

# Zhaga Interface Specification

## Book 6 Edition 1.3 February 2014

LED LIGHT ENGINE

TYPE A:  
COMPACT SOCKETABLE LED LIGHT ENGINE  
WITH INTEGRATED ELECTRONIC CONTROL  
GEAR 90 MM x42 MM NOMINAL

LES 92 MM MAXIMUM ROUND



## Zhaga Interface Specification Book 6

### 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.

Each LED light engine belongs to one of the following categories:

Type A: socketable with integrated electronic control gear.

Type B: socketable with separate electronic control gear.

Type C: non-socketable with integrated electronic control gear.

Type D: non-socketable with separate electronic control gear.

#### Contents of Book 6

Zhaga Interface Specification Book 6 defines an LED light engine of type A (socketable with integrated control gear). The LED light engine has a nominal dimension of  $\phi 90 \times 42\text{mm}$ , a GH76p Base and light distribution means that allow small reflector and more compact luminaire design. The holder designed for this LED light engine and specified in Book 6 dose not exceed the diameter of this LED light engine and also allows more compact Luminaire design.

Book 6 must be read together with Book 1 of the Zhaga Interface Specification, entitled "Overview and Common Information." This contains generic information applying to all Books.

#### Intended Use

The light engine can be applicable for downlight, pendant type, wall mount and recessed type luminaires.

#### Conformance

All provisions in the Zhaga Interface Specification are mandatory, unless specifically indicated as recommended, optional or informative



# **Zhaga Interface Specification**

**Book 6: LED Light Engine Type A**

**Compact Socketable LED Light Engine with  
Integrated Electronic Control Gear**

**90 mm ×42 mm Nominal**

**Edition 1.3**

**February 2014**

**Zhaga Interface Specification**  
Book 6: LED Light Engine Type A

Compact Socketable LED Light Engine with Integrated Electronic Control Gear 90 mm ×42 mm Nominal  
Edition 1.3

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## 1 General

### 1.1 Introduction

The Zhaga Consortium is a worldwide organization that aims to define LED Light Engines, which are interchangeable—in the sense that products designed by different manufacturers can be exchanged without complications. A LED Light Engine (LLE) 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 and control electronics (Electronic Control Gear).

Different types of LED Light Engines are defined in different books of the Zhaga Interface Specification. Each book defines at least the following set of interfaces that are connected with interchangeability:

- Mechanical interface.
- Photometric interface.
- Electrical interface.
- Thermal interface.
- Control interface

The individual books of the System Description Zhaga are approved by the general assembly of the Zhaga Consortium and published in the form of technical specifications.

### 1.2 Scope

This Book 6, Compact Socketable LED Light Engine with Integrated Electronic Control Gear, of the Zhaga Interface Specification defines the interfaces for LED Light Engines with integrated Electronic Control Gear that have a nominal dimension of  $\phi 90 \times 42\text{mm}$ , a GH76p Base and light distribution means. See Section 1.5 for the definition of Compact Socketable LED Light Engine. The luminous flux categories of the LED Light Engine family members range from 540 lm to more than 5000 lm. See Table 4-2 for the Luminous flux categories.

This Book 6 also defines the interfaces for a Luminaire on which an LED light engine defined in this Book can be operated.

### 1.3 Main features

A Compact Socketable LED Light Engine, which can be locked into a Luminaire by means of a twisting motion. This document defines:

- A Compact Socketable LED Light Engine with integrated Control Gear, which is operated on mains power with certain optics.
- A Holder for the Compact Socketable LED Light Engine, which is permanently attached to the Luminaire.
- Variants of the Compact Socketable LED Light Engine which use mechanical fit Keying to ensure that operation is possible at the appropriate mains voltage and power ranges.
- An appropriate environment inside the Luminaire for the Compact Socketable LED Light Engine to operate correctly.

### 1.4 Conformance and references

#### 1.4.1 Conformance

All provisions in the Zhaga Interface Specification are mandatory, unless specifically indicated as recommended or optional or informative. Verbal expression of provisions in the Zhaga Interface Specification follows the rules provided in Annex H of ISO/IEC Directives, Part 2. For all 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.

#### 1.4.2 Normative reference

In addition to the provisions in this Book 6 of the Zhaga Interface Specification, product implementations shall also conform to the provisions in the System Descriptions as well as the relevant parts of the International Standards listed below or in section 1.3.2 of [Book 1] of the Zhaga Interface Specification. For undated references, the applicable revision is the one most recently published at the release date of this Book 6, of the Zhaga Interface Specification. As an exception, a reference to [Book 1] always refers to the most recent edition of [Book 1] unless explicitly stated otherwise.

[Book 1]	Zhaga Interface Specification, Book 1: Overview and Common Information.
[IEC 60061]	Lamp caps and holders together with gauges for the control of interchangeability and safety—Part 4: Guidelines and general information, IEC 60061-4.
[IEC 60061-a]	New cap (base)/holder fits; requirements for increased safety, IEC 60061-4 standard sheet 7007-4
[IEC 60061-b]	Creepage distances and clearances for caps on finished lamps, IEC 60061-4 standard sheet 7007-6.
[IEC 60061-c]	Guidelines for the retention of caps in holders, IEC 60061-4 standard sheet 7007-8.
[IEC 60061-d]	Designation of Lamp Caps and Holders, IEC 60061-4 standard sheet 7007-1.
[IEC 60598]	Luminaires—Part 1: General requirements and tests, IEC 60598-1.
[IEC 60838]	Miscellaneous lampholders—Part 1: General requirements and tests, IEC 60838-1.
[IEC 62031]	LED modules for general lighting—Safety specifications, IEC 62031.
IEC/PAS 62717]	LED modules for general lighting—Performance requirements, IEC/PAS 62717.
[JIS Z9112]	“Classification of fluorescent lamps by chromaticity and colour rendering property.” The scope is to be revised including LED light sources.

In addition to the measurement techniques defined in this document, measurement techniques used to characterize product implementations shall conform to the provisions in the International Standards listed below or in section 1.3.2 of [Book 1] of the Zhaga Interface Specification. For undated references, the applicable revision is the one most recently published at the release date of this Book 6 of the Zhaga Interface Specification.

[CIE 13.3]	Method of measuring and specifying colour rendering properties of light sources, CIE 13.3.
[IEC/TR 61341]	Method of measurement of centre beam intensity and beam angle(s) of reflector lamps, IEC/TR 61341.

#### 1.4.3 Informative reference

In addition to the references given in section 1.3.3 of [Book 1], the following references provide additional information that may be relevant to the provisions in this Book 6 of the Zhaga Interface Specification.

[CIE 121]	The photometry and goniophotometry of luminaires, CIE 121.
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[CIE 84]                      The measurement of luminous flux, CIE 84.

## 1.5 Definitions

Definitions common to all books of the Zhaga Interface Specification are given in section 1.4 of [Book 1]. The following additional definitions apply for this Book. In case of conflicts, the definitions given here overrule the definitions from [Book 1].

Base	The part of a Compact Socketable LLE that fits in the Holder.
Holder	The part of a Luminaire that locks the Compact Socketable LLE in a clear, stable, and functional position.
Keying	Differentiation—usually mechanical—to distinguish between options that are non-interchangeable (for example different mains voltage ranges). Keying is a safety feature.
Mechanical Force Pin	An extrusion of the LLE, which has the purpose for a Holder to apply an axial force thereon, such that the Thermal Interface Surface is firmly pressed against the heat sink of the Luminaire.
Socketable LLE	A LED Light Engine that contains one or more LED Modules and the associated Electronic Control Gear in a single enclosure, and which can be inserted into or removed from a Holder by means of a twisting motion.
Compact Socketable LLE	The LLE of which a Holder in a Luminaire does not exceed the diameter of itself. The integrated optics allows small reflector and more compact luminaire design. In this Book, hereinafter called as “Compact Socketable LLE” or “the LLE.”
Thermal Test Engine	A device that is used to define the thermal properties of a Luminaire. This version 1.3 of Book 6 of the Zhaga Interface Specification defines a single Thermal Engine.

## 1.6 Acronyms

AWG	American Wire Gauge
CIE	Commission Internationale de l’Eclairage
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LLE	LED Light Engine
MFG	Mechanical Force Gauge
MTG	Mechanical Test Gauge
NA	not applicable
NMI	National Metrology Institute
UL	Underwriters Laboratories

## 1.7 Symbols

Symbols commonly used in all books of the Zhaga Interface Specification are given in section 1.5 of [Book 1]. The following additional symbols are used in this Book.

$P_{thCH}$                       electrical power applied to the internal correction heater of TPTF

$R_{i,j}$	thermal spreading resistance between measurement points $i$ and $j$ (unit: K/W)
$R_{sp}^{max}$	measured maximum spreading resistance (unit: K/W)
$R_{th,rear}$	thermal resistance from the Thermal Interface Surface to the environment (unit: K/W)
$t_a$	ambient temperature (unit: °C)
$t_{grad}$	temperature difference between measurement points $i$ and $j$ (unit: K)
$t_i$	temperature at measurement point $i$ (unit: °C)
$t_r$	highest of the temperatures at the predefined measurement points (unit: °C)
$V_{HFS}$	response of the heat flux sensor in calibration process (unit: mV)
$V_{LLE}$	response of the heat flux sensor in case of the LLE under test (unit: mV)
$\kappa$	heat flux conversion coefficient (unit: W/V) from sensor output to thermal power through the sensor.

## 1.8 Conventions

This Section 1.8 defines the notations and conventions used in the System Description Zhaga.

### 1.8.1 Cross references

Unless indicated otherwise, cross references to Sections in either this document or documents listed in Section 1.4 refer to the referenced Section as well as the sub Sections contained therein.

### 1.8.2 Informative text

With the exception of Sections that are marked as informative, informative text is set in italics.

### 1.8.3 Terms in capitals

All terms that start with a capital are defined in Section 1.5.

### 1.8.4 Units of physical quantities

Physical quantities are expressed in units of the International System of Units.

### 1.8.5 Decimal separator

The decimal separator is a comma (“,”).

## 2 System Overview (Informative)

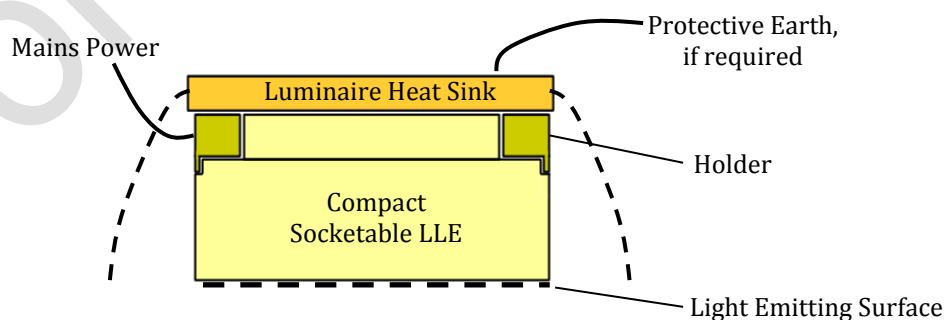
The Zhaga Interface Specification consists of a series of books, which define the interfaces between various kinds of LED Light Engines (LLE) and the Luminaires in which these LED Light engines can be applied. A LED Light Engine is a light source that complies with the provisions in one or more of the books in the Zhaga Interface Specification. Typically, a LED Light Engine consists of one or more LED Modules, associated Electronic Control Gear, and additional mechanical and/or optical components, which may be distributed across several separate enclosures. In the context of the Zhaga Interface Specification, a Luminaire is a lighting fixture, which is designed to operate with a LED Light Engine. Interchangeability of a LED Light Engine and a Luminaire can be recognized from the Zhaga logo, which is applied to the product and/or its associated documentation.

This Book 6 of the Zhaga Interface Specification defines a Compact Socketable LLE with integrated Electronic Control Gear. This is a particular kind of LED Light Engine, which contains the light source—typically one or more LED Modules—the Electronic Control Gear, and the optional optics in a single enclosure. A Compact Socketable LLE can be easily inserted into and removed from a Luminaire, without requiring the use of a special or general-purpose tool<sup>1</sup>. In particular, the Compact Socketable LLE defined in this Book 6 of the Zhaga Interface Specification can be locked into position by means of a twisting motion. For this purpose, this Book 6 of the Zhaga Interface Specification also defines a Holder, which is mounted inside the Luminaire to lock the Compact Socketable LLE into a clear, stable, and functional position.

A Luminaire typically comprises a Holder to lock the Compact Socketable LLE into position, a heat sink to carry away the heat generated in the Compact Socketable LLE, a possible reflector to reshape the optical output of the Compact Socketable LLE, means to supply electrical power to the Compact Socketable LLE, and means to attach the Luminaire to a wall, ceiling, stand, etcetera.

Figure 2-1 below illustrates the arrangement of the LLE, Holder, and Luminaire schematically. From this diagram, it is clear that there are several interfaces between these three components that affect interchangeability, namely:

- The mechanical interface, which defines the fit of the LLE in the Luminaire.
- The photometric interface, which defines the light output characteristics from the LLE.
- The electrical interface, which define the mains power requirements of the LLE.
- The thermal interface, which defines the heat management between the LLE and the Luminaire.
- The control interface, which defines the functionality to adjust the light output characteristics from the LLE.



**Figure 2-1: Schematic view of the assembly of a Compact Socketable LLE, Holder and Luminaire**

<sup>1</sup> However, note that depending on the industrial design of the Luminaire, it may be necessary to use a tool to open the Luminaire in order to reach the Socketable LED light Engine.

## Zhaga Interface Specification

### Book 6: LED Light Engine Type A

Compact Socketable LED Light Engine with Integrated Electronic Control Gear 90 mm ×42 mm Nominal  
2 System Overview (Informative) Edition 1.3

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Section 3 defines the mechanical interface. The enclosure of the LLE consists of a Base and a top construction. The Base is the part of the enclosure that locks in the Holder, and includes the electrical contacts and the mechanical fit Keying to distinguish between different mains voltages and power ranges. Section 3 defines the maximum outline of the complete enclosure—including Base and top construction—as well as details of the Base (including variants). In addition, Section 3 defines the Holder (including variants) that locks the LLE in the Luminaire.

Section 4 defines the photometric interface, which is characterized by the size and shape of the Light Emitting Surface of the LLE, the luminous flux, the luminous intensity distribution, color temperature, and the color rendering index (CRI). Section 4 defines a number of discrete ranges for the luminous flux.

Section 5 defines the electrical interface. The mains power interface of the LLE includes the mains voltage ranges for different regions as well as safety features such as insulation and protective earth.

Section 6 defines the thermal interface. This edition 1.3 of Book 6 of the Zhaga Interface Specification neither limits the amount of heat that the LLE may generate, nor the amount of heat a Luminaire should drain away.

Section 7 is intended to define the control interface in terms of generic functionalities.<sup>2</sup> This edition 1.3 of Book 6 of the Zhaga Interface Specification does not require a specific method to implement a generic functionality. Instead, relevant information is to be made available from the product's data sheet. This edition 1.3 of Book 6 of the Zhaga Interface Specification does not require control functionality other than mains power on/off.

Annex A defines a set of compliance testing procedures for both LED Light Engines and Luminaires. Products have to pass these tests in order to obtain the Zhaga logo, as a sign of interchangeability between LED Light Engines, now and in the future. The tests defined in Annex A verify compliance with the provisions that are specific to Book 6 of the Zhaga Interface Specification only. Products may be subject to additional testing as well, e.g. to show compliance with (local) regulations. However, such additional testing is outside the scope of this document.

Annex B defines the requirements for products data sheet.

Annex C informs safety requirements

Annex D records the history of change

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<sup>2</sup> An example of such a generic functionality is “dimmable to 10 % of the maximum light output.”

## 3 Mechanical Interface

### 3.1 Drawing Principles

All technical drawings that define the mechanical interfaces in Section 3 are made according to the principles defined in [ISO 128]. In general, the drawings use the first angle projection method defined in [ISO 128-30]. Unless indicated otherwise, dimensions are in millimeters.

The minimum and maximum values provided in tables that accompany the drawings represent absolute limits, without any implied tolerance (neither positive, nor negative); typical values as well as values between parentheses are informative, unless indicated otherwise.

### 3.2 Compact Socketable LLE

This Section 3.2 defines the mechanical properties of the LLE which has a GH76p Base [IEC 60061-d]. The mechanically non-interchangeable variants are defined for operation with different mains voltages, different engine power range. An additional variant is defined for operation with any mains voltage. (See Section 5.1 for the relation of the mechanical fit Keying and the mains voltage).

#### 3.2.1 Maximum outline

Figure 3-1 and Table 3-1 define the maximum outline of the LLE, in the case that it is not locked into a Holder. The demarcation line (2) divides the LLE into a Base and a top construction. The Base is defined in detail in Section 3.2.2. The top construction shall provide for a Light Emitting Surface that complies with the provisions of Section 4.1. Moreover, the extent of the top construction shall not exceed the volume defined by the diameter  $A3$  and the height  $BB$  above the Thermal Interface Surface (1).

(Informative) *Note that the LLE product does not need to have a clearly visible indication of the position of the demarcation line.*

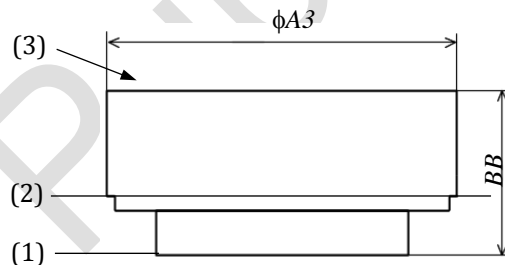


Figure 3-1: Maximum outline of a GH76p Compact Socketable LLE

Notes to Figure 3-1:

- (1) The Thermal Interface Surface shall consist of Thermal Interface Material (TIM), which may be compressible.
- (2) Demarcation line between the Base and top construction of the LLE.
- (3) Small notches or rims which may exist on the top surface of the LLE for easy twisting motion, are excluded from the dimension  $BB$ .

## Zhaga Interface Specification

Book 6: LED Light Engine Type A

Compact Socketable LED Light Engine with Integrated Electronic Control Gear 90 mm ×42 mm Nominal  
3 Mechanical interface

Edition 1.3

**Table 3-1: Maximum outline of a GH76p Socketable LLE**

Dimension	Minimum	Typical	Maximum	Notes
<i>A3</i>	NA	NA	92	For all types, (4)
<i>BB</i>	NA	NA	44	Up to 25 W or less class engine, (4)
	NA	NA	TBD	Greater than 25 W class engine, (4)

Notes to Table 3-1:

(4) *(informative) Any small LLE is acceptable which complies with Annex A.*

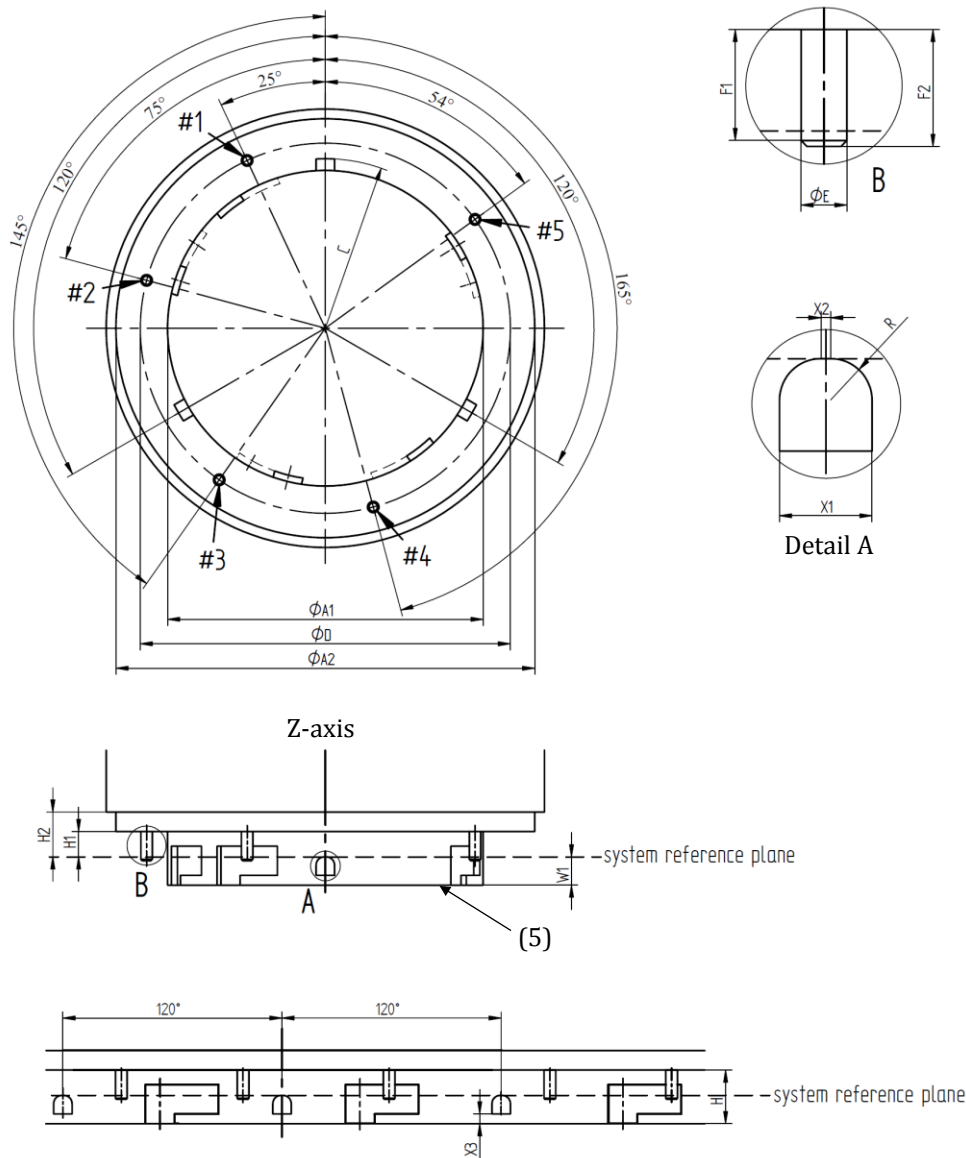


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**3.2.2 Common Base dimensions**

Figure 3-2 and Table 3-2 define the common dimensions of the Base. The Base typically has a cylindrical shape, and contains the following features:

- Three Mechanical Force Pins indicated in Detail A in Figure 3-2, which a Holder shall use to apply an axial force-parallel to the reference Z-axis to the LLE, in order to press the Thermal Interface Surface to the heat sink of the Luminaire (enabling proper thermal contact to be established.)
- Electrical contacts with two contacts for power supply from mains voltage and additional two contacts for control and one additional contact for earthing.
- Mechanical fit Keying features, which ensure that Socketable LLEs having different combination of Rated mains voltages and maximum power are not interchangeable. See Section 3.2.3 for the specific combinations of Keying features that may be present.



**Figure 3-2: Dimensions of Base GH76p**

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Notes to Figure 3-2:

- (5) The reference plane indicated as (1) in Figure 3-1 is the reference plane that includes the compression of the TIM.
- (6) The purpose of individual electrical contact pins are:
  - #1 is for mains voltage
  - #2 is for mains voltage
  - #3 is for additional control
  - #4 is for additional control
  - #5 is for functional earthing
- (7) Tolerance of all angles is  $\pm 0,5^\circ$

Table 3-2: Dimensions of the Base

Dimension	Minimum	Typical	Maximum	Notes
A1	64,60	64,90	65,20	(8)
A2	85,50	86,00	86,50	
C	34,80	35,00	35,20	
D	-	76,00	-	
E	2,29	2,54	2,67	
F1	5,47	-	-	
F2	5,80	6,00	6,20	(9)
H	-	11,65	-	
H1	5,20	5,50	5,80	
H2	9,20	-	-	
R	0,50	-	-	(10)
W1	5,90	6,15	6,40	
X1	3,65	3,80	3,95	
X2	0,30	-	-	(10)
X3	0,50	-	-	

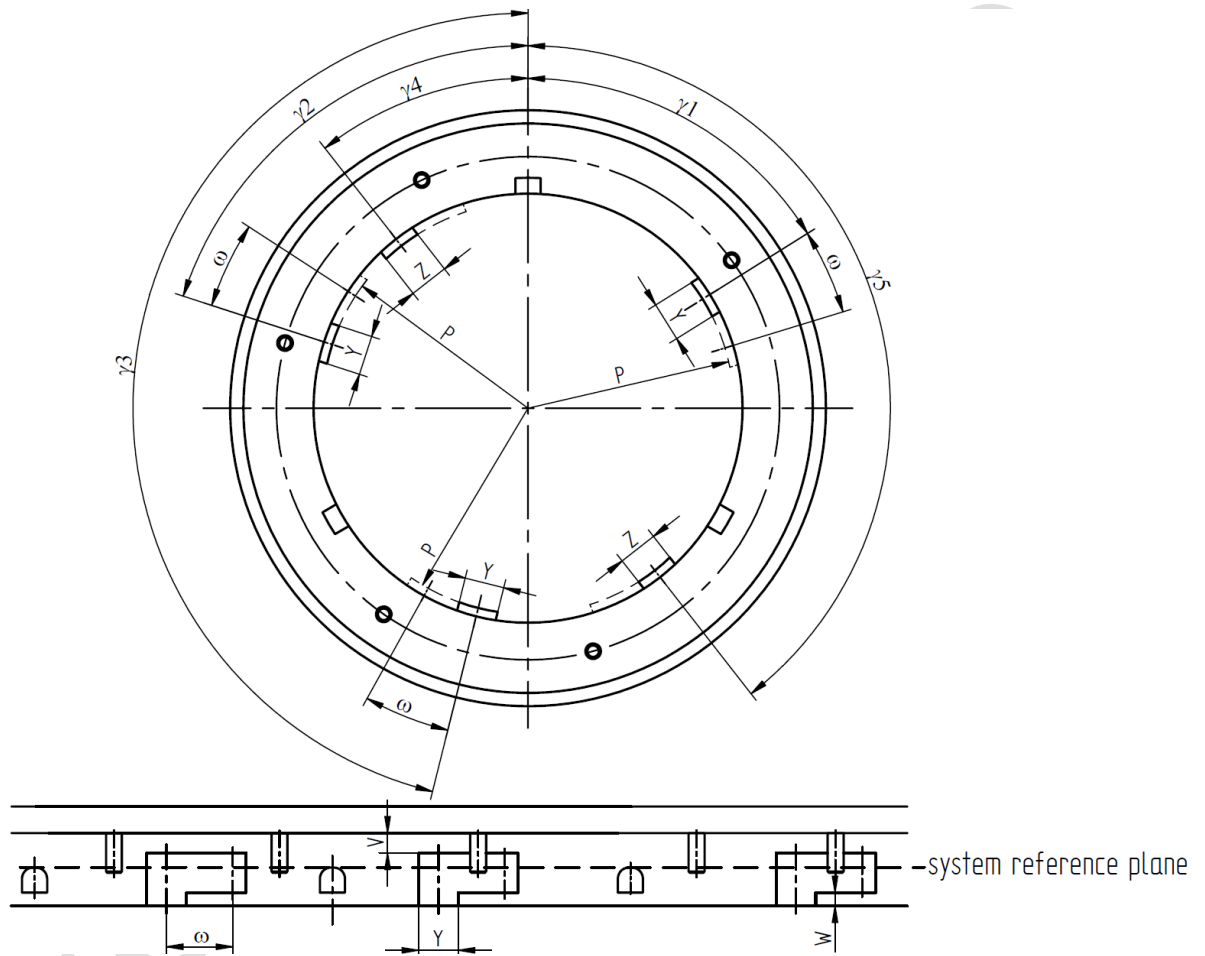
Notes to Table 3-2:

- (8) Diameter A1 Minimum is applied over the length of V and W, shown in Figure 3-3. A free movement of coding pins in the Holder must be ensured.
- (9) No sharp edges or burrs.
- (10) For design purpose only.

**3.2.3 Keying-specific definitions**

Figure 3-3 and Table 3-3 define the Keying for the mechanical fit of the Base. The Keying enables the design of Luminaires and Holders that ensure that a Compact Socketable LLE can be operated at its combination of Rated mains voltage and maximum power defined in Table 5-1. The mechanical fit Keying features consist of the following set:

As shown in Figure 3-3 and Table 3-3, the mechanical fit Keying features shall be used in specific combinations only.



**Figure 3-3: Base mechanical fit Keying definition (top view)**

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**Table 3-3: Base mechanical fit Keying definition**

Dimension	Minimum	Typical	Maximum	Notes
P	30,7	31	31,3	
V	-	-	2,2	
W	1,00	2,50	4,00	
Y	5,60	6,00	6,40	(11), (12)
	3,60	4,00	4,40	(13), (14)
	8,40	8,80	9,20	(15), (16)
Z	5,60	6,00	6,40	(15)
	NA	NA	NA	(11), (12), (13), (14), (16)
$\gamma_1$	-	58°	-	(11), (13)
	-	63°	-	(12), (14)
	-	60,5°	-	(15), (16)
$\gamma_2$	-	72°	-	(11), (13)
	-	67°	-	(12), (14)
	-	69,5°	-	(15), (16)
$\gamma_3$	-	166°	-	(11), (13)
	-	171°	-	(12), (14)
	-	168,5°	-	(15), (16)
$\gamma_4$	-	38°	-	(15)
	-	NA	-	(11), (12), (13), (14), (16)
$\gamma_5$	-	142°	-	(15)
	-	NA	-	(11), (12), (13), (14), (16)
$\omega$	-	15°	-	

Notes to Table 3-3:

- (11) For Base GH76p-1
- (12) For Base GH76p-2
- (13) For Base GH76p-3
- (14) For Base GH76p-4
- (15) For Base GH76p-5
- (16) For Base GH76p-6
- (17) Tolerance of all angles is  $\pm 0,5^\circ$ .

**3.2.4 Mass**

The mass of the LLE shall not exceed 0,300 kg.

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### 3.3 Holder GH76p

This Section 3.3 defines the mechanical properties of a Holder for the LLE with a GH76p Base [IEC 60061-d]. Six mechanically non-interchangeable variants are defined for use with different mains voltages and different maximum power range defined in Table 5-1. (See Section 5.1 for the relation of the mechanical fit Keying and the mains voltage).

Provisions in this Section 3.3 address the mechanical interface between the LLE and the Holder as well as the mechanical interface between the LLE and the Luminaire, and determine the position of the photometric interface and the thermal interfaces.

#### 3.3.1 Maximum outline

Figure 3-4 and Table 3-4 define the maximum outline of the Holder (both with and without a Compact Socketable LLE locked therein). Some of the details shown in Figure 3-4 apply to a GH76p Holder only, see Section 3.3.3. The Holder shall be mounted on a heat sink of a Luminaire.

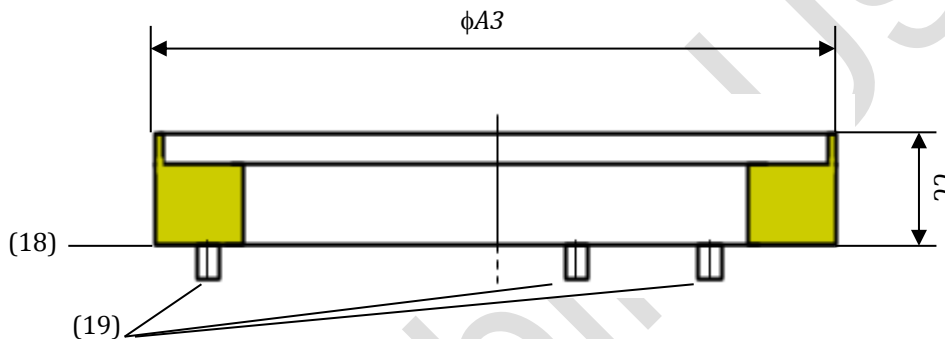


Figure 3-4: Maximum outline of a Holder

Notes to Figure 3-4:

- (18) The top surface of the heat sink.
- (19) Screw holes for attaching the Holder to a heat sink using M 3 screws. It is recommended that the heat sink provides screw holes of at least 4,50 mm depth. Screws may not be parts of the holder.

Table 3-4: Maximum outline of a Holder

Dimension	Minimum	Typical	Maximum	Notes
A3	NA	NA	92,00	
CC	NA	NA	15,20	(20)

Notes to Table 3-4:

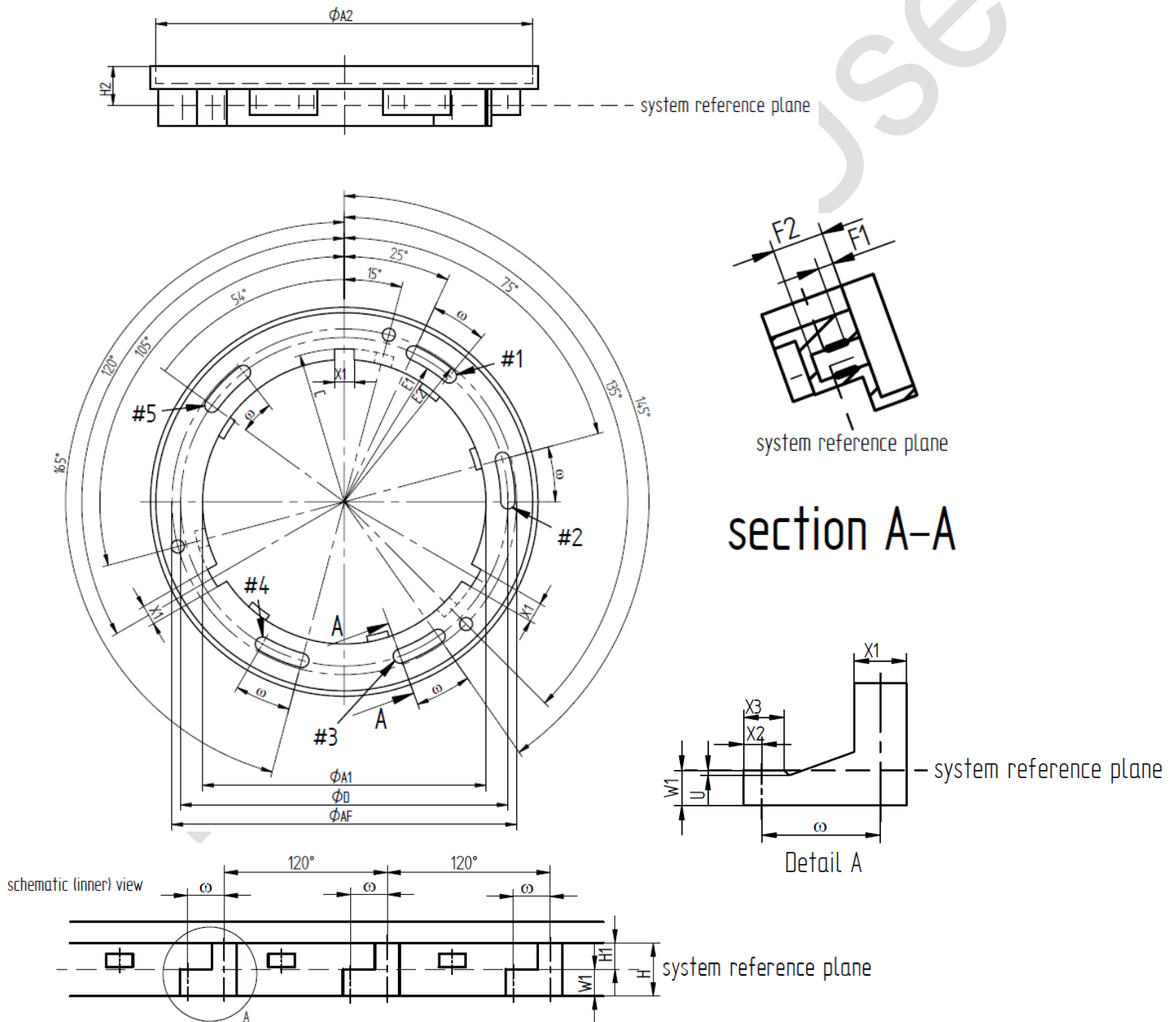
- (20) Dimension CC in Figure 3-4 shows Holder at the working position.

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**3.3.2 Common Holder dimensions**

Figure 3-5 and Table 3-5 define the common dimensions of the Holder. Some of the details in Figure 3-6 apply to a GH76p Holder only, see Section 3.3.3. The Holder has a circular opening to receive the Compact Socketable LLE, and contains the following features:

- Cut-outs for the Mechanical Force Pins and electrical contact carrier, such that the Compact Socketable LLE can be inserted in clockwise orientation only.
- Electrical contact pins are defined in Section 3.2.2, which are locked into the Holder.
- Mechanical fit Keying features, which ensure that the Holder can receive a Compact Socketable LLE of its combination of Rated mains voltage and maximum power defined in Table 5-1. See Section 3.3.3 for the specific combination of Keying features that may be present.



**Figure 3-5: Dimensions of Holder (containing some details of a GH76p Holder)**

Notes to Figure 3-5:

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- (21) (1) in Figure 3-1 is the reference plane locates the system reference of LLE in inserted and locked position.
- (22) The purpose of individual electrical contact pins are:
- #1 is for mains voltage
  - #2 is for mains voltage
  - #3 is for additional control
  - #4 is for additional control
  - #5 is for functional earthing.
- (23) Tolerance of all angles is  $\pm 0,5^\circ$ .

Table 3-5: Dimensions of Holder GH76p

Dimension	Minimum	Typical	Maximum	Notes
A1	65,50	65,80	66,10	
A2	87,00	87,50	88,00	
AF	79,20	79,50	79,70	
C	35,30	35,45	35,60	
D	-	76,00	-	
E1	36,15	36,35		
E2		39,65	39,95	
F1	1,00	-	2,00	
F2	6,20	-	-	
H	-	10,60	-	
H1	4,30	4,50	4,70	(24)
H2	8,30	8,50	8,70	(24)
U		0,40	-	
W1	-	(6,15)	-	(24)
X1	4,30	4,60	4,90	
X2		2,50		(25)
X3	3,00	-	-	(26)
$\omega$	-	15°	-	(27)



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Notes to Table 3-5:

- (24) System reference plane is shown in the locked position. In this position Mechanical Force Pins in of LLE push the force keys of the Holder.  
The Holder dimension W1 has to be taken from the base dimension W1 and shall be designed in a way, that the resulting force of the LLE to the heat sink will be at least 8 N and shall not exceed 40 N in locked position.  
H1 and H2 shall be designed in the way, that during rotation of LLE from the inserted position to the locked position, Holder shall not make collision to the LLE.
- (25) The mechanical stop of the LLE shall be applied by at least 1 force pin.
- (26) Dimension X3 defines the flat area for dimension X2 of the base.  
In case dimension X3 is not defined because of the shape of this portion, the gauge shall be used for testing.
- (27) It is allowed to increase  $\omega$  of #5 to achieve a first make of the earthing contact if possible.
- (28) Tolerance of all angles is  $\pm 0,5^\circ$ .

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### 3.3.3 Keying-specific dimensions

Figure 3-6 and Table 3-6 define the Keying of the mechanical fit of Holder GH76p. The Keying enables a Holder to discriminate between Compact Socketable LLEs that have different combination of Rated mains voltage and maximum power defined in Table 5-1.

As shown in Figure 3-6, the mechanical fit Keying features shall be used in specific combinations only.

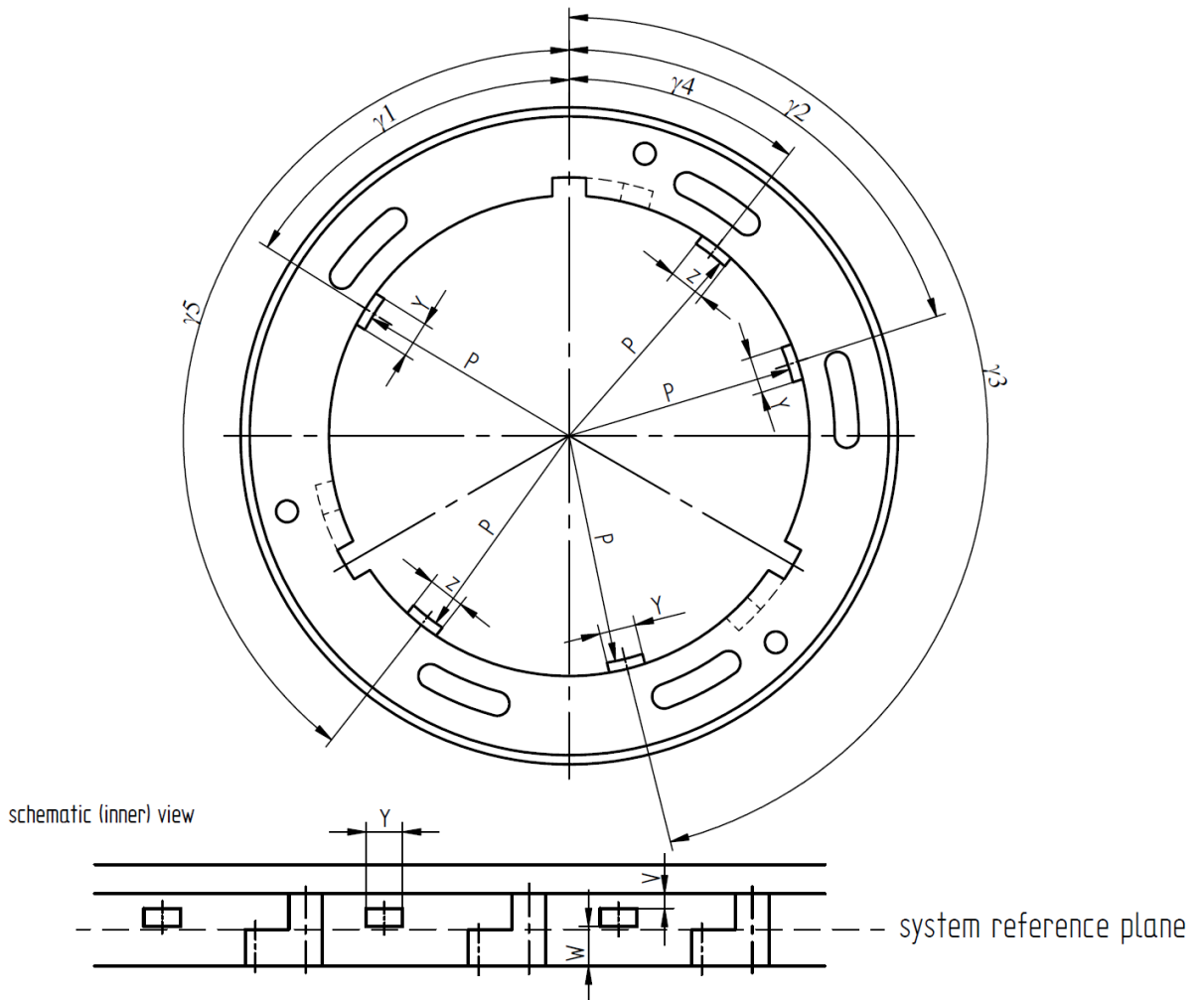


Figure 3-6: Holder mechanical fit Keying definition

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**Table 3-6: Holder mechanical fit Keying definition**

Dimension	Minimum	Typical	Maximum	Notes
P	31,40	31,60	31,80	
V	1,80	2,00	2,20	(29)
W	4,40	5,20	6,00	
Y	4,80	5,00	5,20	(30), (31)
	2,80	3,00	3,20	(32), (33)
	7,60	7,80	8,00	(34), (35)
Z	4,80	5,00	5,20	(34)
	NA	NA	NA	(30), (31), (32), (33), (35)
$\gamma_1$	-	58°	-	(30), (32)
	-	63°	-	(31), (33)
	-	60,5°	-	(34), (35)
$\gamma_2$	-	72°	-	(30), (32)
	-	67°	-	(31), (33)
	-	69,5°	-	(34), (35)
$\gamma_3$	-	166°	-	(30), (32)
	-	171°	-	(31), (33)
	-	168,5°	-	(34), (35)
$\gamma_4$	-	38°	-	(34)
	-	NA	-	(30), (31), (32), (33), (35)
$\gamma_5$	-	142°	-	(34)
	-	NA	-	(30), (31), (32), (33), (35)

Notes to Table 3-6:

- (29) V shall be designed in the way, that during rotation of LLE from the inserted position to the locked position, holder shall not make collision to the LLE.
- (30) For Holder GH76p-1
- (31) For Holder GH76p-2
- (32) For Holder GH76p-3
- (33) For Holder GH76p-4
- (34) For Holder GH76p-5
- (35) For Holder GH76p-6
- (36) Tolerance of all angles is  $\pm 0,5^\circ$ .

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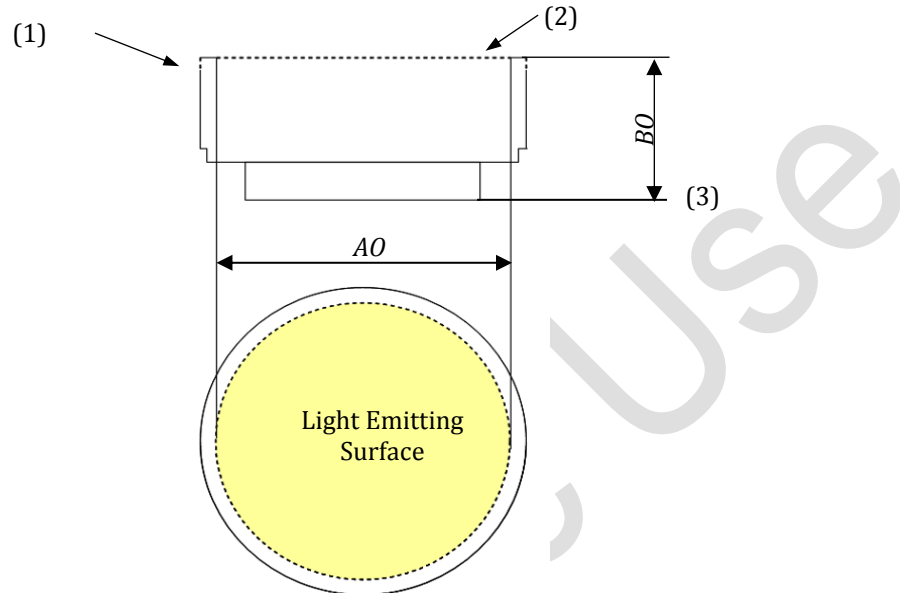
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## 4 Photometric Interface

### 4.1 Light Emitting Surface

As shown in Figure 4-1 and Table 4-1, the Light Emitting Surface shall have a circular shape with a diameter  $AO$ , and shall be positioned at height  $BO$  above the Thermal Interface Surface.



**Figure 4-1: Definition of Light Emitting Surface**

Notes to Figure 4-1:

- (1) The LLE may emit light from the side surface of the LLE. This area is excluded from Light Emitting Surface.
- (2) Small notches or rims which may exist on the top surface of the LLE for easy twisting motion, shall not affect to the light distribution characteristic.
- (3) Neither the minimum nor the maximum value of the height  $BO$  shall be violated due to any compression of the TIM.

**Table 4-1: Definition of Light Emitting Surface**

Dimension	Minimum	Typical	Maximum	Notes
$AO$	NA	NA	92	For all types, (1)
$BO$	NA	NA	44	Up to 25W or less class engine, (1)
	NA	NA	TBD	Greater than 25W class engine, (1)

Notes to Table 4-1:

- (4) (informative) Any small LLE is acceptable which complies with Annex A.

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#### 4.2 Operating conditions

In general, the optical output of the LLE depends on the operating conditions. For example, the luminous flux depends on the applied mains power and the temperature of the Thermal Interface Surface. This Section 4.2 defines the operating conditions that shall apply for the provisions of the photometric interface as defined in Section 4 of this Book 6 of the Zhaga Interface Specification. If the LLE is operated under different conditions, the optical properties of the LLE may differ from the provisions defined in Section 4.

If the LLE is operated under the conditions listed below,<sup>3</sup> the LLE shall comply with the provisions in Section 4:

- The LLE shall be locked into position in the Holder of Test Fixture OETF-GH76p.<sup>4</sup> The orientation of Test Fixture OETF-GH76p shall be vertical base up, unless the data sheet of the LLE indicates otherwise.
- Test Fixture OETF-GH76p shall be mounted in a draught free room. The ambient air temperature in the room shall be stable at  $(25 \pm 5)$  °C. Movement of the ambient air in the closed room shall be limited to air flow caused by the operation of the LLE in Test Fixture OETF-GH76p.
- Test Fixture OETF-GH76p shall be connected to mains power. The mains voltage and frequency shall be within 0,2 % of the Rated voltage and Rated frequency. The RMS summation of the harmonic components in the mains voltage shall not exceed 3 % of the fundamental frequency.
- Test Fixture OETF-GH76p shall actively regulate the temperature at the Thermal Interface Surface to be stable within 1 °C of the Rated operating temperature. The temperature shall be deemed stable if the difference between two consecutive temperature (unit: °C) measurements, taken at least 15 min apart, is less than 0,5 %.
- The optical output of the LLE shall not be affected in any way, by object(s)—reflectors, glass or plastic windows, heat sink features, etcetera—that are exterior to the LLE and Test Fixture OETF-GH76p.

#### 4.3 Luminous flux

The luminous flux of the LLE shall be in one of the flux categories listed in Table 4-2. For reporting the luminous flux on the data sheet of the LLE, the flux category name shall be used.

Table 4-2: Luminous flux categories

Flux category name	Luminous flux lm	
	Minimum	Maximum
C006	540	800
C008	720	1100
C011	990	1500
C015	1350	2000
C020	1800	2500
C025	2250	3000
C030	2700	4000
C040	3600	5000
C050	4500	N.A.

<sup>3</sup>(Informative) These conditions closely follow the operating conditions specified in [IES LM-79-08].

<sup>4</sup>See Annex A for a definition of Test Fixture OETF-GH76p.

## 4.4 Luminous intensity distribution

### 4.4.1 Beam angle<sup>5</sup>

The beam angle of the LLE shall be in one of the beam angle categories listed in Table 4-3. For reporting the beam angle on the data sheet of the LLE, the beam angle category name shall be used.

**Table 4-3: Beam angle categories**

Beam angle category name	Beam angle Range °	
	Minimum	Maximum
6	3	9
12	8	16
17.5	14	21
25	19	32
35	28	42
50	38	60
60	50	80
90	75	105
120	100	140

### 4.4.2 Luminous intensity uniformity

The Luminous Intensity shall not deviate from the averaged luminous intensity distribution of the LLE by more than  $\pm 20\%$  in each polar angle from  $-60^\circ$  to  $+60^\circ$  in any C - Plane. In the angles  $-65^\circ$  to  $-75^\circ$  and  $65^\circ$  to  $75^\circ$ , it shall not deviate by more than  $40\%$ . The C-Planes range from  $0^\circ$  to  $345^\circ$  in an  $15^\circ$  interval, whereas the polar angles range from  $0^\circ$  to  $180^\circ$  in an interval of  $5^\circ$ . See **Figure 4-2** in the next page.

## 4.5 Correlated color temperature

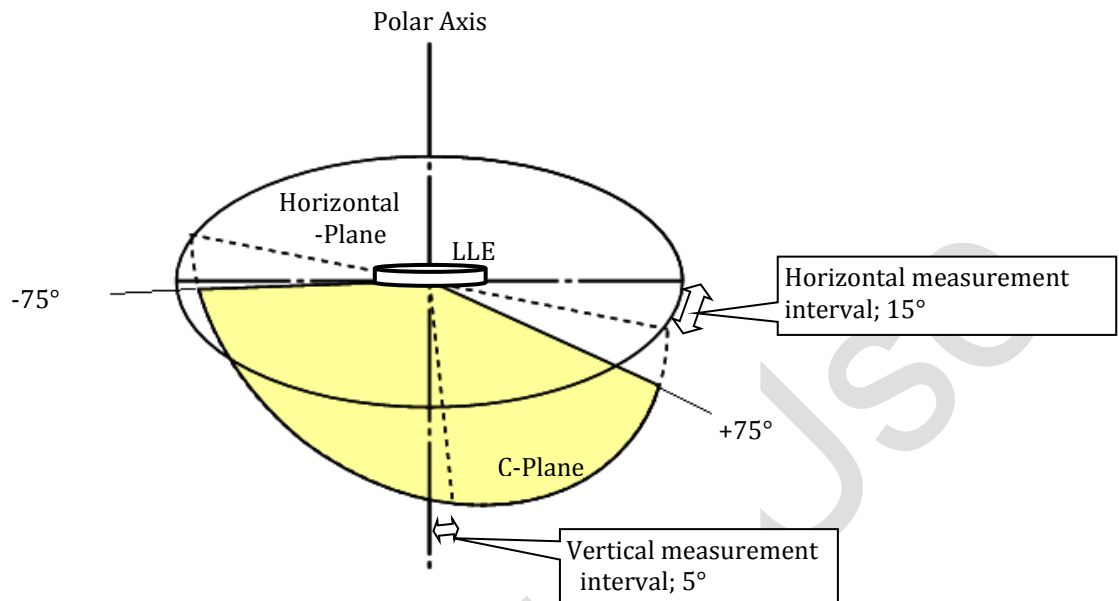
The correlated color temperature (CCT) of the LLE shall comply with the provisions of [ANSI C78.377] or [JIS Z9112], with the exception that the target color points may be chosen freely within the quadrangles defined therein.<sup>6</sup> It is recommended to use the nominal CCT values specified in [ANSI C78.377] or the category name of the quadrangle specified in [JIS Z9112].

## 4.6 Color rendering index

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define limits on the color rendering index of the LLE. However, this edition 1.3 of Book 6 of the Zhaga Interface Specification does require the data sheet of the LLE to provide the color rendering index at the Rated operating temperature (see Annex B.1).

<sup>5</sup>(Informative) See definition of Beam Angle in [IEC/TR 61341]

<sup>6</sup>Note that notwithstanding this exception, a Socketable LLE shall have a CCT that is within the quadrangle of the Rated CCT.



**Figure 4-2: Schematic explanation of measurement<sup>7</sup>**

<sup>7</sup>Figure 4-2 is the schematic explanation of measurement procedure according to [CIE121]



## 5 Electrical Interface

### 5.1 Mains input

#### 5.1.1 Maximum input

Table 5-1 lists the relation of the Keying of the mechanical fit to the appropriate mains power sources. In addition, Table 5-1 defines the maximum amount of power that the LLE shall consume.

**Table 5-1: Mains power mechanical fit codes Socketable LLE**

Fit code	Rated Voltage V	Rated Frequency Hz	Maximum Power W
GH76p-1	100...157	50 or 60	25
GH76p-2	200...277		
GH76p-3	100...157		35(U.C)
GH76p-4	200...277		
GH76p-5	100...277		25
GH76p-6			35(U.C)

#### 5.1.2 Holder mains power requirements

A Holder shall be able to handle power, current and voltage levels up to the levels defined in Table 5-2.

**Table 5-2: Mains power mechanical fit codes Holder**

Fit code	Rated Power W	Rated Current A	Rated Voltage V
GH76p-1	50	2	150
GH76p-2	50	2	500
GH76p-3	50	2	150
GH76p-4	50	2	500
GH76p-5	50	2	500
GH76p-6	50	2	500

#### 5.1.3 Protective earth

The insulation of the LLE shall be at least basic insulation [IEC 60598].

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## 6 Thermal Interface

### 6.1 Thermal interface model

Figure 6-1 illustrates the model for the thermal in to the environment of the Luminaire through the front side of the LLE by means of terface. The LLE is locked into position in the Holder and makes thermal contact with the heat sink of the Luminaire. The LLE generates an amount of heat, which is represented by the total thermal power  $P_{th} = P_{th,rear} - P_{th,front}$ . The part of the heat is transferred radiation and/or convection<sup>8</sup>. The  $P_{th,front}$  part of the heat is transferred to the environment of the Luminaire through the Thermal Interface Surface.

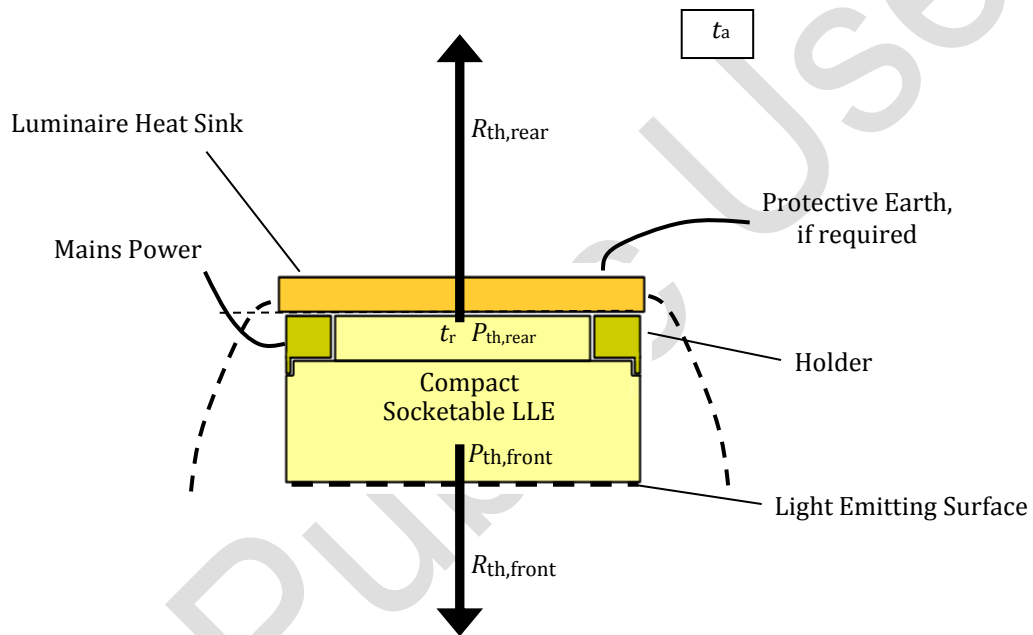


Figure 6-1: Thermal model

After switching on the LLE, the temperature of the Thermal Interface Surface starts to rise. In the steady state—with the LLE switched on—the Thermal Interface Surface reaches a temperature  $t_r$  (see Section 6.2.1 for the location of the measurement point). This temperature  $t_r$  depends on the temperature  $t_a$  of the environment of the Luminaire, the thermal resistance of the Luminaire, and the amount of heat generated in the LLE. Using a simple 1-dimensional model, the following relation is obtained:

$$t_r = t_a + R_{th,rear} \cdot P_{th,rear}$$

Here,  $R_{th,rear}$  is the thermal resistance, which the Luminaire presents to the LLE. Note that in general the temperature distribution across the Thermal Interface Surface is not uniform. See also Section 6.2.

This edition 1.3 of Book 6 of the Zhaga Interface Specification does neither define a maximum for the thermal resistance of the Luminaire, nor a maximum for the amount of heat generated in the LLE. Instead, this edition 1.3 of Book 6 of the Zhaga Interface Specification requires the LLE manufacturer to characterize the thermal performance—in terms of  $P_{th}$  and  $P_{th,rear}$ —of the LLE under the condition that

<sup>8</sup> A part of the heat is thought to be transferred to the environment through the side surface of the LLE. The part of heat is considered to be included in  $P_{th,front}$ .

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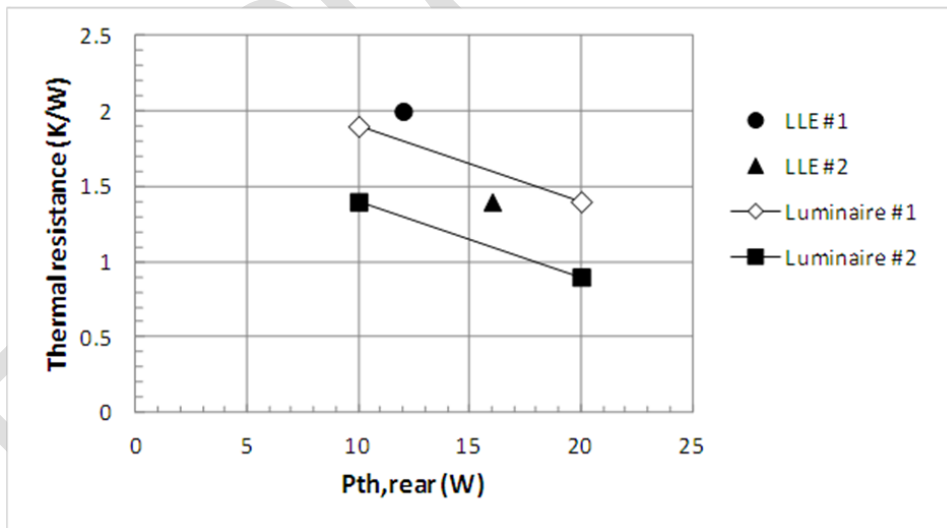
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the LLE is operated in Test Fixture OETF-GH76p and TPTF-GH76p<sup>9</sup> respectively, and provide the results on the data sheet of the LLE. See Annex B.1. Similarly, this edition 1.3 of Book 6 of the Zhaga Interface Specification requires a Luminaire manufacturer to characterize the thermal performance—in terms of  $R_{th,rear}$ —of the Luminaire under the condition that the Luminaire is operated with Thermal Test Engine TTE-GH76p locked into position, and provide the results on the data sheet of the Luminaire. See Annex B.3.

In order to determine if—from a thermal point of view—a particular Compact Socketable LLE can be used reliably in a particular Luminaire, it shall be verified that the applicable thermal resistance specified in the data sheet of the Luminaire is less than or equal to the thermal resistance specified in the data sheet of the LLE. Here, thermal power under which a thermal resistance of Luminaire is measured shall be smaller than or equal to the maximum thermal power at the Thermal interface surface of the LLE defined in the data sheet, see negative correlation in Figure 6-2. The applicable thermal resistance can be linearly approximated from thermal resistances corresponding to thermal powers specified in the data sheet of the Luminaire.

1. (Informative) In case of a closed Luminaire design, the total thermal power should be used instead of the thermal power applied at the Thermal Interface Surface.
2. (Informative) As an example of an open Luminaire, consider the information listed in the data sheets of particular Compact Socketable LLEs and Luminaires. Note that the numbers in this example are not necessarily realistic:

Compact Socketable LLE data sheets:	data sheet #1	data sheet #2
• Maximum total thermal power (unit: W)	16	18
• Maximum thermal power applied at the Thermal Interface (unit: W)	12	16
• Maximum allowable thermal resistance of the Luminaire (unit: K/W)	2	1,4
Luminaire data sheets	data sheet #1	data sheet #2
• Thermal Resistance at 10 W (unit: K/W)	1,9	1,4
• Thermal Resistance at 20 W (unit: K/W)	1,4	0,9



**Figure 6-2: Explanation of the thermal fit condition of LLE in Luminaire**

From these numbers it can be seen that Compact Socketable LLE #1 can be used reliably in both Luminaire #1 and #2, whereas Compact Socketable LLE #2 can be used reliably in Luminaire #2 only. Figure 6-2 visually explains the situations.

<sup>9</sup>Note that  $P_{th,rear}$  can be determined from the heat flow through the heat sink of the Luminaire to the environment. In addition,  $P_{th}$  can be determined from the electrically consumed power  $P_{el}$  and radiated optical power  $P_{vis}$  using the relation . See Annex A.2.4 for details on specific measurement methods.

## 6.2 Thermal uniformity

### 6.2.1 Thermal interface temperature uniformity requirement

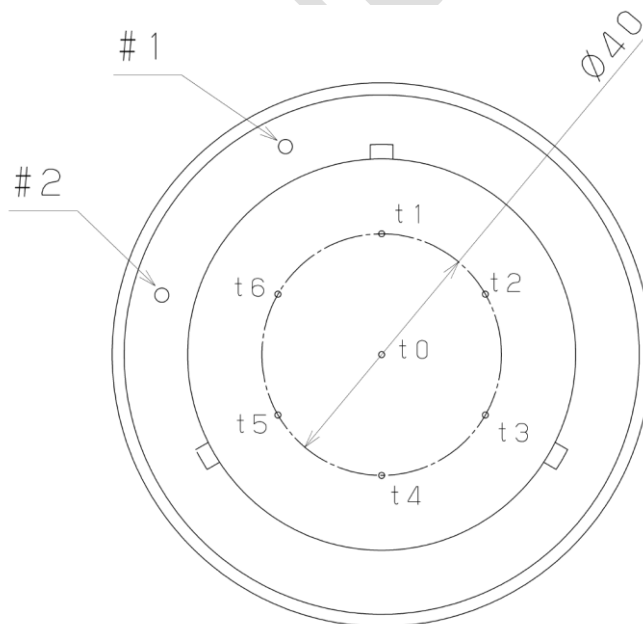
The non-uniformity of the temperature distribution across the Thermal Interface Surface depends on the details of the construction of both the LLE and the Luminaire. This edition 1.3 of Book 6 of the Zhaga Interface Specification does not restrict this non-uniformity in the case of an arbitrary Socketable LLE being operated in an arbitrary Luminaire. Instead, this edition 1.3 of Book 6 of the Zhaga Interface Specification restricts the non-uniformity in the case of an arbitrary Socketable LLE being operated in Test Fixture TUTF-GH76p:

The non-uniformity of the temperature distribution across the Thermal Interface Surface shall be such that the thermal spreading resistance  $R_{i,j}$  between any pair of the measurement points shown in Figure 6-3 is at most 0,2 K/W. Here, the thermal spreading resistance between two measurement points  $i$  and  $j$  is defined as:

$$R_{i,j} = \frac{t_i - t_j}{P_{th,rear}}$$

Here  $t_i$  and  $t_j$  are the temperatures at the measurement points  $i$  and  $j$ , located on the heat sink surface of Test Fixture TUTF-GH76p that makes physical contact with the Thermal Interface Surface, and  $P_{th,rear}$  is the amount of heat that is transferred through the Thermal Interface Surface (see Section 6.1). Measurement point 0 is at the center of the Thermal Interface Surface i.e. at the center of dimension  $\phi A1$  of the LLE, see Figure 3-2 and Table 3-2 in Section 3.2.2. Measurement points  $i = 1, 2, \dots, 6$  are located equidistantly on a circle, which is centered on measurement point 0 and has a diameter of  $40 \pm 1$  mm. Moreover, the orientation of the measurement points is such that measurement points 1 to 6 are located against the position of pin #1 and #2 (see Figure 3-2 in Section 3.2.2). The highest temperature value  $t_i$ ,  $i = 0, 1, 2, \dots, 6$  at these measurement points shall be used as the temperature  $t_r$  defined in Section 6.1.

The exact operating conditions for the above restriction are listed in Sections 6.2.2 below.



**Figure 6-3: Temperature distribution at the thermal interface**

### 6.2.2 Compact Socketable LLE operating conditions

The temperature non-uniformity in the case of an arbitrary Compact Socketable LLE being operated in Test Fixture TUTF-GH76p shall be determined under the conditions listed below:<sup>10</sup>

- The LLE shall be locked into position in the Holder of Test Fixture TUTF-GH76p. The orientation of Test Fixture TUTF-GH76p shall be vertical base up, unless the data sheet of the LLE indicates otherwise.
- Test Fixture TUTF-GH76p shall be mounted in a draught free room. The ambient air temperature in the room shall be stable at  $(25 \pm 5)$  °C. Movement of the ambient air in the closed room shall be limited to air flow caused by the operation of the LLE in Test Fixture TUTF-GH76p.
- Test Fixture TUTF-GH76p shall be connected to mains power. The mains voltage and frequency shall be within 0,2 % of the Rated voltage and Rated frequency. The RMS summation of the harmonic components in the mains voltage shall not exceed 3 % of the fundamental frequency.
- The temperature of the Thermal Interface Surface shall be stable. The temperature shall be deemed stable if the difference between two consecutive temperature measurements (unit: °C) at the same measurement point in all measurement points  $i = 0, 1, 2, \dots, 6$  taken at least 15 min apart, is less than 0,5 %.

<sup>10</sup>(Informative) *These conditions closely follow the operating conditions specified in [IES LM-79-08].*

## 7 Control Interface

This edition 1.3 of Book 6 does not define means to control the light output characteristics of the LED Light Engine other than mains power on/off. LED Light Engines that include other control functionality shall provide relevant information in the Product Data Set. In particular, LED Light Engines may include dimming functionality.

Whereas this edition 1.3 of Book 6 does not define a specific technology to realize such dimming functionality, the Product Data Set shall provide at least the following information if the product is to be considered dimmable:

- The required dimming technology, such as phase cut dimming, 0-10V, DALI, etc. Phase cut dimming should comply with the provisions of existing and/or future standards, such as [ NEMA SSL 7A], etc.
- The expected ratio of the minimum and maximum total luminous flux when dimmed —i.e. a low-end dimming percentage such as 10%, 20%, etc.

In addition, it is recommended that the Product Data Set provides information on compatible controls.

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## Annex A Compliance Testing (Normative)

### A.1 Specific testing tools

#### A.1.1 Compact Socketable LLE testing tools

This section of Book 6 specifies testing tools on mechanical, photometrical, electrical and thermal interfaces of the LLE.

For gauges to test dimensional interface, unless specified otherwise, all sharp angles should be chamfered or rounded with a dimension  $R < 0,2$  mm, in accordance with [IEC 60061]. In addition, unless specified otherwise, the gauges shall be manufactured from stainless steel, which is hardened to at least 55 HRC and should have a surface finish of  $R_a = 0,4$   $\mu\text{m}$ .

No undue force shall be used to fit a Compact Socketable LLE under test to any of the gauges.

Mechanical interface may be tested by other means.

##### A.1.1.1 Gauges

Table A-1: Base Gauge list

Section	Gauge name	Purpose	Notes
A.1.1.1.1	MTG-6-B1	To check dimensions W1 maximum and W1 minimum.	
A.1.1.1.2	MTG-6-B2	To check dimensions H1 maximum and H1 minimum.	
A.1.1.1.3	MTG-6-B3	To check dimensions A2 maximum and H2 minimum.	
A.1.1.1.4	MTG-6-B4	To check dimensions of E maximum, E minimum, F2 maximum and F1 minimum.	
A.1.1.1.5	MTG-6-B5	To check dimensions and the alignment of electrical contact pins.	
A.1.1.1.6	MTG-6-B6	To check dimension A1 maximum, X1 maximum, X1 minimum and correct alignments of force keys and voltage keys.	
	MTG-6-B7		
	MTG-6-B8		
	MTG-6-B9		
	MTG-6-B10		
	MTG-6-B11		

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### A.1.1.1.1 Gauges MTG-6-B1

Figure A-1 and Table A-2 define W1 Go and Not-go gauge MTG-6-B1.

PURPOSE : To check dimensions W1 maximum and W1 minimum.

TESTING : Put the test LLE on a flat molding board TIM side down and put the gauge on it surface 0 down. Slide the gauge over a force key of the test LLE. A test force key shall pass the surface X part of the gauge and not pass the surface Y part of the gauge. Three force pins shall be tested independently.

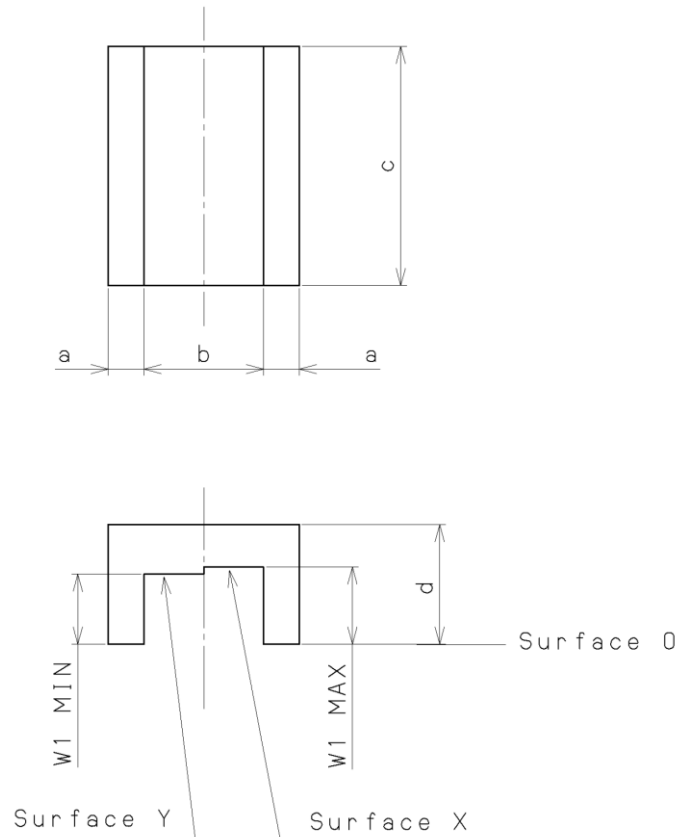


Figure A-1: Dimensions of MTG-6-B1

Table A-2: Dimensions of MTG-6-B1

Dimension	Nominal	Tolerance	Notes
W1 MAX	6,45	-0,02	
W1 MIN	5,85	+0,02	
a	3,00	± 0,10	
b	10,00	± 0,10	
c	20,00	± 0,10	
d	10,00	± 0,10	

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### A.1.1.1.2 Gauges MTG-6-B2

Figure A-2 and Table A-3 define dimensions Go and Not-go gauge MTG-6-B2.

PURPOSE : To check dimensions H1 maximum and H1 minimum.

TESTING : Put surface 0 of the gauge to the corresponding surface of the test LLE, where electrical contact pins are located. Slide the gauge under a force key of the test LLE. A test force key shall pass the surface X part of the gauge and not pass the surface Y part of the gauge. Three force pins shall be tested independently.

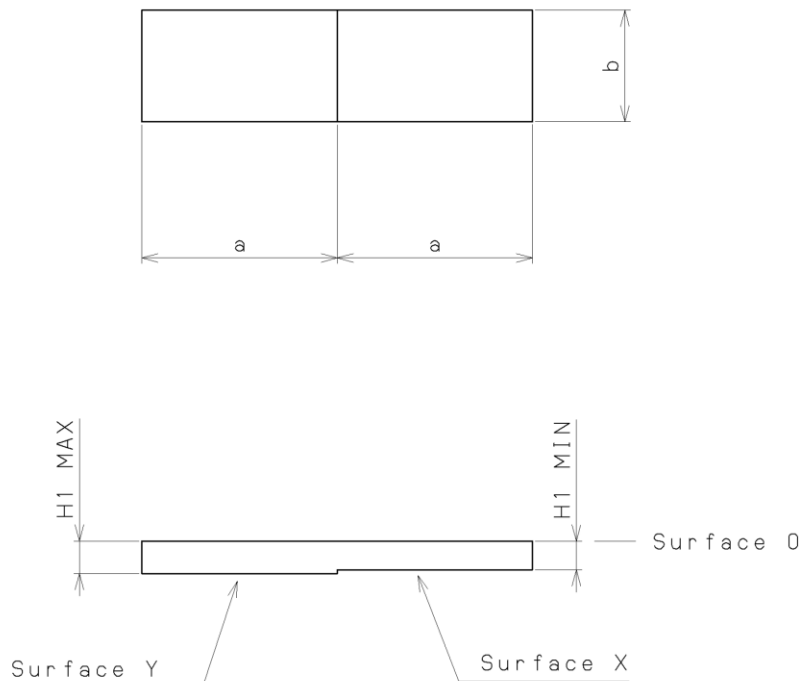


Figure A-2: Dimensions of MTG-6-B2

Table A-3: Dimensions of MTG-6-B2

Dimension	Nominal	Tolerance	Notes
H1 MAX	5,85	-0,02	
H1 MIN	5,15	+0,02	
a	35,00	± 0,10	
b	20,00	± 0,10	

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### A.1.1.1.3 Gauges MTG-6-B3

Figure A-3 and Table A-4 define Go gauge MTG-6-B3.

PURPOSE : To check dimensions A2 maximum and H2 minimum.

TESTING : The gauge shall be inserted into the test LLE. The gauge shall be rotated to the stop position keeping surface 0 touching to the corresponding LLE surface.

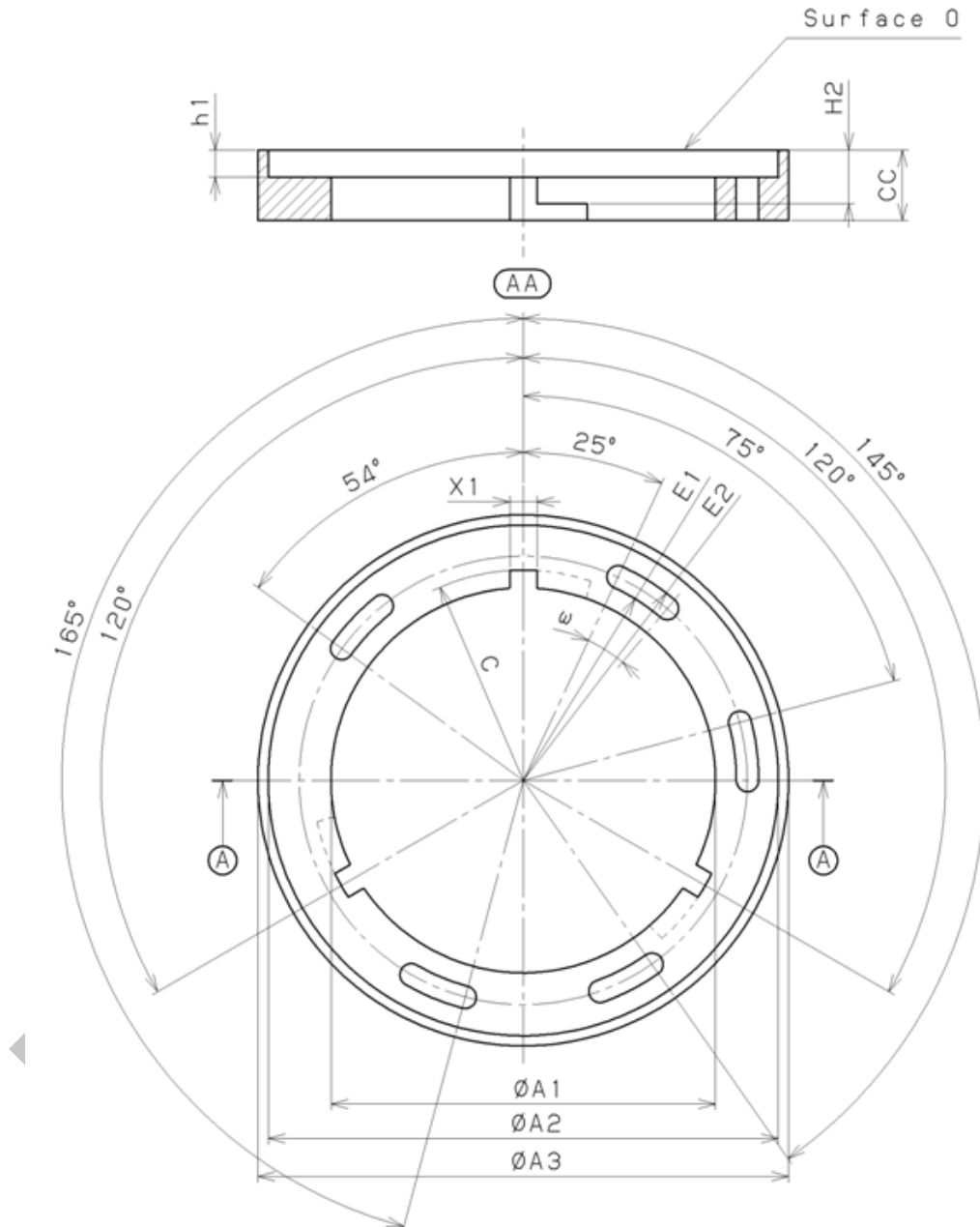


Figure A-3: Dimensions of MTG-6-B3

Note to Figure A-3

- (1) Tolerance of all angles is  $\pm 0,5^\circ$

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Table A-4: Dimensions of MTG-6-B3

Dimension	Nominal	Tolerance	Notes
A1	65,40	± 0,10	
A2	86,55	-0,02	
A3	90,00	± 0,10	
C	35,00	± 0,05	
CC	12,00	± 0,10	
E1	36,10	± 0,05	
E2	40,00	± 0,05	
H2	9,15	+0,02	
h1	4,60	± 0,10	
ω	15°	-	
X1	4,60	± 0,10	

Note to Table A-4

(2) Tolerance of the angle is ± 0,5°

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#### A.1.1.1.4 Gauges MTG-6-B4

Figure A-4 and Table A-5 define Go and Not-go electrical pin gauge MTG-6-B4.

**PURPOSE :** To check dimensions of E maximum, E minimum, F2 maximum and F1 minimum.

**TESTING :** Each individual electrical pin shall enter hole e1 at surface 0 until the face of the pin and the surface of the gauge contact. In this position the end of F1 dimension part shall be co-planar with or project beyond surface X, but the end of pin which is the end of F2 dimension shall not project beyond surface Y. Each individual electrical pin shall not enter hole e2.

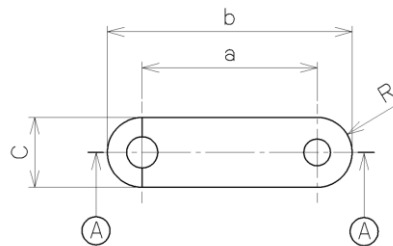
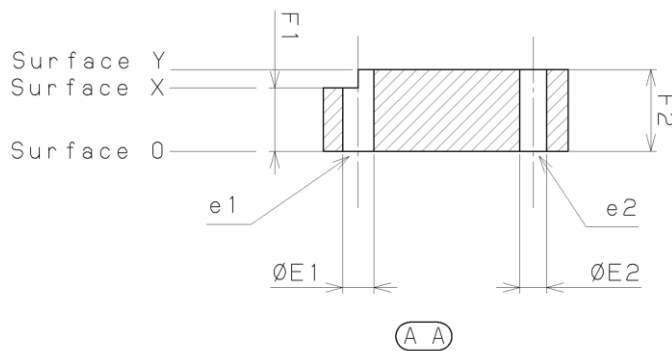


Figure A-4: Dimensions of MTG-6-B4

Table A-5: Dimensions of MTG-6-B4

Dimension	Nominal	Tolerance	Notes
E1	2,67	+0,01	
E2	2,29	-0,01	
F1	5,42	+0,02	
F2	6,25	-0,02	
a	15,00	$\pm 0,10$	
b	21,00	$\pm 0,10$	
c	6,00	$\pm 0,10$	
R	3,00	-	

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#### A.1.1.1.5 Gauges MTG-6-B5

Figure A-5 and Table A-6 define electrical pin alignment Go gauge MTG-6-B5.

PURPOSE : To check dimensions and the alignment of electrical contact pins.

TESTING : The gauge shall be fully inserted to the test LLE.

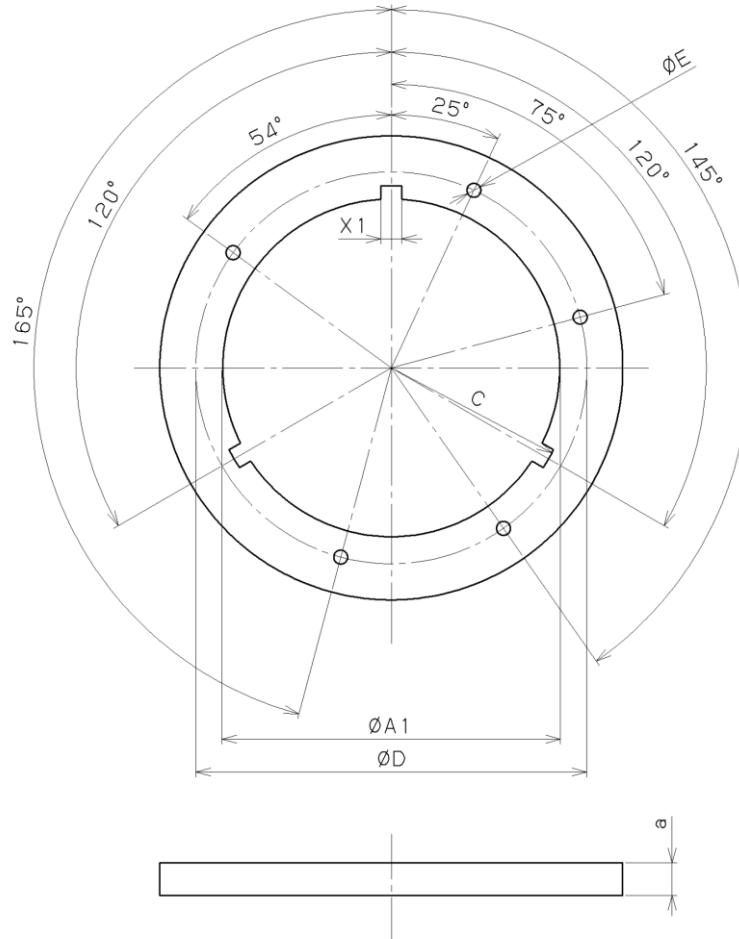


Figure A-5: Dimensions of MTG-6-B5

Note to Figure A-5

(3) Tolerance of all angles is  $\pm 0,5^\circ$

Table A-6: Dimensions of MTG-6-B5

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Dimension	Nominal	Tolerance	Notes
A1	65,80	± 0,02	
C	35,30	± 0,02	
D	76,00	± 0,02	
E	2,72	+0,02	
X1	4,30	-0,02	
a	6,30	± 0,10	



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#### A.1.1.1.6 Gauges MTG-6-B6, Gauges MTG-6-B7, Gauges MTG-6-B8, Gauges MTG-6-B9, Gauges MTG-6-B10, Gauges MTG-6-B11

Figure A-6, Table A-7 and Table A-8 define Go and Not-go gauge for all keys.

PURPOSE : To check dimension A1 maximum, X1 maximum, X1 minimum and correct alignments of force pins and voltage keys.

TESTING : The gauge shall be inserted into the test LLE and be rotated to the stop position. The test base shall fulfill Go/Not-go requirements for 6 gauges specified in Table A-7.

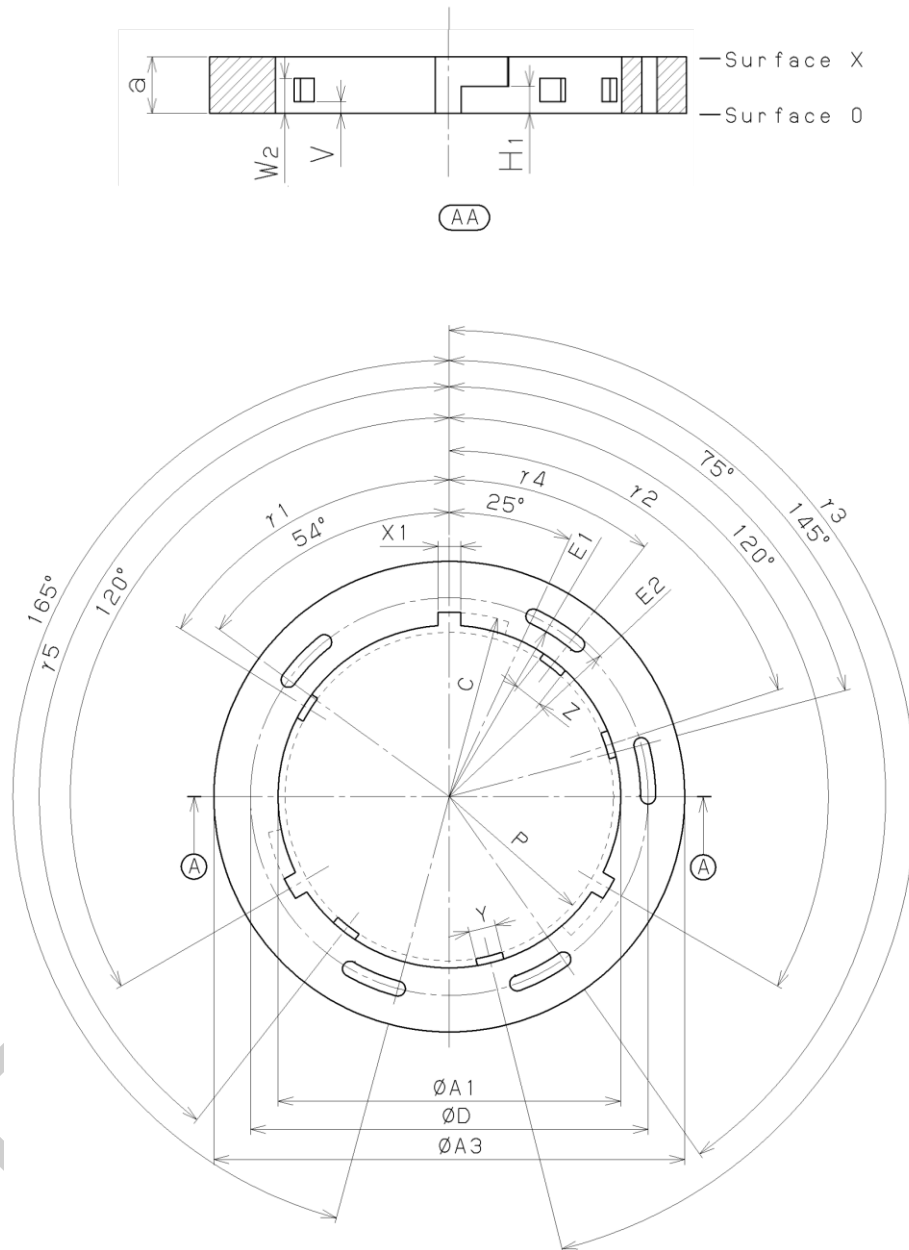


Figure A-6: Dimensions of MTG-6-B6

Note to Figure A-6

(4) Tolerance of all angles is  $\pm 0,5^\circ$

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**Table A-7: Combinations of Go/Not go Gauges**

Gauge \ Base	Base	GH76p-1	GH76p-2	GH76p-3	GH76p-4	GH76p-5	GH76p-6
MTG-6-B6	Go	Not go	Not go	Not go	Not go	Go	Go
MTG-6-B7	Not go	Go	Not go	Not go	Not go	Go	Go
MTG-6-B8	Go	Not go	Go	Not go	Not go	Go	Go
MTG-6-B9	Not go	Go	Not go	Not go	Go	Go	Go
MTG-6-B10	Not go	Not go	Not go	Not go	Not go	Go	Not go
MTG-6-B11	Not go	Not go	Not go	Not go	Not go	Go	Go

**Table A-8: Dimensions of MTG-6-B6, MTG-6-B7, MTG-6-B8, MTG-6-B9, MTG-6-B10, and MTG-6-B11**

Dimension	Nominal	Tolerance	Notes
A1	65,50	-0,02	
A3	90,00	± 0,10	
C	35,30	-0,02	
D	76,00	± 0,10	
E1	36,15	-0,1	
E2	39,95	+0,1	
H1	5,15	+0,02	
P	31,40	-0,02	
V	2,25	-0,02	
W2	7,05	-0,02	
X1	4,30	-0,02	(11)
a	10,60	± 0,10	
Y	5,20	+0,02	(5), (6)
	3,20	+0,02	(7), (8)
	8,00	+0,02	(9), (10)
Z	5,20	+0,02	(9)
	NA		(5), (6), (7), (8), (10)

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$\gamma_1$	58°	-	(5), (7)
	63°	-	(6), (8)
	60,5°	-	(9), (10)
$\gamma_2$	72°	-	(5), (7)
	67°	-	(6), (8)
	69,5°	-	(9), (10)
$\gamma_3$	166°	-	(5), (7)
	171°	-	(6), (8)
	168,5°	-	(9), (10)
$\gamma_4$	38°	-	(9)
	NA	-	(5), (6), (7), (8), (10)
$\gamma_5$	142°	-	(9)
	NA	-	(5), (6), (7), (8), (10)

Notes to Table A-8:

- (5) For Base GH76p-1
- (6) For Base GH76p-2
- (7) For Base GH76p-3
- (8) For Base GH76p-4
- (9) For Base GH76p-5
- (10) For Base GH76p-6
- (11) In addition, dimensions of X1 in the test LLE shall be measured by a caliper.
- (12) Tolerance of all angles is  $\pm 0,5^\circ$ .

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### A.1.2 Holder mechanical testing tools

This section of Book 6 specifies testing tools on mechanical and electrical interface of the holder for Compact Socketable LLE.

For gauges to test dimensional interface, unless specified otherwise, all sharp angles should be chamfered or rounded with a dimension  $R < 0,2$  mm, in accordance with [IEC 60061]. In addition, unless specified otherwise, the gauges shall be manufactured from stainless steel, which is hardened to at least 55 HRC and should have a surface finish of  $R_a = 0,4$   $\mu\text{m}$ .

No undue force shall be used to fit a Holder under test to any of the gauges.

Mechanical interface may be tested by other means.

#### A.1.2.1 Gauges

Table A-9: Holder Gauge list

Section	Gauge name	Purpose	Notes
A.1.2.1.1	MTG-6-H1	To check proper acceptance of a base GH76p with respect to critical height dimensions F2, H1, H2, V, W and W1 of the Holder, especially during insertion and withdrawal.	
A.1.2.1.2	MTG -6-H2	To test contact making in Holder GH76p	
A.1.2.1.3	MTG -6-H3	To check existence of coding pins by maximum diameter of P.	
A.1.2.1.4	MTG -6-H4	To check maximum diameter A1 to ensure sufficient overlap between force pins and Holder.	
A.1.2.1.5	MTG -6-H5	To check proper acceptance of a base GH76p with respect to critical minimum Holder dimensions A1, C, P, X1.	
A.1.2.1.6	MTG -6-H6	To check proper acceptance of the relevant base keys GH76p in the Holder. Additionally non-interchangeability with other keys is checked.	
	MTG -6-H7		
	MTG -6-H8		
	MTG -6-H9		
	MTG -6-H10		
A.1.2.1.7	MFG-6-H1	To check the minimum and maximum forces applied to the LLE by the Holder under test.	
	MFG-6-H2		

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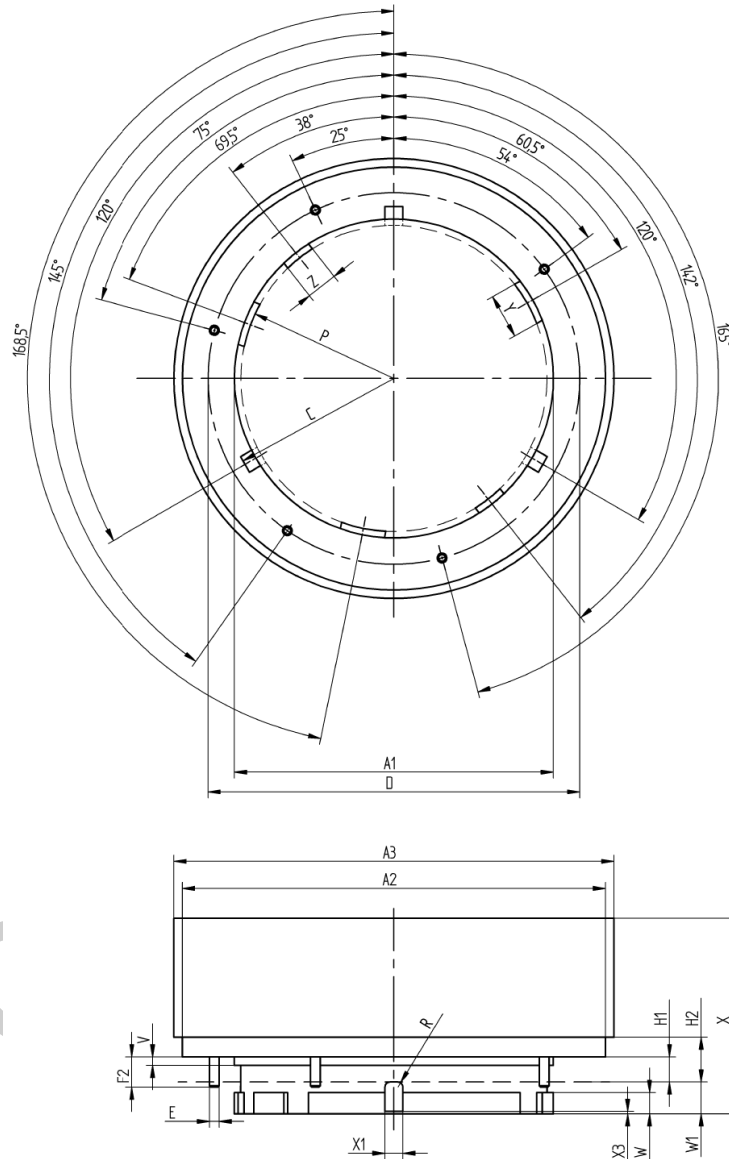
Annex A Compliance Testing (Normative)

#### A.1.2.1.1 Gauges MTG -6-H1

Figure A-7 and Table A-10 define Go gauge MTG-6-H1.

**PURPOSE :** To check proper acceptance of a base GH76p with respect to critical height dimensions F2, H1, H2, V, W and W1 of the Holder, especially during insertion and withdrawal.

**TESTING ;** It shall be possible to fully insert the gauge into the Holder and turn it in a clockwise direction until it reaches the stop position.



**Figure A-7: Dimensions of MTG -6-H1**

Note to Figure A-7

(13) Tolerance of all angles is  $\pm 0,5^\circ$ .

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Table A-10: Dimensions of MTG -6-H1

Dimension	Nominal	Tolerance	Notes
A1	65,20	± 0,10	
A2	86,50	± 0,10	
A3	90,00	± 0,10	
C	35,20	± 0,10	
D	76,00	± 0,10	
E	2,00	± 0,10	
F2	6,20	- 0,02	
H1	5,15	- 0,02	
H2	9,15	- 0,02	
P	31,30	± 0,05	
R	1,00	± 0,10	
V	1,75	- 0,02	
W	4,35	+ 0,02	
W1	6,50	+ 0,02	
X1	3,65	± 0,10	
X3	0,50	± 0,10	
X	50	± 0,10	
Y	9,20	± 0,10	
Z	6,40	± 0,10	

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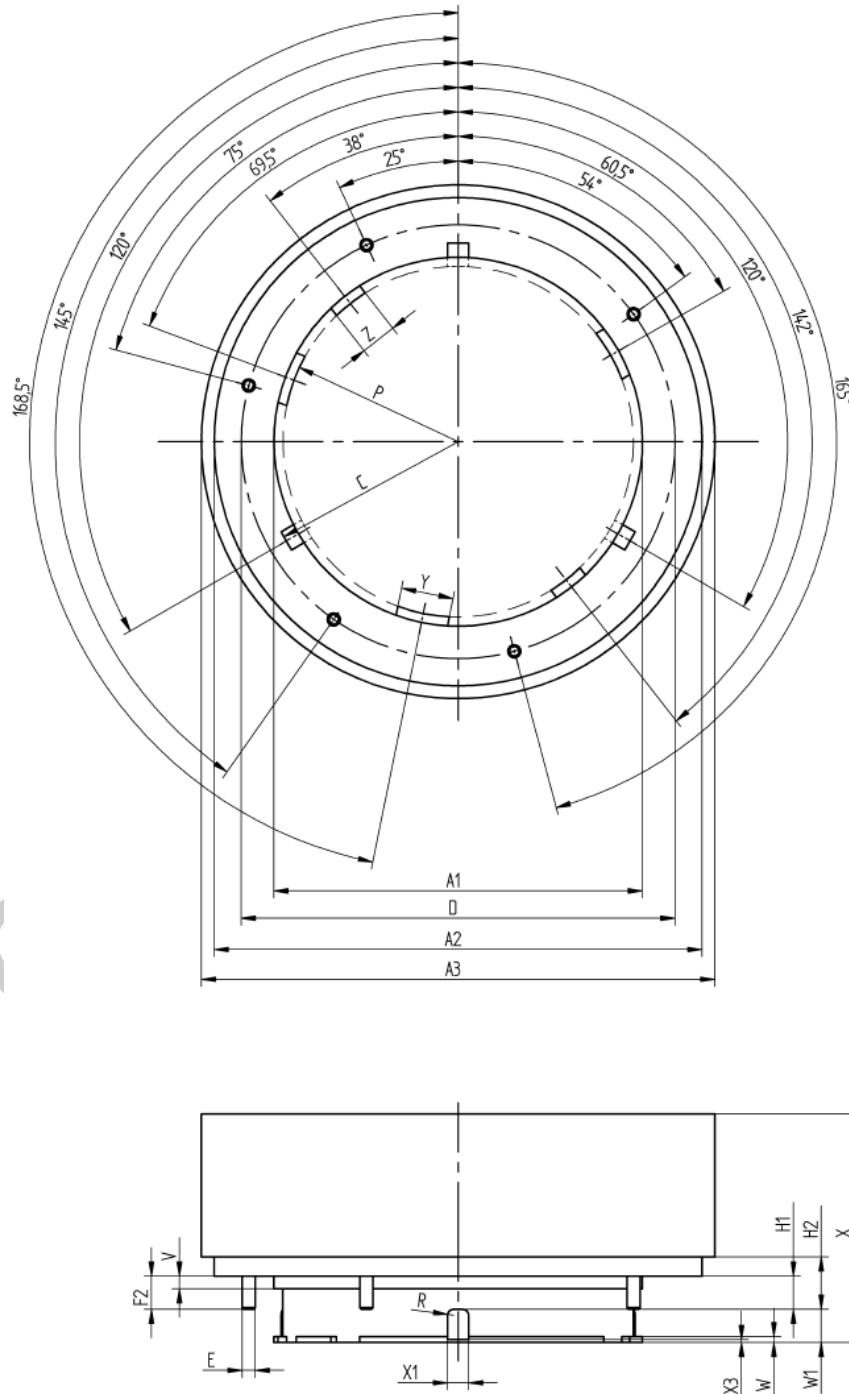
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#### A.1.2.1.2 Gauges MTG -6-H2

Figure A-8 and Table A-11 define Gauge for checking contact making MTG -6-H2.

PURPOSE : To test contact making in Holder GH76p.

TESTING : The Holder is connected at one contact to the test circuit as shown. With the gauge fully inserted the second test circuit connection is connected to each of the remaining Holder contacts. The Holder shall be assumed to be correct if the indicator lamp lights up and remains alight when all possible operating positions, including most unfavorable position, of a LLE are simulated.



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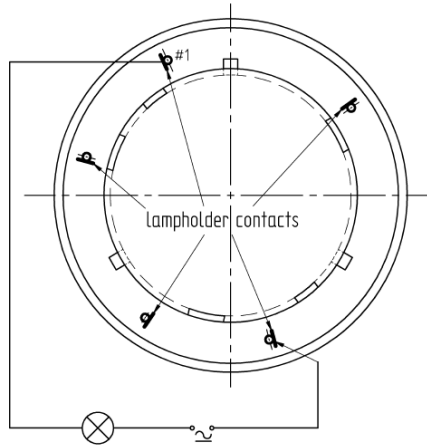


Figure A-8: Dimensions of MTG -6-H2

Note to Figure A-8

(14) Tolerance of all angles is  $\pm 0,5^\circ$ .

Table A-11: Dimensions of MTG -6-H2

Dimension	Nominal	Tolerance	Notes
A1	64,60	$\pm 0,10$	
A2	85,50	$\pm 0,10$	
A3	90,00	$\pm 0,10$	
C	34,80	$\pm 0,10$	
D	76,00	$\pm 0,01$	
E	2,29	$\pm 0,01$	
F2	5,80	- 0,02	
H1	5,80	- 0,02	
H2	9,20	- 0,02	
P	30,70	$\pm 0,10$	
R	1,00	$\pm 0,10$	
V	2,20	$\pm 0,10$	
W	1,00	$\pm 0,10$	
W1	5,80	$\pm 0,10$	
X1	3,65	$\pm 0,10$	
X3	0,50	$\pm 0,10$	
X	40	$\pm 0,10$	
Y	9,20	$\pm 0,10$	
Z	6,40	$\pm 0,10$	



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#### A.1.2.1.3 Gauges MTG -6-H3

Figure A-9 and Table A-12 define Not Go gauge MTG -6-H3.

PURPOSE : To check existence of coding pins by maximum diameter of P1.

TESTING : It shall not be possible to insert the gauge into the Holder from surface X beyond line Y.

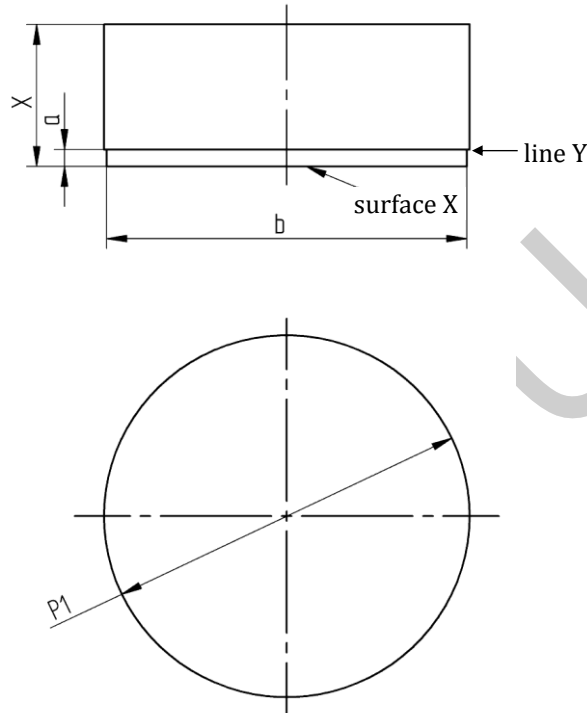


Figure A-9: Dimensions of MTG -6-H3

Table A-12: Dimensions of MTG -6-H3

Dimension	Nominal	Tolerance	Notes
P1	63,65	-0,02	
X	25,00	± 0,10	
a	3,00	± 0,10	
b	60,00	± 0,10	

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### A.1.2.1.4 Gauges MTG -6-H4

Figure A-10 and Table A-13 define Not Go gauge MTG -6-H4.

PURPOSE : To check maximum diameter A1 to ensure sufficient overlap between force pins and Holder.

TESTING : It shall not be possible to insert the gauge into the Holder beyond surface X.

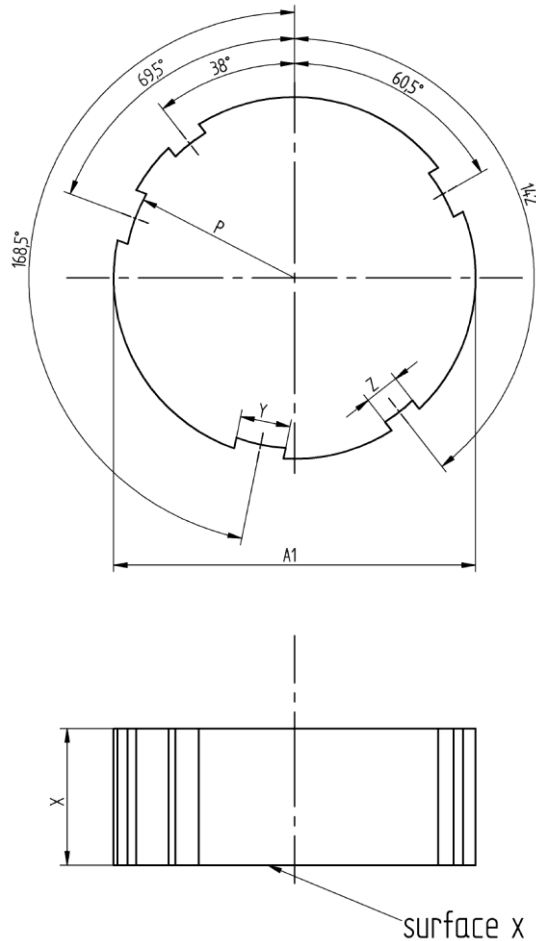


Figure A-10: Dimensions of MTG -6-H4

Note to Figure A-10

(15) Tolerance of all angles is  $\pm 0,5^\circ$ .

Table A-13: Dimensions of MTG -6-H4

Dimension	Nominal	Tolerance	Notes
A1	66,15	-0,02	
P	31,10	$\pm 0,10$	
X	25,00	$\pm 0,10$	
Y	9,20	$\pm 0,10$	
Z	6,40	$\pm 0,10$	

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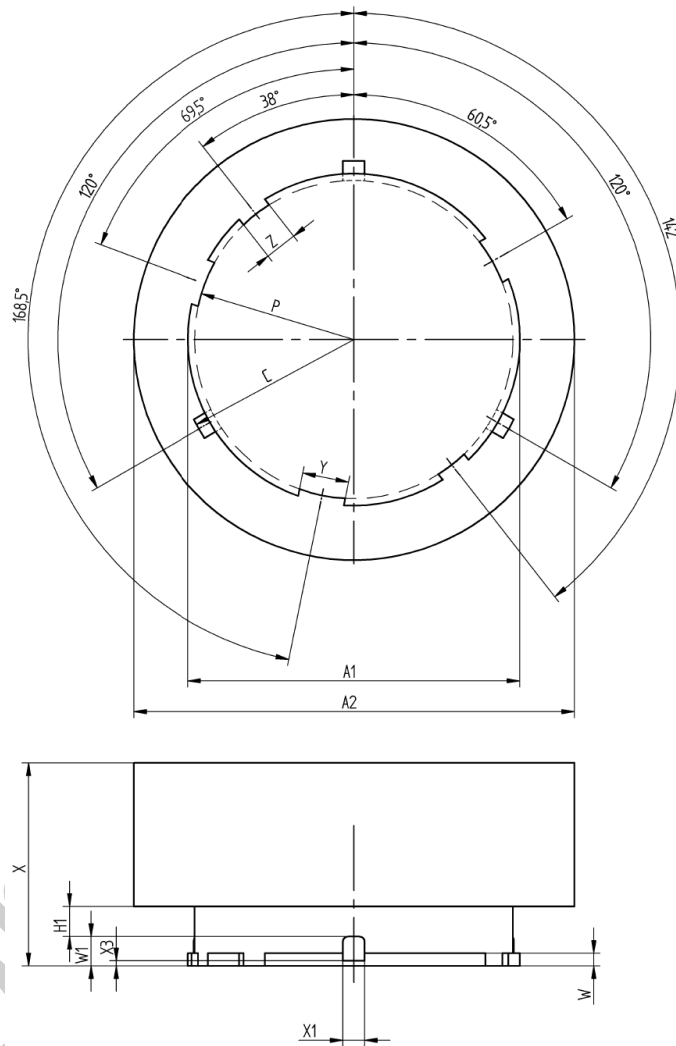
Annex A Compliance Testing (Normative)

#### A.1.2.1.5 Gauges MTG -6-H5

Figure A-11 and Table A-14 define Go gauge MTG -6-H5.

**PURPOSE :** To check proper acceptance of a base GH76p with respect to critical minimum Holder dimensions A1, C, P, X1.

**TESTING :** It shall be possible to fully insert the gauge into the Holder and turn it in a clockwise direction until it reaches the stop position.



**Figure A-11: Dimensions of MTG -6-H5**

Note to Figure A-11 :

(16) Tolerance of all angles is  $\pm 0,5^\circ$ .

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Table A-14: Dimensions of MTG -6-H5

Dimension	Nominal	Tolerance	Notes
A1	65,45	+ 0,02	
A2	86,95	+ 0,02	
C	35,25	+ 0,02	
P	31,35	+ 0,02	
H1	5,80	- 0,02	
W	1,00	± 0,10	
W1	5,80	± 0,10	
X1	4,25	+ 0,02	
X3	3,00	± 0,10	
X	25,00	± 0,10	
Y	9,20	± 0,10	
Z	6,40	± 0,10	

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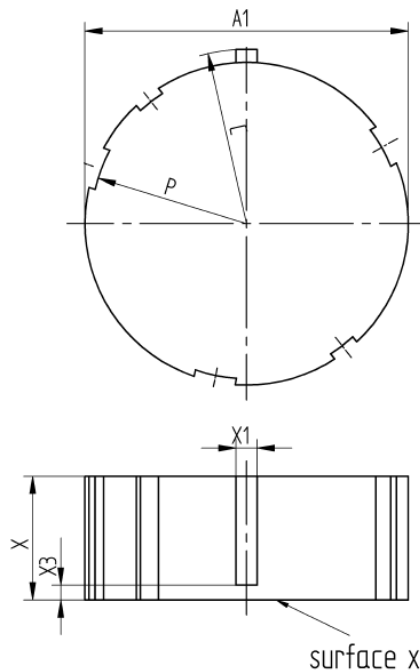
Annex A Compliance Testing (Normative)

### A.1.2.1.6 Gauges MTG-6-H6, Gauges MTG-6-H7, Gauges MTG-6-H8, Gauges MTG-6-H9, Gauges MTG-6-H10, Gauges MTG-6-H11

Figure A-12, Figure A-13, and Table A-16 define MTG-6-H6, MTG6-H7, MTG-6-H8, MTG-6-H9, MTG-6-H10, and MTG-6-H11.

**PURPOSE :** To check proper acceptance of the relevant base keys GH76p in the Holder. Additionally non-interchangeability with other keys is checked.

**TESTING :** The Coding in GH76p Holders have to be checked by different test sequences which are shown in Table A-15. It shall be possible to fully insert the gauge into a related Holder. It shall not be possible to insert the gauge into non-related Holders.



**Figure A-12: Common dimensions of MTG-6-H6, MTG-6-H7, MTG-6-H8, MTG-6-H9, MTG-6-H10, and MTG-6-H11**

**Table A-15: Combinations of Go/Not go Gauges**

Gauge \ Holder	GH76p-1	GH76p-2	GH76p-3	GH76p-4	GH76p-5	GH76p-6
<b>MTG-6-H6</b>	Go	Not go	Go	Not go	Not go	Not go
<b>MTG-6-H7</b>	Not go	Go	Not go	Go	Not go	Not go
<b>MTG-6-H8</b>	Not go	Not go	Go	Not go	Not go	Not go
<b>MTG-6-H9</b>	Not go	Not go	Not go	Go	Not go	Not go
<b>MTG-6-H10</b>	Go	Go	Go	Go	Go	Go
<b>MTG-6-H11</b>	Go	Go	Go	Go	Not go	Go

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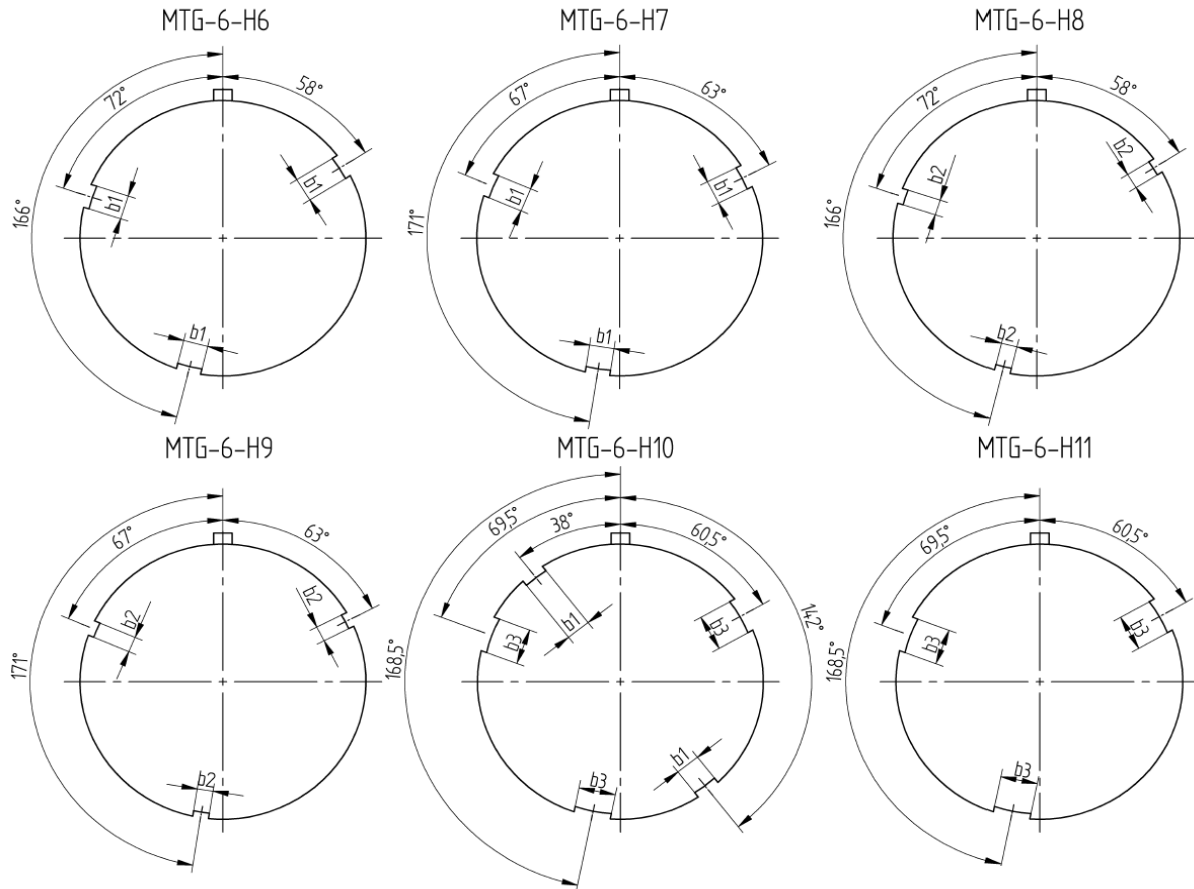


Figure A-13: key dimensions of MTG-6-H6, MTG-6-H7, MTG-6-H8, MTG-6-H9, MTG-6-H10, and MTG-6-H11

Note to Figure A-13 :

(17) Tolerance of all angles is  $\pm 0,5^\circ$ .

Table A-16: Dimensions of MTG-6-H6, MTG-6-H7, MTG-6-H8, MTG-6-H9, MTG-6-H10, and MTG-6-H11

Dimension	Nominal	Tolerance	Notes
A1	65,20	$\pm 0,05$	
C	35,25	$\pm 0,05$	
P	31,30	$\pm 0,05$	
X	25,00	$\pm 0,10$	
X1	4,25	+ 0,02	
X3	3,00	$\pm 0,10$	
b1	5,65	- 0,02	
b2	3,65	- 0,02	
b3	8,45	- 0,02	

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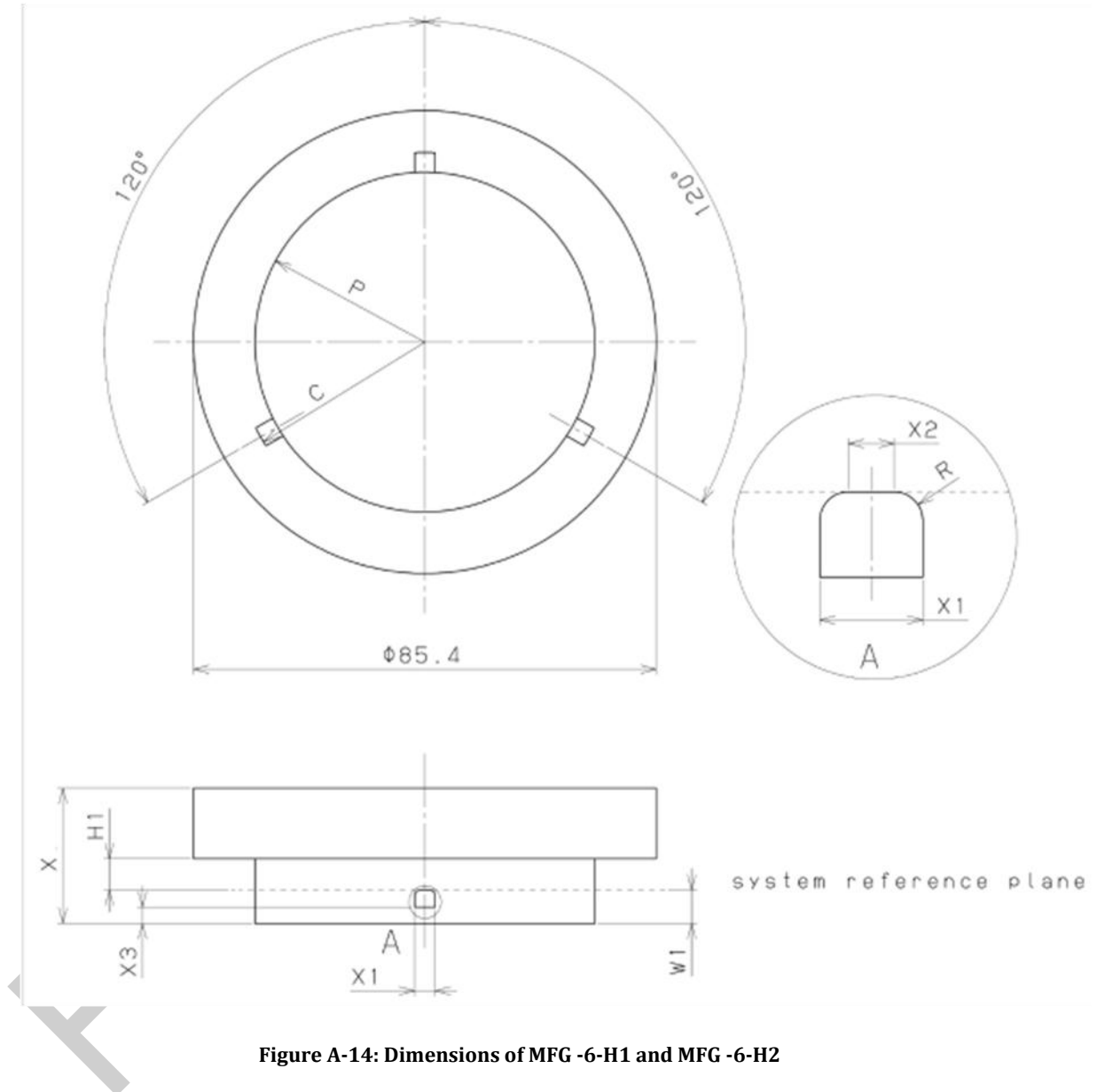
Annex A Compliance Testing (Normative)

### A.1.2.1.7 Gauges MFG-6-H1 and Gauges MFG-6-H2

Figure A-14 and Table A-17 define Gauge for checking force applied by Holder: gauge MFG-6-H1 and MFG-6-H2.

PURPOSE : To check the minimum and maximum forces applied to the LLE by the Holder under test.

TESTING : Details in test procedure is defined in Section A.3.1.2.



Note to Figure A-14 :

(18) Tolerance of all angles is  $\pm 0,5^\circ$ .

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Table A-17: Dimensions of MFG -6-H1 and MFG -6-H2

Dimension	Nominal	Tolerance	Notes
P	31,35	+ 0,02	
C	35,25	+ 0,02	
H1	5,80	- 0,02	
W1	5,90	+ 0,02	(19)
	6,40	- 0,02	(20)
X1	3,65	+ 0,02	(19)
	3,95	- 0,02	(20)
X2	0,45	+0,02	(19)
	2,95	- 0,02	(20)
X3	3,00	± 0,10	
R	1,6	-	(19)
	0,5	-	(20)
X	31,30	± 0,10	

Notes to Table A-17:

(19) MFG -6-H1 for checking minimum force

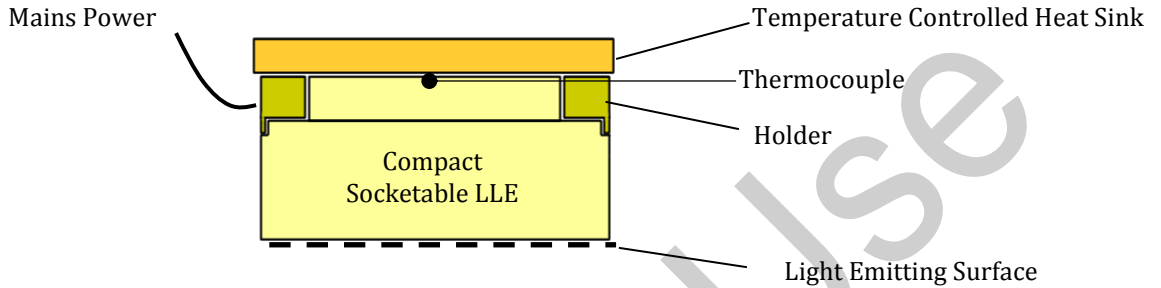
(20) MFG -6-H2 for checking maximum force



**A.1.3 Compact Socketable LLE optical and electrical testing tools**

**A.1.3.1 Test Fixture OETF-GH76p (optical and electrical)**

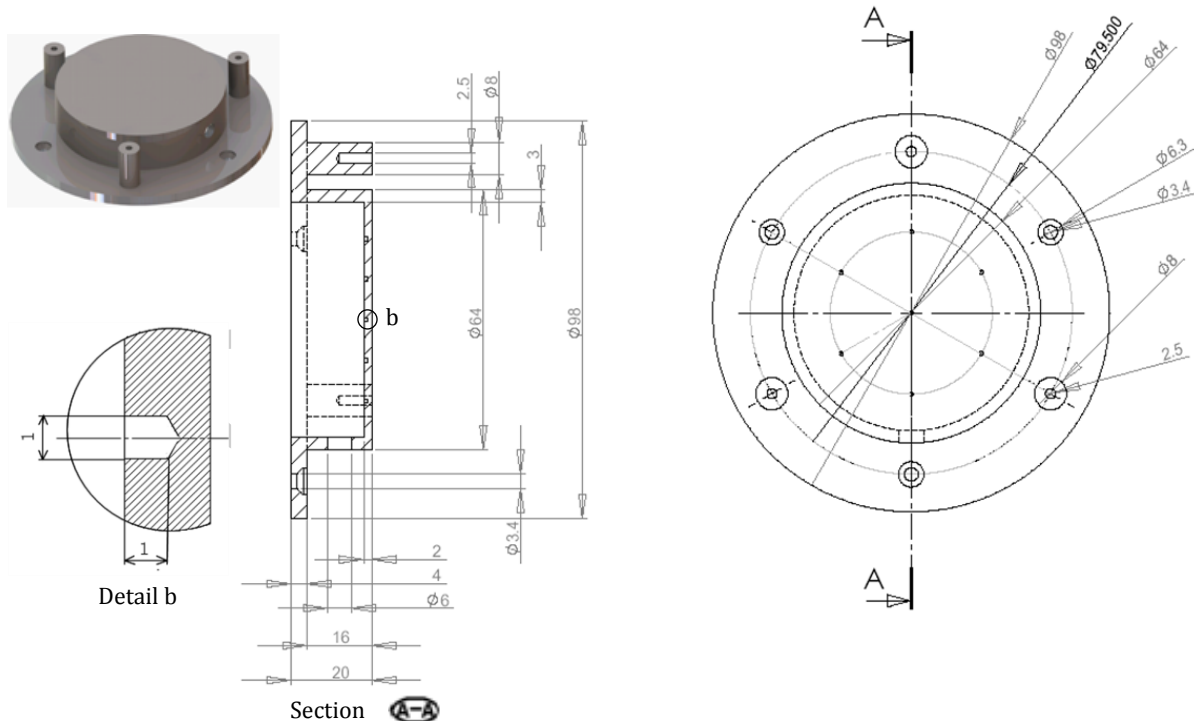
Figure A-15 illustrates Test Fixture OETF-GH76p schematically. The Holder used in a physical realization of Test Fixture OETF-GH76p shall comply with the provisions of Section 3.3. The temperature controlled heat sink shall be constructed to comply with the requirements in Section 4.2. The thermocouple for Test Fixture OETF-GH76p shall be with uncertainty  $\pm 0,5 \text{ }^\circ\text{C}^{11}$ .



**Figure A-15: Definition of Test Fixture OETF-GH76p**

**A.1.3.2 Test Fixture TUTF-GH76p (temperature uniformity)**

Figure A-16 illustrates the base plate that is a part of Test Fixture TUTF-GH76p. A Holder GH76p specified in Section 3.3, not seen in the figure, shall be fixed on the base plate. The bottom part of the base plate shall be placed on a temperature control device. The material of the base plate shall have the thermal conductivity of  $96 \pm 10 \text{ W/(m}\cdot\text{K)}$ , such as an aluminum alloy of ADC 12. The thermocouple for Test Fixture OETF-GH76p shall be with uncertainty  $\pm 0,5 \text{ }^\circ\text{C}^{11}$ .



**Figure A-16: Drawing of the base plate: an element of Test Fixture TUTF-GH76p**

Note to Figure A-16:

<sup>11</sup> The recommended thermocouple types are type T and type J.

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(21) Tolerance of lengths shown in the figure is  $\pm 0,1$ .

Angles between each screw holes are all  $60^\circ$ .

### A.1.3.3 Test Fixture TPTF-GH76p (thermal power)

Figure A-17 illustrates Test Fixture TPTF-GH76p schematically. The Holder used in a physical realization of Test Fixture TPTF-GH76p shall comply with the provisions of Section 3.3. The thickness of the heat flow elements shall be such that a 1-dimensional heat flow through the heat flux sensor is guaranteed.

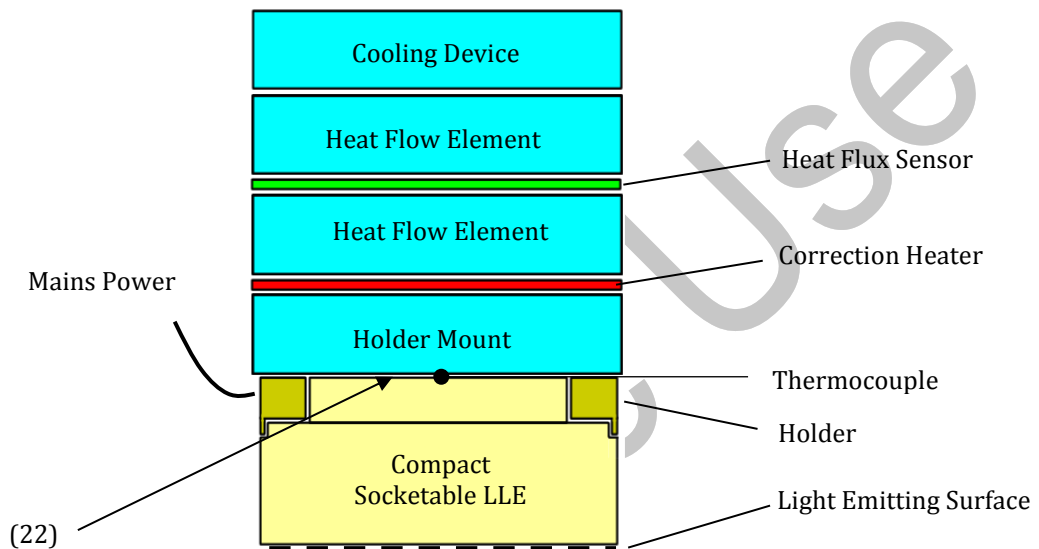


Figure A-17: Definition of Test Fixture TPTF-GH76p

Note to Figure A-17

(22) Holder mount needs to be contacted to the test LLE to ensure good thermal contact.

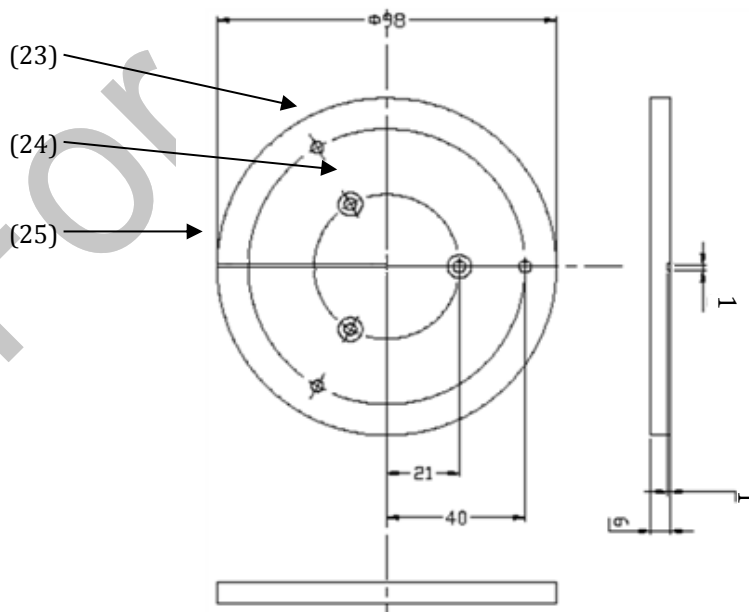


FIGURE A-18. DIMENSION OF HOLDER MOUNT

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Note to Figure A-18 ;

- (23) Screw holes for Holder. See 3.3.1.
- (24) Screw holes for Heat Flow Element and Correction Heater dimension of screw holes should be according to the design of Heat Flow Element and Correction Heater.
- (25) Groove for the thermocouple wire.

#### A.1.4 Luminaire testing tools

##### A.1.4.1 Gauges

Gauges will be used to perform the mechanical interface tests.

##### A.1.4.2 Thermal Test Engine TTE-GH76p

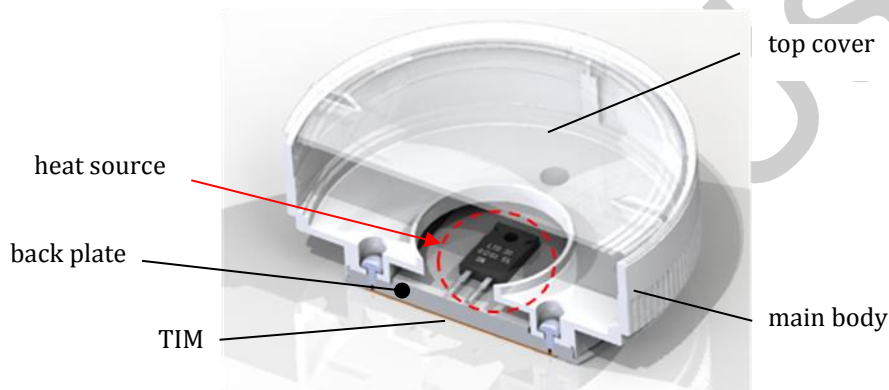


Figure A-19: Setting of TTE-GH76p (Thermal Test Engine)

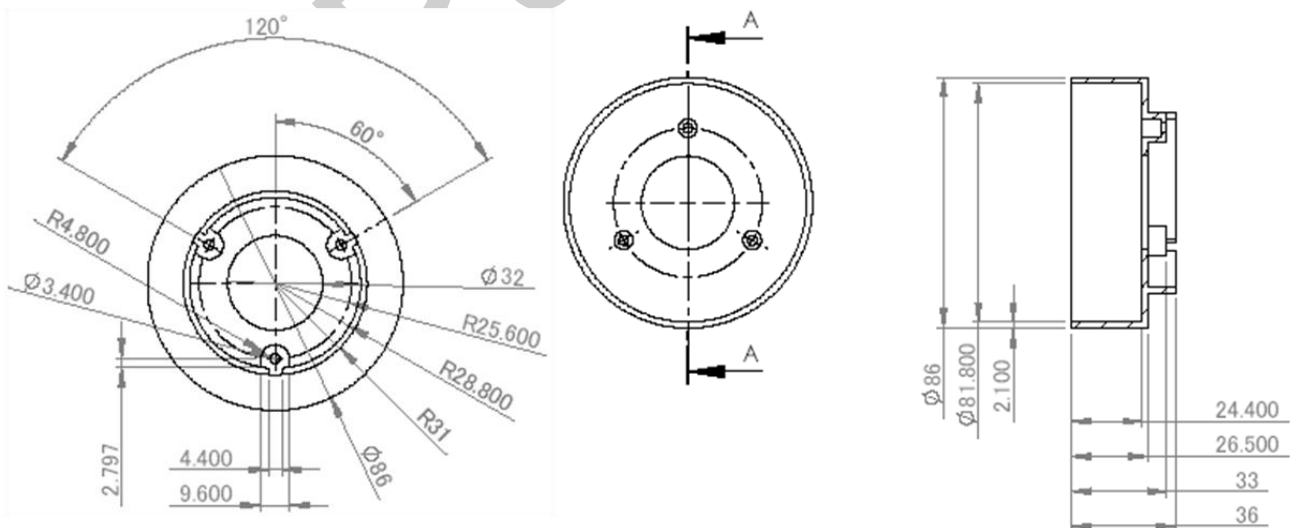


Figure A-20 : Main body of TTE-GH76p (Thermal Test Engine)

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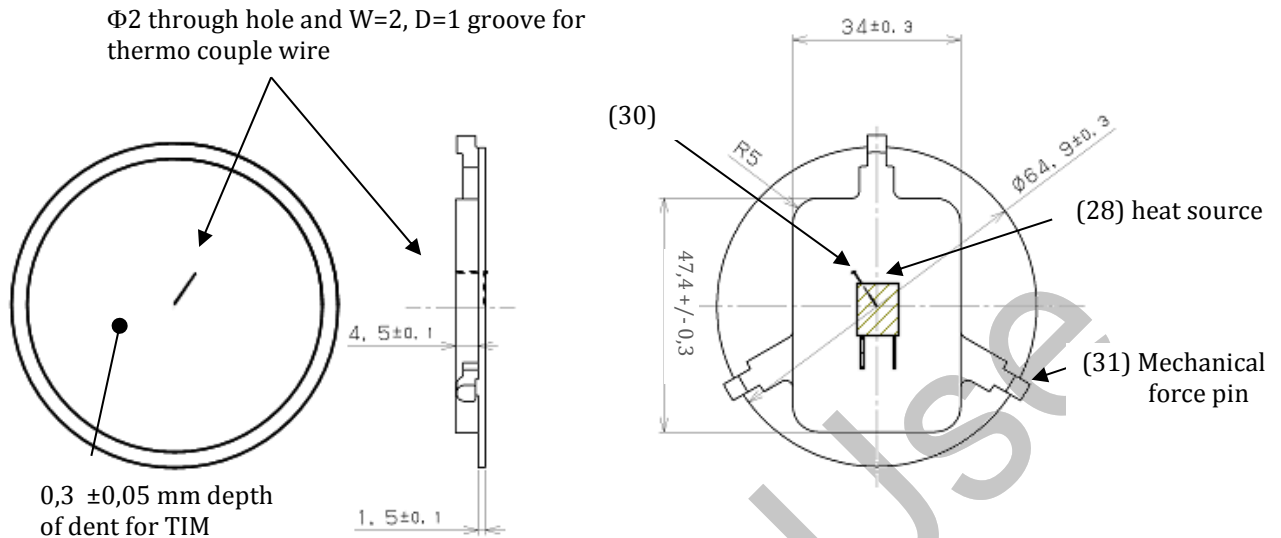


Figure A-21: Back plate of TTE-GH76p

Figure A-19, Figure A-20 and Figure A-21 illustrate Setting and parts of Thermal Test Engine. Basic outer dimensions shall comply with the provisions of the mechanical requirements for the LLE in Section 3.2. The heat source, which is Vishay's LTO100, shall be thermally well contacted on the center of the back plate by using thermal grease, and fixed with M 3 screw. The thermocouple for Thermal Test ENGINE TTE-GH76p shall be with uncertainty  $\pm 0,5 \text{ }^\circ\text{C}^{11}$ .

Note to Figure A-19, Figure A-20 and Figure A-21

- (26) top cover; made of polycarbonate material with diameter of 86 mm, and thickness of 1,5mm. A small through hole (not shown) is needed to lead thermocouple wire out of the TTE-GH76p. The top cover shall be attached to the main body by temporary means such as screws, tabs or tape for easy replacement of the heater.
- (27) main body: made of PBT
- (28) heat source: Vishay's LTO100 ; 15,76 x 20,7 mm
- (29) back plate: aluminum alloy having thermal conductivity of  $96 \pm 10 \text{ W}/(\text{m} \cdot \text{K})$ , such as ADC 12
- (30) Position of the through hole can be selected according to the diameter of the hole of the main body defined in Figure A-20 and the dimension of the heater source shown in note (28).
- (31) Dimension of the mechanical force pins are defined in Figure 3-2.
- (32) TIM: circle or hexagon shape with a surface area of  $20 \pm 3 \text{ cm}^2$ , a thickness of  $0,5 \pm 0,15 \text{ mm}$ , and thermal conductivity of  $6,0 \text{ W}/(\text{m} \cdot \text{K})$

## **A.2 LLE tests**

All tests defined in this Annex A.2 shall be performed on 1 specimen of the LLE.

### **A.2.1 Mechanical interface tests**

#### **A.2.1.1 Dimensional measurement**

Test equipment are defined in Section A.1.1.

##### **A.2.1.1.1 Test Purpose (informative)**

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

##### **A.2.1.1.2 Test equipment**

The test tools are defined in Section A.1.1.

##### **A.2.1.1.3 Test conditions**

Not applicable.

##### **A.2.1.1.4 Test Procedure**

The procedure of the test and the usage of the test tools are defined in Section A.1.1

##### **A.2.1.1.5 Test result**

The LLE under test passes if the dimensions of the LLE meet the dimension specified in Section 3.2.

#### **A.2.1.2 Mass**

##### **A.2.1.2.1 Test Purpose (informative)**

The purpose of this test is to verify that the mass of the LLE under test does not exceed the maximum allowed value.

##### **A.2.1.2.2 Test equipment**

Balance. The accuracy of the balance shall be  $\pm 0,001$  kg.

##### **A.2.1.2.3 Test conditions**

Not applicable.

##### **A.2.1.2.4 Test Procedure**

Determine the mass of the LLE.

##### **A.2.1.2.5 Test result**

The LLE under test passes if the mass of the LLE is less than or equal to 0,300 kg.

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#### A.2.2 Photometric Interface tests

##### A.2.2.1 Luminous flux

###### A.2.2.1.1 Test purpose (informative)

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

###### A.2.2.1.2 Test equipment

- Test Fixture OETF-GH76p.
- A sphere-spectroradiometer system, 1 m diameter minimum, geometry.<sup>12</sup> This system shall be calibrated against total spectral radiant flux standards or a distribution temperature standard lamp traceable to a NMI. The accuracy of this system shall be  $\pm 5\%$

###### A.2.2.1.3 Test conditions

See Section 4.2. Test Fixture OETF-GH76p shall regulate the temperature of the Thermal Interface Surface of the LLE under test to within 1 °C of the Rated operating temperature.

###### A.2.2.1.4 Test procedure

- Lock the LLE under test into position in Test Fixture OETF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 4.2 (see Annex A.2.2.1.3).
- Perform the test as described in [IES LM-79-08], Section 9.1.

###### A.2.2.1.5 Test result

The Socketable LLE under test passes if the measured total luminous flux lies within the range listed in Table A-18 that is appropriate for the Rated total luminous flux.

Table A-18: Luminous flux categories

Flux category name	Luminous flux lm	
	Minimum	Maximum
C006	510	840
C008	680	1155
C011	940	1575
C015	1280	2100
C020	1710	2625
C025	2135	3150
C030	2565	4200
C040	3420	5250
C050	4275	N.A.

<sup>12</sup>See [IES LM-79-08], Section 9.1 and sub Sections therein. (Informative) *For additional information with respect to measurements with integrating sphere photometers see [CIE 84].*

**A.2.2.2 Luminous intensity distribution (Beam angle and Luminous intensity uniformity)**

**A.2.2.2.1 Test purpose (informative)**

The purpose of this test is to verify luminous intensity distribution of the LLE under test.

**A.2.2.2.2 Test equipment**

- Test Fixture OETF-GH76p.
- A goniophotometer system. The accuracy of the goniophotometer system shall be  $\pm 2\%$ .

**A.2.2.2.3 Test conditions**

See Section 4.2. Test Fixture OETF-GH76p shall regulate the temperature of the Thermal Interface Surface of the LLE under test to within 1 °C of the Rated operating temperature.

**A.2.2.2.4 Test procedure**

- Lock the LLE under test into position in Test Fixture OETF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 4.2 (see Annex A.2.2.2.3).
- Perform the test as described in [IEC/TR 61341], Sections 5 and 6<sup>13</sup>.
- Measurement intervals described in Section 4.4.2 shall be kept.

**A.2.2.2.5 Test result**

The Socketable LLE under test passes if the measured beam angle is within the category specified in Section 4.4.1 and the measured luminance uniformity within the limits specified in Section 4.4.2.

**A.2.2.3 Correlated color temperature**

**A.2.2.3.1 Test purpose (informative)**

The purpose of this test is to verify the Rated correlated color temperature of the LLE under test.

**A.2.2.3.2 Test equipment**

- Test Fixture OETF-GH76p.
- Spectrophotometer

**A.2.2.3.3 Test conditions**

See Section 4.2. Test Fixture OETF-GH76p shall regulate the temperature of the Thermal Interface Surface of the LLE under test to within 1 °C of the Rated operating temperature.

**A.2.2.3.4 Test procedure**

- Lock the LLE under test into position in Test Fixture OETF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 4.2 (see Annex A.2.2.3.3).
- Perform the test as described in [ANSI C87.377], with an accuracy of 0,002 for the chromaticity coordinates.<sup>14</sup>

<sup>13</sup> (Informative) For additional information with respect to measurements with a goniophotometer see [CIE 121].

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#### A.2.2.3.5 Test result

The LLE under test passes if the measured correlated color temperature complies with the provisions of [ANSI C87.377] or [JIS Z9112], and both the measured correlated color temperature and Rated correlated color temperature are in the same quadrangle as defined in [ANSI C87.377] or [JIS Z9112].

#### A.2.2.4 Color rendering index

##### A.2.2.4.1 Test purpose (informative)

The purpose of this test is to verify the Rated color rendering index of the LLE under test.

##### A.2.2.4.2 Test equipment

- Test Fixture OETF-GH76p.
- Spectrophotometer

##### A.2.2.4.3 Test conditions

See Section 4.2. Test Fixture OETF-GH76p shall regulate the temperature of the Thermal Interface Surface of the LLE under test to within 1 °C of the Rated operating temperature.

##### A.2.2.4.4 Test procedure

- Lock the LLE under test into position in Test Fixture OETF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 4.2 (see Annex A.2.2.4.3).
- Perform the test as described in [ANSI C87.377], with an accuracy of 0,002 for the chromaticity coordinates.<sup>15</sup>

##### A.2.2.4.5 Test result

The Socketable LLE under test passes if the measured color rendering index is not less than the Rated color rendering index minus 3 points.

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<sup>14</sup>(Informative) For additional information with respect to color rendering of white LED light sources see [IES LM-79-08].

<sup>15</sup>(Informative) For additional information with respect to color rendering of white LED light sources see [IES LM-79-08].



**A.2.3 Electrical interface tests**

**A.2.3.1 Power use**

**A.2.3.1.1 Test purpose (informative)**

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

**A.2.3.1.2 Test equipment**

- Test Fixture OETF-GH76p.
- Power meter. The accuracy of the power meter shall be  $\pm 0,5 \%$ .

**A.2.3.1.3 Test conditions**

See Section 4.2. Test Fixture OETF-GH76p shall regulate the temperature of the Thermal Interface Surface of the LLE under test to within 1 °C of the Rated operating temperature.

**A.2.3.1.4 Test procedure**

- Lock the LLE under test into position in Test Fixture OETF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 4.2 (see Annex A.2.3.1.3).
- Use the wattmeter to determine the power usage of the LLE under test.

**A.2.3.1.5 Test result**

The LLE under test passes if the measured value is below the maximum power specified in Table 5-1.

## **A.2.4 Thermal interface tests**

### **A.2.4.1 Temperature uniformity**

#### **A.2.4.1.1 Test purpose (informative)**

The purpose of this test is to verify the temperature uniformity of the Thermal Interface Surface of the LLE under test.

#### **A.2.4.1.2 Test equipment**

- Test Fixture TUTF-GH76p.

#### **A.2.4.1.3 Test conditions**

See Section 6.2.2. Test Fixture TUTF-GH76p shall regulate the temperature of the Thermal Interface Surface of the LLE under test to within 1 °C of the Rated operating temperature.

#### **A.2.4.1.4 Test procedure**

- Lock the LLE under test into position in Test Fixture TUTF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 6.2.2 (see Annex A.2.4.1.3).
- Measure the temperatures  $t_i$ ,  $i = 0, 1, 2, \dots, 6$ .
- Determine the maximum temperature difference  $t_{\text{grad}} = \max(t_i) - \min(t_j)$ ,  $i, j = 0, 1, 2, \dots, 6$ , where  $\max(t_i)$  means to take the maximum of the measured temperatures, and  $\min(t_j)$  means to take the minimum of the measured temperatures.
- Determine the maximum thermal spreading resistance  $R_{\text{sp}}^{\text{max}} = \frac{t_{\text{grad}}}{P_{\text{th,rear}}}$ , where  $P_{\text{th,rear}}$  is the thermal power as determined from the test defined in Annex A.2.4.3.

#### **A.2.4.1.5 Test result**

The LLE under test passes in  $R_{\text{sp}}^{\text{max}} \leq 0,36 \text{ K/W}$ .

### **A.2.4.2 Maximum total thermal Power generated**

#### **A.2.4.2.1 Test Purpose (informative)**

The purpose of this test is to verify the Rated maximum total thermal power of the LLE under test.

#### **A.2.4.2.2 Test equipment**

See Annex A.2.2.1.2 and Annex A.2.3.1.2.

#### **A.2.4.2.3 Test conditions**

See Annex A.2.2.2.3 and Annex A.2.3.1.3.

#### **A.2.4.2.4 Test procedure**

- Lock the LLE under test into position in Test Fixture OETF-GH76p, and connect to mains power as appropriate for the LLE under test.
- Wait until the temperature at the Thermal Interface Surface is stable, as defined in Section 4.2 (see Annex A.2.2.1.3).
- Determine the total spectral radiant flux  $P_{\text{vis}}$  as described in [IES LM-79-08], Section 9.1.

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- Use the power meter to determine the power usage  $P_{el}$  of the LLE under test.
- Determine the total thermal power as  $P_{th} = P_{el} - P_{vis}$ .

#### A.2.4.2.5 Test result

The LLE under test passes if the measured total thermal power  $P_{th}$  shall not exceed the Rated maximum total thermal power by more than 5 %.

#### A.2.4.3 Maximum thermal power at the Thermal Interface Surface

##### A.2.4.3.1 Test purpose (informative)

The purpose of this test is to verify the Rated maximum thermal power at the Thermal Interface Surface  $P_{th,rear}$  of the LLE under test.

##### A.2.4.3.2 Test equipment

The requirements of Section A.1.3.2.1 of Book 1 apply.

The test fixture for this Book shall be TPTF-GH76p.

##### A.2.4.3.3 Test conditions

- The requirements of Section A.1.3.2.2 and A.1.3.2.3 of Book 1 apply.
- The electric power  $P_1$  is 10 W and  $P_2$ ,  $P_3$  and  $P_4$  are 20 W, 30W and 40W respectively shall be use for the calibration of LLE s rated up to 25 W.

##### A.2.4.3.4 Test procedure

- The requirements of Section A.1.3.2.4 of Book1 apply.

##### A.2.4.3.5 Test result

The LLE under test passes if the measured thermal power  $P_{th,rear}$  does not exceed the Rated maximum thermal power applied at the Thermal Interface Surface by more than 5 %.

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### A.2.5 Control interface tests

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define control interface tests for the LLE.

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### A.3 Holder tests

All tests defined in this Annex A.3 shall be performed on 1 specimen of a Holder.

#### A.3.1 Mechanical interface tests

##### A.3.1.1 Dimensional measurement

Test equipment are defined in Section A.1.2.

##### A.3.1.2 Force

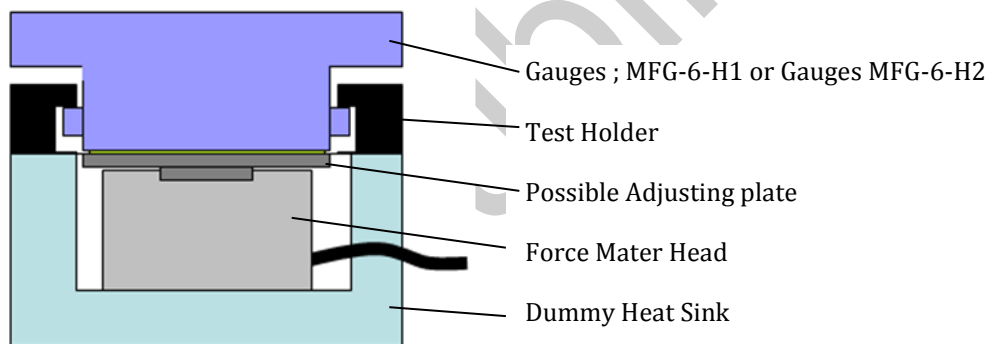
###### A.3.1.2.1 Test Purpose (informative)

The purpose of this test is to verify that the force applied parallel to the Z-axis to each Compact Socketable LLE is at least 8 N and at most 40 N, including the effect of the mass of the LLE.

###### A.3.1.2.2 Test equipment

- Gauges defined in the Section A.1.2.1
- Force mater, with accuracy of  $\pm 0,05$  N

###### A.3.1.2.3 Test Procedure



**Figure A-22: Example of measurement setting**

Figure A-22 illustrates an example of the setting for force measurement.

Maximum force shall be measured using Gauges MFG-6-H2 and according to the method and calculation shown in Table A-19.

Minimum force shall be measured using Gauges MFG-6-H1 and according to the method and calculation shown in Table A-20.

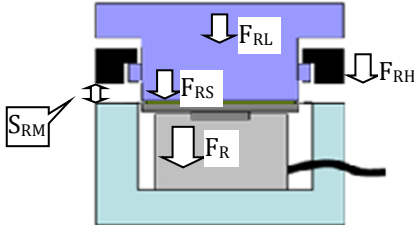
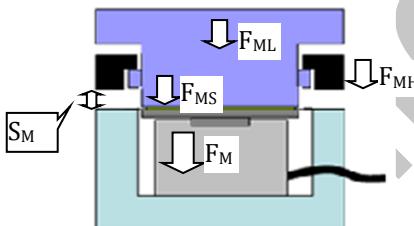
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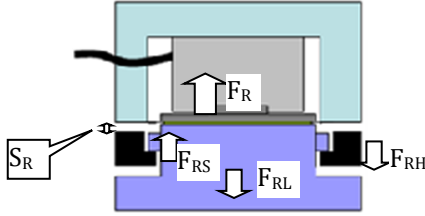
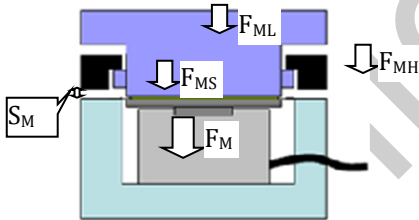
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Table A-19 : Measurement method and calculation of the maximum force

Schematic figure and calculation	
With a real LLE	 <p>Formula -1</p> $F_R = F_{RS} + F_{RH} + F_{RL}$ $= F_{RS} + g \times (\text{Holder mass}) + g \times 0,3$ <p><math>F_R</math> ; Maximum force with a real LLE  <math>S_{RM}</math> ; Maximum stroke length of springs set in the test Holder.  <math>F_{RS}</math> ; Force by the springs according to <math>S_{RM}</math>  <math>F_{RH}</math> ; Force by the test Holder mass  <math>F_{RL}</math> ; Force by LLE mass, The LLE mass is fixed to 0,3 kg</p>
Measurement with Gauges MFG-6-H2	 <p>Formula -2</p> $F_M = F_{MS} + F_{MH} + F_{ML}$ $= F_{RS} + g \times (\text{Holder mass}) + g \times 0,3$ <p><math>F_M</math> ; Measured force with Gauges MFG-6-H2  <math>S_M</math> ; Maximum stroke length of springs set in the test Holder.  <math>S_M</math> equals to <math>S_{RM}</math>  <math>F_{MS}</math> ; Force by the springs according to <math>S_M</math>.  <math>F_{MS}</math> equals to <math>F_{RS}</math>  <math>F_{MH}</math> ; Force by the test Holder mass.  <math>F_{MH}</math> equals to <math>F_{RH}</math>  <math>F_{ML}</math> ; Force by mass of LLE Gauges MFG-6-H2.  <math>F_{ML}</math> should be set to zero using zero adjustment function of the meter or calculation.</p>
calculation	<p>From Formula -1 and -2 ;</p> $F_R = F_M + g \times 0,3$

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Table A-20 : **Measurement method and calculation of the minimum force**

Schematic figure and calculation	
With a real LLE	 <p>Formula -1</p> $F_R = F_{RS} + F_{RH} + F_{RL}$ $= F_{RS} + g \times (\text{Holder mass}) + g \times 0,3$ <p><math>F_R</math>; Minimum force with a real LLE  <math>S_R</math>; Minimum stroke length of springs set in the test Holder.  <math>F_{RS}</math>; Force by the springs according to <math>S_R</math>  <math>F_{RH}</math>; Force by the test Holder mass  <math>F_{RL}</math>; Force by LLE mass, The LLE mass is fixed to 0,3 kg</p>
Measurement with Gauges MFG-6-H1	 <p>Formula -2</p> $F_M = F_{MS} + F_{MH} + F_{ML}$ $= F_{RS} + g \times (\text{Holder mass}) + g \times 0,3$ <p><math>F_M</math>; Measured force with Gauges MFG-6-H1  <math>S_M</math>; stroke length of springs set in the test Holder.  <math>S_M</math> is equal to <math>S_R</math>  <math>F_{MS}</math>; Force by the springs according to <math>S_M</math>.  <math>F_{MS}</math> is equal to <math>F_{RS}</math>  <math>F_{MH}</math>; Force by the test Holder mass.  <math>F_{MH}</math> is equal to <math>F_{RH}</math>  <math>F_{ML}</math>; Force by mass of LLE Gauges MFG-6-H1.  <math>F_{ML}</math> should be set to zero using zero adjustment function of the meter or calculation.</p>
calculation	<p>From Formula -1 and -2 ;</p> $F_R = F_M - 2 \times g \times (\text{Holder mass}) - g \times 0,3$

Note ; In case the test Holder mass is equal to or less than 0,03 g that is 10% of the specified maximum LLE mass, the test Holder mass can be negligible.  
The other calculation or measurement method can be applicable according to the design of the test Holder.

**A.3.1.2.4 Test result**

The Holder under test passed if The minimum and maximum forces will be at least 8 N and not exceed 40 N. See Note (24) to Table 3-5.

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### A.3.2 Photometric Interface tests

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define optical interface tests for the Holder.

### A.3.3 Electrical interface tests

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define electrical interface tests for the Holder.

### A.3.4 Thermal interface tests

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define thermal interface tests for the Holder.

### A.3.5 Control interface tests

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define control interface tests for the Holder.



## **A.4 Luminaire tests**

All tests defined in this Annex A.4 shall be performed on 1 specimen of a Luminaire.

### **A.4.1 Mechanical interface tests**

The mechanical interface tests of a Luminaire are identical to the mechanical interface tests of a Holder. See Annex A.3.

### **A.4.2 Photometric interface tests**

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define tests for the optical interface of a Luminaire.

### **A.4.3 Electrical interface tests**

The electrical interface tests of a Luminaire are identical to the electrical interface tests of a Holder. See Annex A.3.

### **A.4.4 Thermal interface tests**

#### **A.4.4.1 Thermal resistance**

##### **A.4.4.1.1 Test purpose (informative)**

The purpose of this test is to verify the Rated thermal resistance of the Luminaire under test.

##### **A.4.4.1.2 Test equipment**

- Thermal Test Engine TTE-GH76p.

##### **A.4.4.1.3 Test conditions**

The Luminaire shall be mounted in a draught free room, with an orientation that is according to the “intended use” as indicated in the data sheet of the Luminaire under test. The ambient air temperature in the room, at a distance of at most 1 m from the edge of the Luminaire, shall be  $(25 \pm 5) ^\circ\text{C}$ . If the Luminaire is not positioned horizontally, the ambient air temperature shall be determined at the lowest point that satisfies the above distance requirement. Movement of the ambient air throughout the closed room shall not exceed 15 cm/s, unless caused by the operation of the Luminaire.

##### **A.4.4.1.4 Test procedure**

- Lock Thermal Test Engine TTE-GH76p into position in the Luminaire under test, and configure Thermal Test Engine TTE-GH76p to consume 5 W of electrical power.
- Wait until the temperature  $t_r$  at the Thermal Interface Surface is stable. The temperature  $t_r$  shall be deemed stable if the difference between two consecutive temperature (unit:  $^\circ\text{C}$ ) measurements, taken at least 15 min apart, is less than 0,5 %.
- Measure the temperature  $t_r'$  with a accuracy at least 0,5 $^\circ\text{C}$
- Determine the thermal resistance of the Luminaire under test as

$$R_{\text{th,rear}} = \frac{t_r' - \Delta t_{\text{TIM}}(P_{\text{th}}) - t_a}{P_{\text{th,rear}}}$$

Where  $P_{\text{th}}$  is the thermal power generated in Thermal Test Engine TTE-GH76p,  $\Delta t_{\text{TIM}}(P_{\text{th}})$ <sup>17</sup> is a correction for the temperature drop over the TIM as defined in Table A-21 and  $t_a$  is the temperature of the ambient air (see also Section 6.1).

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- Repeat the above four steps with Thermal Test Engine TTE-GH76p configured to consume 10 W, 20 W, and 30 W of electrical power respectively. On each condition, the value of  $P_{th,rear}$  equals to 9,8W, 19,2 W, and 29,1 W, respectively<sup>16,17</sup>. Each differences between the consuming power and  $P_{th,rear}$  means a few percent of thermal power is transferred into air as  $P_{th,front} = P_{el} - P_{th,rear}$ .

Table A-21 : Correction for temperature drip over TIM

$P_{el}$ [W]	$\Delta t_{TIM}$ [°C]
5	1,8
10	3,2
20	6,0
30	9,0

#### A.4.4.1.5 Test result

The Luminaire under test passes if

- The thermal resistance  $R_{th,rear}$  as determined in the test using a 5,0 W load from the Thermal Test Engine does not exceed the Rated thermal resistance at 5,0 W thermal power applied to the heat sink by more than 5 %; and
- The thermal resistance  $R_{th,rear}$  as determined in the test using a 9,8 W load from the Thermal Test Engine does not exceed the Rated thermal resistance at 9,8 W thermal power applied to the heat sink by more than 5 %; and
- The thermal resistance  $R_{th,rear}$  as determined in the test using a 19,2 W load from the Thermal Test Engine does not exceed the Rated thermal resistance at 19,2 W thermal power applied to the heat sink by more than 5 %; and
- The thermal resistance  $R_{th,rear}$  as determined in the test using a 29,1 W load from the Thermal Test Engine does not exceed the Rated thermal resistance at 29,1 W thermal power applied to the heat sink by more than 5 %.

#### A.4.5 Control interface tests

This edition 1.3 of Book 6 of the Zhaga Interface Specification does not define tests for the control interface of a Luminaire.

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<sup>16</sup> These four values of  $P_{th,rear}$  were obtained through the TTE tests during the drafting activity of this Book 6.

<sup>17</sup> These thermal loads shall be applied for the LLE of which rated wattage is not greater than 25 W having base keys of GH76p-1,-2,-5. The thermal load values for the LLE having rated wattage over 25 W are under consideration.

## **Annex B Product Data Sheet Requirements (Normative)**

### **B.1 Socketable LLE**

The data sheet of the LLE product shall contain at least the following information:

- The mechanical fit (GH76p-1, GH76p-2, GH76p-3, GH76p-4, GH76p-5 or GH76p-6).
- The luminous flux at the Rated operating temperature (a flux category name from Table 4-2).
- The color rendering index at the Rated operating temperature.
- The correlated color temperature at the Rated operating temperature (i.e. the quadrangle as defined in [ANSI C87.377]. And/or the correlated color temperature at the Rated operating temperature by 100 units and the category name of the quadrangle as defined in [JIS Z9112])
- The rated beam angle and the beam angle category name specified in Table 4-3.
- The operating mains voltage and frequency.
- The maximum mains power consumed.
- The maximum total thermal power and the maximum thermal power applied at the Thermal Interface Surface.
- The Rated operating temperature, measured at the Thermal Interface Surface.
- The maximum allowable thermal resistance of the Luminaire. The ambient temperature for which this maximum applies is 25 °C, unless explicitly indicated otherwise.

### **B.2 Holder**

The data sheet of a Holder product shall contain at least the following information:

- The mechanical fit (GH76p-1, GH76p-2, GH76p-3, GH76p-4, GH76p-5 or GH76p-6).

### **B.3 Luminaire**

The data sheet of a Luminaire shall contain at least the following information:

- The mechanical fit (GH76p, GH76p-1, GH76p-2, GH76p-3, GH76p-4, GH76p-5 or GH76p-6).
- The thermal resistance at 5,0 W, 9,8 W, 19,2 W, and 29,1 W thermal power applied to the heat sink with electrical power at 5 W, 10 W, 20 W, and 30 W, respectively. The ambient temperature for which these thermal resistances apply is 25 °C, unless explicitly indicated otherwise.

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## **Annex C Safety Requirements (Informative)**

International and local regulations require both the LLE and a Luminaire to comply with several standards for product safety. This Annex C list a number of the most relevant of such standards.

### **C.1 Compact Socketable LLE requirements**

Safety provisions with respect to the LLE comprise—amongst others—the provisions of [IEC 62031] for a “self-ballasted LED module.”

### **C.2 Holder requirements**

Safety provisions with respect to a Holder are defined in [IEC 60061-a], [IEC 60061-b], [IEC 60061-c] and [IEC 60838].

### **C.3 Luminaire requirements**

Safety provisions with respect to a Luminaire are defined in [IEC 60598].

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Annex D History of Change

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## Annex D History of Changes

**Table D-22: Changes from version 1.2 to edition 1.3.**

Location	Old	New	Reason

Book 6 Edition 1.3 is the first edition for public use and Table D-22 is empty.

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