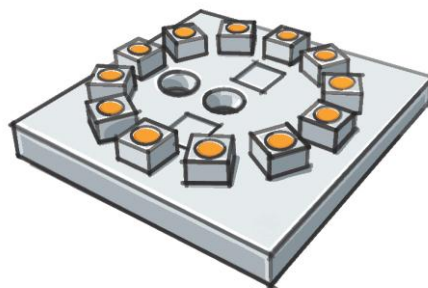


# Zhaga Interface Specification

Book 9  
Edition 1.0  
March 2015

Non-Socketable LLE with Ring-shaped LES and  
Separate ECG



## **Zhaga Interface Specification Book 9**

### **Summary (informative)**

#### **Background**

The Zhaga Consortium is a worldwide organization that aims to standardize LED light engines.

The Zhaga Interface Specification consists of a series of Books, which have been approved by the general assembly of the Zhaga Consortium. Each Book defines a LED light engine by means of its mechanical, photometric, electrical, thermal, and control interfaces to a luminaire. This makes the LED light engines interchangeable in the sense that is easy to replace one LED light engine with another, even if they have been made by different manufacturers.

The Zhaga Interface Specification distinguishes between four kinds of LED light engines, namely:

- socketable with integrated electronic control gear.
- socketable with separate electronic control gear.
- non-socketable with Integrated electronic control gear.
- non-socketable with Separate electronic control gear.

#### **Contents**

This Book 9 of the Zhaga Interface Specification defines two Non-socketable LLEs with Ring-shaped light emitting surfaces and Separate ECGs.

This Book must be read together with Book 1 of the Zhaga Interface Specification.

#### **Intended Use**

The Book-9 LED light engine can be mounted in a Luminaire, for example by means of screws. Book-9 LLEs are intended to be replaced by professionals only.



**Zhaga Interface Specification**  
**Book 9: Non-Socketable LLE with Ring-**  
**shaped LES and Separate ECG**

**Edition 1.0**

**March 2015**



## Zhaga Interface Specification

Book 9: Non-Socketable LLE with Ring-shaped LES and Separate ECG

Edition 1.0

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# 1 General

## 1.1 Introduction

The Zhaga Consortium is a worldwide organization that aims to standardize LED Light Engines. A LED Light Engine is a light source for general lighting that is based on solid state technology, and typically consists of one or more LEDs combined with stabilization electronics (Electronic Control Gear). The Zhaga Interface Specification consists of a series of Books defining interfaces between individual LED Light Engines or families of closely related LED Light Engines and associated Luminaires.

Book 1 of the Zhaga Interface Specification is a special Book in the sense that it provides common information, which is relevant to all other Books in the series. In addition, the Book 1 defines requirements and compliance tests, which are applicable to most LED Light Engines or associated Luminaires. The other Books of the Zhaga Interface Specification refer to those requirements and compliance tests as applicable.

The Zhaga Interface Specification distinguishes between four kinds of LED Light Engines, namely:

- Socketable with Integrated Electronic Control Gear.
- Socketable with Separate Electronic Control Gear.
- Non-socketable with Integrated Electronic Control Gear.
- Non-socketable with Separate Electronic Control Gear.

Apart Book 1, each Book of the Zhaga Interface Specification defines five interfaces between the LED Light Engine or family of LED Light Engines and the associated Luminaire. These interfaces consist of:

- A mechanical interface.
- A photometric interface.
- An electrical interface.
- A thermal interface.
- A control interface.

## 1.2 Scope

The LED Light Engines defined in this book 9 have LED Modules with a ring-shaped Light Emitting Surfaces and a separated ECG. Two categories are defined:

- LLE category RL25 with a LES ring with inner and outer diameter of approximately 20 and 30 mm respectively.
- LLE category RL12 with a LES ring with an inner and outer diameter of approximately 7 and 17 mm respectively.

The LED modules can be mounted in the Luminaires by means of screws. Book-9 LLEs are intended to be replaced by professionals only.

## 1.3 Conformance and references

### 1.3.1 Conformance

All provisions in the Zhaga interface Specification are mandatory, unless specifically indicated as recommended, optional or informative. Verbal expressions of provisions in the Zhaga Interface Specification follow the rules provided in Annex H of ISO/IEC Directives, Part 2. For clarity, the word "shall" indicates a requirement that is to be followed strictly in order to conform to the Zhaga Interface Specification, and from which no deviation is permitted. The word "should" indicates that among several

possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited. The word “may” indicates a course of action permissible within the limits of the Zhaga Interface Specification. The word “can” indicates a possibility or capability, whether material, physical or causal.

### 1.3.2 References

For references that are not listed in this section, see [Book 1]. For undated references, the most recently published edition applies.

[Book 1] Zhaga Interface Specification, Book 1: Overview and Common Information

## 1.4 Definitions

This section defines terms that have a specific meaning in the context of this Book 9. Terms that have a specific meaning across all Books of the Zhaga Interface Specification are defined in [Book 1].

Book-9 LED Light Engine LED Light Engine according to the specifications in this book.

LED Module Demarcation The mechanical boundary between a LED Module and its environment consisting of a Luminaire and interconnect.

## 1.5 Acronyms

Acronyms that have a specific meaning across all Books of the Zhaga Interface Specification are defined in [Book 1].

## 1.6 Symbols

This section defines symbols that have a specific meaning in the context of this Book 9. Symbols that have a specific meaning across all Books of the Zhaga Interface Specification are defined in [Book 1].

$t_p$  Temperature at a specific point on the LED Module (unit: °C).

$t_{p,normal}$  Value of the temperature  $t_p$  at normal operating conditions (see section 9.4.1; unit: °C).

$t_{p,max}$  Value of the temperature  $t_p$  at which the Rated LLE values are specified (unit: °C).

$t_{p,headroom}$  =  $t_{p,max} - t_{p,normal}$  (unit: °C).

## 1.7 Conventions

This section defines the notations and conventions used in the Zhaga Interface Specification.

### 1.7.1 Precedence

In the case of any perceived discrepancy between the definitions provided in Part 1, Interface Definition and the definitions provided in Part 2, Compliance Testing, the definitions provided in Part 2 take precedence over the definitions provided in Part 1.

### 1.7.2 Cross references

Unless indicated otherwise, cross references to sections include the sub sections contained therein.

**1.7.3 Informative text**

Informative text is set in italics, unless the whole section is marked as informative.

**1.7.4 Terms in capitals**

Terms that have a specific meaning in the context of this Book 9 are capitalized. See section 1.4.

**1.7.5 Units of physical quantities**

Physical quantities are expressed in units of the International System of Units. All lengths that omit an explicit unit indication are in millimeters.

**1.7.6 Decimal separator**

The decimal separator is a comma.

## 2 Overview (Informative)

### 2.1 General

General information with respect to the Zhaga Interface Specification and certification of products that comply with this Book 9 can be found in [Book 1], section 2.

### 2.2 Description of the LED Light Engine

The LED Light Engines defined in this book 9 have LED Modules with a ring-shaped Light Emitting Surface and can be applied in for example consumer Luminaires. Typically, the light distribution of the Luminaire is shaped by means of Luminaire Optics, either a lens or a diffuser into a beam with a typical FWHM of 45°. Two categories are defined:

- LLE category RL25 with a LES ring with inner and outer diameter of approximately 20 and 30 mm respectively. Figure 2-1 shows an informative 3D drawing.

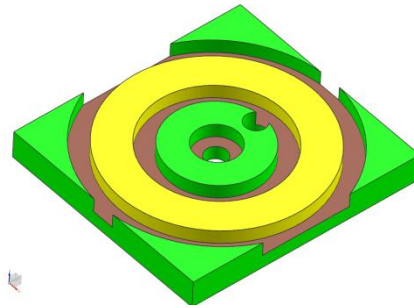


Figure 2-1: 3D drawing of the RL25 category LED Module (informative).

- LLE category RL12 with a LES ring with an inner and outer diameter of approximately 7 and 17 mm respectively. Figure 2-2 shows an informative 3D drawing.

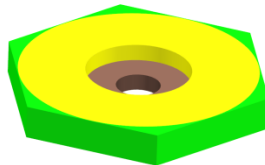


Figure 2-2: 3D drawing of the RL12 category LED Module (informative).

The LED Modules can be mounted in the Luminaires by means of screws. Book-9 LLEs are intended to be replaced by professionals only.

### 2.3 Outline of this Book

This Book 9 consists of two parts:

Part 1, Interface Definition, defines the LLE-Luminaire interface in terms of the five sub interfaces:

- The mechanical interface (section 3).
- The photometric interface (section 4).
- The electrical interface (section 5).
- The thermal interface (section 6).
- The control interface (section 7).

Part 2, Compliance Testing, defines:

- Specific tools, which are used for testing compliance of a Book-9 LLE or a Book-9 Luminaire (section 8).
- The LLE compliance tests (section 9).
- The Luminaire compliance tests (section 10).

The Annexes to this Book 9 provide the following additional information:

- An overview of the information that shall be listed in the Product Data Sets (Annex A).
- Guidelines for the mechanical interface test (Annex B).

# Part 1: Interface Definition

## **3 Mechanical interface**

### **3.1 Drawing principles**

For the purpose of this section, the provisions in [Book 1] - section 3.1, apply.

### **3.2 Book-9 LLE categories**

This Book 9 of the Zhaga Interface Specification specifies two LLE categories that are identified by a designation. In the following sub-sections, the LED Module Demarcations of these Book-9 LLE categories are defined.

No part of a LED Module (excluding interconnect) shall cross the boundaries of the LED Module Demarcation. And no part of a Luminaire (excluding interconnect) shall cross the boundaries of the LED Module Demarcation.

In case the LED Module is applied in combination with a Thermal Interface Material, this material is defined to be part of the LED module. Thus the total height of the Module + TIM (also while not compressed) shall not exceed the maximum height  $H_a$  (Figure 3-1 and Figure 3-2).

Additionally, for the purpose of this section, the provisions in [Book 1] - section 3.3, apply.



### 3.2.1 RL25

The LED Module Demarcation of the RL25 category is defined in Figure 3-1 and Table 3-1. The designation for this category is 'RL25'. The complete electrical interconnect to operate the module shall be in the green hatched area outside the LES (Figure 3-1).

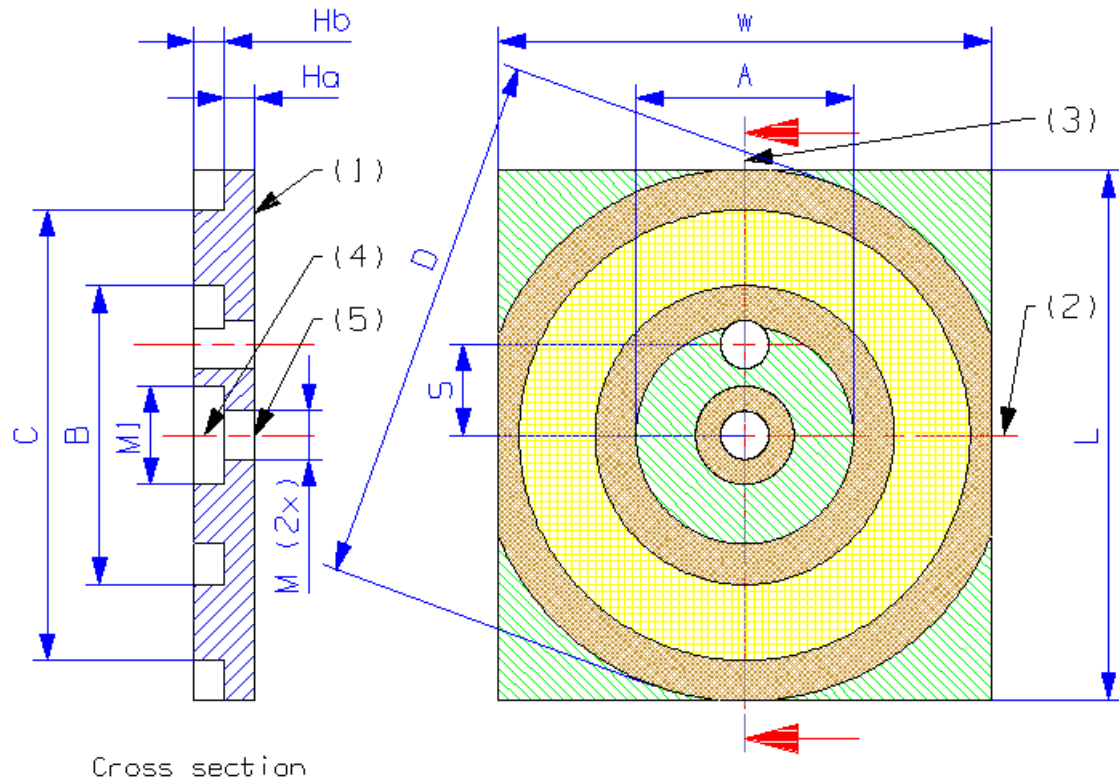


Figure 3-1: LED Module Demarcation of the RL25 category.

Notes to Figure 3-1:

- (1) Reference plane
- (2) Reference X axis. This is a symmetry axis for the outline and all circles except for the off-center hole.
- (3) Reference Y axis. This is a symmetry axis for the outline and all circles.
- (4) Reference Z axis
- (5) Reference point
- The blue hatched area (in the cross section) indicates the keep-in zone for the LED Module and the keep-out zone for the Luminaire.
- The brown hatched areas indicate Optics Contact Areas (OCAs).
- The yellow hatched area indicates the Light Emitting Surface (LES). This area is available for light emitting components and other components with maximum height defined by dimension Hb.
- The green hatched area indicates the region available for additional components with maximum height defined by dimension Hb.

<b>Dimension</b>	<b>Value</b>
A	14.36
B	19.76
C	29.76
D	35.16
Ha	2.0
Hb	2.0
L	35.0
M	3.2
M1	6.5
S	6.0
W	32.5

**Table 3-1: LED Module Demarcation of the RL25 category.**

3.2.2 RL12

The LED Module Demarcation of the RL12 category is defined in Figure 3-2 and Table 3-2. The designation for this category is 'RL12'. The complete electrical interconnect to operate the module shall be in the LES or the green hatched area (Figure 3-2).

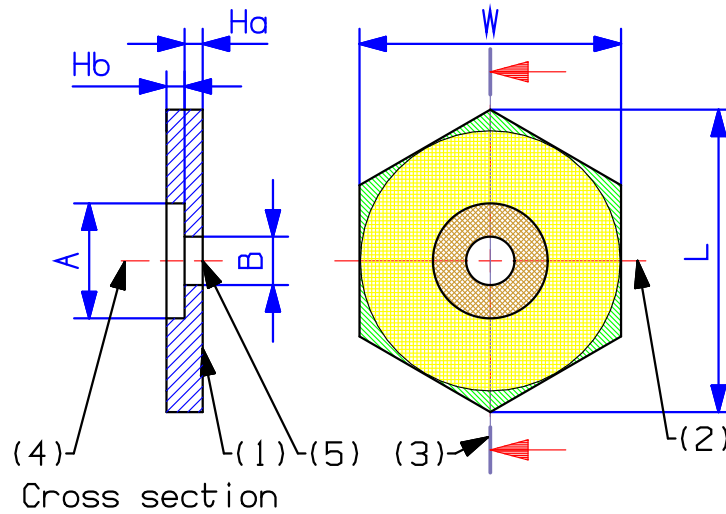


Figure 3-2: LED Module Demarcation of the RL12 category.

Notes to Figure 3-1:

- (1) Reference plane
- (2) Reference X axis. This is a symmetry axis for the outline and all circles.
- (3) Reference Y axis. This is a symmetry axis for the outline and all circles.
- (4) Reference Z axis
- (5) Reference point
- The blue hatched area (in the cross section) indicates the keep-in zone for the LED Module and the keep-out zone for the Luminaire.
- The brown hatched areas indicate Optics Contact Area (OCA).
- The yellow hatched area indicates the Light Emitting Surface (LES). This area is available for light emitting components and other components with maximum height defined by dimension Hb.
- The green hatched area indicates the region available for additional components with maximum height defined by dimension Hb.

dimension	Value
A	7.6
B	3.2
Ha	2.0
Hb	2.0
L	20.0
W	17.32

Table 3-2: LED Module Demarcation of the RL12 category.

### **3.3 Mechanical dimensions of ECG**

For the purpose of this section, the provisions in [Book 1] - section 3.2, apply.

## 4 Photometric interface

### 4.1 Light Emitting Surface

General information with respect to the Light Emitting Surface can be found in [Book 1], section 4.1. A Book-9 LLE shall have ring-shaped Light Emitting Surface with dimensions as defined in section 3.2.

### 4.2 Operating conditions

For the LLE defined in this Book 9 of the Zhaga Interface Specification, the operating conditions defined in [Book 1], section 4.2 apply, with the following exceptions:

- The requirement on  $t_r$  does not apply.
- The heat sink(s) of the photometric & electrical test fixture(s) (PETF) shall maintain the temperature ( $t_p$ ) within the range  $t_{p,max} \pm 1$  °C.

### 4.3 Luminous flux

For the purpose of this section, the provisions in [Book 1] - section 4.3 apply. The luminous flux of a Book-9 LLE shall be measured under the conditions specified in section 4.2. The categories that are allowed for book-9 LLEs are 100, 150, 250, 350, 500, 800, and 1000.

### 4.4 Luminous intensity distribution

This Edition of Book 9 does not contain requirements on the intensity distribution of the LLE<sup>1</sup>.

### 4.5 Luminance uniformity

This Edition of Book 9 does not contain requirements on the luminance uniformity of the LLE.<sup>2</sup>

### 4.6 Correlated color temperature

For the purpose of this section, the provisions in [Book 1] - section 4.6 apply. The correlated color temperature of an LLE shall be measured under the conditions specified in section 4.2.

### 4.7 Color rendering index

For the purpose of this section, the provisions in [Book 1] - section 4.7 apply. The color rendering index of an LLE shall be measured under the conditions specified in section 4.2.

---

<sup>1</sup> In typical applications of Book 9 LLEs, lenses are used to shape the light of the LED Module into a preferred beam with a typical FWHM value of 45°. These applications are very tolerant for variations in light intensity distribution of the LED. For example RL25 LED Modules with a LED light intensity distribution between 100° and 140° FWHM yield beam shapes that visually cannot be distinguished.

<sup>2</sup> In typical applications of Book 9 LLEs, lenses are used to shape the light of the LED Module into a preferred beam with a typical FWHM value of 45°. These applications are very tolerant for variations in luminance uniformity of the LED Module. For example a RL25 LED Module with 4 LEDs yields a beam shape that visually cannot be distinguished from the same LED Module with 12 LEDs.

## **5 Electrical interface**

### **5.1 Electrical insulation**

For the purpose of this section, the provisions in [Book 1] - section 5.1 apply.

The Product Data Set of the LLE should include a specification of the implemented electrical insulation according to applicable standard(s).

## 6 Thermal interface

### 6.1 Background information (informative)

In general, one of the most challenging issues in LED lighting is related to the junction temperature of the LED. On the one hand this component is made of a semiconductor material and therefore it is sensitive to operating temperature, both in terms of performance and lifetime. On the other hand the operating temperature of the LED is not only determined by the design of the LLE but also by the design of the Luminaire and the ambient temperature.

For Book-9 LLEs, the situation is special. Many Book-9 LLEs are very tolerant with respect to the thermal interface. These LLEs are more or less self-cooling. Even when the thermal interface is very poor, these modules do not overheat. On the other hand, some Book-9 LLEs are more demanding with respect to the thermal interface. These LLEs may overheat without special precautions.

### 6.2 General requirements for Book-9 LLEs related to the thermal interface

The LLE manufacturer shall indicate in the Product Data Set the position of the temperature measurement point (typically on a hot spot near a LED or a solder point)<sup>3</sup>. The temperature that is measured at this point is denoted  $t_p$ .

The LLE manufacturer shall list the value of  $t_{p,max}$  in the Product Data Set and this value of  $t_{p,max}$  shall be such that if  $t_p = t_{p,max}$ , a new sample of the LLE (zero burning hours) shows photometric values equal to the Rated values within tolerances defined in the Zhaga Interface Specification.

The LLE manufacturer shall list the thermal headroom  $t_{p,headroom}$  (see section 6.3) in the Product Data Set.

### 6.3 Thermal headroom of Book-9 LLEs

In order to determine the thermal headroom of the LLE, the LLE is mounted in the Test Fixture which is defined in section 8.1.1. Following the test procedure as defined in section 9.4.1.3, the value of  $t_p$  is determined during normal operating conditions (among others at an ambient temperature of 25°C). This value is denoted  $t_{p,normal}$ . The thermal headroom  $t_{p,headroom}$  is derived from  $t_{p,max}$  and  $t_{p,normal}$  using

$$\text{EQ. 6-1:} \quad t_{p,headroom} = t_{p,max} - t_{p,normal}$$

*The value of the thermal headroom can be used by the Luminaire manufacturer to determine the measures that are required for thermal compatibility. LLEs with higher  $t_{p,headroom}$  value are less demanding with respect to the thermal interface. If an original LLE operates in a specific luminaire below  $t_{p,max}$  and a new LLE has a higher  $t_{p,headroom}$  than the original LLE, this original LLE can be replaced in the Luminaire by the new LLE without problems.*

*LLE manufacturers are recommended to include additional information in the PDS with respect to the thermal interface. And Luminaire manufacturers are advised to use this information and optionally perform additional tests to check thermal compatibility.*

<sup>3</sup> This point is different from the measurement point of the Reference Temperature defined in book 1 as the position of  $t_p$  is LLE dependent and typically does not lie on the Thermal Interface Surface.

## **7 Control interface**

For the purpose of this section, the provisions in [Book 1] - section 7 apply.



## **Part 2: Compliance Testing**

## 8 Compliance test tools

### 8.1 LLE test tools

#### 8.1.1 Thermal power test fixture (TPTF) for RL12 & RL25

The thermal power test fixtures for the RL25 and the RL12 are defined in Figure 8-1 and Figure 8-2 respectively. The cabinet shall be made of aluminum with a thermal conductivity of 160 W/mK +/- 10 W/mK. The cover plate shall be made of transparent polycarbonate with a thickness of 2 mm. The mounting pin ( $\varnothing = 3 \pm 0.1$  mm and a length of approximately 20 mm) plus spring allow for a spring force of 4 N +/- 10% (TBD). The hole (5 mm) in the cabinet is used for the electrical connection of the module and thermocouple leads.

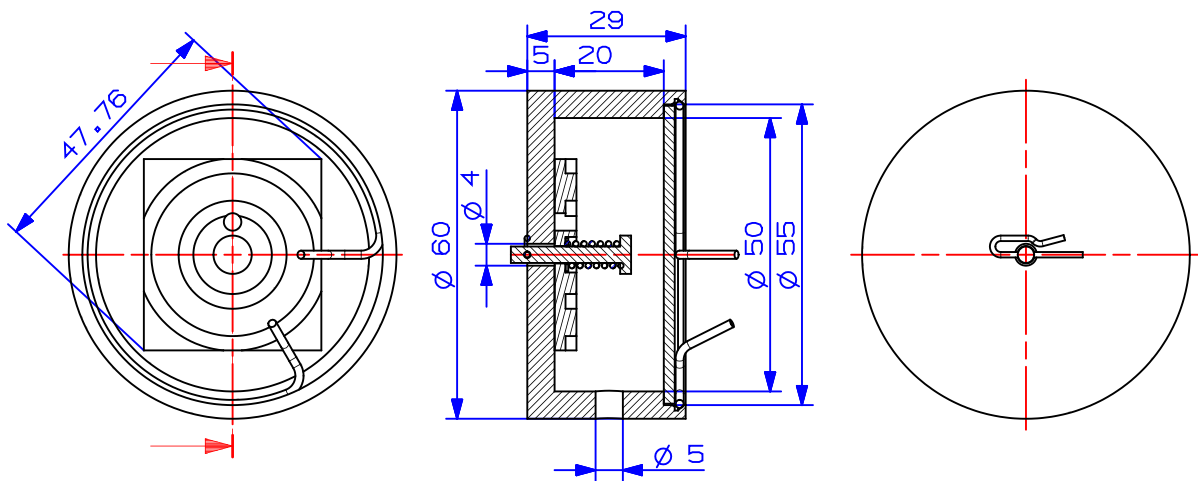


Figure 8-1: Test Fixture for the RL25 category.

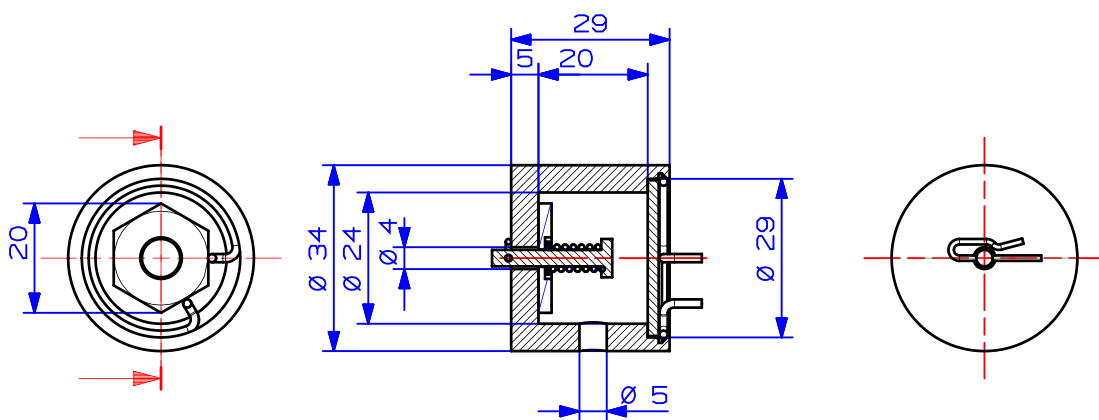


Figure 8-2: Test Fixture for the RL12 category.

#### 8.1.2 Photometric & electrical Test Fixture (PETF) for RL12 & RL25

The PETF for book-9 LLEs is a temperature controlled heat sink that allows for mounting the LED Module under test and that can be attached to the photometric measurement system. The mounting surface of the PETF shall be equal or larger than the Thermal Interface Surface of the applicable book-9 category (RL12 & RL25). The construction, material thickness and material choice of the PETF shall be such that the temperature at the TIS is constant within a range  $\pm 2$  °C in case the LLE is turned off.

## 9 LLE Compliance Tests

### 9.1 LLE mechanical interface tests

#### 9.1.1 Test of the mechanical interface of the LED Module

The purpose of this test is to verify the mechanical interface of the LED Module of the LLE under test.

##### 9.1.1.1 Test equipment

The mechanical interface should be tested with (semi) automated 3D measuring equipment like a non-contact optical measuring system. The measurement accuracy shall be at least  $\pm 0,05$  mm.

Alternatively, the mechanical interface may be tested with a gauge made of a material that ensures the accuracy mentioned below (for example 3 mm aluminum). In that case, it shall be verified that the gauge complies with the corresponding demarcation model. This verification shall be done with a (semi) automated 3D measuring equipment like a non-contact optical measuring system. The measurement accuracy shall be at least  $\pm 0,05$  mm.

##### 9.1.1.2 Test conditions

The mechanical interface shall be verified at a temperature in the range of  $25 \pm 5$  °C.

##### 9.1.1.3 Test procedure

- Determine the designation of the LLE category from the Product Data Set of the LLE under test.
- Find the corresponding LED Module Demarcation in section 3.2.
- To avoid incompatibility due to components on the light engine the LED module should be shifted along the Z-axis as far as possible in positive direction without violating the LED module Demarcation model<sup>4</sup>. Verify that the LED Module under test does not cross the corresponding LED Module Demarcation. Note that such verification includes the outline of the LED Module under test as well as the size, shape and position of the mounting holes within that outline and the maximum height. Additional guidelines for this test are provided in Annex B.

##### 9.1.1.4 Pass criteria

The LLE under test passes if the result of the LED Module Demarcation verification is positive. Using (semi) automated 3D measuring equipment, verification of the LED Module Demarcation is positive if all measurement points are in the keep-in zone of the LED Module Demarcation. Using a gauge, verification of the LED Module Demarcation is positive if the LED Module fits in the gauge.

#### 9.1.2 Test of the mechanical interface of the Separate ECG

For the purpose of this section, the provisions in [Book 1] – section A.1.1.2, apply.

### 9.2 LLE photometric interface tests

#### 9.2.1 Test of Luminous Flux

The purpose of this test is to verify the Rated luminous flux category of the LLE under test.

##### 9.2.1.1 Test equipment

For the purpose of this section, the provisions in [Book 1] – section A.1.2.1.1, apply. Test Fixture (PETF) to be used is defined in section 8.1.2.

---

<sup>4</sup> This alignment ensures that it is verified that components of the LED Module are not too high relative to the OCA.

### 9.2.1.2 Test conditions

See section 4.2.

### 9.2.1.3 Test procedure

- Mount the LED Module-under-test on the PETF. The LES shall be tightly connected to the photometric measurement system.
- In case of an LLE with more than one LED Module, operate the LED Module(s)-not-under-test according to the manufacturer's instructions to enable equal photometric output. If no instructions are provided, the LED Module(s)-not-under-test shall be mounted on temperature controlled test fixture(s), not connected to the photometric measurement system.
- Connect thermocouple(s) to the  $t_p$  point(s) of the LED Module(s) at the position defined in the PDS of the LLE and according to the instructions in the PDS of the LLE. In case no instructions are provided, it is recommended to adhere to the instructions in annex K of [IEC 60598].
- Connect the LED Module(s) to the ECG and connect the ECG to the External Power.
- Turn on the power supply.
- Adjust the Ambient Temperature and the heat sink temperature(s) such that, after stabilization (see book 1; section A.1.3.4), all conditions defined in section 4.2 are met.
- Perform the test as described in [IES LM-79-08], Section 9.1.

### 9.2.1.4 Pass criteria

For the purpose of this section, the provisions in [Book 1] – section A.1.2.1.4, apply.

## 9.2.2 Test of correlated color temperature (CCT)

The purpose of this test is to verify the Rated CCT of the LLE under test.

### 9.2.2.1 Test equipment

Use the test setup as described in section 9.2.1.1.

### 9.2.2.2 Test conditions

See section 4.2.

### 9.2.2.3 Test procedure

Use the procedure in section 9.2.1.3 to measure the spectral power density (SPD) and calculate CCT according to [ANSI C78.377].

### 9.2.2.4 Pass criteria

For the purpose of this section, the provisions in [Book 1] – section A.1.2.3.4, apply.

### 9.2.2.5 Test of color rendering index (CRI)

The purpose of this test is to verify the Rated CRI of the LLE under test.

### 9.2.2.6 Test equipment

Use the test setup as described in section 9.2.1.1.

### 9.2.2.7 Test conditions

See section 4.2.

**9.2.2.8 Test procedure**

Use the procedure in section 9.2.1.3 to measure the spectral power density (SPD) and calculate the CRI simulating a color plate measurement according to [CIE 13.3].

**9.2.2.9 Pass criteria**

For the purpose of this section, the provisions in [Book 1] – section A.1.2.4.4, apply.

**9.3 LLE electrical interface tests**

This edition of Book 9 of the Zhaga Interface Specification does not contain compliance tests for the electrical interface of the LLE.

**9.4 LLE thermal interface tests****9.4.1 Test of thermal headroom of the LLE**

The purpose of this test is to verify the thermal headroom ( $t_{p,headroom}$ ) of the LLE under test.

**9.4.1.1 Test equipment**

This test shall be conducted with a thermocouple with an accuracy of at least  $\pm 1$  K. The Test Fixture to be used is defined in section 8.1.1.

**9.4.1.2 Test conditions**

- The Test Fixture shall be suspended in a draught free room with the cover plate facing down and at a distance of at least 50 cm to the floor, to the ceiling and to the walls. The hole in the cabinet that is used for the electrical connection of the module and thermocouple leads shall be sealed by means of a material that can be withstand the temperatures during this measurement.
- The Ambient Temperature shall be within the range  $25 \pm 5$  °C and stable within the range  $\pm 1$  °C.
- The voltage and frequency of the External Power of the LLE shall be within 0,2 % of the Rated values.
- The photometric output of the LLE shall not be affected in any way by objects (reflectors, glass or plastic windows, heat sink features, etcetera) that are exterior to the LLE or the Test Fixture.
- The ECG shall be mounted at a distance from the LED Module such that the ECG does not influence the results of the measurement.
- In case the LLE consists of more than one LED Module, this measurement shall be conducted with one LED Module mounted in the Test fixture, while the other LED Modules are operated outside the Test Fixture.

**9.4.1.3 Test procedure**

- Attach a thermo couple to the LED Module at the  $t_p$ -point specified in the PDS.
- Mount the LED Module in the Test Fixture accounting to the instructions in the PDS.
- Install the Test Fixture in a draught free and temperature controlled room.
- Turn on the LLE and wait for stabilization of the temperature  $t_p$  (see book 1, section A.1.3.5).
- Measure the value of  $t_p$  and normalize it to an Ambient Temperature of 25 °C:

$$t_{p,normal} = t_p + 25 \text{ °C} - t_a$$

- Calculate  $t_{p,headroom}$  according to EQ. 6-1.

#### 9.4.1.4 Pass criteria

The LLE under test passes if the calculated  $t_{p,headroom}$  is not less than the Rated  $t_{p,headroom} - 4\text{ }^{\circ}\text{C}$ .

### 9.5 LLE control interface tests

This edition of Book 9 of the Zhaga Interface Specification does not contain compliance tests for the control interface of the LLE.

### 9.6 LLE Product Data Set test

For the purpose of this section, the provisions in [Book 1] - section A.1.6 apply.

## 10 Luminaire compliance tests

### 10.1 Luminaire mechanical interface tests

#### 10.1.1 Test on the mechanical interface of the Luminaire for mounting the LED Module(s)

The purpose of this test is to verify the mechanical LED Module interface of the Luminaire under test.

##### 10.1.1.1 Test equipment

The mechanical interface should be tested with (semi) automated 3D measuring equipment like a non-contact optical measuring system. The measurement accuracy shall be at least  $\pm 0,05$  mm.

Alternatively, the mechanical interface may be tested with a gauge made of a material that ensures the accuracy mentioned below (for example 3 mm aluminum). In that case, it shall be verified that the gauge complies with the corresponding demarcation model. This verification shall be done with a (semi) automated 3D measuring equipment like a non-contact optical measuring system. The measurement accuracy shall be at least  $\pm 0,05$  mm.

##### 10.1.1.2 Test conditions

The mechanical interface shall be verified at a temperature in the range of  $25 \pm 5$  °C.

##### 10.1.1.3 Test procedure

- Determine the designation of the LLE category from the Product Data Set of the Luminaire under test. Note that if the Product Data Set of the Luminaire under test lists multiple LLE categories, the next steps shall be repeated for each of the listed LLE categories.
- Find the corresponding LED Module Demarcation in section 3.2.
- Verify that the Luminaire under test, including mounting means such as screws does not cross the corresponding LED Module Demarcation. Additional guidelines for this test are provided in Annex B.

##### 10.1.1.4 Pass criteria

The Luminaire under test passes if the result of the LED Module Demarcation verification is positive for all LED Module positions in the Luminaire and for all LLE categories listed in the PDS.

Using a (semi) automated 3D measuring equipment, verification of the LED Module Demarcation is positive if all measurement points are in the keep-out zone of the LED Module Demarcation with a tolerance of 0,05 mm. Using a gauge, verification of the LED Module Demarcation is positive if the gauge fits in the LED module position in the Luminaire.

#### 10.1.2 Test on the mechanical interface of the Luminaire for mounting the Separate ECG

For the purpose of this section, the provisions in [Book 1] – section A.2.1.1, apply.

### 10.2 Luminaire photometric interface tests

This edition of Book 9 of the Zhaga Interface Specification does not contain compliance tests for the photometric interface of the Luminaire.

### 10.3 Luminaire electrical interface tests

This edition of Book 9 of the Zhaga Interface Specification does not contain compliance tests for the electrical interface of the Luminaire.



#### **10.4 Luminaire thermal interface tests**

This edition of Book 9 of the Zhaga Interface Specification does not contain compliance tests for the thermal interface of the Luminaire.

#### **10.5 Luminaire control interface tests**

This edition of Book 9 of the Zhaga Interface Specification does not contain compliance tests for the control interface of the Luminaire.

#### **10.6 Luminaire Product Data Set test**

For the purpose of this section, the provisions in [Book 1] - section A.2.6 apply.

# Annexes

## Annex A Product Data Set requirements

In this section the requirements with respect to the Product Data Sets of Zhaga products defined in this Book 9 are listed.

### A.1 LLE Product Data Set

The LLE Product Data Sets shall contain the following information:

- The LLE category according to section 3.2.
- Designation(s) of the ECG housing(s) according to [Book 1]
- Number of LED modules in the LLE
- Luminous flux category at  $t_p = t_{p, \max}$ . The Rated Flux category shall be one of the categories listed in section 4.3.
- CCT and CRI category at  $t_p = t_{p, \max}$  using the three digit code as defined in [IEC 62732]. Only the nominal CCT categories as specified in [ANSI C78.377] shall be used. These categories are: 2700K, 3000K, 3500K, 4000K, 4500K, 5000K, 5700K and 6500K.
- the position of the temperature measurement point  $t_p$
- $t_{p, \max}$
- the thermal headroom ( $t_{p, \text{headroom}}$ )

### A.2 Luminaire Product Data Set

The Luminaire Product Data Sets shall contain the following information:

- the designations of the Book-9 LLE categories that can be accommodated in the Luminaire. For each category, the Luminaire Product Data Set shall also show the number of modules that can be accommodated.
- List of Designations of ECG housings according to [Book 1] that can be mounted in the Luminaire. Two designations that only differ in “Height” (for example ‘ZC1 H3 (D/S)’ and ‘ZC1 H5 (D/S)’ shall only be indicated once in the list, using the designation with the maximum height (‘ZC1 H5 (D/S)’ in the example).
- Mounting instructions

## Annex B Guidelines for mechanical interface test (informative)

### B.1 Compliance test on outline and mounting holes

The procedure for the compliance test on the mechanical interface of the LED Module or the Luminaire requires verification that the LED Module or the Luminaire does not cross the corresponding LED Module Demarcation. Such verification can be performed using (semi-)automated 3D measuring equipment like a non-contact optical measuring system. This annex provides some guidelines on the number of measurement points and their positions to be used for such verification. The example in Figure B-1 will be used to provide these guidelines.

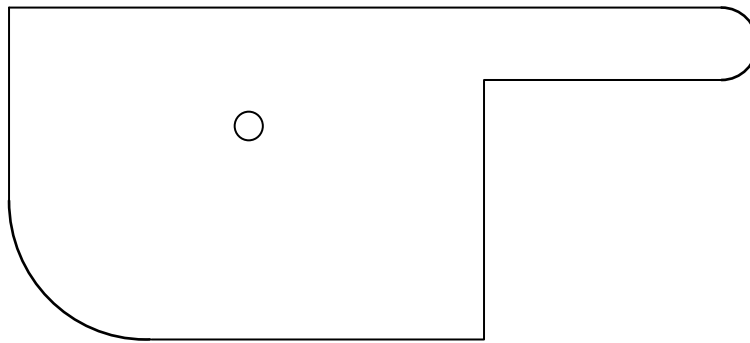


Figure B-1: Example of a LED Module.

As a first step, the outline of the LED Module (including mounting holes) is divided into segments with approximately equal curvature. In each section  $x$ , the minimum curvature in that section is denoted by  $r_x$ .

As a second step, measurement points are defined at the boundaries between sections. The result of these steps is shown in Figure B-2.

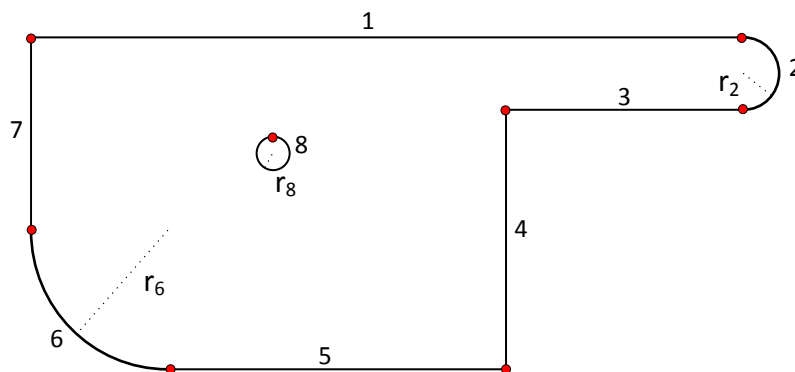


Figure B-2: Example of a LED Module with sections

As a third and final step, each section is divided in sub-sections with a maximum length  $d$  with the value of  $d$  fulfilling the following requirements:

- $d \leq \frac{r_x}{2}$  and
- $d \leq 10 \text{ mm}$

Additional measurement points are defined at the boundaries of these subsections. The result of these steps is shown in Figure B-3.

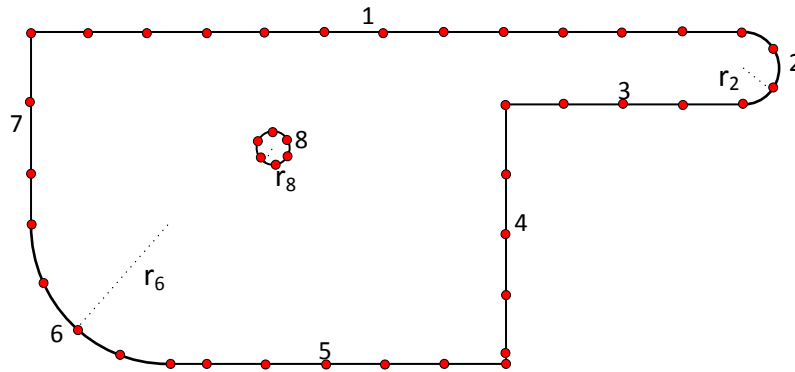


Figure B-3: Example of a LED Module with measurement points.

## B.2 Compliance test on Optics Contact Area

The compliance test on the mechanical interface of the LED Module is a verification that the LED Module does not cross the corresponding LED Module Demarcation. Next to the check on outline and mounting holes as described in section B.1, this also includes a check whether component on the LED Module do not cross the boundaries of the Optics Contact Areas as defined in sections 3.2.1 and 3.2.2. Such verification can be performed using (semi-)automated 3D measuring equipment like a non-contact optical measuring system. Section B.1 provides guidelines on the number of measurement points and their positions to be used for such verification.