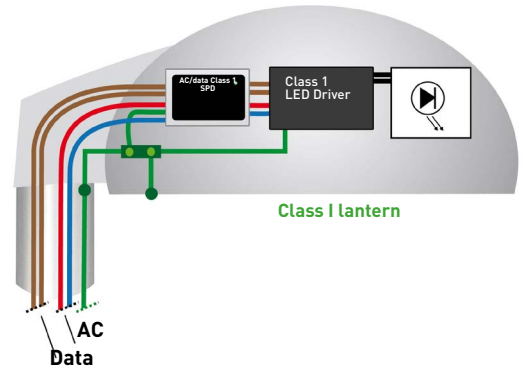


COMBINED AC/DATA SURGE PROTECTION DEVICES

MLP**/RS or MLP**/DL series

If the luminaire driver uses wired data transmission (i.e. DALI, DMX, 0-10V, RS485) then the risk of faults from transient overvoltages is very high and installing a surge protection device is necessary. CITELE offers a combination surge protection device that protects both the AC power access and data communication lines.

CITEL Model	MLP**/RS	MLP**/DL
Network	230 V ⁽¹⁾ single phase 120 V ⁽²⁾ single phase	230V ⁽¹⁾ single phase 120V ⁽²⁾ single phase
AC characteristics		
Max. line Current	2.5 A	2.5 A
Currents In/Imax	5 kA / 10 kA	5 kA / 10 kA
Up (MC/MD)	1.5/1.5 kV ⁽¹⁾ - 1.5/1 kV ⁽²⁾	1.5/1.5 kV ⁽¹⁾ - 1.5/1 kV ⁽²⁾
IP rating	IP20	IP20
Security end of life	AC line cut off and signaling ⁽³⁾ AC line disconnection and remote signaling ⁽⁴⁾	AC line cut off and signaling ⁽³⁾ AC line disconnection and remote signaling ⁽⁴⁾
Data characteristics		
Type of line	RS485 or 0-10 V ⁽⁵⁾	DALI ⁽⁶⁾
Currents In/Imax	5 kA / 10 kA	5 kA / 10 kA
Protection level	30 V	50 V
Security end of life	Interruption of transmission	Interruption of transmission
Mechanical characteristics		
Connectors	Removable screw ⁽⁷⁾ Wires ⁽⁸⁾	Removable screw ⁽⁷⁾ Wires ⁽⁸⁾
Mounting	Fixing lug	Fixing lug
IP rating	IP20 ⁽⁹⁾ - IP65 ⁽¹⁰⁾	IP20 ⁽⁹⁾ - IP65 ⁽¹⁰⁾
Part number	MLP1-230L-P/RS ⁽¹⁾ ⁽³⁾ ⁽⁵⁾ ⁽⁷⁾ ⁽⁹⁾ MLP1-230S-P/RS ⁽¹⁾ ⁽⁴⁾ ⁽⁵⁾ ⁽⁷⁾ ⁽⁹⁾	MLP1-230L-W/DL ⁽¹⁾ ⁽³⁾ ⁽⁶⁾ ⁽⁸⁾ ⁽¹⁰⁾
		



DATA SURGE PROTECTION DEVICES

DLA series

Solutions dedicated to protecting only the communication lines are also available.



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SURGE PROTECTION DEVICES FOR CLASS I LANTERNS, FOR REINFORCED COORDINATION WITH DRIVER

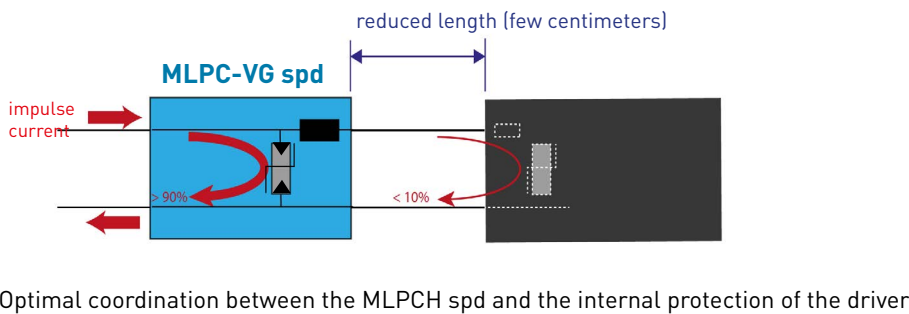
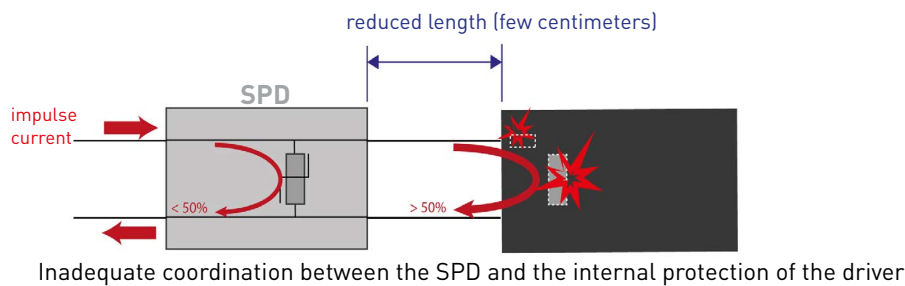
MLPC-VG series

MLPX-VG series



These surge protection devices eliminate the risk of any non-coordination between the surge protector and the driver's internal protection component: this way, if its rating is unsuitable, the efficiency of the external surge protection device may become an issue (probable destruction of the driver input stage by pulse current), especially if the length of the connection between the surge protector and the driver is reduced.

The specific MLPC-VG and MLPX-VG surge protection devices include VG technology that amongst other functions allows ensuring pulse current coordination between the surge protector and the driver, regardless of the type of internal protection provided for the driver and the length of the connection between the protector and the driver.



CITEL model	MLPC-VG1-230L-*	MLPX1VG1-230L	MLPC-VG2-230L-*
Network voltage	230 V single phase	230 V single phase	230 V single phase
Max. line current	10 A	10 A	10 A
Currents In/Imax	5 kA / 10 kA	5 kA / 10 kA	5 kA / 10 kA
Up (MC/MD)	1.5 kV / 1.5 kV	1.5 kV / 1.5 kV	1.5 kV / 1.5 kV
IP rating	IP20	IP67	IP20
Security end of life	AC line cut-off and indication	AC line cut-off and indication	AC line cut-off and indication
Connectors	Screw or spring	Wires	Screw or spring
Mounting	Fitting lug	Fitting lug	Fitting lug
Dimensions	59 x 40 x 20.5 mm	30 x 37 x 20 mm	59 x 40 x 20.5 mm
Part number	MLPC-VG1-230L-V MLPC-VG1-230L-R -	- - MLPX1VG-230L-W	MLPC-VG2-230L-V MLPC-VG2-230L-R -



MLPC-VG1-230L-V



MLPX1VG1-230L-W






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SURGE PROTECTION DEVICES FOR CLASS II LANTERNS

MLPM2 - MLPC2 - MLP2 - MLPX2 series

These surge protection devices are designed to be integrated into Class II luminaires and provide effective protection in differential mode. Several formats are available.

CITEL model	MLPM2	MLPC2	MLP2	MLPX2
Network voltage	230 V	230V	230V ⁽¹⁾ 120V ⁽²⁾	230 V
Max. line current	5 A	5 A	2.5 A	10 A
Currents In/Imax	5 kA / 10 kA	5 kA / 10 kA	5 kA / 10 kA	5 kA / 10 kA
Up (MD)	1.5 kV	1.5 kV	1.5 kV	1.5 kV
IP rating	IP20	IP20	IP20 / IP65	IP67
Security end of life	AC line cut off and mechanical signaling	AC line cut off and signaling	AC line cut off and signaling ⁽³⁾ AC line disconnection and remote signaling	AC line cut off and signaling
Connectors	Ressort ⁽¹⁾	Ressort ⁽¹⁾ Screw ⁽²⁾	Removable screw ⁽⁵⁾ Wire ⁽⁶⁾	Wires
Mounting	Fixing lug	Fixing lug	Fixing lug	Fixing lug
Dimensions	60.6 x 42.2 x 18.7 mm	59 x 40 x 20.5 mm	66 x 49 x 30 mm	37 x 30 x 20 mm
Part number	MLPM2-230L-R ⁽¹⁾	MLPC2-230L-R ⁽¹⁾ MLPC-VG2-230L-R ⁽¹⁾ MLPC-VG2-230L-V ⁽²⁾	MLP2-230L-P ⁽¹⁾ ⁽⁵⁾ MLP2-230L-W ⁽¹⁾ ⁽⁶⁾ MLP2-120L-P ⁽²⁾ ⁽⁵⁾	MLPX2-230L-W
				



SURGE PROTECTION DEVICE WITH **ELECTROSTATIC PROTECTION (ESP)** FOR CLASS II LANTERNS.

MLPC2/ESP2 series

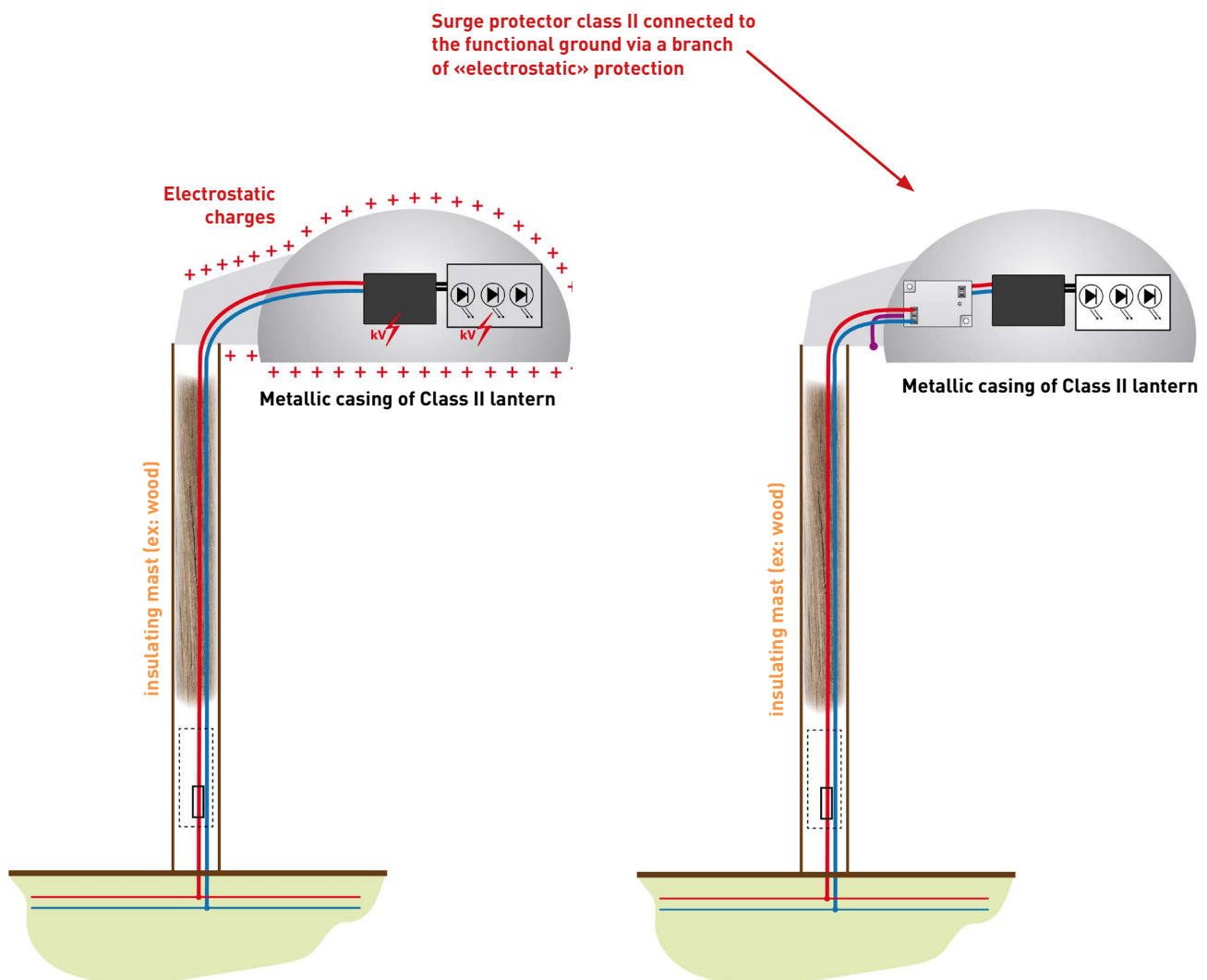
ESP series

If there is any risk of an electrostatic charge on the metal casing of a Class II light, the specific MLPC2-230L/ESP2 surge protector can be used: in addition to a surge protector stage between Phase and Neutral (differential mode protection), it includes an ESP (electrostatic protection) specific branch that connects to the lamp's metal ground (the functional ground) and that will "discharge" the case if the voltage reaches approximately 500 V, thereby avoiding any malfunctions in the light's internal circuits.

The ESP branch of the MLPC2-230L/ESP2 surge protector complies with the insulation rules set out in standards IEC 60598-1 (Luminaires - Part 1: General requirements and tests) and IEC 62368-1 (Audio/video, information and communication technology equipment - Part 1: Safety requirements) as well as with technical guide CENELEC CLC/TR50656. This mechanism does not generate any leakage current.

The ESP function alone is also available: reference CITEL ESP-230.

Warning: The MLPC2-230L/ESP2 surge protector is not sized to protect against common mode "lightning" overvoltages that may appear on Class II lights involuntarily connected to earth (e.g. Class II lights mounted on a conductive mounting).


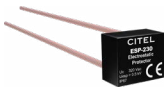


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SURGE PROTECTION DEVICE WITH **ELECTROSTATIC PROTECTION (ESP)** FOR CLASS II LANTERNS

MLPC2/ESP2 series

ESP series

CITEL model	MLPC2/ESP2	ESP
Network	230V single phase	230V single phase 120V single phase
Function	Surge protector + Electrostatique protection	Electrostatique protection
Max. line current	2.5 A	NA
Currents In/Imax	5 kA / 10 kA	5 kA / 10 kA
Up (MD)	1.5 kV	NA
U_{ESP}	> 0.5kV	> 0.5kV
IP rating	IP20	IP65
Security end of life	AC line cut off and signaling	NA
Connectors	Screw terminal	Wires
Mounting	Fixing lug	Wires
Dimensions	59 x 40 x 20.5 mm	20 x 20 x 12 mm
Part number Screw connectors Spring connectors Wire output	MLPC2-230L-V/ESP2 MLPC2-230L-R/ESP2 -	- - ESP-230
		



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SURGE PROTECTION DEVICES FOR STREET LIGHTING POST JUNCTION BOX

DSLSP series

DLPM series

DLPM/15K series

DS98 series

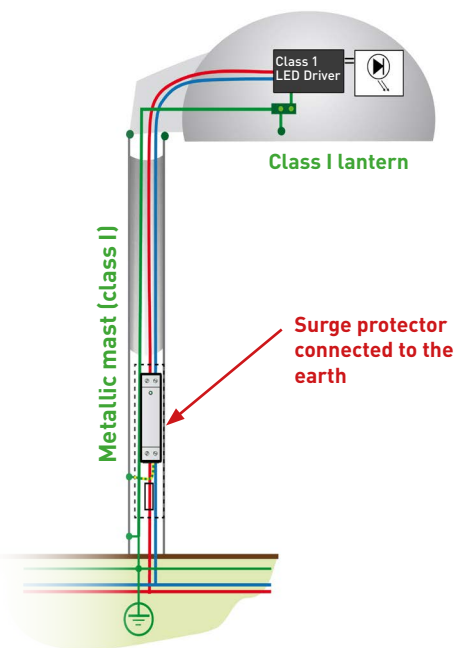
These surge protection devices are designed to be built-into the connection boxes at the base of poles and offer effective common and differential mode protection. A number of sizes and functions are available.

The **DSLSP version** is especially suited to the low profile locations used in most poles.

The **DLPM version**, similar in size to DSLSP, includes a mechanical disconnection indicator that shows the status of the powered down surge protector.

The **DLPM/15K version**, similar to the DLPM, brings increased efficiency (Up 1 kV) as well as an increased discharge current level (Imax15 kA).

The **DS98 versions** propose a number of configurations, including a remote indication option and a two phase + neutral network.



CITEL model	DSLSP/DLPM	DLPM/15K	DS98
Network voltage	230V ⁽¹⁾ 120V ⁽²⁾	230 V ⁽¹⁾	230V ⁽¹⁾ 120V ⁽²⁾ 230V 2L+N ⁽⁵⁾
Classe d'isolement	Class I ^{(1) (2) (4)} Class II ⁽³⁾	Class I ⁽³⁾	Class I
Max. line current	10 A	10 A	16 A
Currents In/Imax	5 kA / 10 kA	5 kA / 15 kA	5 kA / 10 kA
Up (MC/MD)	1.5 kV/1.5 kV ^{(1) (4)} - /1.5 kV ⁽³⁾ 1.5 kV/1 kV ⁽²⁾	1.5 kV/1 kV ⁽⁵⁾	1.5 kV/1.5 kV ⁽¹⁾ 1.5 kV/1 kV ⁽²⁾
Ip rating	IP20	IP20	IP20
Security end of life	AC line cut off and signaling LED indicator ^{(1) (2) (3)} mechanical indicator ⁽⁴⁾	AC line cut off and signaling LED indicator ⁽⁸⁾ Mechanical indicator ⁽⁹⁾	AC line cut off and signaling ⁽³⁾ AC line disconnection and remote signaling ⁽⁴⁾
Connectors	Screw	Screw	Screw
Mounting	DIN rail	DIN rail	DIN rail
Dimensions	90x17,9x38 mm	90 x 17,9 x 38 mm	90x18x58 mm
Part number	DSLSP1-230L ⁽¹⁾ DSLSP1-120L ⁽²⁾ DSLSP2-230L ⁽³⁾ DLPM1-230L ⁽⁴⁾	DLPM1-230L/15K ^{(1) (3) (5) (9)}	DS98-230/G ^{(1) (3)} DS98L-400 ^{(1) (4)} DS98L-120 ^{(2) (4)} DS98S-230/G ^{(1) (3)} DS98L-230G/2L ⁽⁵⁾





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PROTECTION AGAINST **PERMANENT** AND SURGE OVERVOLTAGES

MLPVM2 range VM230 range

These POP (Permanent Overvoltage Protection) devices are designed to protect the equipment against temporary or permanent overvoltages caused by the quality of the distribution network, wiring errors or neutral loss problem.

The MLPVM2 version also includes a surge protection device stage providing full protection against overvoltages, whether they are permanent, temporary or transient.

CITEL model	MLPVM2-230L-5A	VM230-DIN
Description	Protection against surge/temporary/permanent overvoltages for Class II luminaire	Protection against temporary and permanent overvoltages for Class I and Class II luminaire
AC network	230 V single phase	230 V monophasé
Max. load current	5 A	5 A
«Surge protection» feature		
Protection modes	L/N	NA
Max. operating voltage	255 Vac	NA
Nominal discharge current	5 kA	NA
Protection level	1.5 kV	NA
«Permanent/Temporary overvoltage protection» feature		
Operation on temporary / permanent overvoltage	Disconnection if $U_{ac} > 270 V$ Disconnection time : 0.1 sec typical Green indicator = voltage OK/SPD OK Red indicator = overvoltage/disconnection	Disconnection if $U_{ac} > 270 V$ Disconnection if $U_{ac} < 195 V$ Disconnection time : 1 sec typical Green indicator = voltage OK Red indicator = disconnection on overvoltage Yellow indicator = disconnection on undervoltage
Caractéristiques mécaniques		
Dimensions	59 x 40 x 25 mm	90 x 58 x 18 mm
Wiring	in series through 1.5 mm ² wire Spring contact terminal	in series through 1.5 mm ² wire Screw terminal
IP rating	IP20	IP20
Mounting	Fixing lug	DIN rail
		





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