Characterizing the Thermal Resistance Coefficient of LEDs

The performance of LED lighting—including light output, color and life—is affected by heat. The amount of heat at the *p-n* junction of an LED (where light is created) can vary, depending on the application. An LED-based MR16 lamp used in a well-ventilated space, for example, will have less heat than the same lamp installed in an insulated luminaire such as a recessed can.

Accurately measuring LED junction temperature (Tj) is crucial to predicting LED performance. However, it is difficult to measure LEDs that are packaged into a system, such as an MR16 or PAR lamp, without taking the system apart. Instead, researchers use indirect measurement methods.

The most common indirect method requires knowledge of the LED's thermal resistance coefficient, a measure of how much resistance the heat flow will encounter between the junction and the electronics board, where the LED is attached.

The accuracy of the Tj estimate depends on the value of the thermal resistance coefficient. Most LED manufacturers characterize a product's thermal resistance for only one drive current, ambient temperature, and junction temperature. However, these parameters may change when LEDs are packaged into a system, which in turn may change the thermal resistance coefficient.

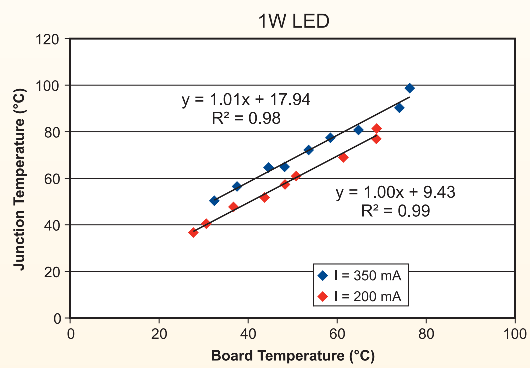
Experiment

The LRC conducted an experiment to understand the dependence of the LED thermal resistance coefficient on changes in power, ambient temperature, heat sink size, and orientation for high-power 1 W and 3 W LEDs. Board temperature (Tb) was also measured and analyzed.

Results

- Thermal resistance increases when the power or the ambient temperature increases.
- Thermal resistance decreases when the size of the heat sink increases.
- The orientation of the LED attached to the heat sink affects the LED's heat dissipation. As a consequence, the thermal resistance changes.

This study also showed a linear correlation between Tj and Tb of an LED attached to a heat sink and operated at constant power. This linear relationship can be used to estimate the junction temperature for any board temperature.



An analysis of LED junction temperature and LED board temperature showed a linear relationship between the two.

Future Work

The next step is to find a relationship between the outer surface temperature of an LED lamp and the LED junction temperature. This would provide an easy, indirect method of estimating the performance of a complete LED system.

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