Testing the Thermal Interface Power of Zhaga Book 3 Modules Correctly

Jan de Graaf from Philips Lighting, Uli Mathis from Tridonic and Evans Thompson from Cooper Lighting demonstrate a correct setup and procedure to measure Zhaga compliant modules properly.

To enable interchangeability of LED light engines, the Zhaga consortium has specifications for LED light engines covering several interfaces: mechanical, photometric, thermal, electrical and control. For different general lighting applications the requirements with respect to these interfaces are defined in different Zhaga books. In addition to these specifications, Book 1 has been written containing specifications that are common in multiple Zhaga interface specifications such as:

- Common definitions and conventions
- General system aspects and general aspects of the mechanical, photometric, electrical, thermal and control interface
- The mechanical interface of separated electronic control gear
- Common test procedures
- One of the key common thermal tests in Zhaga is the determination of the thermal power at the thermal interface surface of the LED light engine-luminaire system. In this article we explain the use and the application of this thermal test procedure

Thermal Power Affects the Heatsink Size

A key part in the LED light engine–luminaire system is the heatsink that is needed to dissipate the heat generated in the LED light engine to the ambient. The required size and thus cost of this heatsink depends on the maximum temperature that the LED light engine can tolerate and the thermal power that needs to be dissipated from the LED light engine through the heatsink to the ambient.

Thermal power that is dissipated through the heatsink, $P_{th,\ rear}$

The electrical power consumed by the LED light engines is transformed into light (P_{vis}) and heat, i.e. thermal power P_{th} (Figure 1). This thermal power needs to be dissipated to the ambient. Part of this power is dissipated to the front of the LED light engine by convection and radiation ($P_{th,front}$). The main part of this thermal power is dissipated through the rear of the LED light engine through the heat sink of the luminaire as $P_{th,rear}$ (Figure 2).

For the thermal design of the heatsink the $P_{th,rear}$ needs to be known. Using P_{th} instead would lead to an overdesign of heat sinks in terms of volume and cost.

The Test equipment for measuring $P_{th,\ rear}$

Zhaga specifies equipment and a measuring method for measuring the thermal power at the thermal interface surface of the LED light engine–luminaire system. The equipment and method were developed by the company Hukseflux, Delft, in the Netherlands. Figure 3 shows a sketch of the measurement equipment.

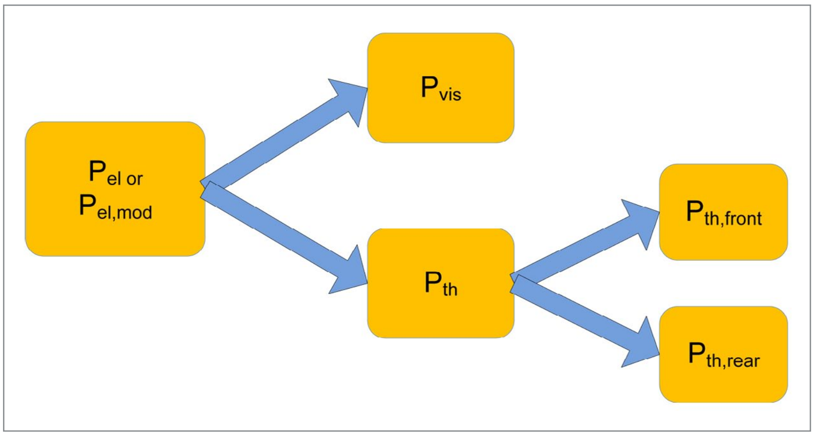

Figure 1: Power conversion

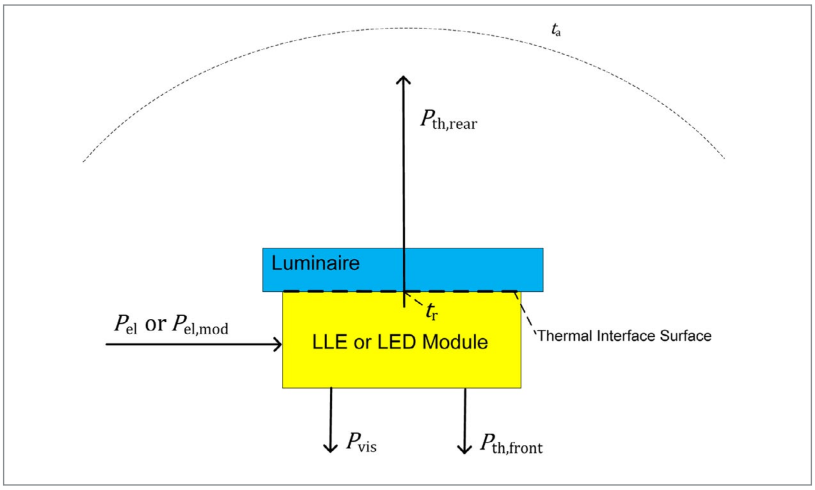

Figure 2:
Thermal model of a LLE- luminaire combination

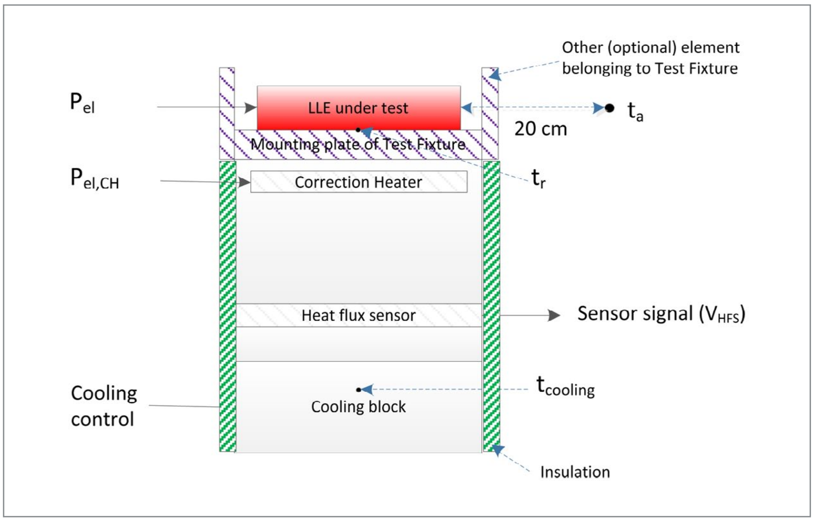

Figure 3:
Model of the thermal power test fixture (TPTF)

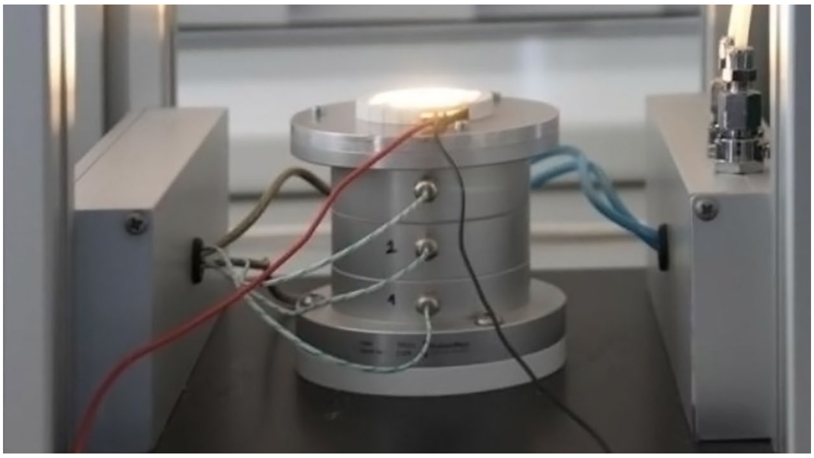

Figure 4:
The thermal power test fixture (TPTF) without insulation

The Test procedure for measuring $P_{th,rear}$

The Thermal Power Test Fixture (TPTF) is a one-dimensional heat flux measuring device which measures the amount of heat traveling from the rear of the LLE into the luminaire.

The first step in measuring $P_{th,rear}$ of the LLE will be calibrating the TPTF with the LLE attached.

While keeping the cooling block set to 25°C, the correction heater is configured to consume an electrical power P1 as specified in the different books. After the stabilization of the reference temperature t_r the average of six measurements of heat flux sensor voltage V_{HFS} shall be recorded. Additional V_{HFS} are to be taken at different values (P_2...P_n) of correction heater input power. The results for the different V_{HFS} measurements will be plotted as a curve.

Once the TPTF has been calibrated, $P_{th,rear}$ can now be measured. With the LLE attached to the TPTF, apply power to the LLE using the appropriate control gear. Wait for the stabilization of t_r. By controlling the power on the internal correction heater the temperature on t_r is kept at the value $t_{r,max}$. $P_{th,rear}$ is determined from the measured value V_{HFS} and the previously developed response curve.

Summarizing, Zhaga enables luminaire designers to obtain optimum heat sink designs in terms of volume and cost by defining a test method and procedure for the measurement of the thermal power at the thermal interface surface of the LED light engine – luminaire system.

Definitions and References:

LED Light Engine: A combination of on ECG (Electronic Control Gear) and one or more LED modules.

LED Module: A light source that is supplied as a single unit. In addition to one or more LEDs, their mechanical support and their electrical connection, it may contain components to improve its photometric, thermal, mechanical and electrical properties, but it does not include the electronic control gear.

Book 1: This book contain specifications that are common in multiple Zhaga interface specifications, such as: common definitions, the mechanical interface of separated electronic control gear, the generic aspects of the thermal interface. See also: http://www.zhagastandard.org/specifications/book-1.html

Electronic Control Gear or ECG: A unit that is located between the external power and one or more LED modules to provide the LED module(s) with an appropriate voltage or current. It may consist of one or more separate components, and may include additional functionality, such as means for dimming, power factor correction, and radio interference suppression.