The Importance of LED Thermal Management

Everywhere you go, LEDs are touted as the practical solution to a world going 'green.' They are an efficient, reliable and cool-to-the-touch lighting solution. It is correct to say that high power LEDs are efficient, however they do still produce heat as a byproduct, and how to contain that heat is the challenge that faces design engineers today.

A standard LED is roughly 10 microns square, runs on 30mA maximum and outputs anywhere from 1mcd to 1000 mcd depending on construction and packaging. These are very unassuming numbers because, as many designers will explain, heat dissipation is a priority. The junction temperature of a standard LED should not exceed 85°-100°C, depending upon the design's construction. Incorporating these standard LEDs into a design is relatively simple because the small size and low power consumption generates little heat. Therefore one needs only to design around the environment, not the specific LED.

The challenge that has arisen stems from the new, high-power LEDs that have emerged into the marketplace. A high-power LED can draw 1 watt of power or greater and output more than 80 lumens. That's a 90% increase in power consumption (98% for a 5-watt LED). Therefore the amount of heat generated becomes significant. A typical 1-watt LED will have a maximum junction temperature (a point of failure or reduced life) of 125°C. However, left to its own devices a 1-watt LED can increase the temperature in its immediate environment by 55°C or more. Heat management is now a critical consideration to the overall product functionality, performance and, possibly, safety.

Through experienced LED manufacturers such as Lumex, there are tools available to combat this new nemesis and take advantage of the efficiency offered though high-power LEDs. The first tool is the thermal resistance of the package from the junction to the leads. This is typically given in °C per watt. A fairly efficient design may have 10°C per watt. This means that the leads to the device will be 10°C cooler than the junction itself. The goal is to route the heat away from the junction to the heat dissipater (generally a metal heatsink block). PCB boards can also be developed to have a metal core and thus a low thermal resistance. Thermal pastes can help reduce the resistance from contact to PCB and PCB to heat sink. The heat sinks dissipate heat with surface-area contact to air. In essence, the more heat the LED generates, the larger heat sink a designer will need.

High power LEDs are fast becoming the preferred lighting solution of the future. Knowing how to handle the heat puts you ahead of the curve.