How to safely power LEDs

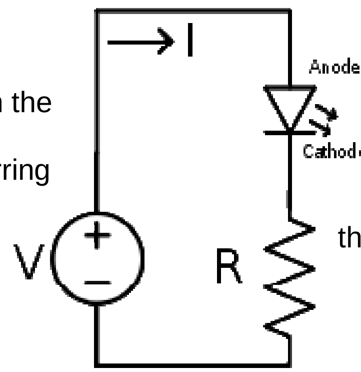
By Mel Berman, TDK-Lambda Americas

For well over 25 years, LEDs (Light Emitting Diodes) have been used in TV remote controls. These specific LEDs emit invisible light pulses in the infrared (IR) light spectrum. Because the LED can be turned on and off very rapidly, it easily transmits pulses of binary-coded messages to the receiver built into the TV.

In addition, early applications of LEDs included red-segment clocks, calculators and even digital watches that have now been replaced by more modern display technologies, such as LCDs (Liquid Crystal Displays).

Today, white or multi-colored LEDs are rapidly being employed in modern home/street lighting, signage, traffic signals, large screen displays and backlit LCD monitors, etc. In these applications, multiple LEDs are placed in either clusters or connected as strings to provide the required light intensity or light distribution.

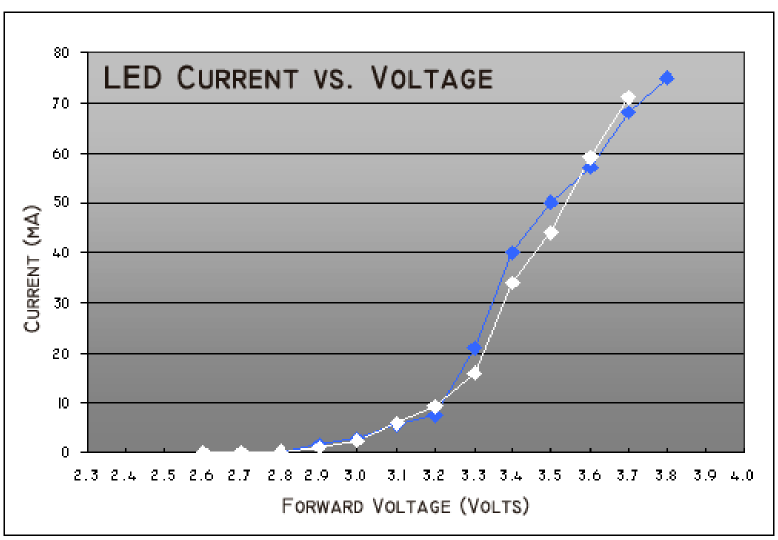
LEDs are similar to conventional diodes in that they are designed to conduct current in one direction and when doing so, in most cases, they emit visible light. A basic LED circuit consists of a voltage source, a current limiting resistor and the LED as shown below.



The current limiting resistor (R) is required to maintain the current flowing through the LED at a safe operating level. When conducting current LEDs have an inherent “voltage drop” that can vary from 1.2V to 4.0V, depending upon the model. Referring the circuit diagram, if the LED has a voltage drop of say 2V (Vd) with a safe operating current of 20mA (I), and the voltage source (Vs) is 5VDC, the value of the current limiting resistor can be calculated as follows:

R = (Vs –Vd) ÷ I, therefore, R = (5V – 2V) ÷ 0.02A = 150 ohms

The voltage drop across an LED and its light output will vary with the current flowing through it. Below are curves that show the forward voltage drop (Vd) versus the current (I) flowing through two sample LEDs.



In viewing the white curve above, it’s important to notice that the forward voltage drop across the LED between 3.2V and 3.6V (a 0.4V change), results in a current increase of over five times (from 10mA to 60mA). In this example, if the maximum allowable LED current is 40mA and if 60mA or more current is allowed to flow through it, the LED could be destroyed or its operational life substantially reduced.

As current flows through an LED its forward voltage drop times the current results in wasted power (e.g., 3.3V x 40mA = 132mW). This wasted power, in the form of heat, becomes a real problem when high brightness LEDs is employed in lighting applications. The internal LED heat must be dissipated by either its design, the substrate it's mounted on, or via added heat sinks. As the internal junction of an LED gets warmer, the current through it at a given voltage increases. If not controlled, this can result in thermal runaway, where the LED self-destructs.

The main point here is that LEDs are "current driven" devices and that this current must be carefully controlled. In the circuit above, the resistor is used to control the current though the LED. However, the resistor also causes a voltage drop which contributes further to wasted power. As a result "constant-current" LED drivers have been developed that maintain the current flowing through the LED (or strings/clusters of multiple LEDs) at a safe level with improved efficiency.

For more information about selecting power supplies and drivers for LEDs, see the article at this web link:
http://power-topics.blogspot.com/search/label/LED%20lights

References:

http://en.wikipedia.org/wiki/LED_circuit
http://led.linear1.org/why-do-i-need-a-resistor-with-an-led/
http://us.tdk-lambda.com/lp/products/ledsigns.htm