XVI International Conference on
ELECTROMAGNETIC DISTURBANCES EMD 2006

27-29 September 2006 Kaunas, Lithuania

# LED INDICATOR OVERVOLTAGE PROTECTION

Jaroslaw M. WIATER
Białystok Technical University, Poland

***Summary***: LED lamps are very often used instead traditional light sources. This paper will present simple LED indicator overvoltage protection (OVP). Of course there many solution of LED OVP but they all focus on LED maximal current not on the real overvoltage during switching or lightning conditions.

***Keywords***: LED, overvoltage protection, OVP, lightning, switching transient.

## 1. Introduction

LED (Light Emitting Diodes) as a light source are very often used nowadays. Although advances made in LED technology in the past few years have dramatically broadened the applications for these little light sources. LED use a fraction of the power (80% - 90%) required by conventional filament bulbs.
Solid-state design allows LED to withstand shock, vibration, frequent switching and mechanical shocks extremes without compromising their life - typically 100,000 hours.
Typical LED have 3 major parameters that determines their life span:

- DC forward current,
- transient forward current (10μs pulse),
- reverse voltage [1].

DC forward current is crucial for steady work. In typical LED upper limit is 20mA. For different manufacturers it may be even 30mA. DC forward current rise above the limit will damage LED.
Electronic industries are using special DC-DC converters to control LED but they are used in high integrated electronic devices. Typical LED application uses resistor as the current limiting devices – fig. 1a. Many LED application are supplied from electric network and they are exposed for lightning or switching transients.
In this paper will consider typical LED indicator. It is common used in fuse board.

## 2. Typical LED driver application

There is many different electronic devices for precise LED parameters control. As the example is used LM3557 manufactured by National Semiconductor Corporation [2].

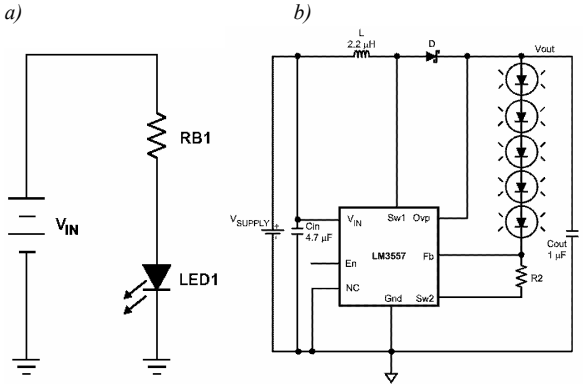


**Fig. 1.** LED current control: a) voltage source with ballast resistor [3], b) LM3557 application diagram [2].

The LM3557 is a complete solution for white LED drive applications. With minimal external component count, no DC current leakage paths to ground, cycle-by-cycle current limit protection (constant current mode), input undervoltage protection and output overvoltage protection circuitry (OVP) – fig. 1b.
Operating a power supply in a constant current mode requires overvoltage protection. Constant output current makes larger output voltage when the load resistance increases. If the load is disconnected or resistance in high the output voltage can increase above the voltage rating of the IC or other discrete circuit components. In all IC OVP controls only DC-DC converter during burst operation but don't work during external overvoltages. In both cases LED will work prefect until lightning or switching transient appears.

## 3. Common LED indicator protection

Presented on figure 2 LED indicator is often used in fuse boards to show voltage present. It is characterized

by very low power consumption with respect to bulb one. Also it has got long life span. Figure 2 shows photo of real one. It consists of four red ultra bright LED's.

**Fig. 2.** Common LED indicator photo.

They are supply directly from AC electric network. It isn't protected against overvoltage from supply line. During normal exploitation there isn't any problem with indicator. Presented unit was installed in high voltage lab. During first cycle of normal surge generator work LED indicator was damaged. The lightning overvoltages were produced by the high-voltage surge generator (SG) – type UCS 500M6B. The SG covers transient and power fail requirement according to international standards with voltage capability of up to 1,2/50µs 6,6kV. Two different configurations were examined. First investigation shows that diode D1 and D2 was shorted. In this case LED lamp it self wasn't damaged. To prevent future dysfunction fee elements were added: metal oxide varistor (ZnO1) and L1 – fig. 3.

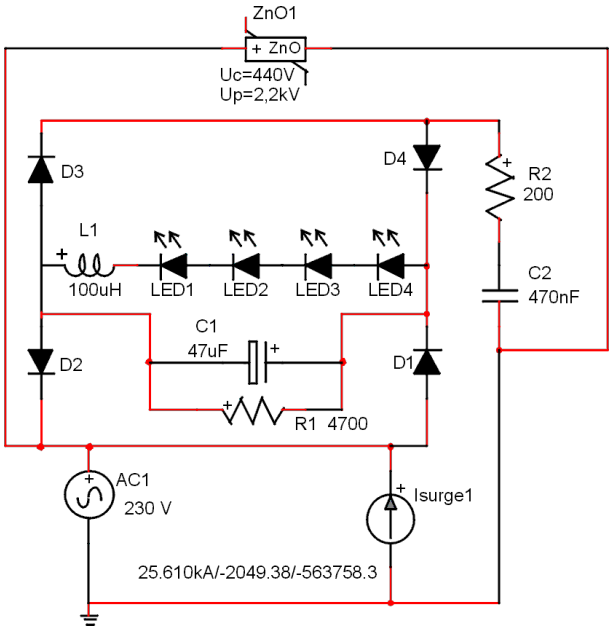


**Fig. 3.** Common LED indicator diagram with lightning and switching overvoltage protection.

During LED indicator tests with fast changing rectangular impulse were observed large di/dt. Fast current change can provide to overflow LED limits [1] – fig. 4. It is necessary to minimalize it by L1 element. Application results are shown of figure 5.

## 4. Conclusions

For many applications LED lamps substitute bulbs. There is tens of millions switches, indicators, control panels, signs, annunciators, displays, decor lights and dozens of other applications where LED technology is used.

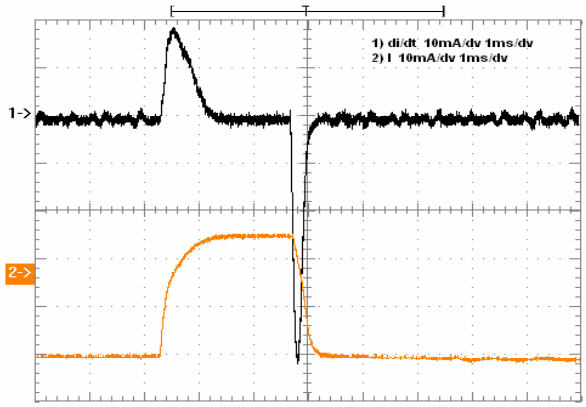


**Fig. 4.** Common LED indicator di/dt (1st line) and voltage waveform (2nd one).

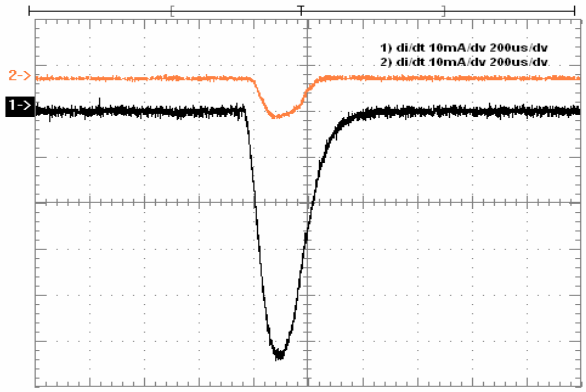


**Fig. 5.** Common LED indicator di/dt waveform without (1st line) and with overcurrent protection (2nd one).

With growing LED lamps number lighting or switching overvoltage risk is higher then before. It is necessary to protect it. This paper shows way how to protect simple often used LED application.

## 5. References


1. T-13/4 Super Ultra-Bright LED Lamps Technical Data, Agilent Technologies, Inc., http://downloads.solarbotics.com/PDF/UBLED_HLMP-C%20LEDs.pdf
2. "LM3557 - Step-Up Converter for White LED Applications". National Semiconductor, www.national.com
3. Day M.: "LED driver considerations". Texas Instruments http://focus.ti.com/lit/an/slyt084/slyt084.pdf