TECH NOTE

LRS-9550 Device Temperature Algorithm

PURPOSE

This technical note describes the algorithm used to calculate device temperature in the LRS-9550 High Power Laser Diode Test System.

BACKGROUND

The LRS-9550 system houses up to 32 removable laser diode fixtures. Depending on the package style and current requirements a fixture can hold between 2 and 16 devices. Devices are mounted to the fixture base plate, which is composed of nickel-plated aluminum.

The fixture temperature is controlled by thermoelectric coolers (TECs) located in the shelf under each fixture location. Every fixture has four AD590 temperature sensors. The TECs heat or cool the entire fixture so that the average of the high and low AD590 temperatures on the fixture equals the temperature set point as entered by the user. There are four resistive trim heaters, one per AD590, which can apply a small amount of heat to the cooler zones to improve temperature uniformity across the fixture.

Depending on the number of devices on the fixture, one temperature sensor may report on a zone that contains up to four devices. Due to the localized nature of device heat loads, a temperature gradient exists across the fixture, with the highest temperatures usually occurring directly under the devices. Each device in a zone may have a different heat output at a given current, and therefore a slightly different temperature. It is advantageous to know the temperature of the fixture base as close to each individual device as possible. In order to achieve this, an algorithm is utilized to estimate the temperature at each device location.

THEORY AND IMPLEMENTATION

Figure 1 displays a top view of an eight device fixture including the locations of devices and temperature sensors. Figure 2 shows a thermal resistance network representative of one fixture zone.

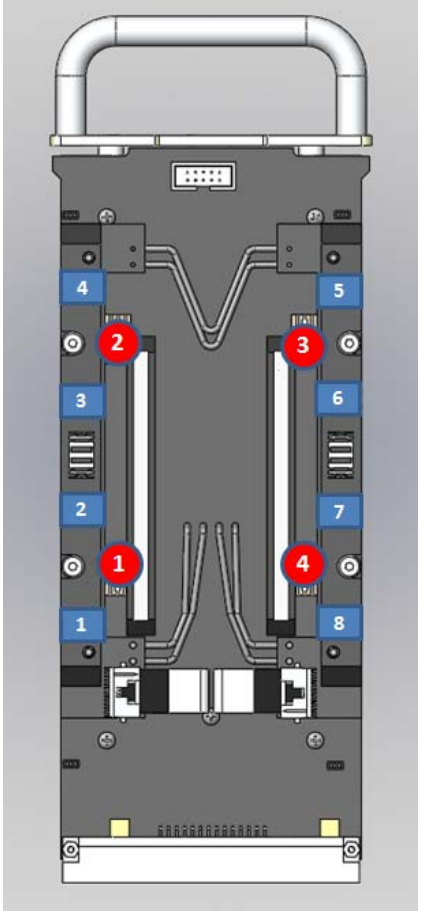

Figure 1: An eight device fixture for COC devices, showing device locations (blue) and temperature sensor locations (red).

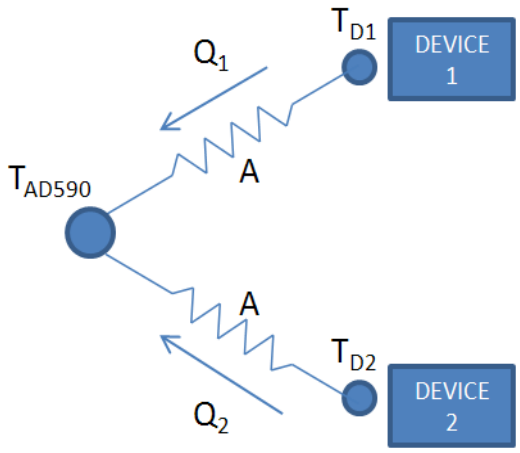

Figure 2: The thermal resistance network for multiple devices and a single temperature sensor.

In Figure 2, "Q" is the device waste heat and "A" represents the local thermal resistance. The thermal resistance network illustrates the fact that if one device is operating at a higher voltage, and thus producing more heat, the temperature at that device location will be higher. Although the temperature at one device location is affected by the waste heat from both active devices, the impact of Q_2 on the estimation of T_{D1} is relatively small and neglected for simplicity.

The thermal resistance value, known as the "A term", is a function of the geometry and material of the fixture base. Each type of fixture design has a slightly different A term which is derived empirically during the design process. The fixtures are arranged so that devices are symmetrical around a temperature sensor so the value of A remains similar for every device.

The temperature of each device is calculated as follows:

$$T_d = T_{AD590} + V*I*(1-E)*A$$

T_d = Device temperature (as reported by the system)
T_{AD590} = Temperature of the AD590 sensor
V = Voltage drop across the device
I = Device set-point drive current
E = Expected optical conversion efficiency (user defined device attribute)
A = Thermal resistance between the device and the AD590 sensor

Device temperature, T_d, is defined as the temperature of the fixture base immediately adjacent to the device location. Many fixtures have small thermistor wells at these locations to allow external verification. This is the temperature that is reported to the user by the ReliaTest software.

SUMMARY

LRS-9550 fixtures hold multiple laser diode devices on a single temperature controlled base plate. Individual device temperatures vary depending on the heat output of the device. The LRS-9550 system uses an algorithm to predict the fixture temperature at each device location. The reported device temperature is based on the heat output of the device, the temperature of the nearest AD590 sensor, and the thermal resistance between the device and the AD590.