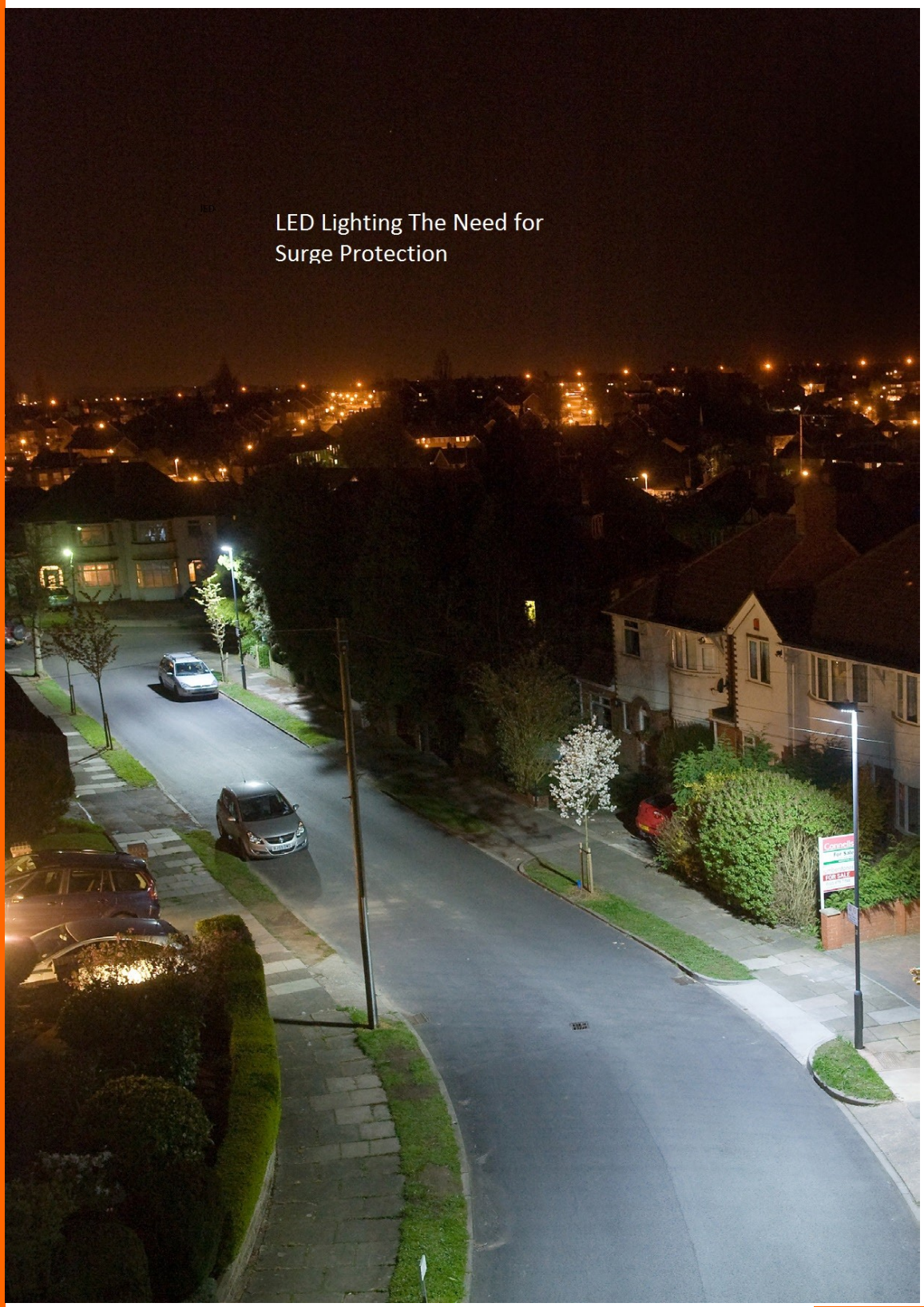

LED Lighting The Need for
Surge Protection

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.

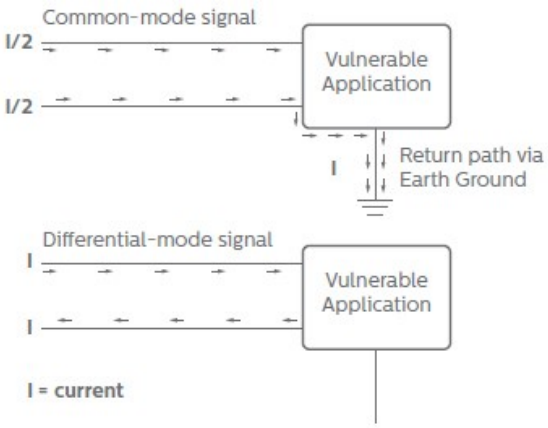


Fig.2 Definition of common and differential-mode currents

Surge overvoltage protection is provided by installing a protective device (surge arrester) on the vulnerable line, and connecting it in parallel or in series.
When connected in series, the protection device acts as a fuse. But when it's connected in parallel, the luminaire continues to function even after the Surge Protection Device (SPD) is damaged. 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.

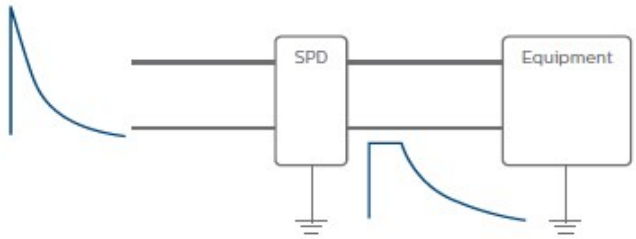


Fig.3 Working principle of a surge protection device (SPD)

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).

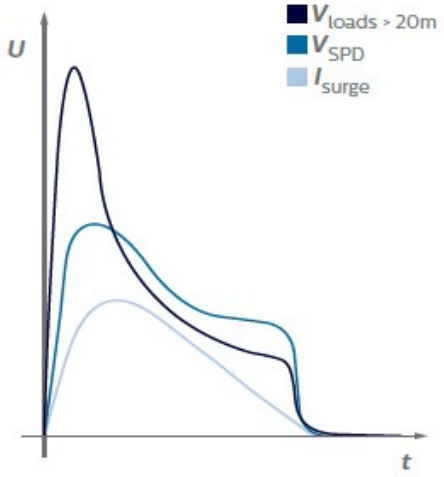
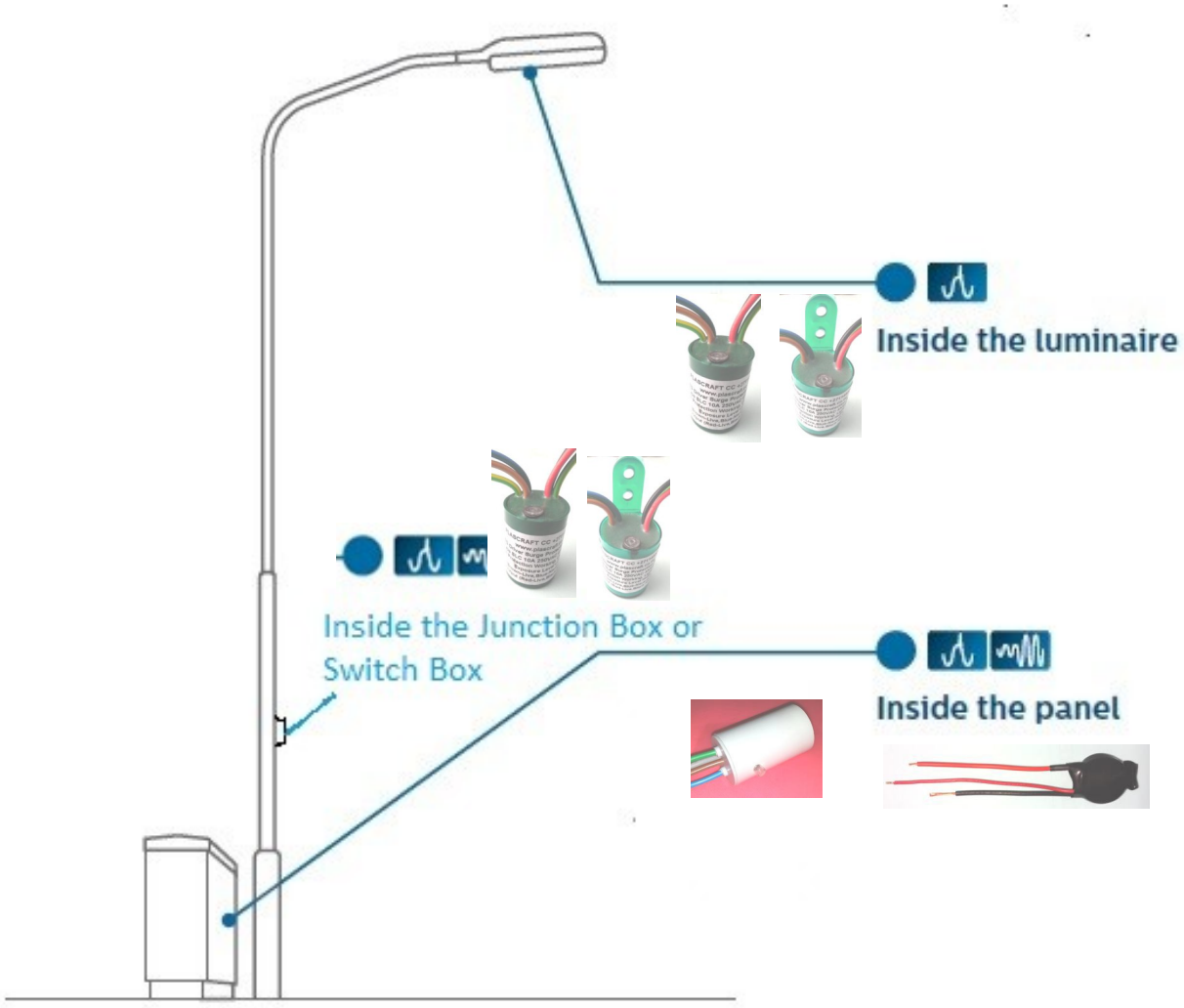


Fig.4 Effect of cable distance on the voltage protection level

Practical approach

Fig.5 Circuit protection solutions for luminaires Switch boxes/Junction Boxes and street-lighting distribution panels.
This may be applied to Warehouse Lighting, Field Lighting, Office Lighting and Residential lighting where there is a Distribution panel , Junction or Switch box and a LED Light or Luminaire



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, in practice many units installed in South Africa do not have the necessary protection built in whilst some of the better units have additional protection up to 10KV

Stage 2: Additional protection of luminaires
When designing installations, the area should be assessed for its vulnerability to lightning strikes. If the vulnerability is high, 10 kV protection is recommended. In these cases, it is recommend to use an SPD, in addition to the standard protection at luminaire level to ensure a higher level of protection (10 kV).

Stage 3: Junction Box or switch Box protection
In the most vulnerable environments, the Plascraft Types are suitable as they protect for surge overvoltages up to max surge current of 25 kA.

Stage 4: Distribution panel board protection
See next section for suitable Types up to 5KA

Practical approach

Selection of Surge Protection Products for each Stage.

Stage 1 : Standard protection at Luminaire or LED Light Level.
If possible establish what protection the LED Driver has and note this. Should this not be possible assume a 2KV to 4KV level .

Stage 2: Additional protection of Luminaire or LED Driver of double reinforced insulation.
First establish whether the Luminaire is with Double re-inforced insulation (previously class II) . Current standards require that an SPD may not be connected to the protective conductor or the metal Luminaire enclosure in the LED Light.
In this case only the path Live to Neutral can be protected.

2 Wire Surge Protection Devices without Thermal Disconnect for Parallel Connection					
Live to Neutral	**Rating**	**Voltage AC**	**Type**	**Stock Code**	**Connection**
2 Wire	6KA	275			
2 Wire	10KA	275			
2 Wire	20KA	275	SAA	45/023	C5
2 Wire	25KA	460	SAA	45/604	C5
2 Wire	30 KA	275	SAA	45/024	C5

Stage 2: Additional protection of Luminaire or LED Driver with 3 wire Live,Neutral,Earth

3 Wire Surge Protection Devices without Thermal Disconnect for Parallel Connection					
Live to Neutral	**Rating**	**Voltage AC**	**Type**	**Stock Code**	**Connection**
3 Wire	6KA	275	SLA	45/032	C3
3 Wire	10KA	275	SLA	45/008	C3
3 Wire	25KA	460	SAD	45/536	C3

3 Wire Surge Protection Devices withThermal Disconnect for Parallel Connection with built in Status Indicator					
Live to Neutral	**Rating**	**Voltage AC**	**Type**	**Stock Code**	**Connection**
3 Wire	6KA	275	SLC	45/035	C3
3 Wire	10KA	275	SLC	45/017	C3
3 Wire	25KA	460	SAB	45/026	C3

Practical approach

Selection of Surge Protection Products for each Stage.

Stage 2: Additional protection of Luminaire or LED Driver with 3 wire Live,Neutral,Earth Continued

3 Wire Surge Protection Devices withThermal Disconnect for Series Connection with built in Status Indicator					
Live to Neutral	**Rating**	**Voltage AC**	**Type**	**Stock Code**	**Connection**
3 Wire	6KA	275	SLC	45/034	C4
3 Wire	10KA	275	SLC	45/016	C4
3 Wire	25KA				

3 Wire Surge Protection Devices withThermal Disconnect for Series Connection with built in switch for remote monitoring					
Live to Neutral	**Rating**	**Voltage AC**	**Type**	**Stock Code**	**Connection**
3 Wire	6KA	275	SLC	45/036	C2
3 Wire	10KA	275	SLC	45/038	C2
3 Wire	25KA				

Stage 3 : Junction Box or Switch Box Protection

All of the protection devices outlined for Stage 2 Protection may be used in Stage 3. Depending on the space available ,the protection level required and Connection requirement items should be selected from Stage 2

Practical approach

Selection of Surge Protection Products for each Stage.

Stage 3 : Junction Box or Switch Box Protection

All of the protection devices outlined for Stage 2 Protection may be used in Stage 3. Depending on the space available ,the protection level required and Connection requirement items should be selected from Stage 2

Stage 4: Distribution Panel Board Protection.

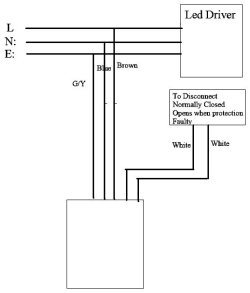
Distribution Panel Board Protection					
	Rating	**Voltage AC**	**Type**	**Stock Code**	**Connection**
2 Wire	25KA	460	SMB	45/604	C5
2 Wire with Thermal Disconnect	25KA	460	SAF	45/New	C5
2 Wire with Status Indicator	25KA	460	SAF	45/New	C5
2 Wire With Load Disconnect	25KA	460	SAF	45/TR	C8
2 Wire	30KA	275	SAA	45/024	C3
3 Wire	25KA	460	SAD	45/536	C3
3 Wire with Status Monitor	25KA	460	SAB	45/026	C3
3 Wire with Load Disconnect	25KA	460	SAB	45/004	C6
3 Phase 4 Wire	3x10KA	460	SAC	45/458	
3 Phase with Thermal disconnect and Status Monitor	25KA	460	SAE	45/025	
3 Phase 5 Wire	7 x 10KA		SAC	45/577	

Connection

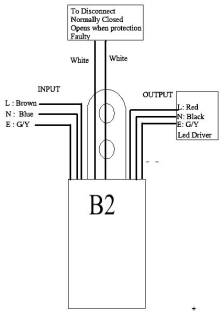
Connection Diagrams

Connection is made as per diagrams

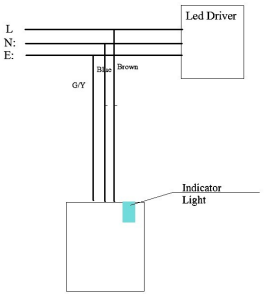
Connection. Fig C1
3 wire parallel with switch
The brown, blue and Green and Yellow wires are to be connected to the mains Live , Neutral and Earth respectively
The 2 Grey or White wires in the centre are isolated from the mains and can be connected as a normally closed switch to control 6 amps for switching or illumination of a fault condition



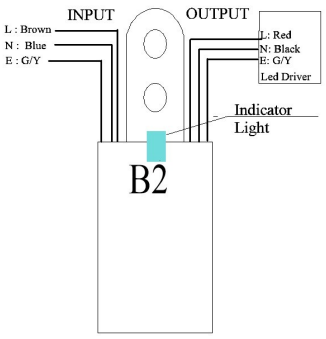
Connection. Fig C2
3 wire series with switch
The brown, blue and Green and Yellow wires are to be connected to the mains Live , Neutral and Earth respectively and the Red , Black and Green and yellow are to be connected to the Led Lights or LED driver Live , Neutral and Earth respectively.
The 2 Grey or White wires in the centre are isolated from the mains and can be connected as a normally closed switch to control 6 amps for switching or illumination of a fault condition



Connection. Fig C3
3 wire parallel
The brown, blue and Green and Yellow wires are to be connected to the mains Live , Neutral and Earth respectively They should be situated where the LED is visible so as to allow replacement as soon as possible



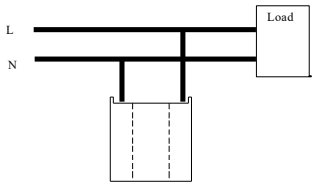
Connection. Fig C4
3 wire series
The brown, blue and Green and Yellow wires are to be connected to the mains Live , Neutral and Earth respectively and the Red , Black and Green and yellow are to be connected to the Led Lights or LED driver Live , Neutral and Earth



Connection

Connection Diagrams

Connection. Fig C5



Connection. Fig C6
3 Wire Parallel with Load Disconnect
Brown Live In , Blue Neutral, G/Y Earth, Grey Live Out

Connection. Fig C7
4 Wire 3 Phase

Connection. Fig C8
2 Wire with Load Disconnect