LED operation guidelines for LZ LED products

A. Introduction

The new LedEngin LZ LED products are extremely energy efficient with a low forward voltage for a given driving current. However, when switching power supplies are used to drive LZ LED series, care should be taken since the switching power supplies are first turned on, they can produce high initial inrush current with a fast rise time. The peak inrush current can be several orders of magnitude greater than the circuit's steady state current. This power surge can seriously damage the LEDs in operation. Further, the output voltage rating of the LED driver needs to be taken under consideration to avoid damage to LEDs as well. The following is a brief overview of basic electrical properties followed with data from experiments based on GE thermistor CL120 and 160A used as a reference design which may not be suitable for some practical applications due to a variety of constraints from the system package design aspect or operating conditions.

B. The basic electrical modeling

A LED is equivalently an ideal diode together with associated resistance and parasitic capacitance, which can be shown in Figure 1.0

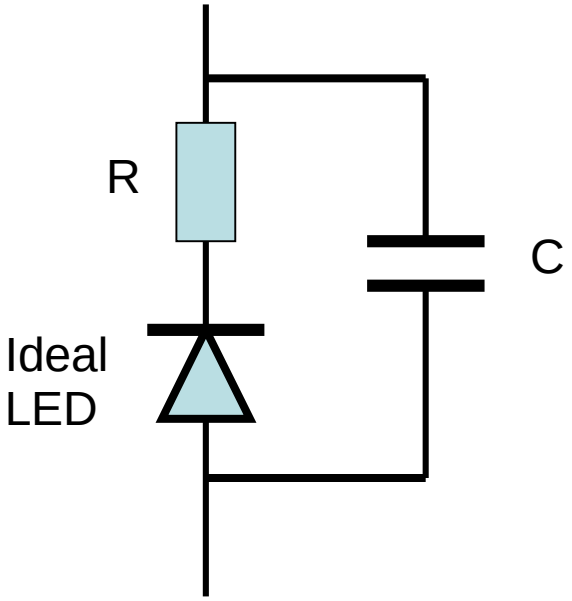


Figure 1.0: Electrical Model for a LED

The associated resistance R includes the connecting wire resistance, the metal contact resistance, the buffer layer and substrate layer resistance, etc. The associated capacitance C includes all the effects caused by the internal charge storage mechanisms.

The new LZ series LED from LedEngin is optimized to have the resistance R minimized, which increases the energy conversion efficiency and the output lm/W. As a result, the LED is very sensitive to outside driver voltage variation and special care should be taken.

The I-V characteristics of a typical LZ series LED is shown in Figure 2.0

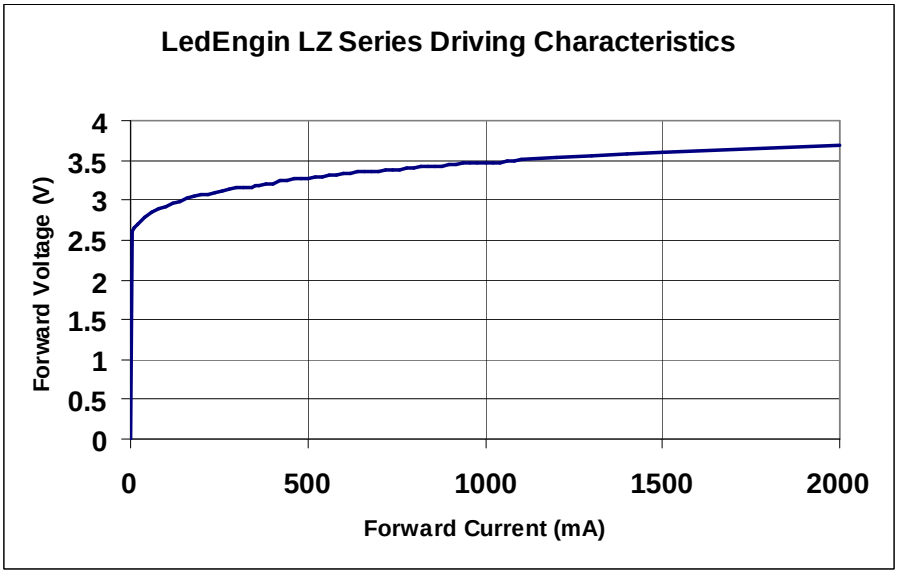


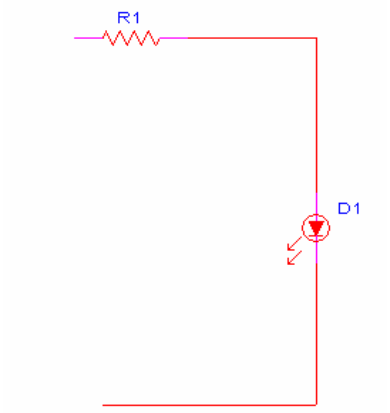
Figure 2.0: Driving characteristics of LedEngin LZ Series LEDs

The differential resistance of the LED, defined as dV/dI, is 0.75Ω at 350mA, and 0.40 Ω at 700mA. This means when driving at 700mA, any slight changes in driver voltage overshoot will cause a big current spike on the LED. For example, a mere 0.3V overshoot in voltage will cause the current to increase from 700mA to 1900mA, which can affect the LED's lifetime or even kill the LED instantly.

C. LED driver design guidelines

To insure proper operation of the LZ series LED, the following notes should be taken when a switching power supply is used to power the LED (s) on,

1. It is important to have the driver carefully designed to avoid this voltage/current overshoot issues.
2. When turn the LED on with a power supply in the lab environment, start with a small limiting voltage and increase it gradually to full operation status to avoid the overshoot caused by sudden changes.
3. Make sure that the driving circuits is securely connected since intermittent open can cause LED failures.
4. Employ an inrush current thermistor. It is one of the common design options used in switching power supplies to prevent component damage caused by inrush current surges. A thermistor is a thermally-sensitive resistor with a resistance that changes significantly and predictably as a result of temperature changes. The resistance of a surge limiting thermistor decreases as its temperature increases. It should be connected in series between a power supply and an anode of the LED as shown in figure 3.0 below.



Where R1 is an inrush current thermistor.

Figure 3.0: Inrush current thermistor in series with a LED

D. Experiment results

An experiment was performed with a Protek DC power supply, model number 3006B, switch S1 to simulate the intermittently open and close of the circuit and the LED under test with and without an inrush current thermistor. The setups were shown in figure 4.0 and 5.0

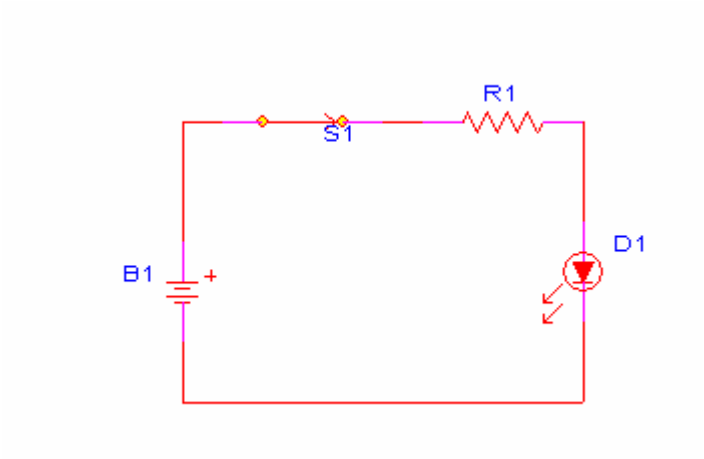


Figure 4.0: LED under test with an inrush current thermistor (R1) connected in series.

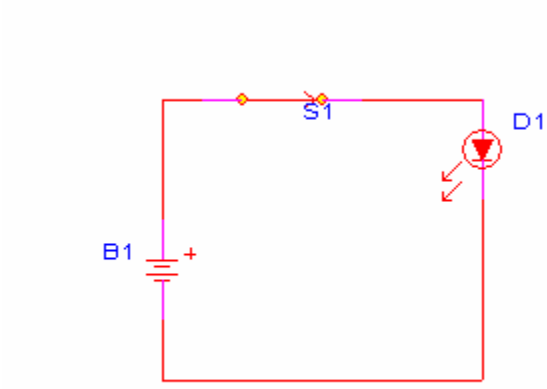


Figure 5.0: LED under test without an inrush current thermistor

Following is a test summary of the experiments.

LED type / Test condition	1W LED @If = 350 mA	3W LED @If = 700 mA	5W LED @If = 1050 mA	10W LED @If =700 mA	15W LED @If = 1050 mA
Voltage level induced failure due to inrush current without employing a thermistor as shown in figure 5.0	~9V	~9V	~9V	~35V	~35V
Voltage level induced failure due to inrush current when thermistor CL120 is used as shown in figure 4.0	45V	35V	30V	55V	40V
Voltage level induced failure due to inrush current when thermistor CL160A is used as shown in figure 4.0	45V	40V	30V	55V	45V

Based on the experiment, the inrush-current thermistor, such as, CL120, CL160A, or other similar thermistors could be used to prevent the damage to the LED due to inrush current. Below are a summary of thermistors suggested for different LEDs as shown in table 1.0 and resistance versus current graphs of CL120 and CL160A as shown in figure 6.0 for reference.

LED type / Thermistor	1W LED	3W LED	5W LED	10W LED	15W LED
Themistor type from GE	CL120 or CL160A	CL160A	CL160A	CL120 or CL160A	CL160A

Table 1.0 : Recommended thermistors for LEDs

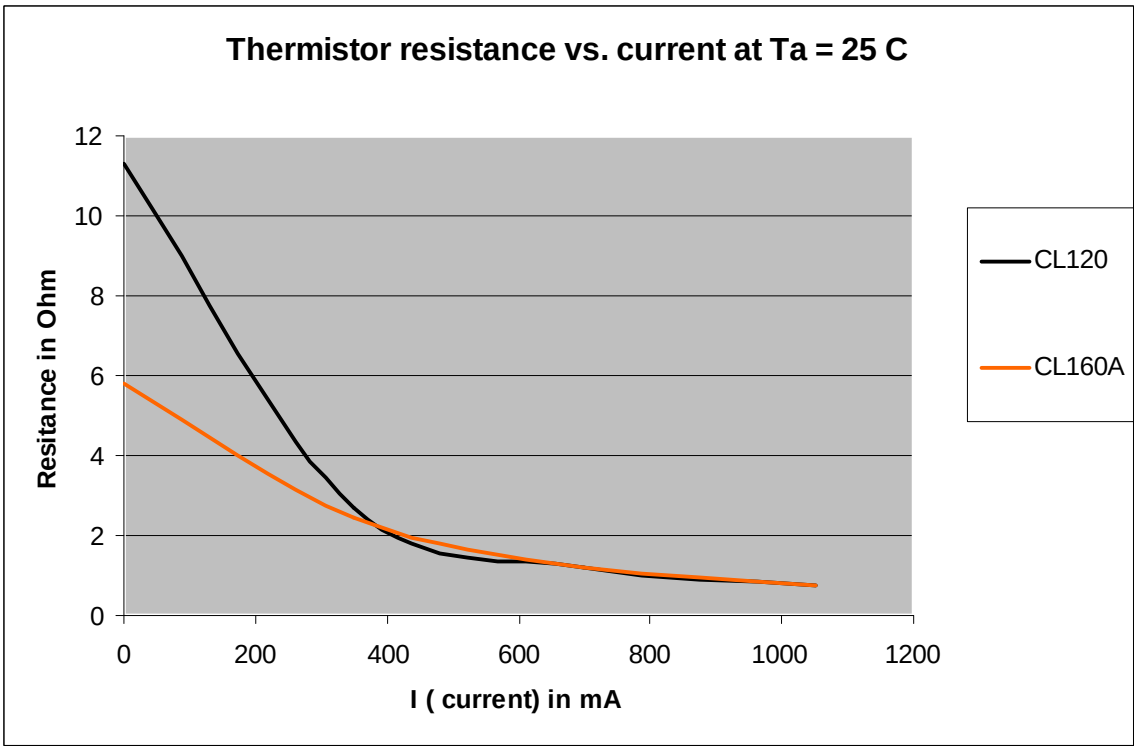


Figure 6.0: Resistance vs. current of the CL120 and CL160A (typ.)

E Summary

With the LZ Series LED optimized in output luminous intensity and driving voltage, it is more sensitive to driver variations, especially any overshoot during device turn-on. Care should be taken to address this issue by either careful design of the driver or by including an inrush current thermistor similar to the ones as mentioned above, and all circuits should be secured to avoid intermittent open and close.

More info for the thermistors can be found at the following websites:

http://www.gesensing.com
http://www.thermistors.com/welcome.html

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ABOUT US

LedEngin, Inc. develops, manufactures, and sells ultra-small, ultra-bright, ultra-cool LED components and light source modules for general lighting, display, automotive, and medical/dental applications. LedEngin deploys extensive light source design capabilities and works closely with customers to develop customer-specific solid-state lighting solutions. The company operates facility in Santa Clara, CA in USA. For further information visit www.ledengin.com.