

Zhaga's Light Emitting Surface (LES) Concept and its Impact on the Light Distribution

Stefan Lorenz from Osram gives a detailed explanation how the Light Emitting Surface (LES) of Book 3 modules is defined and how various sizes of the LES enable different beam angles.

To enable interchangeability of LED light sources, the Zhaga consortium has created several interface specifications for LED light engines covering different general lighting applications. One of these interface specifications is called “Book 3: Spot LED Light Engine with Separate Electronic Control Gear”. This Book defines the interface between a luminaire and a LED light source consisting of a round, 50 mm diameter, LED module with a central light emission and its associated electronic control gear (driver) in separate housings.

LED light sources that comply with “Book 3” are interchangeable. That means that a luminaire manufacturer can replace the light source with another Book 3 compliant light source without any change in the mechanical, thermal, and photometric components of the luminaire.

The Light Emitting Surface LES

Zhaga Book 3 LED Light Engines are expected to be used mainly in combination with collimating optics like reflectors within a luminaire. The Zhaga specification uses a generalized description of the optical interface between LED light engine and luminaire optics, called Light Emitting Surface (LES). This generalization enables comparison and categorization of LED light engines without referring to specific LED technologies or LED layouts, thus providing design freedom for the LED Light Engine while at the same time ensuring similar optical properties. For the luminaire optics design, on the other hand, it is sufficient to use the abstract LES description as optical reference, and not a specific LED light engine.

The Light Emitting Surface (LES) in Zhaga Book 3 is a round plane from which ideally the light of the LED module should be emitted. It covers all

light emitting parts of a given LED module. Zhaga Book 3 defines four LES size categories, depending on the LES diameter.

The Zhaga Specification includes instructions on how to determine the actual LES diameter as well as the LES category of a given LED light engine. Both values are included in the product data set of each Zhaga LED module or LED light engine, so that optical interchangeability can easily be checked by comparing the individual LES categories.

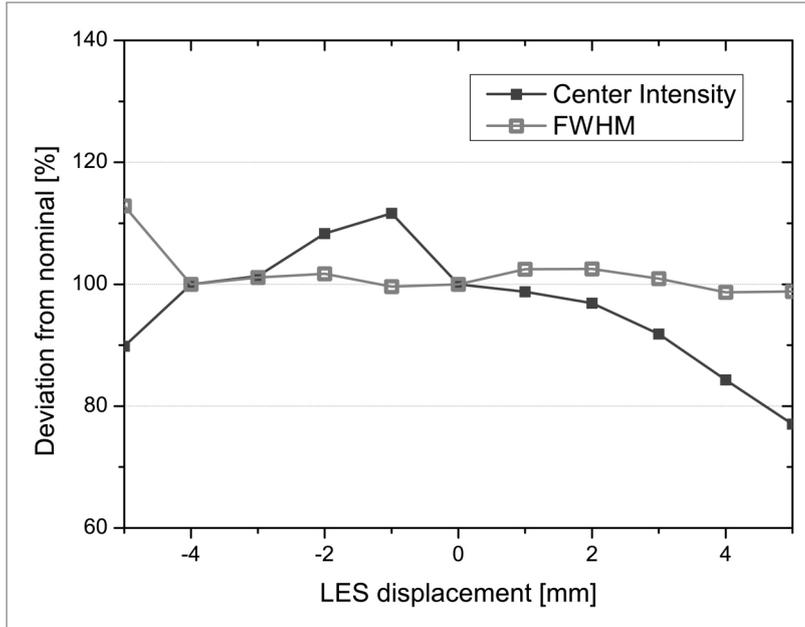
Apart from the LES diameter, also the allowed LES height is also specified within Zhaga Book 3. The range of possible heights depends on the LES category, being smaller for small nominal LES diameters. The categorization of LES diameter and LES height is introduced to ensure that LED light engines within the same category will have similar optical performance in a luminaire optics with regard to beam angle. The category sizes were chosen

LES category name	LES category nominal diameter [mm]	LES maximum diameter [mm]	LES minimum diameter [mm]
LES 9	9.0	9.0	>6.3
LES 13.5	13.5	13.5	>9.0
LES 19	19.0	19.0	>13.5
LES 23	23.0	23.0	>19.0

Table 1:
LES categories, including nominal, maximal and minimal LES diameters

This article explains how the optical emissive area of the LED module is defined, and how design freedom for luminaire optics as well as interchangeability for different LED light engines is ensured by this definition.

Figure 2:
 Variation of beam angle and center intensity with different LES height, shown with a sample LES of 16mm diameter (i.e. LES category 19) in a typical reflector



The same is true for LES height. The LES height range associated with each LES category ensures that optical performance with typical reflectors is not altered when exchanging different LED light engines from one category. A sample calculation with a typical reflector is shown in figure 1, where FWHM and center beam intensity are shown versus LES displacement from nominal 4,0 mm height. Note that for LES category 19 as in this example, the allowed deviation would be -4,0 up to +2,4, as defined in Zhaga Book 3. It is clearly visible that within the category limits, the variation of LES height has negligible impact on optical output.

such that beam angle of a given optical system will not vary by more than 12,5% when using LED light engines from the same LES category.

For the design of luminaire optics, e.g. reflectors, it is sufficient to use the LES category as a reference. The nominal LES diameters are given in table 1, the nominal LES height is always 4,0 mm. This coincides with the height of the Optical Contact Area (OCA), which is the mechanical reference surface for reflector attachment in Zhaga Book 3 LED light engines. An optical system, which is designed for a given LES category, can be used optically with all LED light engines which have the same LES category.

Impact of LES Position and Category on Optical Luminaire Performance

The LES category spacing has been chosen so that a few categories can cover a large range of actual diameters, while still ensuring that beam angles don't exceed a certain variation band. In most reflector designs, the beam angle decreases with decreasing LES diameter. As long as a LED light engine is exchanged with another one from the same category, the beam angle variation stays sufficiently small. If a LED light engine is exchanged with another one from a different category, significant changes in beam angle can be the result.

Summary

To summarize, the LES concept allows luminaires to be constructed independently of a certain LED light engine. By having a luminaire optics which is suited for one LES category, all Zhaga Book 3 LED light engines which fall into this category can be used for this luminaire, regardless of their LED type or layout, and will produce comparable optical output. ■

Definitions and References:

LED Light Engine: A combination of an 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 3: The interface specification for a spotlight LED light engine, consisting of an LED module and an electronic control gear in separate housings. See also: <http://www.zhagastandard.org/specifications/book-3.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.

Light Emitting Surface or LES: A physical or virtual plane on the LED module or LED Light Engine which characterizes the light emission in a simplified and generalized way. Its shape, size, and position allow to group the LED Light Engines into different categories which are optically interchangeable, and enable Luminaire Optics design without referencing to a specific LED Light Engine.

Luminaire Optics: A set of one or more optical elements, which shape the light output of the LED Light Engine, not being part of the LED Light Engine itself.