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Status

Immunity of LED Luminaires to Transient Overvoltages

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Lighting Division

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Peak overvoltages (surges) occur in the power supply system and are caused by different physical effects. IEC 60664-1 assigned the normally expected peak voltages to different supply voltage levels (overvoltage categories). These surges are passed on to light sources via the ballasts. This can affect the peak voltages, depending on the design of the ballasts/luminaires etc. In the past these overvoltages rarely caused any problems in conventional light sources and their power supply units. However, new aspects now need to be taken into account with the advent of LED light sources. Poor designs can lead to flashovers and therefore to damage of LED modules or power supply units.

Suitable LED power supply units and LED modules combined with harmonised luminaire designs can help achieve effective protection from transient overvoltages.

This information document describes ways in which effective transient protection can be obtained. The main focus is on luminaires for indoor use, however the information can also be applied to luminaires designed for outdoor use.

Luminaires are assigned to overvoltage category II. The measures described in this paper (e.g. the implementation of recommended clearances etc.) concern transient overvoltage protection as the basis for ensuring sufficient availability of the lighting device, making it a performance characteristic. Regulations concerning the safety of lighting devices and associated clearances and creepage distances are not affected. These are stipulated by the relevant safety standards.

IEC 61547 (EMC Immunity Requirements) stipulates a surge test to check the immunity of luminaires to transient overvoltages. To ensure that the test is viable, the voltage of the surge generator should be set to 2 kV (peak) on L/N against PE (for details see IEC 61547).

The interactions between luminaire design, power supply unit and LED modules mean that the effectiveness of the selected protective measures can only be ensured by checking the luminaire as a whole. Furthermore, the surge test is only effective if the luminaire is mounted in realistic conditions during the test.

Effective testing of luminaire immunity to transient overvoltages

The surge test described in IEC 61547 only constitutes an effective test of luminaire and LED module immunity if the following points concerning LEDs are observed:

- All parts of the luminaire which could be connected at the place of use, either deliberately or inadvertently, with earth potential must be connected securely to the PE (surge generator earth) during the surge test.
- Examples of inadvertent connection or capacitive coupling with earth potential when fitting the luminaire include the mounting of an electrically conductive luminaire housing to a brick wall or metal wall or ceiling constructions.
- The necessity for additional earthing (for the surge test) of luminaire parts applies in particular to protection class II and III luminaires.
- The test should be conducted with a surge voltage of 2 kV (peak) on L/N against PE.

Only if these points are observed will the LED module be exposed during the surge test to a similarly high stress level to that of a poorly fitted luminaire.

Measures for improving luminaire immunity

The following actions are designed to protect luminaires from transient overvoltages. These are based on three different circumstances:

1. Use of power supply units with no details of transient overvoltages at the LED output

Two cases are distinguished between:

a) LED power supply units without galvanic insulation between output and input voltage:

- In this case the output voltage on the LED module is galvanically connected to the mains voltage.
- The relevant clearance and creepage distances as stipulated in IEC 60598 should be adhered to (e.g. basic insulation against PE potential).
- Depending on the switching, mains transients could be amplified in the power supply unit. In order to ensure sufficient immunity against these transients, too, clearances and creepage distances of ≥ 2.5 mm to the PE potential should be observed on the output of the LED power supply unit and on the LED module (conductive earthed parts, e.g. PE, heat sink, housing).

b) LED power supply units with galvanic insulation between output and input voltage (e.g. SELV):

- In this case the output voltage on the LED module is galvanically insulated from the mains voltage.
- The energy of a transient can only be transmitted capacitively across the galvanic barrier (transformer) on the output of the LED power supply unit and on the LED module. The amount of energy transmitted to the LED module is low.

- In SELV class (safety extra-low voltage) LED systems, small clearances and creepage distances and thin insulation foils are sufficient to fulfil the system safety requirements.
- The small distances to PE potential (< 2.5 mm) can cause flashover to the earth potential. In adverse setups (e.g. LED module with sensitive LED switching and/or LED power supply unit with high surge transmission factor) this can lead to damage of the LED module and/or the LED power supply unit.
- In order to recognise and avoid adverse luminaire setups, the immunity should be documented using the surge tests specifically designed for LEDs described above during the development of a luminaire.

2. Use of power supply units with details of transient voltage at the LED output

The luminaire producer can use the information about possible transient overvoltage on the output of ballasts to select or qualify suitable LED modules.

Transient voltage[1)] on LED output of power supply unit	**Required insulation of LED module to PE**
> 3500 Vp to 4000 Vp	Basic insulation, clearance ≥ 3.0 mm
> 2000 Vp to 3500 Vp	Basic insulation, clearance ≥ 2.5 mm
> 1000 Vp to 2000 Vp	basic insulation
> 500 Vp to 1000 Vp	a. for LED modules with no details: basic insulation b. suitable for LED modules up to max. 1000 Vp: no action required
≤ 500 Vp	No action necessary
[1)] Details provided by power supply unit manufacturer	

Recommended insulation action related to transient voltage on LED output

Contact:
Wolfram Pajek

ZVEI - German Electrical and Electronic Manufacturers´ Association
Lighting Division
Lyoner Strasse 9
60528 Frankfurt am Main, Germany
Telephone +49 69 6302-349
Fax: +49 69 6302-400
www.zvei.org