

Introduction to Zhaga and Zhaga's Spotlight Specification

Menno Treffers from Philips Lighting, and Zhaga's Secretary General gives background information about Zhaga and explains why the selected articles are relevant for better understanding the aims of Books One and Three.

The lighting industry has always worked with standard light sources. Conventional light sources, such as fluorescent tubes, are available from different manufacturers, and when a fluorescent tube from another supplier is used, the luminaire need not be modified. Conventional light sources are interchangeable. LED retrofit lamps are also interchangeable, but LED retrofit lamps cannot unlock the full potential of the LED revolution.

Making LED Light Sources Interchangeable

The industry uses LED modules with new form factors and optimized thermal design in high performance LED spotlighting applications. LED modules, unfortunately, are not interchangeable. At least not until today.

LED modules are offered in many different shapes and light distributions, and many lighting companies make their own mutually incompatible LED modules. All these variations are useful in the early stages of a technology, when we experiment with product architectures and system solutions, but by now the lack of standardization is becoming a limiting factor in mass market adoption of LED in general lighting.

The R&D cost of LED lighting systems will remain high without interchangeable light sources. The rapid improvement in LED technology makes it necessary to constantly upgrade the LED light source: new LEDs, new drivers, and frequent testing for certification marks such as UL, CE, or ENEC.

And, even more important, the business risks of developing and selling LED lighting systems remain high without interchangeable light sources because the supply of components is uncertain, stock levels must be high to hedge that uncertainty, and the risk of obsolescence and write-offs is high.

The Zhaga Consortium was established with the goal to make LED light sources interchangeable. This will benefit luminaire manufacturers because it lowers their R&D costs and business risks, and it benefits the manufacturers of LED modules because they can supply a larger and faster growing market with lower selling expenses and reduced risk of obsolescence.

What Is an Interchangeable Light Source?

In this context we consider two light sources interchangeable when one light source can replace the other light source without any change in the luminaire. We are not only talking about end-user replaceable light sources, but also about LED modules (PCBs) that are integrated into the luminaire and can be sealed for life. In the latter case, interchangeability means that the manufacturer can switch from one supplier to another without modification in the manufacturing process of the luminaire.

In Zhaga we use the term "LED light engine" when we talk about interchangeable light sources. We use this term to identify the combination of an LED module and its associated current source. As with many conventional light sources, the LED light engine is not necessarily integrated in a single housing: the driver or ECG that supplies a stable current to the LEDs may be separate from the LED module from which the light is emitted.

To achieve interchangeability, the luminaire must “know” what to expect from an LED light engine:

1. The maximum size (the mechanical outline)
2. The fixation method (e.g. screws at fixed positions, or a holder)
3. The amount of heat generated by the LED light engine as well as the maximum operating temperature
4. The location and size of the light emitting surface, in relation to the luminaire’s reflector
5. The distribution, uniformity, and other photometric properties of the light emitted by the LED light engine
6. The electrical characteristics (e.g. mains voltage requirements, control methods)

Note that “interchangeable” does not imply “identical”. “Interchangeable” means that the differences are acceptable in the context of a particular lighting application. It is not necessary that light engines are identical. If we ask that light sources become identical it would limit innovation, it would limit the possibility to differentiate lighting products, and it would make it more difficult to target applications with special requirements.

What Is an Interface Specification?

Zhaga specifies the interface between an LED luminaire and an LED light engine. A good interface specification defines only the interaction between luminaire and light engine. It should not unnecessarily restrict the design of the light engine, or the design of the luminaire. A good interface specification allows innovation inside the light engine while keeping the interaction with the luminaire stable.

Zhaga specifications have requirements for products on both sides of the interface: the LED luminaire has to provide the proper environment for the LED light engine, and the light engine has to fit inside the luminaire.

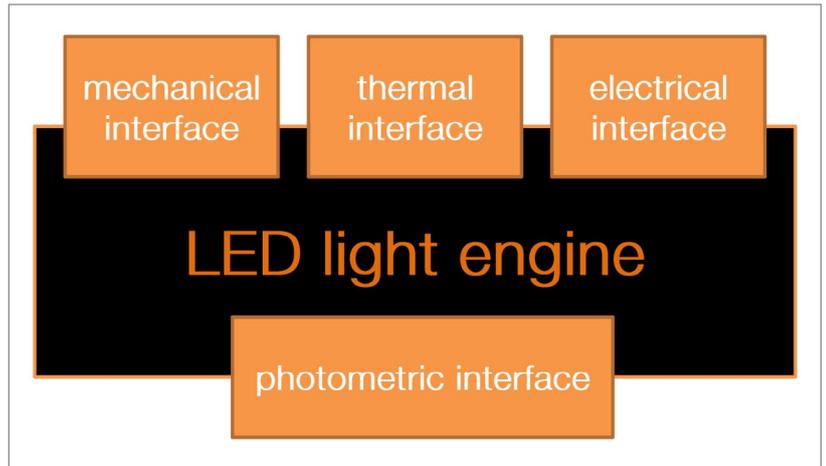


Figure 1: Zhaga specifications define the interaction between light source and luminaire without restricting innovation in the technology inside the light engine

Zhaga specifications describe test procedures for luminaires and test procedures for light engines. These test procedures help the product developer to determine whether their product complies with all the Zhaga requirements. The test procedures are meant to be complete and sufficient. Ideally, an LED light engine that passed all tests will fit in all luminaires that passed the tests, and the behavior of the lighting system (the combination of luminaire and light engine) is fully predictable. In practice it is difficult to specify the test procedures 100% complete. The Zhaga members deal with this challenge by building prototypes and testing them before the specification

is released. That way it is possible to identify ambiguities and inconsistencies, and revise and improve the specifications. By the time the first products arrive on the market the test specifications are mature and give sufficient coverage.

Book 3 - the Interface Specification for a Spotlight Engine

Spotlight engines are the first products in the market that use a Zhaga specification. This Zhaga specification is called “Book 3: Spot LED Light Engine with Separate Electronic Control Gear”. It defines a 50 mm round LED module.



Figure 2: Impression of a Zhaga spotlight engine

The Zhaga members who developed Book 3 faced many engineering challenges. Some of these challenges are described in articles that are published together with this introductory paper.

1. How the mechanical dimensions and optics contact area (OCA) are used to fix the LED spotlight module to the heat sink and to accurately position the reflector.
2. How the position of the Light Emitting Surface (LES) influences beam angle and center intensity.
3. How non-uniformity of the emission from the LES is characterized, and what deviations from an ideal Lambertian source can be tolerated in an LED spotlight module.
4. How an optional locking ring makes it possible to replace an LED spotlight module without using screws and special tools.
5. How the thermal properties of luminaire and light engine are determined and how the system behavior can be derived from the test result of the components.
6. How to measure the heat dissipation by the light engine at the interface with the luminaire. This is a new type of thermal test that was developed to avoid over-dimensioned heat sinks when matching LED light engines with luminaires.
7. How the specification of the mechanical dimensions of Electronic Control Gear (ECG), makes it possible to easily interchange the ECG when the manufacturer chooses a different LED spot light module for the luminaire.

Book 1 – a Special Specification

Several test procedures and aspects of the Book 3 specification are not unique to the Book 3 spotlight engine. The thermal test methods, for example, apply equally well to Zhaga's Book 2, Book 4, Book 5 and Book 6. The mechanical dimensions of ECG housings apply to all Zhaga light engines that have a separate electronic control gear.

The Zhaga members have collected these common specifications in Book 1 "Overview and Common Information". Whereas this book does not specify a light engine and you will find that the other Zhaga books reference Book 1 quite often. ■

Definitions and References:

LED Luminaire: A lighting fixture which provides an appropriate environment for one or more LED light engines.

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 1: A specification that provides a set of requirements and tests which are considered to be generally applicable to most types of LED light engines and corresponding luminaires.

See also: <http://www.zhagastandard.org/specifications/book-1.html>

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.