Keep LED Strings Lit Using Open LED Protection Technology

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Introduction

The light-emitting diode (LED) lighting market is growing quickly, thanks in part to aggressive global government mandates. LEDs are now being used in many different ways, including critical lighting applications such as traffic signals and airport runway lighting.

The global market for LEDs is projected to grow from $205 million in 2006 to $985 million in 2011, according to Mountain View-based market research group Strategies Unlimited. The overall lighting market worldwide is about $100 billion – of which the LED lighting segment is expected to increase from $4 billion in 2005 to $12 billion in 2010.

Prices for LEDs are already dropping. LEDs are 10 percent to 15 percent less expensive in 2007 as compared to the previous year, and Phillips LED Lighting Division projects that the price of LEDs will continue to decline by at least 10 percent a year. Inexpensive LEDs will accelerate the transition to LED lighting.

Even with less expensive LEDs, lighting manufacturers must be concerned with quality and reliability. One of the problems for the design engineer is that LEDs are susceptible to damage by transients and surges. This is especially true in outdoor applications. But new technologies have emerged that protect LEDs. For instance, new protection devices can prevent an entire string of LEDs from going out if a single LED fails. Such devices help LED lighting applications where reliability is critical to safety, and where low-maintenance is essential. Such “open LED” protection is a new technology that many engineers don’t yet know about.

Open LED protection technology

LEDs are fragile solid-state devices. An LED is essentially a diode, structured as a P-N junction that emits light when forward biased. One of the major causes of an electrical open in an LED is thermo-mechanical stress on the wire bonds. Another cause of LED open circuits are electrostatic discharge (ESD) events or surges induced by nearby lightning events.

Open LED protection is designed as an electronic shunt which provides a current bypass in the case of an open circuit caused by a single LED failure. It is an internally triggered two terminal device which automatically resets if the LED heals itself or is replaced. This protector is a voltage-triggered switch with low leakage on the order of microamps that becomes a low-impedance switch when it is triggered on, which minimizes power consumption. Once an LED fails open, there is sufficient circuit voltage to trigger the protector to the on-state when it is placed in parallel with the LED. This protector also features built-in surge immunity which helps protect the LED from surges induced by nearby lightning strikes or ESD events.

Because LEDs are susceptible to failure due to surges and other transient conditions, these failures can result in the loss of LED lighting strings in critical applications. And as LED lighting becomes more popular, there will be applications where high reliability and quality of the lighting must be maintained. Open LED protection devices can help LED lighting manufactures provide designs and products that are reliable for their customers requiring a higher level of quality.

Applying Open LED protection

Open LED protection is simple to employ into any design. Typically, a protection device is placed in parallel with each LED in a string. A single LED failing by opening in a string of LEDs can cause a partial or full loss of the entire string. Open LED protection provides a shunt current bypass around the open LED, thus saving the LED string from partial or complete failure.

Sometimes, two LEDs in parallel can be protected with one protection device, as a way to lower costs if needed. An LED in the on-state drops approximately 0.7V, which is not sufficient to turn on the protector device. With wide operating temperature ranges, from -40 to +150C, open LED protection can be used in extreme environments often with minimal derating. Another important feature is that such devices are compatible with LED switching speeds up to 10kHz, which eliminates accidental turn on in some high-frequency circuits.

Conclusion

Lighting manufacturers are switching to LEDs because of their low cost, high performance, minimum maintenance, and the fact that they can theoretically last forever. There are various new applications where they are being increasingly used in harsh environments, outdoors, in lighting situations, etc. This is different from their traditional use in test benches and as indicator lights. As beneficial as open LED protection may be, it is still only one part of a total protection solution which may include MOVs and other diode devices.

Graphics and Captions

Fig 1 – The circuit schematic shows a typical LED circuit with open LED protection. Open LED protection devices usually have low on-state voltage, typically 1.5V, and a low off-state current. Such devices are compatible with one-, two-, or three-watt LEDs that have a nominal 350mA, 3V forward voltage characteristic, but can support LED applications up to 1000mA.

Fig 2 – Key parameters for the PLED are V_{BR}, I_S, I_H, I_T, and V_T, as shown in the V-I curve. V_{BR} is the region from off-state voltage to breakdown voltage rating of the device. In the off-state, Vbr is the continuous peak combination of AC and DC voltage that may be applied to the device with less than 5 µA conducted through the device. I_S is the value of current that causes the device to switch from the off-state to the on-state when a minimum V_{BR} is applied. Holding current (I_H) is the minimum current required to maintain the device in the on state. On-state voltage (V_T) is the maximum voltage across the device during full conduction. I_T is the maximum rated current the can be conducted through the device during the on-state for two seconds.

Fig 3 – Open LED protection devices, like the PLED 6 Series from Littelfuse, provide a switching electronic shunt path when a single LED in an LED array fails as an open circuit, ensuring that the entire array of LEDs will continue to function. A single PLED6 device can protect three individual LEDs.