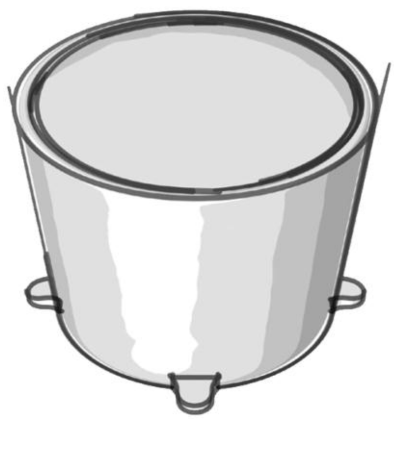
Zhaga Interface Specification

Book 8
Edition 1.1
June 2013

LED LIGHT ENGINE

TYPE A: SOCKETABLE WITH INTEGRATED CONTROL GEAR 95 MM × 45 MM

LES 57 MM MINIMUM ROUND



Zhaga Interface Specification Book 8

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
This book 8 of the Zhaga Interface Specification defines a type A socketable LED light engine with integrated control gear. It has a round drum shape with maximum dimensions of 95 mm diameter and 45 mm height. It has a light emitting surface dimension of (typically) 59 mm diameter round and a PHJ65d type base.

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

Intended Use
The light engine can be locked into a luminaire by means of a twisting motion. Mechanical fit keying is present to ensure that the luminaire provides the correct mains voltage.

The light output is essentially lambertian, which enables the luminaire optics to shape the light distribution to the needs of the application.

The light engine is primarily intended for use in LED downlighting luminaires.

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

Zhaga Interface Specification

Book 8: LED Light Engine Type A:

socketable with integrated control gear

95 mm × 45 mm

Edition 1.1

June 2013

NOTICE

For any further explanation of the contents of this document, or in case of any perceived inconsistency or ambiguity of interpretation, visit www.zhagastandard.org or contact info@zhagastandard.org.

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1 General

1.1 Introduction

The Zhaga Consortium is a worldwide organization that aims to standardize LED Light Engines. A LED Light Engine is a light source for general lighting that is based on solid state technology, and typically consists of one or more LEDs combined with stabilization and control electronics (Electronic Control Gear). Different types of LED Light Engines are defined in individual books of the Zhaga Interface Specification. LED Light Engines that comply with a particular book of the Zhaga Interface Specification are interchangeable—in the sense that it is possible to replace one of such LED Light Engines by another, regardless of its manufacturer.

Each book of the Zhaga Interface Specification defines at least the following set of interfaces between the LED Light Engine and an appropriate Luminaire:

- Mechanical interface.
- Optical interface.
- Electrical interface.
- Thermal interface.
- Control Interface.

1.2 Scope

This edition 1.1 of Book 8, LED Light Engine Type A: socketable with integrated control gear 95 mm × 45 mm, of the Zhaga Interface Specification defines the functional interfaces for LED Light Engines (LLE) with integrated Electronic Control Gear that have a typical diameter of 95 mm, a typical height of 45 mm, and a PHJ85d type Base. This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define LLE and Luminaire product safety aspects, unless these aspects take shape in the functional interface.

1.3 Main features

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

- A LED Light Engine with integrated Electronic Control Gear, which is operated on mains power.
- Variants of the LED Light Engine, which use mechanical fit Keying to ensure that operation is possible at the Rated mains power only.
- An appropriate environment inside the Luminaire for the 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 follow 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 References

For undated references, the most recently published version applies. In the case of any perceived discrepancy between the provisions of this edition 1.1 of Book 8 of the Zhaga Interface Specification and the most recently published version of an undated reference, an earlier version of that reference may be applied.

[ANSI C78.377] American National Standard for electric lamps—Specifications for the Chromaticity of Solid State Lighting Products, ANSI NEMA ANSLG C78.377.

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

[CIE 121] The photometry and goniophotometry of luminaires, CIE 121.

[CIE 13.3] Method of measuring and specifying colour rendering properties of light sources, CIE 13.3.

[IEC 60061 (a)] Lamp caps and holders together with gauges for the control of interchangeability and safety—Part 4: Guidelines and general information—Designation of Lamp Caps and Holders, IEC 60061-4 standard sheet 7007-1.

[IEC 60061 (b)] Lamp caps and holders together with gauges for the control of interchangeability and safety—Part 4: Guidelines and general information—Recommended tolerances for gauges in IEC 60061, IEC 60061-4 standard sheet 7007-11.

[IEC/TR 61341] Method of measurement of centre beam intensity and beam angle(s) of reflector lamps, IEC/TR 61341.

[IES LM-79-08] IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products, IES LM-79-08.

[NEMA SSL 7A] Phase Cut Dimming for Solid State Lighting: Basic Compatibility, NEMA SSL 7A-2013.

1.5 Definitions

Base The part of the LED Light Engine that fits into the Holder.

Holder The part of the Luminaire that locks the LLE in a functional position, and establishes electrical contact with the LLE.

Keying Mechanical differentiation in a fit system, which discriminates between options that are not interoperable—for example discrimination between a LLE and a Luminaire, which are designed for operation with different mains voltages. Keying typically is a safety feature.

LED Light Engine In this edition 1.1 of Book 8 of the Zhaga Interface Specification, the term LED Light Engine specifically refers to a light source that offers a PHJ85d, PHJ85d-1 or PHJ85d-2 mechanical fit to a Luminaire.

Least Material Condition The minimum volume of the LLE or the Luminaire. This minimum volume does not necessarily have a fixed outline. The Least Material Condition is the different for the LLE and the Luminaire.

Luminaire In this edition 1.1 of Book 8 of the Zhaga Interface Specification, the term Luminaire specifically refers to a lighting fixture that offers a PHJ85d-1 or PHJ85d-2 mechanical fit to a LED Light Engine.

Maximum Material Condition
The absolute boundary of the mechanical interface between the LLE and the Luminaire. Rigid parts of neither the LLE nor the Luminaire shall extend through this boundary. The Maximum Material Condition is identical for both the LLE and the Luminaire.

Thermal Fit Code A code consisting of a capital letter followed by two decimal digits, representing an operating temperature-thermal power combination. A Thermal Fit Code

	assists with the verification of the thermal compatibility of a specific LLE and a specific Luminaire.
Thermal Test Engine	A device that is used to define the thermal properties of a Luminaire. This edition 1.1 of Book 8 of the Zhaga Interface Specification defines a single Thermal Test Engine.

1.6 Acronyms

Acronyms that appear in this edition 1.1 of Book 8 of the Zhaga Interface Specification, but are not listed in this Section 1.6, are defined in [Book 1].

AC	Alternating Current
DC	Direct Current
LMC	Least Material Condition
MMC	Maximum Material Condition

1.7 Symbols

Symbols that appear in this edition 1.1 of Book 8 of the Zhaga Interface Specification, but are not listed in this Section 1.7, are defined in [Book 1].

P_{HE}	electrical power applied to the heating element of the heat flux measurement system
R_{a}	surface roughness
V_{HFS}	output voltage of the heat flux sensor of the heat flux measurement system
$t_{\mathrm{a,max}}^{\mathrm{exp}}$	expected maximum ambient temperature
t_{min}, t_{max}	lowest and highest temperature measured at the Thermal Interface Surface of a LLE
t_{r}	temperature measured at the center of the Thermal Interface Surface of TTE-PHJ85d
t_{r}'	temperature of the Thermal Test Engine close to the TIM [°C]
$t_{\mathrm{r,max}}^{\mathrm{exp}}$	expected maximum operating temperature
Δt_{TIM}	temperature drop over the TIM [°C]
γ_1, γ_2	bounding angles of a luminous flux category
κ	inverse response of the heat flux sensor in the heat flus measurement system

1.8 Conventions

This Section 1.8 defines the notations and conventions used in the Zhaga Interface Specification.

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 either in Section 1.5 or in [Book 1].

1.8.4 Units of physical quantities

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

1.8.5 Decimal separator

The decimal separator is a comma.

1.8.6 Limits

All limits specified in this edition 1.1 of Book 8 of the Zhaga Interface Specification are absolute, without any implied tolerance (neither positive, nor negative). Values that are indicated as typical as well as values between parentheses are informative.

2 System Overview

2.1 PHJ85d fit system

This edition 1.1 of Book 8 of the Zhaga Interface Specification defines the interface between a LED Light Engine (LLE), which consists of a single housing that integrates a LED Module and an Electronic Control Gear, and an associated Luminaire, which typically consists of a heat sink, a Holder, and a reflector. The LLE can be locked into and removed from the Holder without the use of generic or specialized tools.[1] Typically, this involves a rotational motion of the LLE.

A typical application of the LLE-Luminaire system defined in this edition 1.1 of Book 8 of the Zhaga Interface Specification is downlighting, from a recessed mount of the system in a ceiling.

The mechanical interface between the LLE and the associated Luminaire is shown schematically in Figure 2-1. This mechanical interface is designated as a PHJ85d fit, according to the classification system defined in [IEC 60061 (a)]. In addition to this so-called "universal" fit—which is intended for application by LLEs that can operate on any mains voltage—two additional mutually exclusive, mains voltage specific fits are defined—namely PHJ85d-1 and PHJ85d-2.[2]

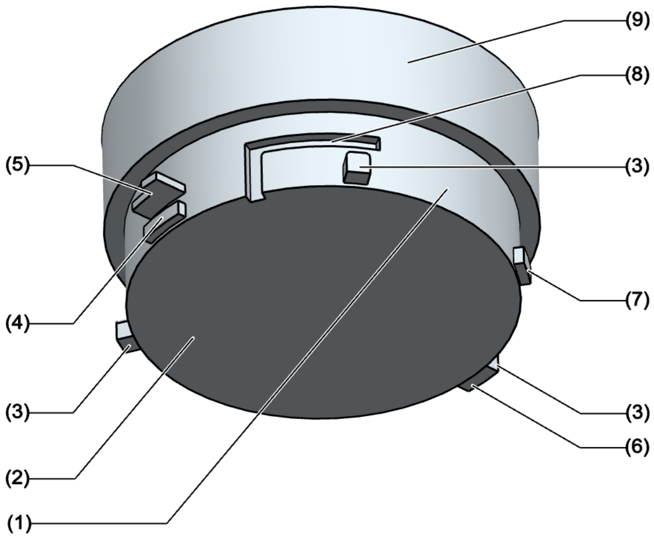

Figure 2-1: 3-D illustration of the mechanical interface

From a LLE point of view, the mechanical interface consists of the following elements (refer to the corresponding labels in Figure 2-1):

(1) *Base.* This is the—typically cylindrical—part of the LLE that is locked into the Holder. As described below, the Base contains several functional elements for electrical contact making, mains voltage discrimination, and heat removal.

(2) *Thermal Interface Surface.* This is the main surface through which the LLE expects to remove its heat. If the LLE is locked into the Luminaire, this surface is firmly pressed against the heat sink of a Luminaire. In order to minimize the thermal resistance across the interface, the Thermal Interface Surface typically consists of—compressible—Thermal Interface Material (TIM).

(3) *Force pin.* The Holder can apply a relatively large axial force to these pins—in order to minimize the thermal interface resistance to the heat sink—without risking damage to the LLE. The first

[1]Apart from any tools—ladders, screwdrivers, etc.—that could be necessary to reach and access the inside of the Luminaire.
[2]The definition of the test fixtures and Luminaire compliance tests in Part 2 use the notation PHJ85d-*x* in order to refer to both the PHJ85d-1 fit and the PHJ85d-2 fit.

force pin in the clockwise direction from the electrical contact tab (in a top view of the LLE) is typically used as a stop for any rotational motion during locking of the LLE into the Holder.

(4) *Protection stub.* This element is optionally present. Its function is to protect the electrical contact tab during insertion of the LLE into the Holder.

(5) *Electrical contact tab.* The electrical contact tab contains two electrical contacts—one line and one neutral contact—on each side. Opposing contacts on the two sides have the same polarity.

(6) *Keying element adjacent to a force pin.* This is the first of the Keying elements, which are used to discriminate between mains voltages. This element is located adjacent to different force pins for a PHJ85d-1 and a PHJ85d-2 fit. It is functional only during axial insertion of the LLE into the Holder.

(7) *Solitary Keying element.* This is the second of the Keying elements, which are used to discriminate between mains voltages. This element is located at different positions for a PHJ85d-1 and a PHJ85d-2 fit. It is functional only during axial insertion of the LLE into the Holder.

(8) *L-shaped Slot.* This slot provides space for a Holder stub, which protrudes into the central opening of the Holder, during axial insertion and rotation of the LLE into a Luminaire. The purpose of this Holder stub is to prevent a LLE force pin from accidentally entering the electrical contact opening of a Holder, in the case that it is attempted to incorrectly insert the LLE into the Luminaire.

(9) *Top construction.* The top construction can have any shape, provided that it does not exceed the maximum boundaries. In addition, the top construction contains the Light Emitting Surface (LES). The luminous intensity distribution emitted from the LES is approximately lambertian.

2.2 Outline of this book

This edition 1.1 of Book 8, of the Zhaga Interface Specification consists of two parts:

Part 1 Interface definition defines the LLE-Luminaire interface in terms of five sub interfaces.

- The mechanical interface in Section 3 defines the PHJ85d fit between a LLE and a Luminaire.
- The photometric interface in Section 4 defines the luminous flux and luminous intentsity distribution provided but the LLE to the Luminaire.
- The electrical interface in Section 5 defines the properties of the mains power provided by the Luminaire to the LLE.
- The thermal interface in Section 6 defines the heat transfer from the LLE to the Luminaire.
- The control interface in Section 7 defines the methods for modifying the behavior of the LLE-Luminaire system.

Note that an arbitrary LLE and an arbitrary Luminaire, which both comply with the definitions in Part 1 of this edition 1.1 of Book 8, of the Zhaga Interface Specification need not necessarily be compatible! In particular, as defined Section 6.5, an end-user should verify the thermal compatibility between a LLE and a Luminaire before using that LLE-Luminaire system in a particular environment.

Part 2 Compliance tests defines the tools (Section 8) and tests, which may be used to verify compliance of a LLE (Section 9), Luminaire (Section 10), or Holder (Section 11) with the definitions provided in Part 1 of this edition 1.1 of Book 8, of the Zhaga Interface Specification. In the case of any perceived discrepancy between the definitions provided in Part 1 and the definitions provided in Part 2, the definitions provided in Part 2 override those provided in Part 1.

The Annexes to this edition 1.1 of Book 8, of the Zhaga Interface Specification provide the following additional information:

- Annex A: This Annex provides an alphabetic list of all interface dimensions, showing the minimum and maximum values for both a LLE and a Holder. These values are derived from the MMC and LMC dimensions defined in Section 3, the gauge dimensions defined in Sections 8.1.1 and 8.2.1. In addition these values contain recommendations for a Holder LMC, such that the Holder can satisfy the functional requirements given in Section 3.9.

- Annex B: This Annex provides an overview of the information, which is required or recommended to be listed on the data sheet of a LLE, Luminaire, and/or Holder product.
- Annex C: This Annex provides references to relevant standards for product safety.
- Annex D: This Annex defines the mechanical interface between a Holder and a Luminaire, in the case that the Holder is not integrated into the Luminaire.
- Annex E: This Annex defines the Thermal Fit Code, which helps to determine if a LLE and Luminaire are (thermally) compatible.

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Part 1: Interface Definition

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3 Mechanical Interface

This Section 3 defines the mechanical properties of the PHJ85d fit system, which forms the basis of the LLE-Luminaire mechanical interface. Specifically, this Section 3 defines two LLE-Luminaire fits that are mutually exclusive—fit codes PHJ85d-1 and PHJ85d-2—as well as one LLE-specific fit—fit code PHJ85d—which matches with any Luminaire. See also Section 5, detailing the electrical interface.

The Thermal Interface Surface of the LLE is the reference plane for vertical dimensions. Typically, the Thermal Interface Surface of the LLE consists of a compressible TIM. Unless indicated otherwise, the MMC and LMC of vertical dimensions apply with the TIM in a compressed state.

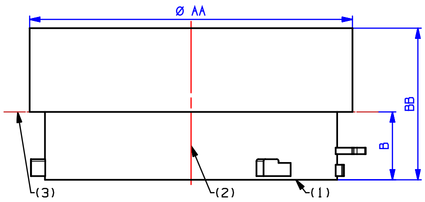
Unless indicated otherwise, all dimensions apply for a LLE or Luminaire temperature of (25 ± 5) °C.

3.1 Outline of the LLE-Luminaire fit

The left hand side of Figure 3-1 and Table 3-1 define the maximum outline of the LLE-Luminaire fit.

From a LLE point of view, the demarcation line divides the LLE into a Base and a top construction. Note that the LLE does not need to have a clearly visible demarcation line. The details of the Base are defined in Sections 3.3, 3.4, 3.5, and 3.6. The top construction shall contain a Light Emitting Surface as shown in the right hand side of Figure 3-1.

A Luminaire may contain flexible elements that violate the maximum outline of the fit if there is no LLE locked in the Luminaire.



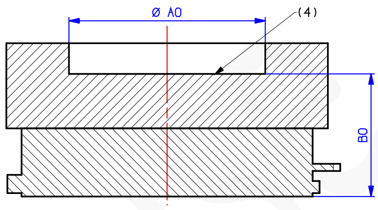


Figure 3-1: Outline of the LLE-Luminaire fit (left) and position of the Light Emitting Surface (right)

Notes to Figure 3-1 (above):

(1) This is the reference plane for vertical dimensions.

(2) The axis at the center of diameter AA is the reference for axial dimensions.

(3) The demarcation line marks the division between the Base and the top construction of a LLE.

(4) This is the position of the Light Emitting Surface (LES) inside the maximum outline of a LLE. The LES need not be circular. The height BO of the LES above the reference plane applies with the TIM in a compressed state—i.e. with the LLE locked into the Luminaire.

Table 3-1: Dimensions of the fit outline and Light Emitting Surface

Dimension	LMC	MMC	Notes
AA	NA	95.00	
BB	NA	45.00	
BO	35.00	40.00	
Dimension	**MMC**	**LMC**	**Notes**
AO	57.00	71.00	
B	20.00	(45.00)	

3.2 System references for contact making

The PHJ85 fit system for contact making relies on three references, namely:

- The center of the fit system (the center point of diameter A).
- The two contact centers (defined by dimensions GHc, Hc; and GJc, Jc).
- The rotation stop (the line that is displaced by dimension Dref/2 from the angle αa).

Figure 3-2 and Table 3-2 define these system references.

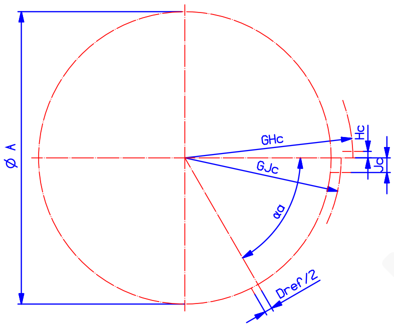


Figure 3-2: System references for contact making

Table 3-2: System references for contact making

Dimension	Nominal	Notes
Dref/2	2.25	
GHc	49.35	
GJc	45.90	
Hc	1.90	
Jc	4.30	
αa	60.00°	

(Informative) *Note that if a LLE is locked into a Holder, the LLE and the Holder should make physical contact at the rotation stop. This implies that if the position of the relevant edge of force pin #1 (see Figure 3-3 in Section 3.3) deviates from the reference, LLE should have a larger contact in order to guarantee proper contact making in any Holder. Similarly, if the position of the rotation stop in the Holder deviates from the reference, the Holder should be able to make contact across a larger area, in order to guarantee proper contact making with any LLE.*

3.3 PHJ85d fit

Figure 3-3 and Table 3-3 define the MMC of the PHJ85d fit. In addition, Figure 3-4 and Table 3-3 define the LMC of the associated Base. For details of the electrical contact tab see Section 3.6.

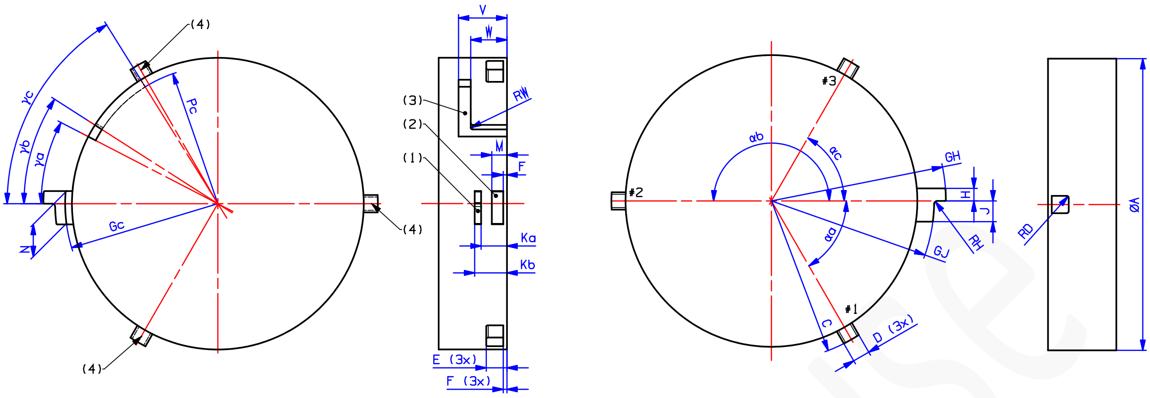


Figure 3-3: PHJ85d fit, MMC

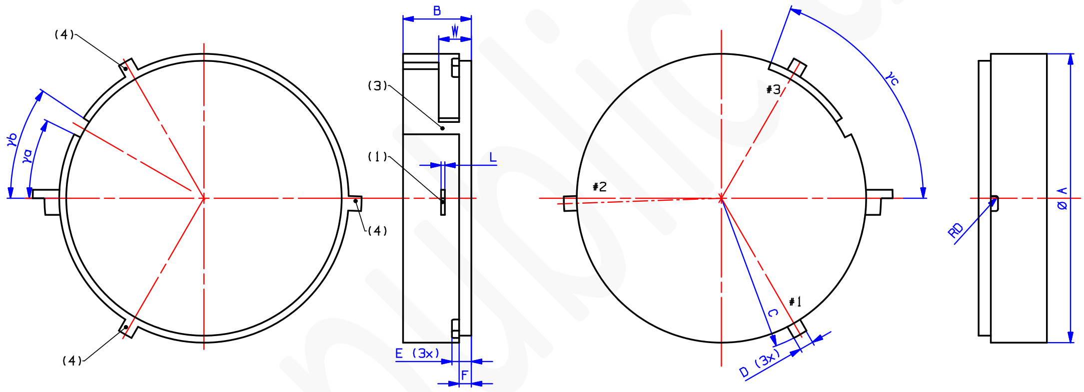


Figure 3-4: PHJ85d fit, Base LMC

Notes to Figure 3-3 and Figure 3-4 (above):

(1) The electrical contact tab (as seen from the perspective of a LLE).

(2) The protection stub (as seen from the perspective of a LLE).

(3) The L-shaped Keying element (as seen from the perspective of a LLE).

(4) The force pins (as seen from the perspective of a LLE). The two corners at the underside of the force pins (i.e. closest to the Thermal Interface Surface) should be slightly chamfered or rounded with a dimension less than 0,20 mm.

Notes to Table 3-3 (below):

(1) The cylindrical body of the Base may have gaps around the protruding elements. Such gaps shall not interfere with the centering functionality of this cylindrical body.

(2) The MMC of this dimension shall not be violated if the TIM is in an uncompressed state.

(3) The thickness of the electrical contact tab of a LLE, including any additional electrical contact material, shall not exceed 1,50 mm. The conductive surface of the electrical contacts shall be elevated above any non-conducting surface of the electrical contact tab.

(4) The protection stub of a LLE shall not exceed beyond the electrical contact tab of the LLE on either side.

Table 3-3: Dimensions of the PHJ85d fit

Dimension	LMC	MMC	Notes
A	85.20	86.00	(1)
C	46.40	47.20	
D	4.30	5.20	
E	5.70	6.10	(2)
Gc	NA	45.05	
GH	NA	51.45	
GJ	NA	48.00	
H	NA	3.80	
J	NA	6.20	
Kb	NA	9.60	(2), (3)
L	1.10	NA	(3)
M	NA	4.55	(2)
N	NA	10.00	(4)
Pc	NA	40.60	
RH	NA	1.00	
W	9.60	10.75	(2)
αa	(60.00°)		
αb	180.00°		
αc	60.00°		
γa	26.30°	27.50°	
Dimension	**MMC**	**LMC**	**Notes**
F	1.00	4.00	(5)
Ka	7.50	NA	(3)
RD	0.50	1.50	
RW	0.50	NA	(6)
V	14.15	NA	
γb	32.50°	33.70°	
γc	58.00°	68.00°	

Notes to Table 3-3 (continued):

(5) Dimension F should be the same for all elements involved.

(6) Instead of a radius, a chamfer of the same dimension may be used.

3.4 PHJ85d-1 fit

Figure 3-5, Table 3-3 (in Section 3.3), and Table 3-4 define the MMC of the PHJ85d-1 fit. In addition, Figure 3-6, Table 3-3 (in Section 3.3), and Table 3-4 define the LMC of the associated Base. For details of the electrical contact tab see Section 3.6.

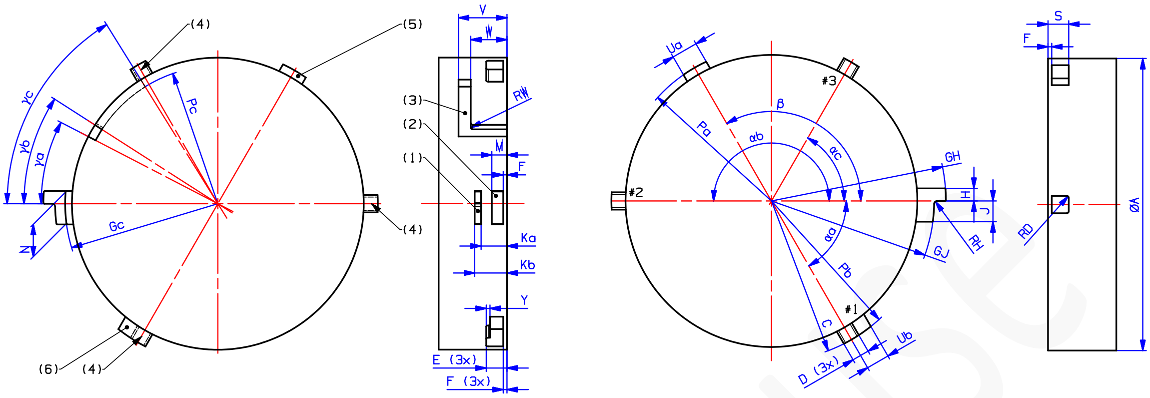


Figure 3-5: PHJ85d-1 fit, MMC

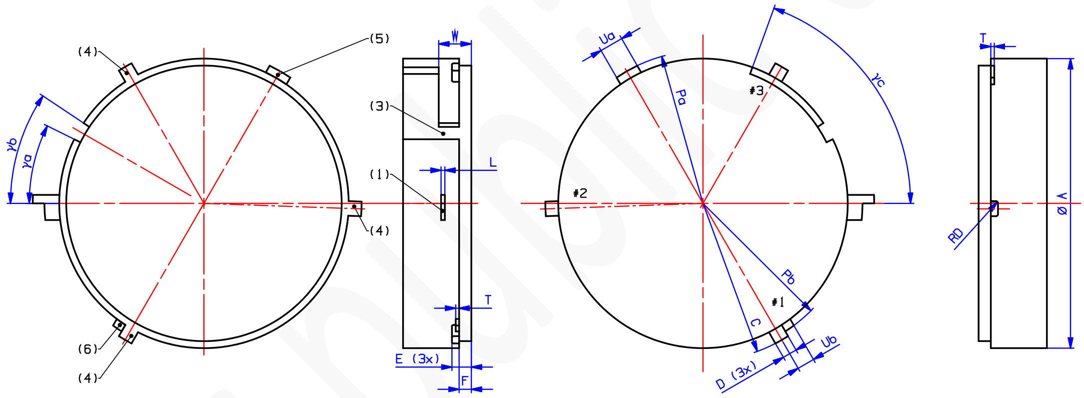


Figure 3-6: PHJ85d-1 fit, Base LMC

Notes to Figure 3-5 and Figure 3-6 (above):

(1) The electrical contact tab (as seen from the perspective of a LLE).

(2) The protection stub (as seen from the perspective of a LLE).

(3) The L-shaped Keying element (as seen from the perspective of a LLE).

(4) The force pins (as seen from the perspective of a LLE).

(5) The solitary Keying element (as seen from the perspective of a LLE).

(6) The Keying element adjacent to a force pin (as seen from the perspective of a LLE).

Table 3-4: Additional dimensions of the PHJ85d-1 and PHJ85d-2 fits

Dimension	LMC	MMC	Notes
Pa	44.90	45.35	(1)
Pb	44.80	47.20	(1)
S	NA	6.05	(2)
T	NA	1.00	
Ua	7.00	7.85	(1)
Ub	5.20	7.00	(1)
β	120.00°		(3)
	130.00°		(4)
Dimension	**MMC**	**LMC**	**Notes**
Y	1.00	NA	

Notes to Table 3-4 (above):

(1) In the LMC of the Base, a LLE shall have material that extends up to the edge of the Keying element in at least one position. The LLE may have material at any other position within the outline of the Keying element.

(2) The MMC of this dimension shall not be violated if the TIM is in an uncompressed state

(3) PHJ85d-1 fit.

(4) PHJ85d-2 fit (See Section 3.5).

3.5 PHJ85d-2 fit

Figure 3-7, Table 3-3 (in Section 3.3), and Table 3-4 (in Section 3.4) define the MMC of the PHJ85d-2 fit. In addition, Figure 3-8, Table 3-3 (in Section 3.3), and Table 3-4 (in Section 3.4) define the LMC of the associated Base. For details of the electrical contact tab see Section 3.6.

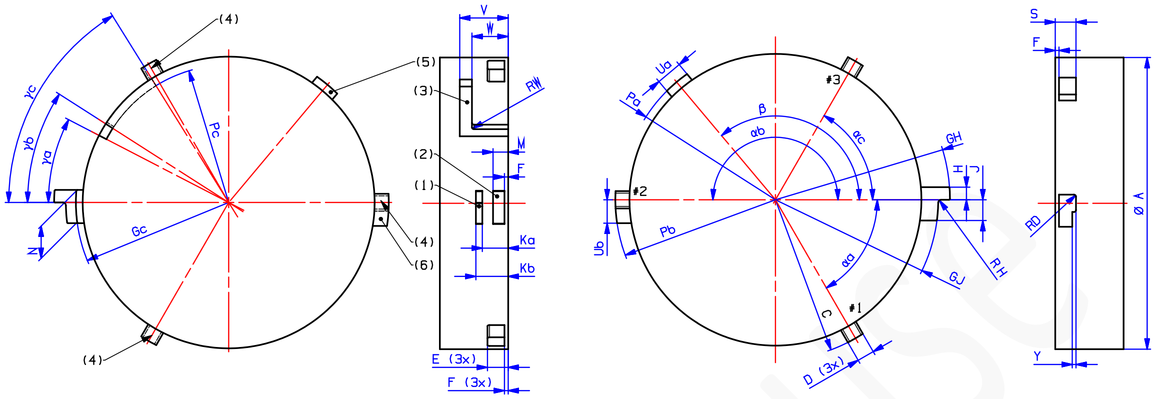


Figure 3-7: PHJ85d-2 fit, MMC

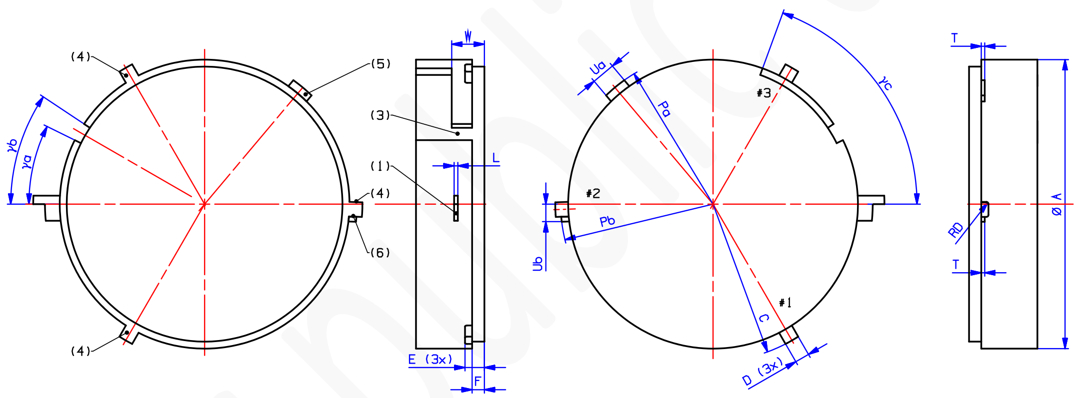


Figure 3-8: PHJ85d-2 fit, Base LMC

Notes to Figure 3-7 and Figure 3-8 (above):

(1) The electrical contact tab (as seen from the perspective of a LLE).

(2) The protection stub (as seen from the perspective of a LLE).

(3) The L-shaped Keying element (as seen from the perspective of a LLE).

(4) The force pins (as seen from the perspective of a LLE).

(5) The solitary Keying element (as seen from the perspective of a LLE).

(6) The Keying element adjacent to a force pin (as seen from the perspective of a LLE).

3.6 Electrical contact tab details (LLE)

Figure 3-9 and Table 3-5 define the minimum outline of the contact pads on the electrical contact tab of a LLE, in the case that the edge of force pin #1 is located at the rotation stop (see Section 3.2) exactly, and the Base diameter A is equal to either the MMC or the LMC. Clearly, a smaller Base diameter implies a larger contact pad. Similarly, any deviation of the edge of force pin#1 from the rotation stop shall be compensated by an increase of the contact pad size in the tangential direction—with on each side an amount that is equal to the deviation of the edge from the rotation stop.

Both sides of the electrical contact tab shall have contact pads. The minimum outline of the contact pads is the same on both sides of the electrical contact tab.

Within a contact pad outline, the shortest distance from an arbitrary point to the nearest conductive part of the electrical contact surface shall be at most 0,20 mm. Both sides of the electrical contact tab shall have contact pads, with opposite contact pads having the same polarity.

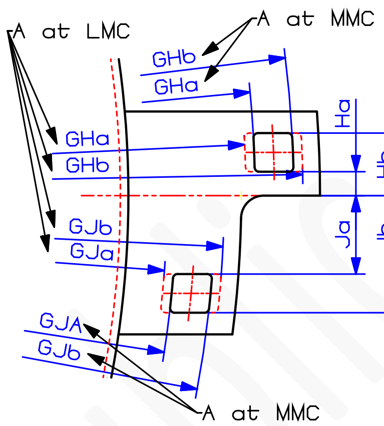


Figure 3-9: Electrical contact tab details

Table 3-5: Electrical contact tab dimensions

	Base dimension A at MMC		Base dimension A at LMC	
Dimension	**LMC**	**MMC**	**LMC**	**MMC**
GHb	50.20	NA	50.60	NA
GJb	46.75	NA	47.15	NA
Hb	2.75	NA	2.75	NA
Jb	5.15	NA	5.15	NA
Dimension	**MMC**	**LMC**	**MMC**	**LMC**
GHa	NA	48.50	NA	48.10
GJa	NA	45.05	NA	44.65
Ha	NA	1.05	NA	1.05
Ja	NA	3.45	NA	3.45

3.7 LLE mass

The mass of a LLE shall not exceed 300 g.

3.8 Luminaire heat sink

The Luminaire shall have a heat sink to drain the thermal power from the LLE. The surface of this heat sink shall extend to a diameter of at least 85,00 mm, should have a planarity of 0,05 mm or better across the diameter of the Thermal Interface Surface, and should have a surface roughness $R_a \leq 3{,}20$ µm.

3.9 Luminaire functional requirements

It shall not be physically possible to lock a PHJ85d-1 Base or a PHJ85d-2 Base into the same Holder.

The Holder shall press the Thermal Interface Surface (of the locked LLE) to the heat sink of the Luminaire, with a force of at least 40 N and at most 75 N.

The Holder shall establish an electrically conductive circuit through the contact pads of the locked LLE.

The Holder should not apply an axial force—i.e. perpendicular to the surface of the contact pads—to the electrical contact tab of the locked LLE.

3.10 Thermal expansion

At the expected operating temperature, thermal expansion of the LLE should not result in a violation of the MMC dimensions provided in Section 3.

At the expected operating temperature, thermal expansion of the Luminaire—and in particular its Holder—should not result in a violation of the MMC dimensions provided in Section 3.

3.11 Product Data Set

The Product Data Sets of the LLE and Luminaire shall list the appropriate mechanical fit code.

4 Photometric Interface

4.1 Operating conditions

The photometric properties defined in Section 4 apply if the following conditions are satisfied:

- The LLE is mounted vertical, Base down, without obstructing the convective air flow originating from the LLE.
- The voltage and frequency of the electrical power applied to the LLE are within 0,20% of the Rated voltage and Rated frequency.
- The temperature at the of center the Thermal Interface Surface is within 1 °C of the Rated Operating Temperature $t_{r,max}$.

See [Book 1] for background information.

4.2 Luminous flux

Whereas this edition 1.1 of Book 8 of the Zhaga Interface Specification does not limit the luminous flux of a LLE, the Product Data set of the LLE shall list one of the luminous flux categories defined in Table 4-1. The luminous flux of the LLE shall be within the limits of the flux category listed in the Product Data Set.

Table 4-1: Luminous flux categories

Luminous flux category	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.

4.3 Luminous intensity distribution

The luminous intensity distribution of a LLE is characterized by the luminous flux emitted into four solid angles of $\frac{1}{2}\pi$ sr each. As shown in Figure 4-1, these solid angles are rotationally symmetric around the vertical axis of the LLE, and bounded by the angles γ_1 and γ_2. The reference point for these solid angles is the intersection of the LES and the vertical axis of the Base.

The percentage of luminous flux, which a LLE emits into each solid angle, shall be within the limits defined in Table 4-2.

Table 4-2: Luminous intensity distribution

γ_1	γ_2	Percentage of luminous flux	
		Minimum	Maximum
0°	41,40°	35%	55%
41,40°	60,00°	25%	40%
60,00°	75,50°	10%	30%
75,50°	90°	0%	10%

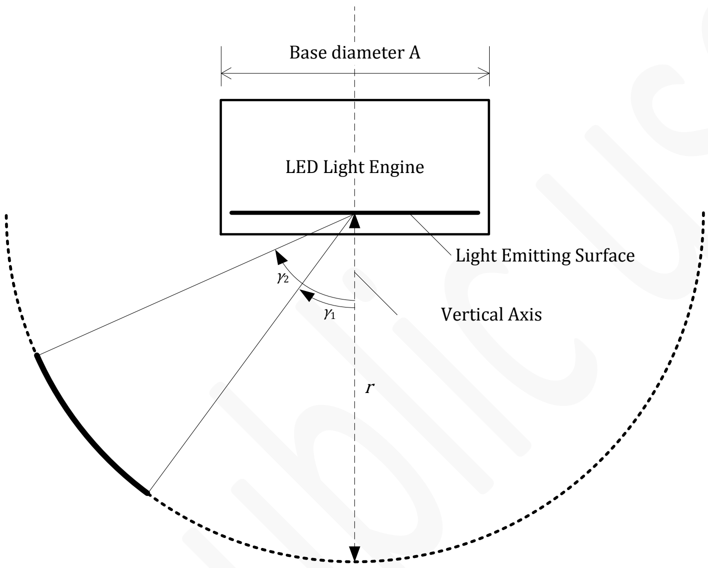


Figure 4-1: Luminous intensity distribution

4.4 Luminance uniformity

This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define limits on the luminance uniformity of a LLE.

4.5 Correlated color temperature

The correlated color temperature of a LLE shall comply with the provisions of [Book 1].

4.6 Color rendering index

The correlated rendering index of a LLE shall comply with the provisions of [Book 1].

5 Electrical Interface

5.1 Mains power

Table 5-1 lists the mains power characteristics associated with the three mechanical fits defined in this edition 1.1 of Book 8 of the Zhaga Interface Specification.

Table 5-1: Mains power characteristics

Fit code	Voltage [V]	Frequency [Hz]	Power [W]
PHJ85d	100…277	50 and/or 60	0…50
PHJ85d-1	100…127	50 and/or 60	0…50
PHJ85d-2	200…277	50 and/or 60	0…50

As shown in Figure 5-1, the contact pads on each side of the electrical contact tab of a LLE shall have opposite polarity; and facing contacts on opposite sides of the electrical contact tab shall have the same polarity. Either set of same polarity contacts may be designated as line or neutral.

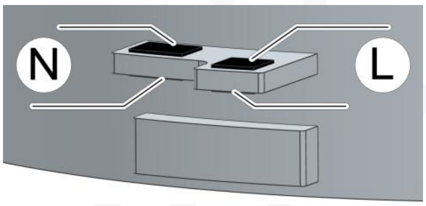


Figure 5-1: Polarity of the electrical contacts

The Product Data Set of a LLE shall list the mains power, voltage and frequency of the LLE. It is recommended that the Product Data Set of a Luminaire list the mains voltage and frequency.

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6 Thermal Interface

6.1 Operating Temperature

This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define limits on the temperature at the Thermal Interface Surface. However, it is recommended that under normal steady state operating conditions, the temperature at any position of the Thermal Interface Surface does not exceed 110 °C.

The Product Data Set of a LLE shall list the temperature $t_{\mathrm{r,max}}$ at the center of the Thermal Interface Surface as the operating temperature at which the photometric properties are defined (see Section 4.1).

6.2 LLE temperature uniformity

In normal steady state operation, the thermal spreading resistance R_{sp} between any two of the Reference Temperature positions at the Thermal Interface Surface defined in Figure 6-1 shall be at most 0,3 K/W. Here, the thermal spreading resistance between Reference Temperature positions i and j is defined as

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

Reference Temperature position 0 is located at the center of the Thermal Interface Surface. Reference Temperature positions 1…6 are located with equidistant spacing on a circle, which is centered on Reference Temperature position 0 and has a diameter of $(78{,}00 \pm 0{,}1)$ mm.

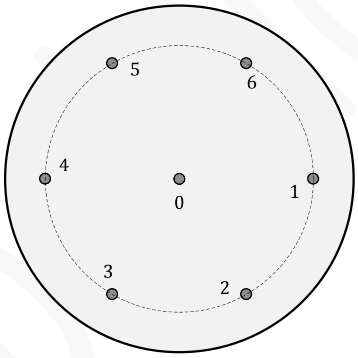

Figure 6-1: Reference Temperature positions

6.3 LLE thermal power

The Product Data Set of a LLE shall list the thermal power $P_{\mathrm{th,rear}}$, which the LLE generates at the Thermal Interface Surface. The accuracy of this Rated thermal power $P_{\mathrm{th,rear}}$ shall be 3%.

6.4 Luminaire thermal resistance

This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define limits on the thermal resistance R_{th} from the Thermal Interface Surface to the environment of the LLE-Luminaire system. However, the Product Data Set of a Luminaire shall list the thermal resistance R_{th} at an applied thermal power of $(10 \pm 5\%)$ W, $(20 \pm 5\%)$ W, $(30 \pm 5\%)$ W, and $(40 \pm 5\%)$ W, and an ambient temperature of (25 ± 5) °C. The accuracy of this Rated thermal resistance R_{th} shall be 10%.

6.5 Thermal compatibility

From a thermal point of view, an arbitrary LLE generally is not necessarily compatible with an arbitrary Luminaire. The reason is that the temperature t_{r} at Reference Temperature position 0 depends on the thermal power $P_{\mathrm{th,rear}}$ generated by the LLE at the Thermal Interface Surface, the thermal resistance R_{th} to the environment of the LLE-Luminaire system, and the ambient temperature t_{a} in the environment of the

LLE-Luminaire system. Thermal compatibility of a specific LLE and a specific Luminaire should be verified prior to the use of that LLE-Luminaire system in a specific environment. See [Book 1] for details.

Annex E defines a simple coding scheme that aids with the verification of the thermal compatibility of a specific LLE and a specific Luminaire.

7 Control Interface

7.1 Dimming (optional)

If a Socketable LLE supports dimming functionality, such dimming functionality shall comply with the provisions of [NEMA SSL 7A].

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Part 2: Compliance Testing

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8 Compliance testing tools

8.1 LLE testing tools

8.1.1 Gauges

This Section 8.1.1 defines gauges that shall be used to verify the compliance of a LLE with the mechanical properties the PHJ85d fit system. See Section 9.1 for the application of these gauges.

(Informative) *Thermal expansion at the operating temperature causes most LLE dimensions to be slightly increased over those in the switched-off state. Therefore, the gauges defined in this Section 8.1.1 are based on the MMC dimensions plus a 0,1 mm clearance from the MMC to compensate for any expected thermal expansion at temperatures that are different from those at which the mechanical interface tests defined in Section 9.1 are performed (LLE switched-off).*

Gauges MTG-B1-PHJ85d-1 and MTG-B2-PHJ85d-2 verify the Maximum Material Condition of the LLE dimensions(radial and tangential).

Gauges MTG-B3a-PHJ85d, MTG-B3b-PHJ85d, MTG-B3c-PHJ85d, and MTG-B3d-PHJ85d verify the Maximum Material Condition of the LLE dimensions (axially).

Gauges MTG-B4-PHJ85d-1 and MTG-B5-PHJ85d-2 verify the contact making and Keying functionality.

Unless specified otherwise, the material composition of the gauges shall be stainless steel, which is hardened to at least 55 HRC.

The gauges should have a surface finish of $R_a \leq 0{,}40\ \mu m$. Sharp angles should be chamfered or rounded with a radius of at most 0,20 mm, as defined in [IEC 60061 (b)].

8.1.1.1 MTG-B1-PHJ85d-1 and MTG-B2-PHJ85d-2

Figure 8-1 and Table 8-1 define gauge MTG-B1-PHJ85d-1.

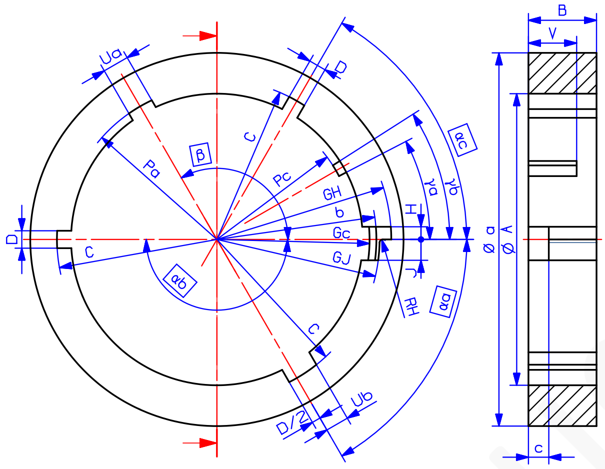

Figure 8-1: MTG-B1-PHJ85d-1

Figure 8-2 and Table 8-1 define gauge MTG-B2-PHJ85d-2.

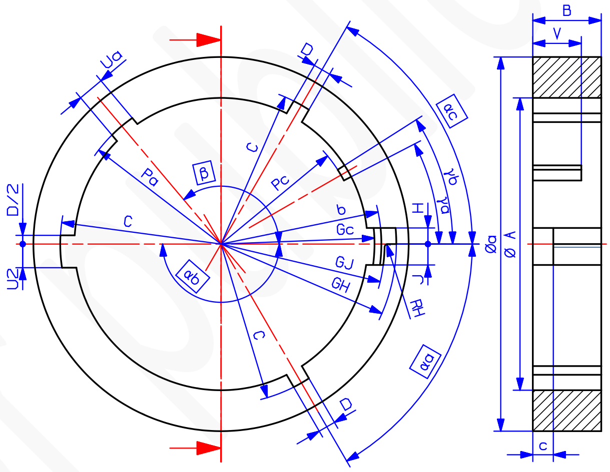

Figure 8-2: MTG-B2-PHJ85d-2

Table 8-1: MTG-B1-PHJ85d-1 and MTG-B2-PHJ85d-2 dimensions

Dimension	Nominal	Tolerance
A	85.96	±0.03
B	20.04	±0.03
C	47.16	±0.03
D	5.16	±0.03
Gc	45.01	±0.03
GH	51.41	±0.03
GJ	47.96	±0.03
H	3.76	±0.03
J	6.16	±0.03
Pa	45.31	±0.03
Pc	40.56	±0.03
RH	0.94	±0.05
Ua	7.81	±0.03

Dimension	Nominal	Tolerance
Ub	6.96	±0.03
V	14.19	±0.03
αa	60.00°	±10'
αb	180.00°	±10'
αc	60.00°	±10'
β (1)	120.00°	±10'
β (2)	130.00°	±10'
γa	27.45°	±10'
γb	32.55°	±10'
a	110.00	±0.20
b	47.00	±0.20
c	6.00	±0.20

(1) PHJ85d-1

(2) PHJ85d-2

8.1.1.2 MTG-B3a-PHJ85d, MTG-B3b-PHJ85d, MTG-B3c-PHJ85d, and MTG-B3d-PHJ85d

Figure 8-3, Figure 8-4, Figure 8-5, Figure 8-6, and Table 8-2 define gauges MTG-B3a-PHJ85d, MTG-B3b-PHJ85d, MTG-B3c-PHJ85d, and MTG-B3d-PHJ85d.

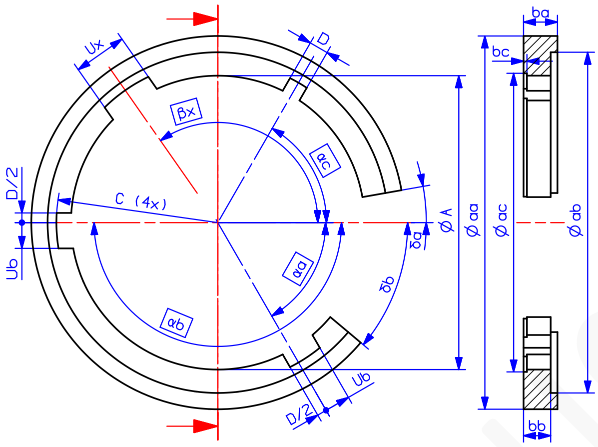

Figure 8-3: MTG-B3a-PHJ85d

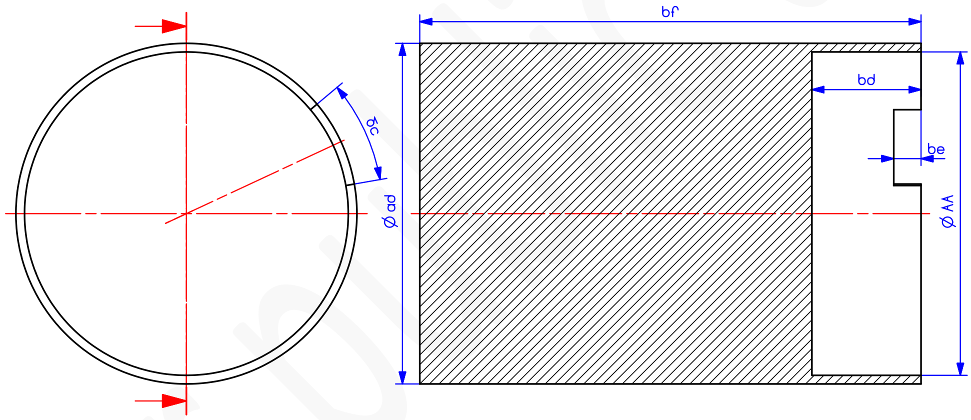

Figure 8-4: MTG-B3b-PHJ85d

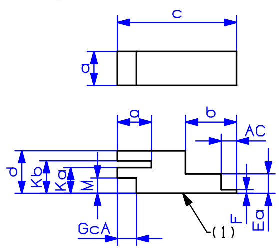

Figure 8-5: MTG-B3c-PHJ85d

Notes to Figure 8-5 (above):

(1) This is the reference plane.

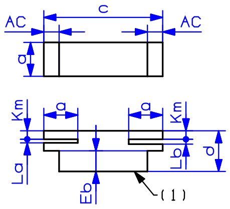

Figure 8-6: MTG-B3d-PHJ85d

Notes to Figure 8-6 (above):

(1) This is the reference plane.

Table 8-2: MTG-B3a-PHJ85d, MTG-B3b-PHJ85d, MTG-B3c-PHJ85d and MTG-B3d-PHJ85d dimensions

Dimension	Nominal	Tolerance	Dimension	Nominal	Tolerance
A	86.60	±0.10	ab	100.40	±0.10
AA	94.96	±0.03	ac	88.00	±0.10
C	47.60	±0.10	ad	100.00	±0.10
D	5.70	±0.10	b	15.00	±0.20
Ea	5.71	±0.03	ba	10.00	±0.20
Eb	6.09	±0.03	bb	8.00	±0.20
F	1.04	±0.03	bc	1.00	±0.20
Ka	7.54	±0.03	bd	33.00	±0.20
Kb	9.56	±0.03	be	8.00	±0.20
La	1.09	±0.01	bf (1)	147.00	
Lb	1.51	±0.01	c	35.00	±0.20
M	4.51	±0.03	d	12.00	±0.20
Ub	7.60	±0.10	GcA	3.40	±0.20
αa	60.00°	±10'	Km	2.50	±0.20
αb	180.00°	±10'	Ux	16.00	±0.20
αc	60.00°	±10'	βx	125.00°	±10'
			δa	10°	±1°
AC	4.50	±0.20	δb	40°	±1°
a	10.00	±0.20	δc	30°	±1°
aa	110.00	±0.20			

(1) The height bf of gauge MTG-B3b-PHJ85d shall be adjusted such that the combined mass of gauges MTG-B3a-PHJ85d and MTG-B3b-PHJ85d is (7,50 ± 0,07) kg.

8.1.1.3 MTG-B4-PHJ85d-1 and MTG-B5-PHJ85d-2

Figure 8-7 and Table 8-3 define gauge MTG-B4-PHJ85d-1.

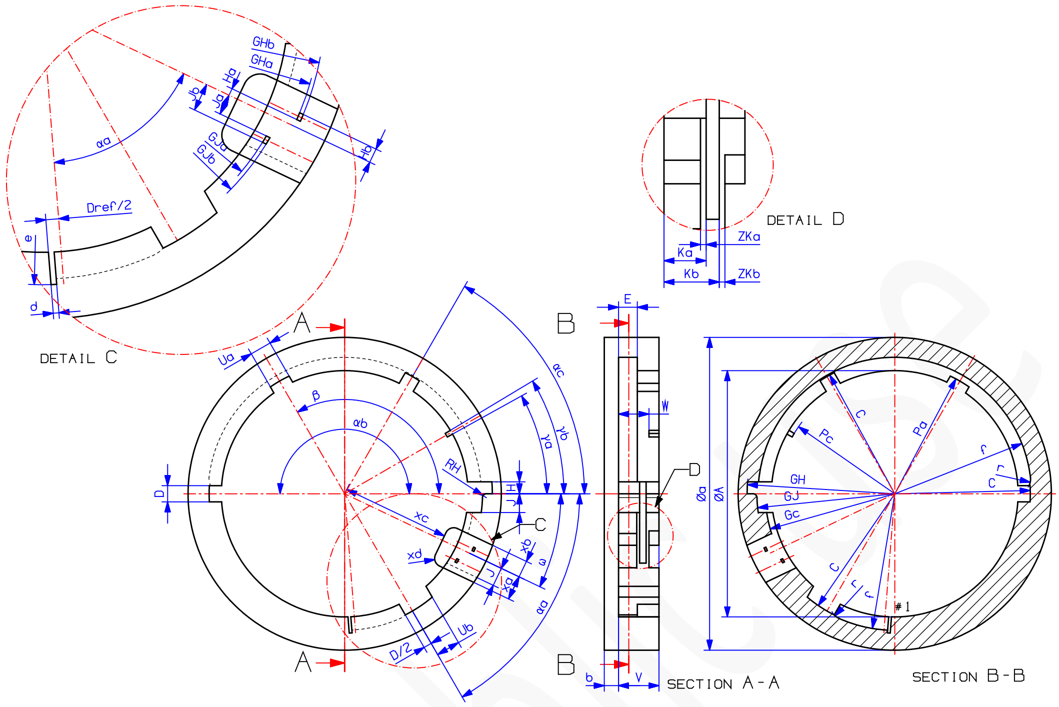

Figure 8-7: MTG-B4-PHJ85d-1

Figure 8-8 and Table 8-3 define gauge MTG-B5-PHJ85d-2.

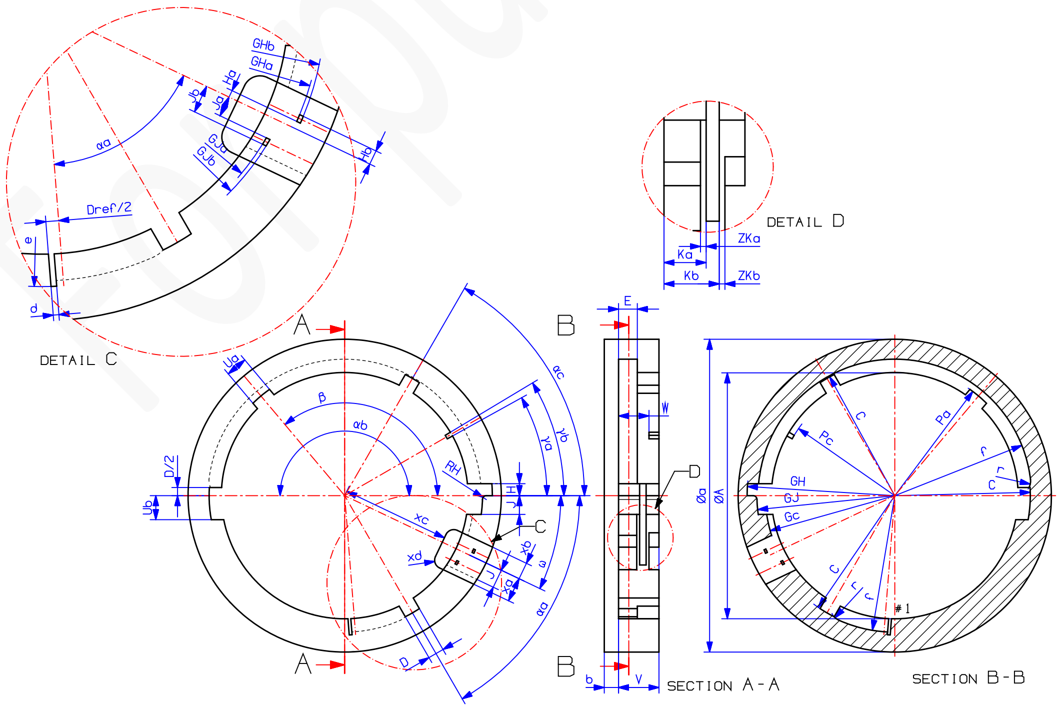

Figure 8-8: MTG-B5-PHJ85d-2

Table 8-3: MTG-B4-PHJ85d-1 and MTG-B5-PHJ85d-2 dimensions

Dimension	Nominal	Tolerance
A	86.60	±0.03
C	47.60	±0.10
D	5.70	±0.10
Dref/2	2.25	±0.03
E	6.60	±0.10
Gc	45.45	±0.10
GH	51.85	±0.10
GHa	49.00	±0.03
GHb	49.70	±0.03
GJ	48.40	±0.10
GJa	45.55	±0.03
GJb	46.25	±0.03
H	4.20	±0.10
Ha	1.25	±0.03
Hb	2.55	±0.03
J	6.60	±0.10
Ja	3.65	±0.03
Jb	4.95	±0.03
Ka	7.40	±0.10
Kb	9.70	±0.10
Pa	45.75	±0.10
Pc	41.20	±0.03
RH	1.40	±0.10
Ua	8.45	±0.03
Ub	7.60	±0.03
V	14.19	±0.03

Dimension	Nominal	Tolerance
W	10.71	±0.03
αa	60.00°	±10'
αb	180.00°	±10'
αc	60.00°	±10'
β (1)	120.00°	±10'
β (2)	130.00°	±10'
γa	29.00°	±10'
γb	31.00°	±10'
a	110.00	±0.20
b	5.00	±0.20
f	48.00	±0.20
d	1.00	±0.20
e	49.00	±0.20
r	5.00	±1.00
xa	8.60	±0.20
xb	6.00	±0.20
xc	38.00	±0.20
xd	3.00	±0.50
zKa	1.00	±0.50
zKb	1.00	±0.50
ω	25.50°	±10'

(1) PHJ85d-1

(2) PHJ85d-2

8.1.2 Test fixture TUTF-PHJ85d-*x* (thermal uniformity)

Test fixture TUTF-PHJ85d-*x* consists of a temperature controlled heat sink and a Holder. In this edition 1.1 of Book 8 of the Zhaga Interface Specification, the Holder shall be any commercially available Holder having a PHJ85d-1 or a PHJ85d-2 fit, which applies a force of at least 40 N and at most 75 N. The Holder, Holder mount, and heat sink shall be assembled and mounted on a cooling device; see Figure 8-9 for an illustration. Proper thermal contact between test fixture TUTF-PHJ85d-*x* shall be ensured.

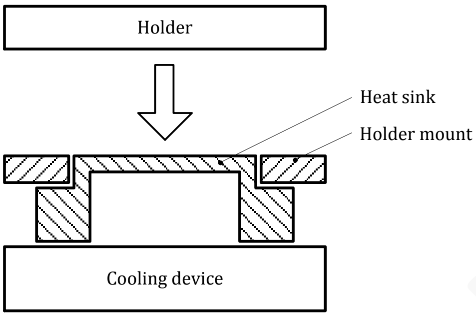

Figure 8-9: TUTF-PHJ85d-*x*—illustration

Figure 8-10 and Table 8-4 define the heat sink of test fixture TUTF-PHJ85d-*x*. The heat sink shall be made of AlMgSiMn 100HV (AA6082) or equivalent.[3] The side of the heat sink facing the LLE shall have a planarity of 0,01 mm across the diameter of the heat sink, and shall have a surface roughness of $R_a \leq$ 3,20 µm. Thermocouples shall be mounted into the groove to measure the temperature at Reference Temperature positions 0…6 (see Figure 6-1 in Section 6.2) with an accuracy of ±1 °C.

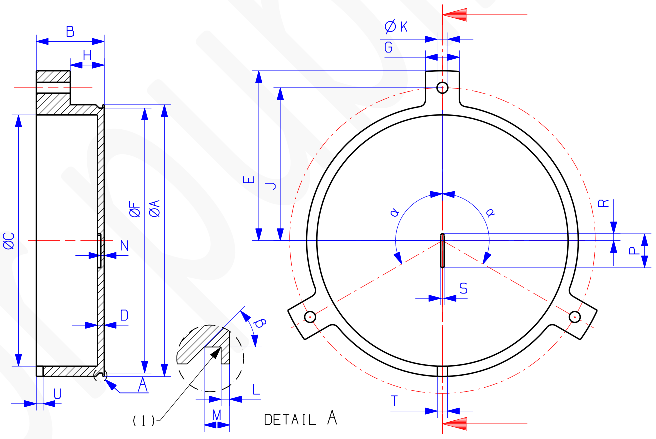

Figure 8-10: TUTF-PHJ85d-*x*—heat sink

Notes to Figure 8-10 (above):

(1) Position of a thermocouple in the groove.

[3]With respect to mechanical and thermal properties.

Figure 8-11 and Table 8-4 define the Holder mount of test fixture TUTF-PHJ85d-*x*. The Holder mount shall be made of 30% glass filled PBT, or equivalent.[4]

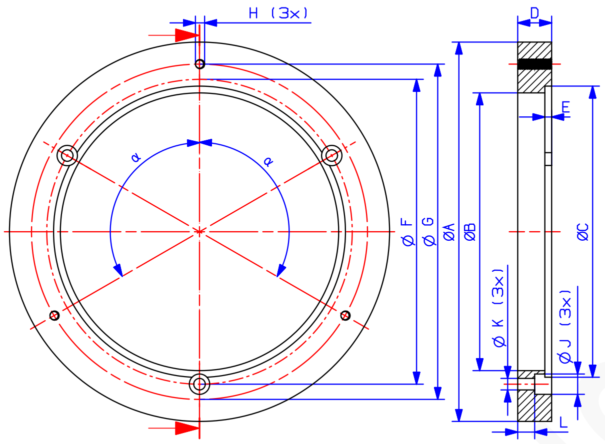

Figure 8-11: TUTF-PHJ85d-*x*—Holder mount

Table 8-4: TUTF-PHJ85d-*x*—dimensions

Heat sink		
Dimension	**Nominal**	**Tolerance**
A	80,00	±0,05
B	20,00	±0,1
C	74,00	±0,05
D	2,00	±0,1
E	50,00	±0,1
F	78,00	±0,1
G	10,00	±0,1
H	10,00	±0,1
J	90,00	±0,1
K	3,20	±0,1
L	0,50	±0,05
M	1,50	±0,1
N	1,00	±0,1
P	10,00	±0,1
R	2,00	±0,1
S	1,00	±0,1
T	3,00	±0,1
U	2,00	±0,1
α	120°	±1°
β	45°	±1°

Holder mount		
Dimension	**Nominal**	**Tolerance**
A	112,00	±0,2
B	82,00	±0,2
C	86,00	±0,2
D	10,00	±0,2
E	2,00	±0,2
F	90,00	±0,2
G	99,00	±0,2
H	M3	NA
J	6,00	±0,1
K	3,30	±0,1
L	5,00	±0,1
α	120°	±1°

[4]With respect to mechanical and thermal properties.

8.1.3 Test fixture PETF-PHJ85d-*x* (photometric and electrical)

Test fixture TPTF-PHJ85d-*x* consists of a temperature controlled heat sink and a Holder. In this edition 1.1 of Book 8 of the Zhaga Interface Specification, the Holder shall be any commercially available Holder having a PHJ85d-1 or a PHJ85d-2 fit, which applies a force of at least 40 N and at most 75 N. The Holder shall be mounted on the heat sink.

The temperature controlled heat sink shall have a surface planarity of 0,01 mm across its surface, shall have a surface roughness $R_a \leq 3{,}2$ µm, shall have a thickness of at least 8 mm across the Thermal Interface Surface, and a heat conductivity of at least 160 W/m·K. The temperature of the temperature controlled heat sink shall be measured at the surface of the heat sink, and centered with Holder.

8.1.4 Test fixture TPTF-PHJ85d-*x* (thermal power)

Test fixture TPTF-PHJ85d-*x* consists of a heat flux measurement system, a Holder mount, and a Holder. In this edition 1.1 of Book 8 of the Zhaga Interface Specification, the Holder shall be any commercially available Holder having a PHJ85d-1 or a PHJ85d-2 fit, which applies a force of at least 40 N and at most 75 N. The Holder shall be mounted on the Holder mount, and the combination shall be mounted on the heat flux measurement system. See [Book 1], A.1.3.2.1 for more details. It shall be ensured that the Holder mount and the heat flux measurement system have proper thermal contact.

(Informative) *The heat flux measurement system typically consists of a stack comprising a heating element, a first heat spreading element, a heat flux sensor, a second heat spreading element, and a temperature controlled heat sink. See Figure 8-12 for a schematic illustration. The purpose of the two heat spreading elements is to transform the heat input to a uniform heat flux through the heat flux sensor. The purpose of the heating element is to provide the means to quickly control the temperature at the Thermal Interface Surface to a specified temperature. The test procedures in this edition 1.1 of Book 8 of the Zhaga Interface Specification assume that an electrical power P_{HE} up to 100 W can be applied to the heating element.*

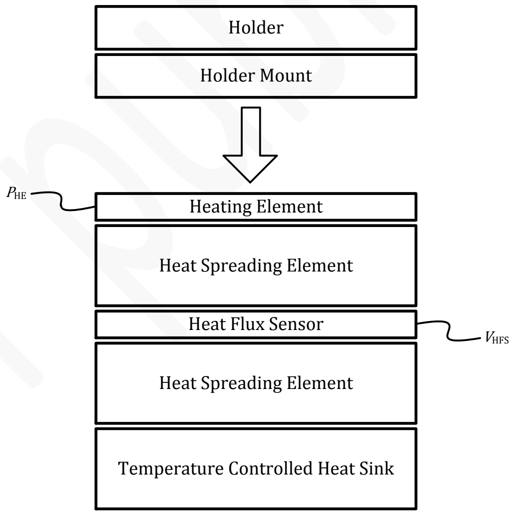

Figure 8-12: TPTF-PHJ85d-*x*—heat flux measurement system (illustration)

Figure 8-13 and Table 8-5 define the Holder mount of test fixture TPTF-PHJ85d-*x*. The Holder mount shall be made of AlMgSiMn 100HV (AA6082) or equivalent.[5] The side of the Holder mount facing the LLE shall have a planarity of 0,01 mm across the diameter of the Holder mount, and shall have a surface roughness of $R_a \leq 3{,}20$ µm. A thermocouple shall be mounted into the groove (dimensions H an J) to measure the temperature at the center of the Holder mount with an accuracy of ± 1 °C.

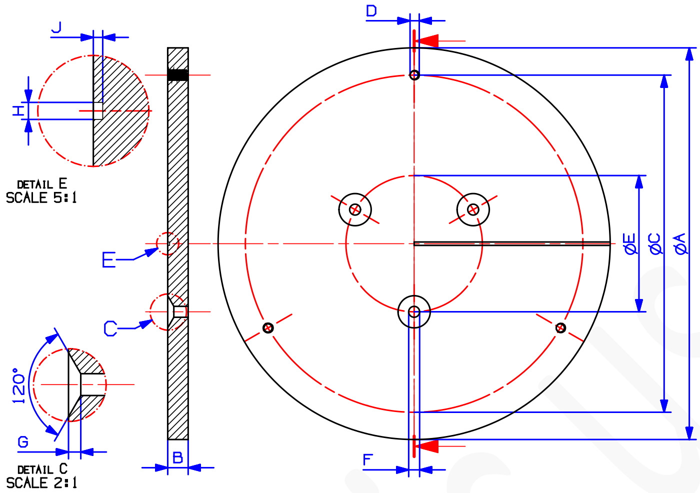

Figure 8-13: TPTF-PHJ85d-*x*—Holder mount

Table 8-5: TPTF-PHJ85d-*x*—Holder mount dimensions

Dimension	Nominal	Tolerance
A	115,00	±0,1
B	6,00	±0,1
C	99,50	±0,1
D	M3	NA
E	41,60	±0,1
F	3,20	±0,1
G	1,80	±0,1
H	1,00	±0,1
J	0,55	±0,05

[5]With respect to mechanical and thermal properties.

8.2 Luminaire testing tools

8.2.1 Gauges

This Section 8.2.1 defines gauges that shall be used to verify the compliance of a Luminaire with the mechanical properties the PHJ85d fit system. See Section 10.1 for the application of these gauges.

(Informative) *Thermal expansion at the operating temperature causes most Luminaire dimensions to be slightly increased over those in the switched-off state. Therefore, the gauges defined in this Section 8.1.1 are based on the MMC dimensions plus a 0,1 mm clearance from the MMC to compensate for any expected thermal expansion at temperatures that are different from those at which the mechanical interface tests defined in Section 9.1 are performed (no heating due to a LLE).*

Gauges MTG-H1-PHJ85d, MTG-H2-PHJ85d, and MTG-H3-PHJ85d-1 verify the Maximum Material Condition of the Luminaire dimensions.

Gauges MTG-H4-PHJ85d-1 and MTG-H5-PHJ85d-2 verify the contact making and Keying functionality.

Unless specified otherwise, the material composition of the gauges shall be stainless steel, which is hardened to at least 55 HRC.

The gauges should have a surface finish of $Ra \leq 0{,}40$ µm. Sharp edges should be chamfered or rounded with a radius 0,20 mm, as defined in [IEC 60061 (b)].

Elements that aid in the manufacturing and handling of the gauges may be added in such a way that the functionality of the gauges is not changed. (Informative) *For example, marks may be made on the top or bottom surface, to enable identification of the gauge and verification of its dimensions. As another example, holes may be made through the central part of the top or bottom surface, in order to attach handles or similar, facilitating rotation of the gauge in the Holder of a Luminaire.*

8.2.1.1 MTG-H1-PHJ85d, MTG-H2-PHJ85d and MTG-H3-PHJ85d

Figure 8-14 and Table 8-6 define gauge MTG-H1-PHJ85d.

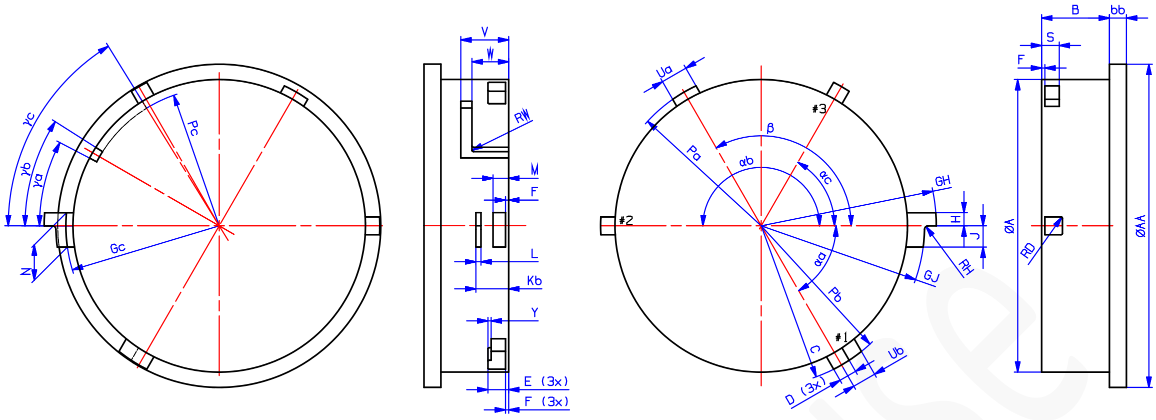

Figure 8-14: MTG-H1-PHJ85d

Figure 8-15 and Table 8-6 define gauge MTG-H2-PHJ85d.

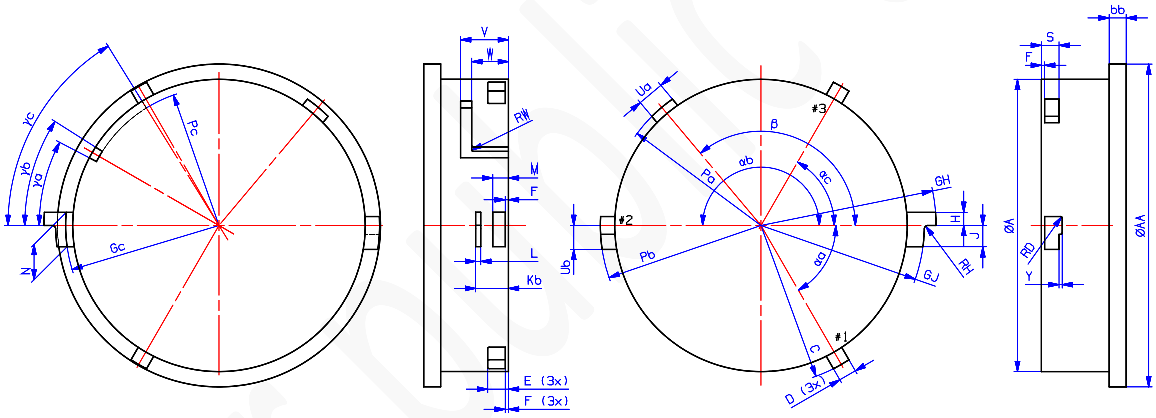

Figure 8-15: MTG-H2-PHJ85d

Figure 8-16 and Table 8-6 define gauge MTG-H3-PHJ85d.

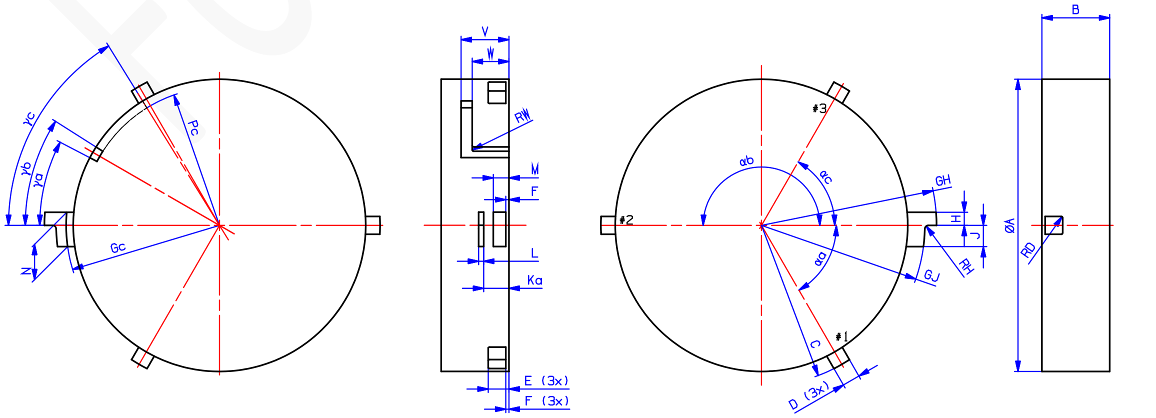

Figure 8-16: MTG-H3-PHJ85d

Table 8-6: MTG-H1-PHJ85d, MTG-H2-PHJ85d and MTG-H3-PHJ85d

Dimension	Nominal	Tolerance
A	86.04	±0.03
AA	95.04	±0.03
B	19.96	±0.03
C	47.24	±0.03
D	5.24	±0.03
E	6.11	±0.03
F	0.96	±0.03
Gc	45.09	±0.03
GH	51.49	±0.03
GJ	48.04	±0.03
H	3.84	±0.03
J	6.24	±0.03
Ka	7.46	±0.03
Kb	9.64	±0.03
L	1.49	±0.01
M	4.59	±0.03
N	10.08	±0.03
Pa	45.39	±0.03
Pb	47.24	±0.03
Pc	40.64	±0.03

Dimension	Nominal	Tolerance
RD	0.44	±0.05
RH	1.06	±0.05
RW	0.44	±0.05
S	6.09	±0.03
Ua	7.89	±0.03
Ub	7.04	±0.03
V	14.11	±0.03
W	10.79	±0.03
Y	0.96	±0.03
αa	60.00°	±10'
αb	180.00°	±10'
αc	60.00°	±10'
β (1)	120.00°	±10'
β (2)	130.00°	±10'
γa	27.55°	±10'
γb	32.45°	±10'
γc	68.00°	+2°
bb	5.00	±0.20

(1) PHJ85d-1

(2) PHJ85d-2

8.2.1.2 MTG-H4-PHJ85d-1 and MTG-H5-PHJ85d-2

Figure 8-17 and Figure 8-18 define gauge MTG-H4-PHJ85d-1.

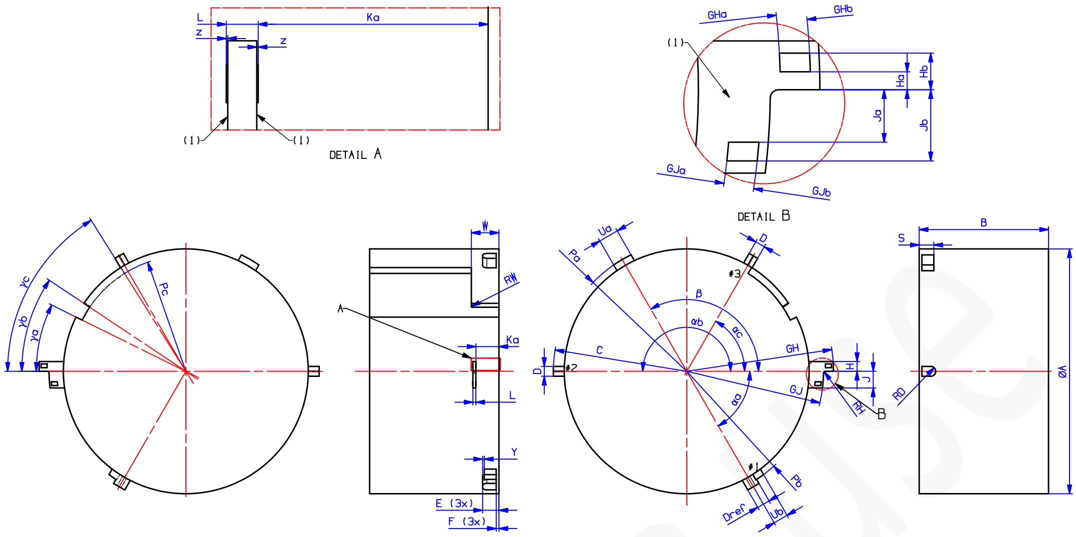

Figure 8-17: MTG-H4-PHJ85d-1

Notes to Figure 8-17 (above):

(1) Insulating layer (does not extend underneath the contact pads).

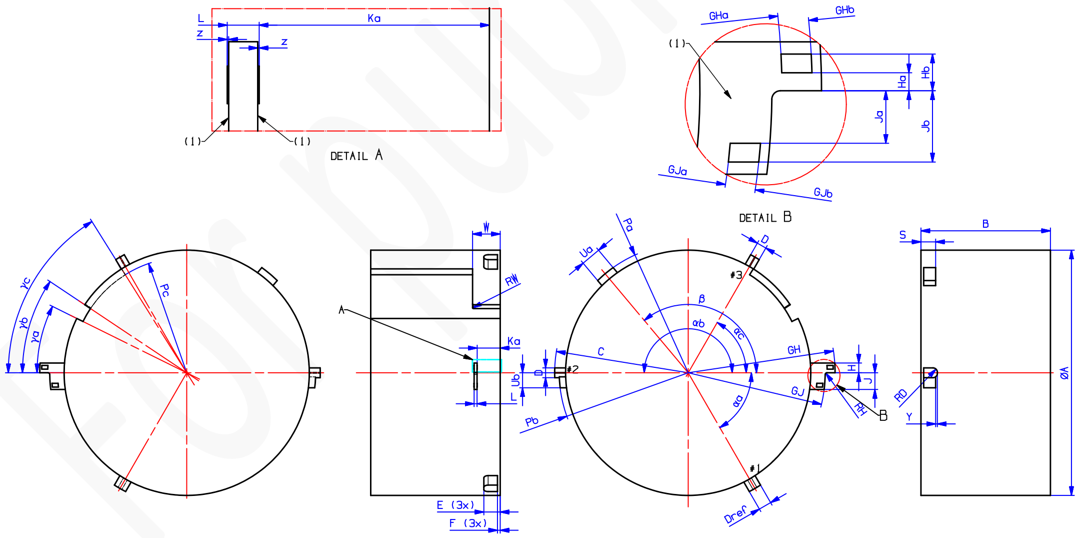

Figure 8-18: MTG-H5-PHJd-2

Notes to Figure 8-17 (above):

(1) Insulating layer (does not extend underneath the contact pads).

Table 8-7: MTG-H4-PHJ85d-1 and MTG-H5-PHJ85d-2 dimensions

Dimension	Nominal	Tolerance
A	85.20	±0.03
B	45.00	±0.10
C	46.40	±0.03
D	3.40	±0.03
Dref	4.50	±0.03
E	5.69	±0.03
F	0.96	±0.03
GH	51.05	±0.10
GHa	48.30	±0.03
GHb	50.40	±0.03
GJ	47.60	±0.10
GJa	44.85	±0.03
GJb	46.95	±0.03
H	3.40	±0.10
Ha	1.25	±0.03
Hb	2.55	±0.03
J	5.80	±0.10
Ja	3.65	±0.03
Jb	4.95	±0.03
Ka	8.00	±0.03
L	1.11	±0.01

Dimension	Nominal	Tolerance
Pa	44.90	±0.03
Pb	44.80	±0.03
Pc	40.20	±0.10
RD	1.50	±0.05
RH	0.60	±0.05
RW	0.30	±0.10
S	5.65	±0.10
Ua	7.00	±0.03
Ub	5.20	±0.03
W	9.60	±0.03
Y	0.60	±0.10
αa	60.00°	±10'
αb	180.00°	±10'
αc	60.00°	±10'
β (1)	120.00°	±10'
β (2)	130.00°	±10'
γa	26.30°	±10'
γb	33.70°	±10'
γc	57.95°	±10'
z	0.05	±0.05

(1) PHJ85d-1

(2) PHJ85d-2

8.2.2 Test Engine TTE-PHJ85d (thermal)

The Thermal Test Engine TTE-PHJ85d consists of two parts:

- A power inducer, which contains a heat generating part as well as a part that conducts the heat to the Thermal Interface Surface of the TTE.
- A force inducer, which implements the mechanical interface of the TTE to the Holder.

Figure 8-19, Figure 8-20, Figure 8-21, and Table 8-8 define the Thermal Test Engine TTE-PHJ85d.

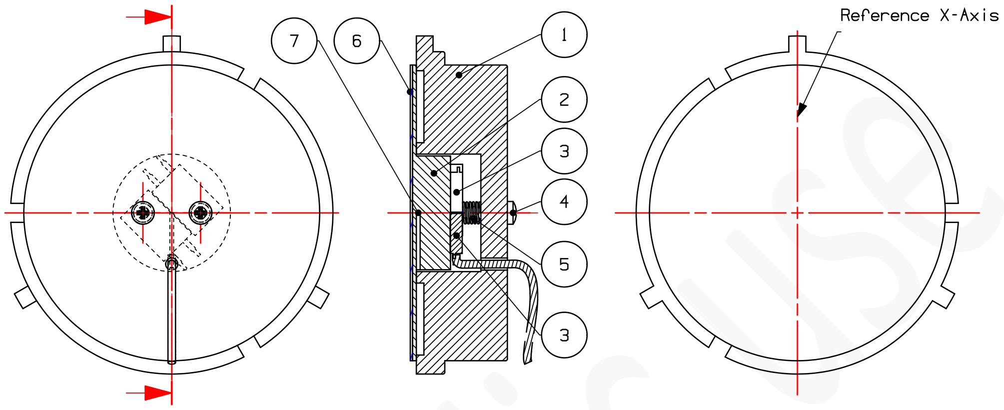

Figure 8-19: TTE-PHJ85d—Composition

The components in Figure 8-19 are the following:

(1) Force inducer (see Figure 8-20), 30% glass-filled PBT or equivalent.[6]

(2) Power inducer (see Figure 8-21), AlMgSiMn 100HV (AA6082) or equivalent.[6]

(3) Power resistors, typeVishay-LTO-30 or equivalent. Alternatively, a single power resistor (Vishay LTO-100 or equivalent) may be used, if a proper thermal and mechanical balance is ensured.

(4) Screw M3×18, stainless steel.

(5) Helical compression spring, (10 ± 1) N in compressed state.

(6) Laird Technologies HR620 TIM plus liner (maximum thickness: 0,60 mm)

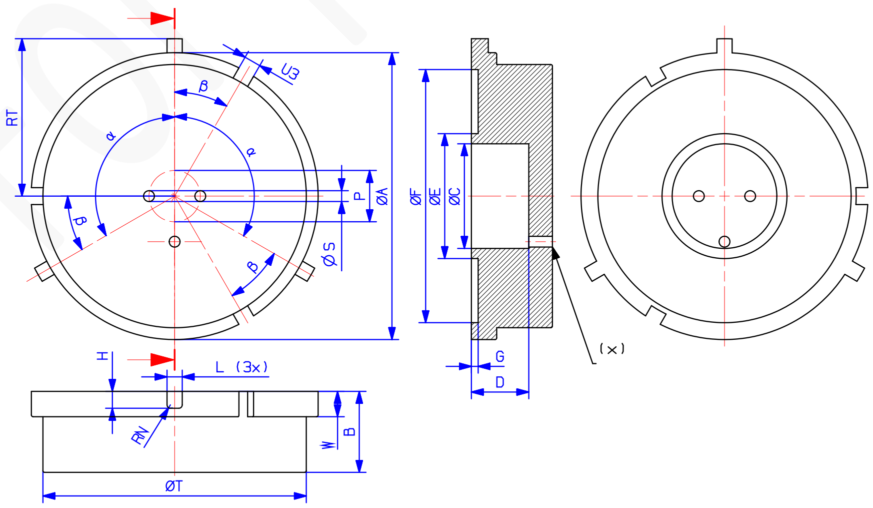

Figure 8-20: TTE-PHJ85d—Force Inducer

[6]With respect to mechanical and thermal properties.

Notes to Figure 8-20 (above):

(1) Thru hole for the wire connection to the power resistor, shall be sealed after attaching the wires.

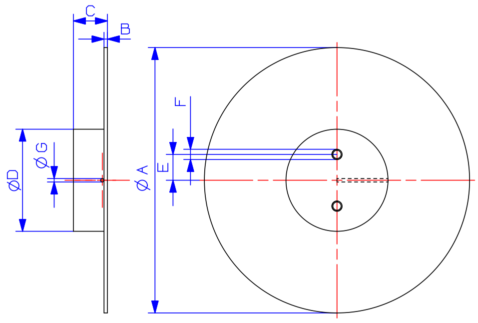

Figure 8-21: TTE-PHJ85d—Power Inducer

Table 8-8: TTE-PHJ85d—Dimensions

Force inducer		
Dimension	**Nominal**	**Tolerance**
A	85,30	±0,10
B	24,00	±0,10
C	31,00	±0,10
D	17,00	±0,10
E	37,00	±0,10
F	75,00	±0,10
G	2,00	±0,10
H	4,40	±0,10
L	4,50	±0,10
P	15,20	±0,10
RN	1,00	±0,10
RT	46,65	±0,10
S	3,20	±0,10
T	78,00	±0,10
U3	5,00	±0,10
W	7,50	±0,10
α	120,00°	±1,00°
β	30,00°	±1,00°

Power inducer		
Dimension	**Nominal**	**Tolerance**
A	78,00	±0,10
B	1,00	±0,05
C	10,00	±0,10
D	30,00	±0,10
E	15,20	±0,10
F	M3	NA
G	1,00	±0,10

8.3 Holder testing tools

8.3.1 Gauges

The gauges that shall be used to verify the compliance of a Holder with the mechanical properties the PHJ85d fit system are identical to the gauges that shall be used to verify compliance of a Luminaire.

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9 LLE tests

All tests defined in this Section 9 shall be performed on 1 LLE specimen. For the purposes of efficiently performing these tests two or more tests may be combined, provided that the measurement accuracy is not affected adversely.

9.1 Mechanical interface tests

Several of the tests defined in this Section 9.1 make use of one or more gauges. When executing those tests, no undue force shall be used to fit a gauge and the LLE under test together.

9.1.1 Test #1—maximum outline

The height BB—as defined in Figure 3-1, see Section 3.1—of the LLE under test should be determined using a caliper.

Test #1 passes if the measured height BB is at most 45,00 mm (including the measurement uncertainty).[7]

9.1.2 Test #2—gauge MTG-B1-PHJ85d-1 or MTG-B2-PHJ85d-2

Test #2 depends on the fit of the LLE under test:

- *PHJ85d fit.* If the LLE under test has a PHJ85d fit, the LLE under test shall be inserted in either gauge MTG-B1-PHJ85d-1 or gauge MTG-B2-PHJ85d-2. See Figure 9-1(a).

  Test #2 passes if the Thermal Interface Surface of the LLE under test moves through the gauge such the LLE under test and the gauge can be aligned as shown in Figure 9-1(b).

- *PHJ85d-1 fit.* If the LLE under test has a PHJ85d-1 fit, the LLE under test shall be inserted in gauge MTG-B1-PHJ85d-1. See Figure 9-1(a).

  Test #2 passes if the Thermal Interface Surface of the LLE under test moves through the gauge such the LLE under test and the gauge can be aligned as shown in Figure 9-1(b).

- *PHJ85d-2 fit.* If the LLE under test has a PHJ85d-2 fit, the LLE under test shall be inserted in gauge MTG-B2-PHJ85d-2. See Figure 9-1(a).

  Test #2 passes if the Thermal Interface Surface of the LLE under test moves through the gauge such the LLE under test and the gauge can be aligned as shown in Figure 9-1(b).

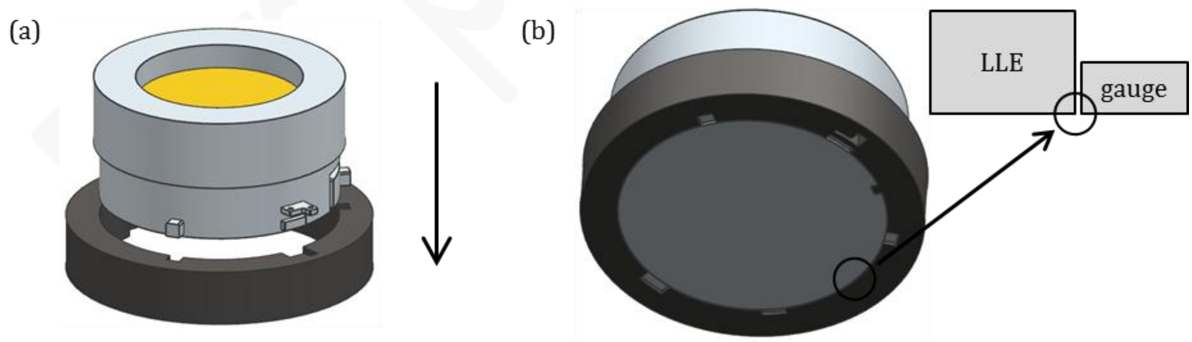

Figure 9-1: Test #2

9.1.3 Test #3—gauge MTG-B3*x*-PHJ85d

Test #3 passes if tests #3(a)–(e) all pass. Unless indicated otherwise, in these tests, the LLE under test shall be positioned vertical, Base down on a flat surface.

[7]Note that fail criteria are not stated explicitly for any LLE test. Instead, each LLE test shall be deemed to fail if its pass criteria are not satisfied fully.

9.1.3.1 Test #3(a)

The reference plane of gauge MTG-B3c-PHJ85d shall be positioned on the flat surface, such that the left-hand side of gauge MTG-B3c-PHJ85d—as shown in Figure 8-5—is in physical contact with the vertical part of the Base next to the electrical contact tab of the LLE under test. Gauge MTG-B3c-PHJ85d shall be slid to the other side of the electrical contact tab, without losing physical contact with the vertical part of the Base of the LLE under test. See Figure 9-2.

Test #3(a) passes if the electrical contact tab can be moved through the slot in gauge MTG-B3c-PHJ85d without lifting either gauge MTG-B3c-PHJ85d or the LLE under test from the flat surface. (Informative) *It should not be necessary to keep the LLE under test in position while moving gauge MTG-B3c-PHJ85d.*

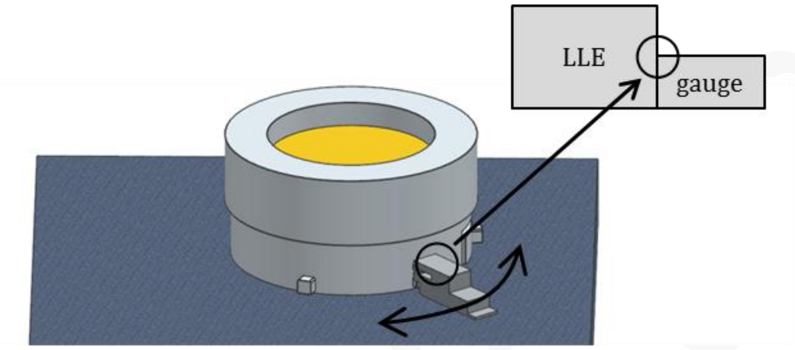

Figure 9-2: Test #3(a)

9.1.3.2 Test #3(b)

Test #3(b) is identical to test #3(a), with the addition that (i) gauge MTG-B3a-PHJ85d shall be stacked on the LLE under test, such that gauge MTG-B3a-PHJ85d rests on the force pins of the LLE under test; and (ii) gauge MTG-B3b-PHJ85d shall be stacked on top of gauge MTG-B3a-PHJ85d. See Figure 9-3(a-c)

Test #3(b) passes if gauge MTG-B3b-PHJ85d rests on gauge MTG-B3a-PHJ85d, and the electrical contact tab can be moved through the slot in gauge MTG-B3c-PHJ85d without lifting either gauge MTG-B3c-PHJ85d or the stack of LLE under test, gauge MTG-B3a-PHJ85d, and gauge MTG-B3b-PHJ85d from the flat surface. See Figure 9-3(d) (and Figure 9-2 for the movement of gauge MTG-B3c-PHJ85d). (Informative) *It should not be necessary to keep the stack in position while moving gauge MTG-B3c-PHJ85d.*

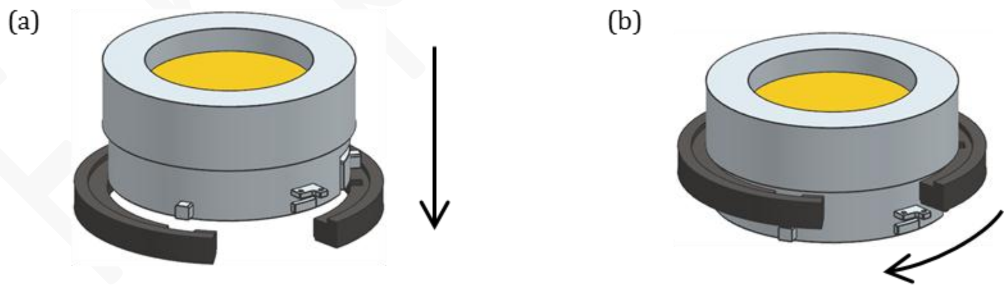

Figure 9-3: Test #3(b)

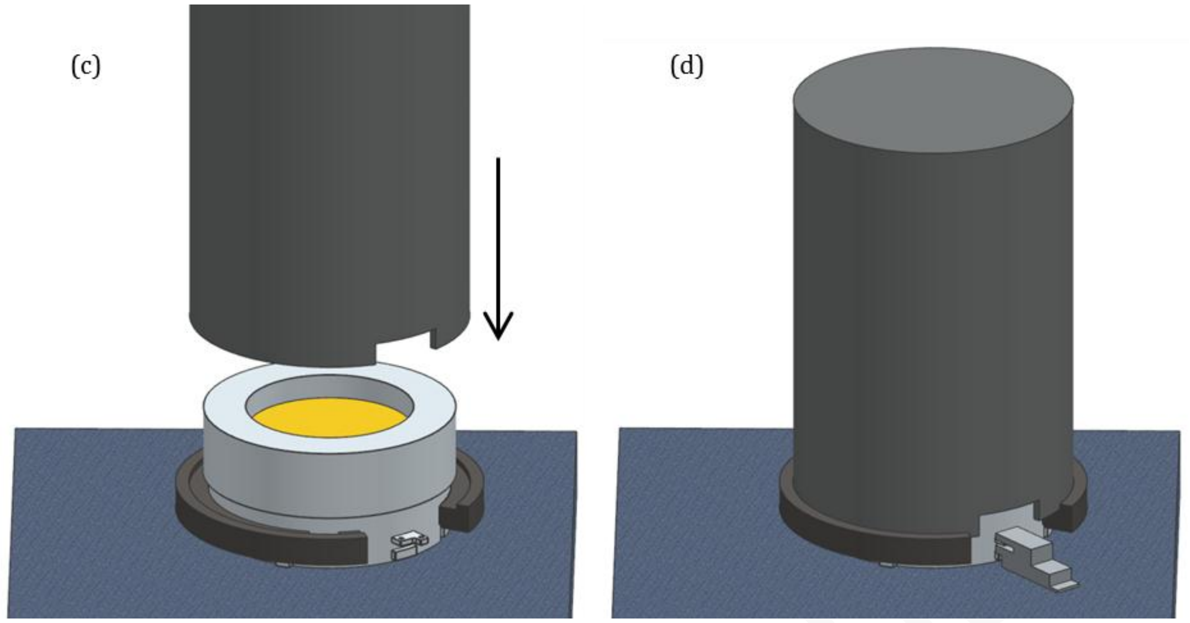

Figure 9-3: Test #3(b) (continued)

9.1.3.3 Test #3(c)

Test #3(c) is identical to test #3(b), except that the right-hand side of gauge MTG-B3c-PHJ85d—as shown in Figure 8-5—shall be in physical contact with the vertical part of the Base next to the electrical contact tab of the LLE under test. See Figure 9-4(a). Gauge MTG-B3c-PHJ85d shall be slid to the other side of the electrical contact tab, without losing physical contact with the vertical part of the Base of the LLE under test. See Figure 9-4(b).

Test #3(c) passes if the gauge MTG-B3c-PHJ85d can be slid along the circumference of the LLE under test, passing the three force pins, without lifting the stack of LLE under test, gauge MTG-B3a-PHJ85d and gauge MTG-B3b-PHJ85d from the flat surface. (Informative) *Gauge MTG-B3c-PHJ85d should slide underneath gauge MTG-B3a-PHJ85d without obstruction*.

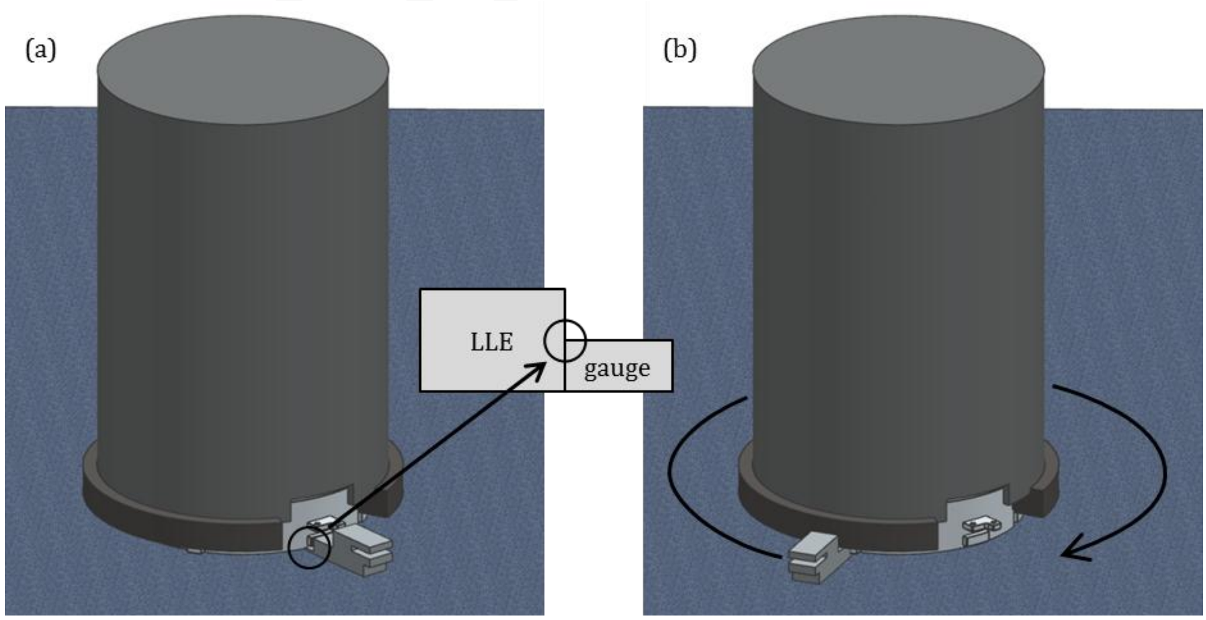

Figure 9-4: Test #3(c)

9.1.3.4 Test #3(d)

The reference plane of gauge MTG-B3d-PHJ85d shall be positioned on the flat surface, such that either the left-hand side or the right-hand side of gauge MTG-B3d-PHJ85d—as shown in Figure 8-6—is in physical contact with the vertical part of the Base next to the electrical contact tab of the LLE under test. Gauge MTG-B3d-PHJ85d shall be slid to the other side of the electrical contact tab, without losing physical contact with the vertical part of the Base of the LLE under test. See Figure 9-5.

Test #3(d) passes if the gauge MTG-B3d-PHJ85d can be slid along the circumference of the LLE under test, passing the three force pins, without lifting gauge MTG-B3d-PHJ85d or the LLE under test from the flat surface. (Informative) *It should not be necessary to keep the LLE under test in position while moving gauge MTG-B3c-PHJ85d*.

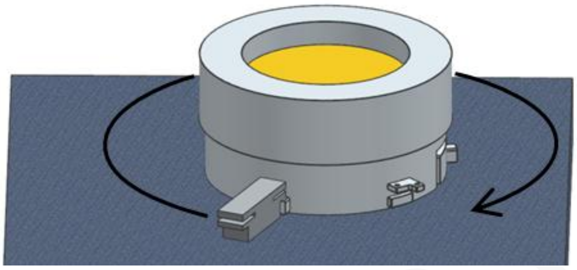

Figure 9-5: Test #3(d)

9.1.3.5 Test #3(e)

For test #3(e) it is not required to position the LLE under test on a flat surface.

Test #3(e) passes if the electrical contact tab of the LLE under test can be moved through exactly one of the two slots in gauge MTG-B3d-PHJ85d. See Figure 9-6.

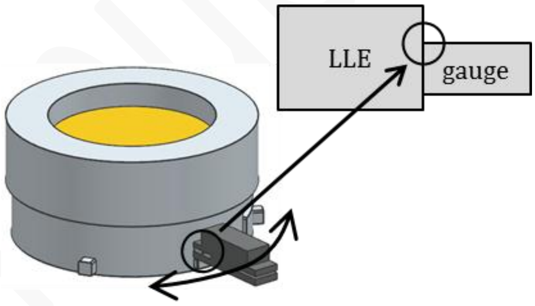

Figure 9-6: Test #3(e)

9.1.4 Test #4—gauge MTG-B4-PHJ85d-1 or MTG-B5-PHJ85d-2

Test #4 passes if both tests #4(a) and #4(b) pass, insofar as these tests are applicable.

9.1.4.1 Test #4(a)

Test #4(a) depends on the fit of the LLE under test:

- *PHJ85d fit.* If the LLE under test has a PHJ85d fit, the LLE under test shall be inserted in either gauge MTG-B4-PHJ85d-1 or gauge MTG-B5-PHJ85d-2, and rotated to the stop position (see Figure 9-7(a))—force pin #1 shows through the slotted window in the gauge (see Figure 9-7(b)). In the stop position, the LLE under test shall be moved between positions 1 and 2, as defined in Figure 9-8.

  Test #4(a) passes if the electrical contacts of the LLE under test show through the two gauge windows, such that the conductive material of the electrical contacts extends up to each side of the windows, throughout the movement of the LLE under test between positions 1 and 2. See also Figure 9-9. (Informative) *A microscope should be used to observe the contact pads of the LLE under test through the gauge windows.*

- *PHJ85d-1 fit.* If the LLE under test has a PHJ85d-1 fit, the LLE under test shall be inserted in gauge MTG-B4-PHJ85d-1, and rotated to the stop position (see Figure 9-7(a))])—force pin #1 shows through the slotted window in the gauge (see Figure 9-7(b)). In the stop position, the LLE under test shall be moved between positions 1 and 2, as defined in Figure 9-8.

  Test #4(a) passes if the electrical contacts of the LLE under test show through the two gauge windows, such that the conductive material of the electrical contacts extends up to each side of the windows, throughout the movement of the LLE under test between positions 1 and 2. See also Figure 9-9. (Informative) *A microscope should be used to observe the contact pads of the LLE under test through the gauge windows.*

- *PHJ85d-2 fit.* If the LLE under test has a PHJ85d-2 fit, the LLE under test shall be inserted in gauge MTG-B5-PHJ85d-2, and rotated to the stop position (see Figure 9-7(a))])—force pin #1 shows through the slotted window in the gauge (see Figure 9-7(b)). In the stop position, the LLE under test shall be moved between positions 1 and 2, as defined in Figure 9-8.

  Test #4(a) passes if the electrical contacts of the LLE under test show through the two gauge windows, such that the conductive material of the electrical contacts extends up to each side of the windows, throughout the movement of the LLE under test between positions 1 and 2. See also Figure 9-9. (Informative) *A microscope should be used to observe the contact pads of the LLE under test through the gauge windows.*

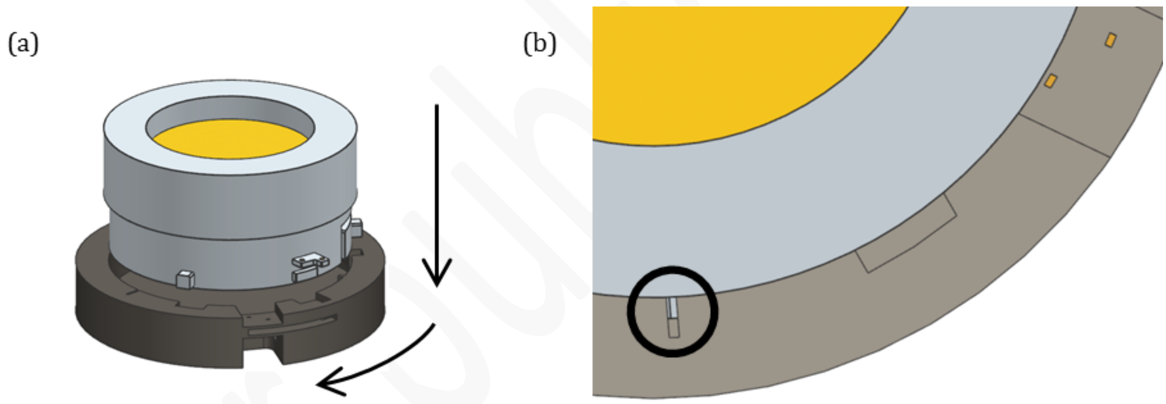

Figure 9-7: Test #4(a)

Figure 9-8: Positions 1 (left) and 2 (right) for verifying the LLE contact pads

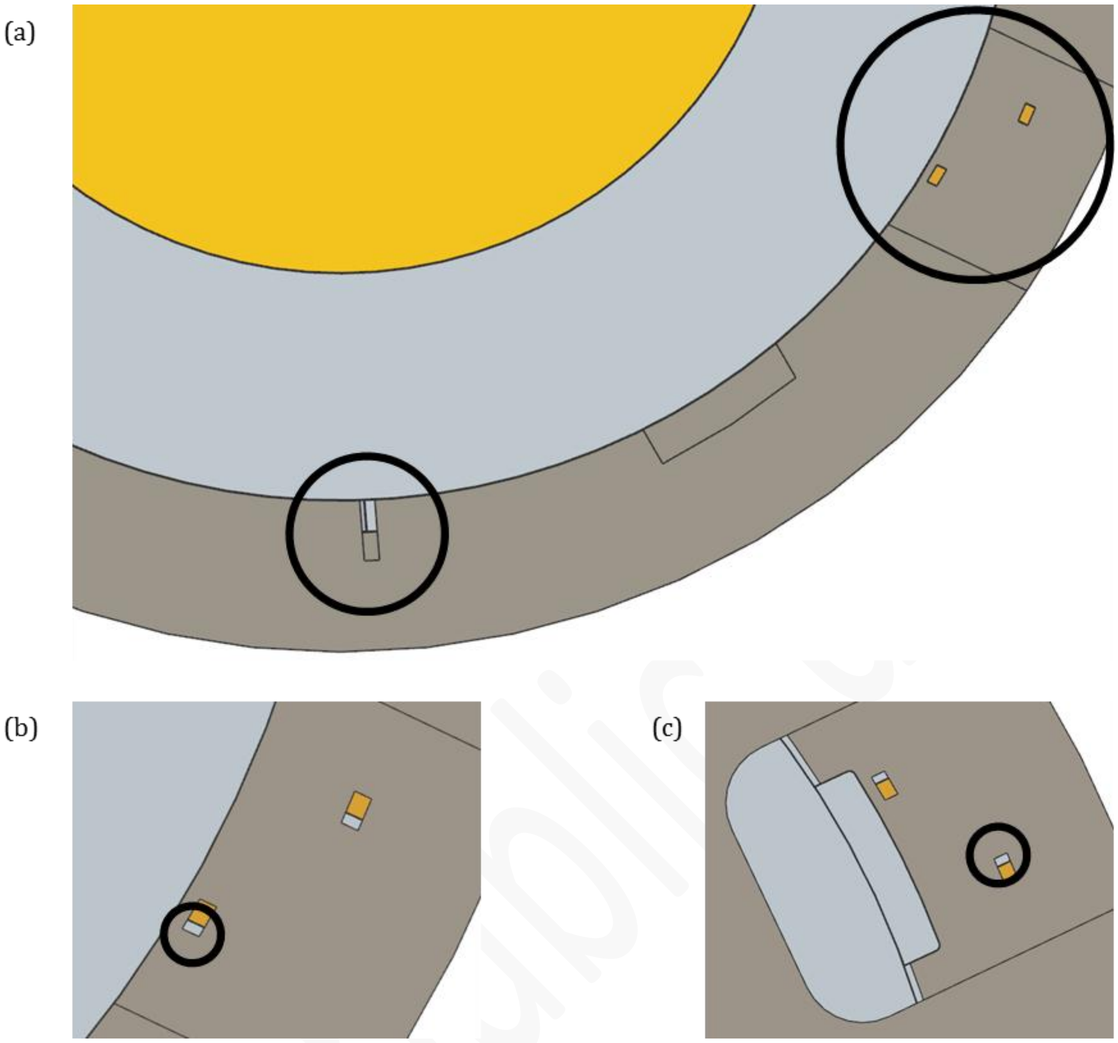

Figure 9-9: Examples of (a) test #4(a) pass, top view; (b) fail, top view; and (c) fail, bottom view

9.1.4.2 Test #4(b)

Test #4(b) depends on the fit of the LLE under test:

- *PHJ85d fit.* In this case, test #4(b) is not applicable.
- *PHJ85d*-1 fit. In this case, test #4(b) passes if the LLE under test cannot be inserted into gauge MTG-B5-PHJ85d-2.
- *PHJ85d*-2 fit. In this case, test #4(b) passes if the LLE under test cannot be inserted into gauge MTG-B4-PHJ85d-1.

9.1.5 Test #5—mass

The mass of the LLE under tests shall be determined with an accuracy of ± 1 g.

Test #5 passes if the measured mass is less than or equal to 301g.

9.2 Photometric Interface tests

9.2.1 Test #6—luminous flux

The LLE under test shall be locked into test fixture PETF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1. For this purpose, mains power shall be applied to the LLE under test, as appropriate, and the temperature of the heat sink of test fixture PETF-PHJ85d-*x* shall be controlled to the Rated Operating Temperature $t_{\mathrm{r,max}}$ of the LLE under test. The stability of the mains power shall be verified to comply with the operating conditions defined in Section 4.1 directly before and directly after the luminous flux measurement. The stability of the heat sink temperature shall be verified to comply with the operating conditions defined in Section 4.1 throughout the luminous flux measurement.

The measurement of the luminous flux shall be carried out according to the guidelines given in [IES LM-79-08]. The luminous flux shall be determined with an accuracy of at least $\pm 5\%$.

Test #6 passes if the measured luminous flux is comprised in the luminous flux category listed in the Product Data Set of the LLE under test. For the comparison, the boundaries of the luminous flux categories defined in Table 4-1 in Section 4.2 shall be extended with the measurement accuracy on either side. (Informative) *For example, any measured luminous flux within the range of 513…840 lm (including the boundaries) is considered to be comprised in the C006 category, assuming a measurement accuracy of* $\pm 5\%$.

9.2.2 Test #7—luminous intensity distribution

The LLE under test shall be locked into test fixture PETF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1. For this purpose, mains power shall be applied to the LLE under test, as appropriate, and the temperature of the heat sink of test fixture PETF-PHJ85d-*x* shall be controlled to the Rated Operating Temperature $t_{\mathrm{r,max}}$ of the LLE under test. The stability of the mains power shall be verified to comply with the operating conditions defined in Section 4.1 directly before and directly after the luminous intensity distribution measurement. The stability of the heat sink temperature shall be verified to comply with the operating conditions defined in Section 4.1 throughout the luminous intensity distribution measurement.

The measurement of the luminous intensity distribution shall be carried out according to the guidelines given in [IEC/TR 61341] sections 5 and 6, using a goniophotometer system. See also [CIE 121]. The luminous intensity distribution shall be determined with an accuracy of at least $\pm 2\%$.

Test #7 passes if the measured luminous intensity distribution complies with the luminous intensity distribution defined in Table 4-2 in Section 4.3. For the comparison, the boundaries of the percentage of luminous flux into each solid angle defined in Table 4-2 in Section 4.3 shall be extended with the measurement accuracy on either side. (Informative) *For example, in the case of the first solid angle—*$\gamma_1 = 0°$, $\gamma_2 = 41{,}40°$*—the minimum percentage becomes 33% and maximum percentage becomes 57%.*

9.2.3 Test #8—correlated color temperature

The LLE under test shall be locked into test fixture PETF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1. For this purpose, mains power shall be applied to the LLE under test, as appropriate, and the temperature of the heat sink of test fixture PETF-PHJ85d-*x* shall be controlled to the Rated Operating Temperature $t_{\mathrm{r,max}}$ of the LLE under test. The stability of the mains power shall be verified to comply with the operating conditions defined in Section 4.1 directly before and directly after the correlated color temperature measurement. The stability of the heat sink temperature shall be verified to comply with the operating conditions defined in Section 4.1 throughout the correlated color temperature measurement.

The measurement of the correlated color temperature shall be carried out according to the guidelines given in [ANSI C78.377]. The correlated color temperature shall be determined with an accuracy of at least ± 0.002 for each chromaticity coordinate.

Test #8 passes if the measured correlated color temperature is comprised in the quadrangle that is associated with the correlated color temperature listed in the Product Data Set of the LLE under test. For the comparison, the boundaries of the quadrangles defined in [ANSI C78.377] shall be extended by 0.002 in each chromaticity direction.

9.2.4 Test #9—color rendering index

The LLE under test shall be locked into test fixture PETF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1. For this purpose, mains power shall be applied to the LLE under test, as appropriate, and the temperature of the heat sink of test fixture PETF-PHJ85d-*x* shall be controlled to the Rated Operating Temperature $t_{r,max}$ of the LLE under test. The stability of the mains power shall be verified to comply with the operating conditions defined in Section 4.1 directly before and directly after the color rendering index measurement. The stability of the heat sink temperature shall be verified to comply with the operating conditions defined in Section 4.1 throughout the color rendering index measurement.

The measurement of the color rendering index shall be carried out according to the guidelines given in [CIE 13.3]. The color rendering index shall be determined with an accuracy of ± 1.

Test #9 passes if the color rendering index listed in the Product Data Set of the LLE under test is comprised in the accuracy range of the measured color rendering index.

9.3 Electrical interface tests

9.3.1 Test #10—mains power

The LLE under test shall be locked into test fixture PETF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1. For this purpose, mains power shall be applied to the LLE under test, as appropriate, and the temperature of the heat sink of test fixture PETF-PHJ85d-*x* shall be controlled to the Rated Operating Temperature $t_{r,max}$ of the LLE under test. The stability of the mains power shall be verified to comply with the operating conditions defined in Section 4.1 directly before and directly after the mains power measurement. The stability of the heat sink temperature shall be verified to comply with the operating conditions defined in Section 4.1 throughout the mains measurement.

The mains power consumed by the LLE under test shall be determined as a function of time during an interval of 10 min, with an accuracy of 0,5%. It is sufficient to take one data point per minute.

Test #10 passes if the measured mains power is less than or equal to 100,5% of the Rated mains power throughout the measurement interval.

9.4 Thermal interface tests

9.4.1 Test #11—thermal uniformity

The LLE under test shall be locked into test fixture TUTF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1. For this purpose, mains power shall be applied to the LLE under test, as appropriate, and the temperature of the Holder mount of test fixture TUTF-PHJ85d-*x* shall be controlled to the Rated Operating Temperature $t_{\mathrm{r,max}}$ of the LLE under test. The stability of the mains power shall be verified to comply with the operating conditions defined in Section 4.1 directly before and directly after the thermal uniformity measurement. The stability of the heat sink temperature shall be verified to comply with the operating conditions defined in Section 4.1 throughout the thermal uniformity measurement.

The measurement of the thermal uniformity shall be carried out by determining the highest temperature $t_{\max}$ and the lowest temperature $t_{\min}$ at the surface of test fixture TUTD-PHJ85d-*x*, as measured using the 7 thermocouples.

Test #11 passes if the thermal spreading resistance $\frac{t_{\max}-t_{\min}}{P_{\mathrm{th,rear}}}$ is less than or equal to 0,36 K/W, where $P_{\mathrm{th,rear}}$ is the Rated thermal power.

9.4.2 Test #12—thermal power

The Rated maximum thermal power at the Thermal Interface Surface ($P_{\mathrm{th,rear}}$) of the Socketable LLE under test shall be verified according to the test and pass criteria defined in [Book 1], Annex A.1.3.2. For this purpose:

- The test shall be performed using test fixture TPTF-PHJ85d-*x*, as appropriate for the LLE under test., with the LLE under test mounted Base down, such that convective air flow is not obstructed.
- The Reference Temperature shall be measured using the thermocouple provided in the test fixture.
- Only the TIM that is part of, or supplied with the LLE under test shall be used.

  For calibration of the test setup, the electrical power applied to the correction heater of the test set up shall be $P_n = n \cdot 10$ W, with $n = 1, \ldots, 9$.

9.4.3 Test #13—thermal fit code

Test #13 passes if the Rated Thermal Fit Code is consistent with the Rated Operating Temperature and the Rated thermal power $P_{\mathrm{th,rear}}$.

9.5 Control interface tests

9.5.1 Test #23—dimming

This test applies only if the data sheet of the LLE under test indicates that dimming functionality is supported.

The LLE under test shall be locked into test fixture PETF-PHJ85d-*x* as appropriate for the LLE under test, and operated according to the conditions defined in Section 4.1.

Testing as defined in [NEMA SSL 7A] Sections 4.9.2 and 4.10.2 shall be conducted.

Test #23 passes if the requirements of [NEMA SSL 7A] Sections 4.9.2 and 4.10.2 are satisfied.

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10 Luminaire tests

All tests defined in this Section 10 shall be performed on 1 LLE specimen. For the purposes of efficiently performing these tests two or more tests may be combined, provided that the measurement accuracy is not affected adversely.

10.1 Mechanical interface tests

Several of the tests defined in this Section 10.1 make use of one or more gauges. When executing those tests, no undue force shall be used to fit a gauge and the Luminaire under test together.

10.1.1 Test #11—heat sink

Test #11 passes if tests #11(a) passes.

10.1.1.1 Test #11(a)

Test #11(a) passes if the heat sink surface of the Luminaire under test extends to beyond the opening of the Holder.[8]

10.1.2 Test #12—gauge MTG-H1-PHJ85d or MTG-H2-PHJ85d

Test #12 passes if test #12(a) passes.

10.1.2.1 Test #12(a)

Test #12(a) depends on the fit of the Luminaire under test:

- *PHJ85d-1 fit.* If the Luminaire under test has a PHJ85d-1 fit, gauge MTG-H1-PHJ85d shall be inserted into the Holder of the Luminaire under test.

  Test #12(a) passes if gauge MTG-H1-PHJ85d can be rotated to the stop position of the Luminaire under test.

- *PHJ85d-2 fit.* If the Luminaire under test has a PHJ85d-2 fit, gauge MTG-H2-PHJ85d shall be inserted into the Holder of the Luminaire under test.

  Test #12(a) passes if gauge MTG-H2-PHJ85d can be rotated to the stop position of the Luminaire under test.

10.1.3 Test #13—gauge MTG-H3-PHJ85d

Gauge MTG-H3-PHJ85d shall be inserted into the Holder of the Luminaire under test.

Test #13 passes if gauge MTG-H3-PHJ85d can be rotated to the stop position of the Luminaire under test.

10.1.4 Test #14—gauge MTG-H4-PHJ85d-1 or MTG-H5-PHJ85d-2

Test #14 passes if tests #14(a)–(b) both pass.

10.1.4.1 Test #14(a)

Test #14(a) depends on the fit of the Luminaire under test:

- *PHJ85d-1 fit.* If the Luminaire under test has a PHJ85d-1 fit, gauge MTG-H4-PHJ85d-1 shall be locked into the Holder of the Luminaire under test.

  Test #14(a) passes if the electrical resistance measured between the two mains terminals of the Holder of the Luminaire under test is less than0,5 Ω.

- *PHJ85d-2 fit.* If the Luminaire under test has a PHJ85d-2 fit, gauge MTG-H5-PHJ85d-2 shall be locked into the Holder of the Luminaire under test.

[8]Note that fail criteria are not stated explicitly for any Luminaire test. Instead, each Luminaire test shall be deemed to fail if its pass criteria are not satisfied fully.

Test #14(a) passes if the electrical resistance measured between the two mains terminals of the Holder of the Luminaire under test is less than0,5 Ω.

10.1.4.2 Test #14(b)

Test #14(b) depends on the fit of the Luminaire under test:

- *PHJ85d-1 fit.* Test #14(b) passes if gauge MTG-H5-PHJ85d-2 cannot be locked into the Holder of the Luminaire under test.
- *PHJ85d-2 fit.* Test #14(b) passes if gauge MTG-H4-PHJ85d-1 cannot be locked into the Holder of the Luminaire under test.

10.2 Photometric Interface tests

This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define tests for the photometric interface of a Luminaire.

10.3 Electrical interface tests

This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define tests for the electrical interface of a Luminaire.

10.4 Thermal interface tests

10.4.1 Test #15—thermal resistance

The Luminaire under test shall be mounted in a draught free room, with an orientation that is according to the intended mounting as indicated in the Product Data Set of the Luminaire under test. The ambient air temperature t_a in the room, at a distance of no more than 1,0 m from the Luminaire under test, shall be (25 ± 5) °C, and shall be determined with an accuracy of $\pm 1{,}0$ °C. The thermal test engine TTE-PHJ85d shall be locked into the Luminaire under test.

Test 15 passes if tests #15(a)-(d) all pass insofar as these tests are applicable.

10.4.1.1 Test #15(a)

An electrical power P_{th} of $(10 \pm 0{,}1)$ W shall be applied to the thermal test engine. When the temperature t_{r}' of the Thermal Test Engine TTE-PHJ85d is stable, this temperature t_{r}' shall be determined with an accuracy of $\pm 0{,}5$ °C. The temperature t_{r}' shall be deemed stable if the difference between two consecutive temperature measurements, taken at least 15 min apart, is less than 1 °C.

Test #15(a) passes if the thermal resistance $R_{\mathrm{th}} = (t_{\mathrm{r}}' - \Delta t_{\mathrm{TIM}}(P_{\mathrm{th}}) - t_{\mathrm{a}})/P_{\mathrm{th}}$ does not exceed the Rated thermal resistance at 10 W applied thermal power by more than 10%, where $\Delta t_{\mathrm{TIM}}(P_{\mathrm{th}})$ is a correction for the temperature drop over the TIM as defined in Table 10-1.

Table 10-1: Correction for temperature drop over TIM

P_{th} [W]	Δt_{TIM} [°C]
10	2,2
20	4,4
30	6,6
40	8,8

10.4.1.2 Test #15(b)

If the Luminaire under test has a Rated maximum thermal power greater than 20 W, or if the Luminaire under test does not have a Rated maximum thermal power, this test is identical to test #15(a), except that an electrical power of $(20 \pm 0{,}1)$ W shall be applied, and the Rated thermal resistance at 20 W applies in the pass criterion. Otherwise, this test is not applicable.

10.4.1.3 Test #15(c)

If the Luminaire under test has a Rated maximum thermal power greater than 30 W, or if the Luminaire under test does not have a Rated maximum thermal power, this test is identical to test #15(a), except that an electrical power of $(30 \pm 0{,}1)$ W shall be applied, and the Rated thermal resistance at 30 W applies in the pass criterion. Otherwise, this test is not applicable.

10.4.1.4 Test #15(d)

If the Luminaire under test has a Rated maximum thermal power greater than 40 W, or if the Luminaire under test does not have a Rated maximum thermal power, this test is identical to test #15(a), except that an electrical power of $(40 \pm 0{,}1)$ W shall be applied, and the Rated thermal resistance at 40 W applies in the pass criterion. Otherwise, this test is not applicable.

10.5 Control interface tests

10.5.1 Test #24—dimming

This test applies only if the data sheet of the Luminaire under test indicates that dimming functionality is built-in.

Testing as defined in [NEMA SSL 7A] Section 3.10.2 shall be conducted. (Informative) *It may be necessary to modify one or more commercially available LLEs in order to construct the test circuit defined in [NEMA SSL 7A].*

Test #24 passes if the requirements of [NEMA SSL 7A] Section 3.10.2 are satisfied.

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11 Holder tests

All tests defined in this Section 11 shall be performed on 1 Holder specimen. For the purposes of efficiently performing these tests two or more tests may be combined, provided that the measurement accuracy is not affected adversely.

11.1 Mechanical interface tests

Unless indicated otherwise, the Holder under test shall be mounted on a flat surface having a planarity of 0,05 mm or better across the diameter of the Holder under test, and a surface roughness $R_a \leq 3{,}20$ µm.

Several of the tests defined in this Section 11.1 make use of one or more gauges. When executing those tests, no undue force shall be used to fit a gauge and the LLE under test together.

11.1.1 Test #16—gauge MTG-H1-PHJ85d-1 or MTG-H2-PHJ85d-2

Test #12 defined in Section 10.1.2 shall be applied to the assembly of the Holder under test on the flat surface.

Test #16 passes if test #12 passes.[9]

11.1.2 Test #17—gauge MTG-H3-PHJ85d

Test #13 defined in Section 10.1.3 shall be applied to the assembly of the Holder under test on the flat surface.

Test #17 passes if test #13 passes.

11.1.3 Test #18—gauge MTG-H4-PHJ85d-1 or MTG-H5-PHJ85d-2

Test #14 defined in Section 10.1.4 shall be applied to the assembly of the Holder under test on the flat surface.

Test #18 passes if test #14 passes.

11.1.4 Test #19—applied force

The Holder under test shall be mounted on a flat surface containing a force sensor, such that the force, which the Holder under test applies to a gauge locked therein, can be measured with an accuracy of ± 1 N. The flat surface including the force sensor shall have a planarity of 0,05 mm or better across the diameter of the Holder under test, and a surface roughness $R_a \leq 3{,}20$ µm.

Test #19 passes if tests #19(a)–(b) both pass.

11.1.4.1 Test #19 (a)

Gauge MTG-H3-PHJ85d shall be locked into the assembly of the Holder under test and the force sensor.

Test #19 passes if the measured force is in the range 38…77 N

11.1.4.2 Test #19 (b)

Test #19(b) depends on the fit of the Holder under test:

- *PHJ85d-1 fit.* If the Holder under test has a PHJ85d-1 fit, gauge MTG-H4-PHJ85d-1 shall be locked into the assembly of the Holder under test and the force sensor.
- Test #19 passes if the measured force is in the range 38…77 N
- *PHJ85d-2 fit.* If the Holder under test has a PHJ85d-2 fit, gauge MTG-H5-PHJ85d-2 shall be locked into the assembly of the Holder under test and the force sensor.
- Test #19 passes if the measured force is in the range 38…77 N

[9] Note that fail criteria are not stated explicitly for any Holder test. Instead, each Holder test shall be deemed to fail if its pass criteria are not satisfied fully.

11.2 Electrical interface tests

This edition 1.1 of Book 8 of the Zhaga Interface Specification does not define tests for the electrical interface of a Holder.

Annexes

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Annex A Base and Holder dimensions overview (Informative)

This Annex A provides a summary of the Base and Holder dimensions, as derived from the LMC and MMC of the PHJ85d-*x* fit defined in Section 3. Note that the dimensions in this overview are not straightforward copies of the values provided in Section 3. As explained in Section 8.1.1 and Section 8.2.1, the effective MMC of the Base and the MMC of the Holder each are offset by 0,1 mm from the MMC defined in Section 3 to ensure a minimum play in the system, even in the case of thermal expansion.

Figure A-1, Figure A-2 and Table A-1 illustrate a Holder outline; for drawings of the LLE, see Section 3. The minimum and maximum values provided include a Holder LMC, which ensures that the Holder can satisfy the Luminaire functional requirements defined in Section 3.9. This Holder LMC is used to define the gauges in Section 8.1.1.

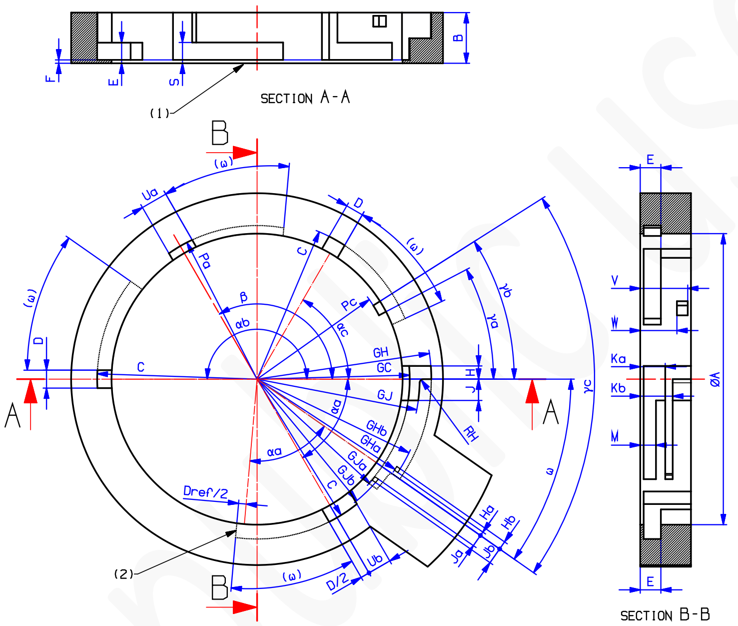

Figure A-1: Holder dimensions PHJ85d-1

Notes to Figure A-1 (above):

(1) This is the reference plane for vertical dimensions.

(2) This is the stop for the rotational motion during locking of the LLE into the Holder.

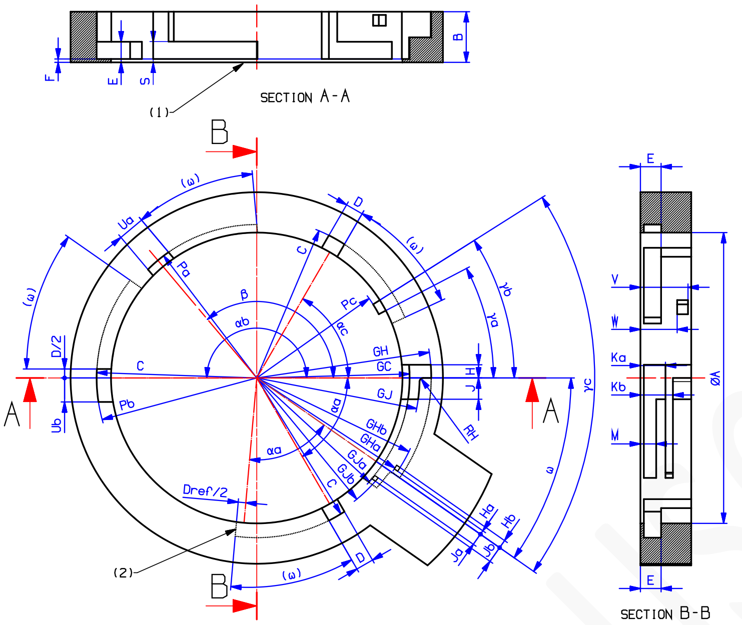

Figure A-2: Holder dimensions PHJ85d-2

Notes to Figure A-2 (above):

(1) This is the reference plane for vertical dimensions.

(2) This is the stop for the rotational motion during locking of the LLE into the Holder.

Table A-1: Base and Holder dimensions overview

	Base		Holder		
Dimension	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Notes**
A	85.20	85.90	86.10	86.60	
B	20.10	45.00	12.90	19.90	
C	46.40	47.10	47.30	NA	
CC	NA	3.50	NA	NA	
D	4.30	5.10	5.30	5.70	
Dref/2	2.25		2.25		
E	5.70	6.10	5.70	6.10	
F	1.10	4.00	NA	0.90	
Gc	NA	44.95	45.15	NA	
GH	NA	51.35	51.55	NA	
GHa	NA	48.65	NA	48.75	(1)
GHb	50.05	NA	49.95	NA	(1)
GJ	NA	47.90	48.10	NA	
GJa	NA	45.20	NA	45.30	(1)
GJb	46.60	NA	46.50	NA	(1)

Table A-1: Base and Holder dimensions overview (continued)

	Base		Holder		
Dimension	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Notes**
H	NA	3.70	3.90	NA	
Ha	NA	1.25	NA	1.25	(1)
Hb	2.55	NA	2.55	NA	(1)
J	NA	6.10	6.30	NA	
Ja	NA	3.65	NA	3.65	(1)
Jb	4.95	NA	4.95	NA	(1)
Ka	7.60	NA	NA	7.40	
Kb	NA	9.50	9.70	NA	
L	1.10	1.50	NA	NA	
M	NA	4.45	4.65	NA	
N	NA	9.80	10.20	NA	
Pa	44.90	45.25	45.45	NA	
Pb	44.80	47.10	47.30	NA	
Pc	NA	40.50	40.70	41.20	
RD	0.60	1.50	NA	NA	
RH	NA	0.90	1.10	NA	
RW	0.60	NA	NA	NA	
S	NA	5.95	6.15	NA	
T	NA	1.00	NA	NA	
Ua	7.00	7.75	7.95	8.45	
Ub	5.20	6.90	7.10	7.60	
W	9.60	10.65	10.85	11.85	
V	14.25	NA	13.05	14.05	
Y	1.10	NA	NA	0.90	
αa	60.00°		60.00°		
αb	180.00°		180.00°		
αc	60.00°		60.00°		
β	120.00°		120.00°		
	130.00°		130.00°		
γa	26.30°	27.37°	27.63°	29.00°	
γb	32.63°	33.70°	31.00°	32.37°	
γc	58.13°	68.00°	NA	57.87°	
ω	NA	NA	15.50°	25.50°	

Notes to Table A-1 (above):

(1) The values listed for the electrical contact dimensions apply with the LLE diameter A equal to the maximum value, and the Holder diameter A equal to the minimum value. In the case that the LLE diameter A is equal to the minimum value, and the Holder diameter A is equal to the maximum value, the values listed in Table A-2 apply.

Table A-2: Electrical contact dimensions for minimum LLE diameter and maximum Holder diameter

	Base		Holder		
Dimension	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Notes**
GHa	NA	48.30	NA	49.00	
GHb	50.40	NA	49.70	NA	
GJa	NA	44.85	NA	45.55	
GJb	46.95	NA	46.25	NA	

Annex B Product Data Set Requirements (Normative)

B.1 LLE Product Data Set

The Product Data Set of a LLE shall contain at least the following information:

- The mechanical fit code (PHJ85d, PHJ85d-1, or PHJ85d-2).
- The mains power consumed, voltage and frequency.
- The maximum operating temperature $t_{r,\,max}$ at the center of the Thermal Interface Surface. (Informative) *This is the temperature at which the LLE is characterized with respect to its photometric properties, life time etc. Operation of the LLE above this temperature can impact these characteristics negatively.*
- The thermal power $P_{th,rear}$, which the LLE generates at the Thermal Interface Surface, with 3% accuracy.
- The luminous flux category at the maximum operating temperature $t_{r,\,max}$.
- The correlated color temperature at the maximum operating temperature $t_{r,\,max}$.
- The color rendering index. at the maximum operating temperature $t_{r,\,max}$.
- The Thermal Fit Code.
- If dimming functionality is supported, the information required by [NEMA SSL 7A] Section 5.

B.2 Holder Product Data Set

- The mechanical fit code (PHJ85d-1, or PHJ85d-2).

B.3 Luminaire Product Data Set

The Product Data Set of a Luminaire shall contain at least the following information:

- The mechanical fit code (PHJ85d-1, or PHJ85d-2).
- The thermal resistance R_{th} at an applied thermal power of $(10 \pm 5\%)$ W, $(20 \pm 5\%)$ W, $(30 \pm 5\%)$ W, and $(40 \pm 5\%)$ W, insofar as these thermal power values do not exeed any Rated maximum thermal power of the Luminaire under test, and an ambient temperature of (25 ± 5) °C; with an accuracy of 10%.
- The expected maximum ambient temperature.
- One or more Thermal Fit Codes that are associated with the expected maximum ambient temperature.

The Product Data Set of a Luminaire should contain at least the following information:

- The mains power, voltage and frequency.
- The intended mounting.
- The maximum thermal power.
- If dimming functionality is built-in, the information required by [NEMA SSL 7A] Section 5.

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Annex C Safety Requirements (Informative)

International and national regulations require a LLE, a Luminaire and a Holder to comply with product safety standards. This Annex C lists a number of the most relevant of such standards.

C.1 LLE product safety standards

The following product safety standards are relevant for a LLE:

- LED modules for general lighting—Safety specifications, IEC 62031; in particular the provisions therein for a "self-ballasted LED module."

C.2 Luminaire product safety standards

The following product safety standards are relevant for a Luminaire:

- Luminaires—Part 1: General requirements and tests, IEC 60598-1.

C.3 Holder product safety standards

The following product safety standards are relevant for a Holder:

- New cap (base)/holder fits; requirements for increased safety, IEC 60061-4 standard sheet 7007-4.
- Creepage distances and clearances for caps on finished lamps, IEC 60061-4 standard sheet 7007-6.
- Guidelines for the retention of caps in holders, IEC 60061-4 standard sheet 7007-8.
- Miscellaneous lampholders—Part 1: General requirements and tests, IEC 60838-1.

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Annex D Holder requirements (Normative)

D.1 Holder-Luminaire interface definition

Typically, a Holder is a separate component, which is mounted in the main body of the Luminaire. In order to ensure interchangeability of different Holders, this Annex D defines the interface between the Holder and the main body of the Luminaire. Figure D-1 and Table D-1 define the maximum outline of the Holder-LLE subsystem—i.e. a Holder with a LLE locked therein.

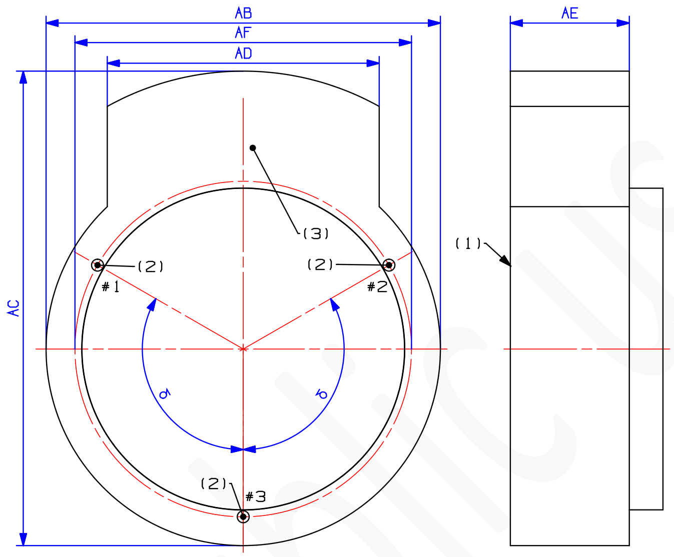

Figure D-1: Outline of the Holder-LLE subsystem

Notes to Figure D-1:

(1) This is the reference plane of the Holder-LLE subsystem. The Thermal Interface Surface coincides with the reference plane.

(2) Holes that may be used to mount the Holder to a heat sink using M3 screws. It is recommended that the heat sink provides screw holes of at least 4,50 mm depth. Fixing means—screws or other—may be part of the Holder and may extend through the reference plane of the Holder-LLE subsystem.

(3) The Holder shall provide mains connection wire terminals in the section of diameter AB, which is located between the mounting holes #1 and #2. A Holder may have a connection zone as defined by dimensions AC, AD, and AE. Mains connection wires may be part of the Holder, and may extend beyond the maximum outline of the Holder-LLE subsystem.

Table D-1: Dimensions of the Holder outline

Dimension	LMC	MMC	Notes
AB	NA	116,00	
AC	NA	140,00	
AD	NA	80,00	
AE	NA	35,00	
AF	99,00 ± 0,25		
δ	120,00° ± 0,30°		

D.2 Testing tools

Figure D-2 and Table D-2 define gauge MTG-H6-PHJ85d.

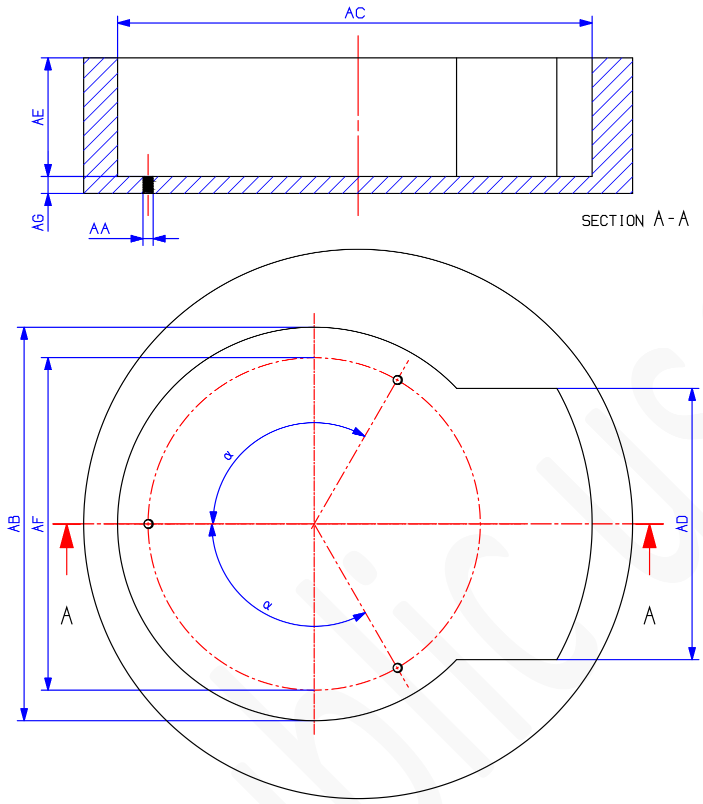

Figure D-2: MTG-H6-PHJ85d

Table D-2: MTG-H6-PHJ85d dimensions

Dimension	Nominal	Tolerance
AA	M3	
AB	116,04	±0,03
AC	140,04	±0,03
AD	80,04	±0,03
AE	35,04	±0,03
AF	99,00	±0,05
AG	5,00	±0,10
δ	120,00°	±10′

D.3 Test #20—gauge MTG-H6-PHJ85d

The Holder under test shall be mounted into gauge MTG-H6-PHJ85d using three M3 screws. MTG-H3-PHJ85d shall be inserted into the Holder under test and rotated to the stop position.

Test #21 passes if the Holder under test does not extend above gauge MTG-H6-PHJ85d. By exception, mains connection wires of the Holder under test may extend above gauge MTG-H6-PHJ85d. Otherwise, test #22 fails.

Annex E Thermal Fit Code (Normative)

This Annex E defines a simple coding scheme that assists with the thermal compatibility verification of a specific LLE and a specific Luminaire.

E.1 Thermal Fit Code definition

A Thermal Fit Code consists of a single capital letter and a two-digit decimal number. The capital letter encodes an operating temperature at the Thermal Interface Surface—i.e. the temperature at Reference Temperature position 0 (see Figure 6-1 in Section 6.1)—as defined in Table E-1. The decimal number encodes a thermal power applied to the Thermal Interface Surface, with the value representing the upper level of a 1 W range.

Table E-1: Operating temperature encoding

Operating Temperature [°C]	Letter	Operating Temperature [°C]	Letter
> 100	A	75…80	F
95…100	B	70…75	G
90…95	C	65…70	H
85…90	D	60…65	J
80…85	E	55…60	K

(Informative) *Examples:*

- *The Thermal Fit Code J13 indicates an operating temperature in the range of 60…65 °C, and a thermal power in the range of 12…13 W.*
- *The Thermal Fit Code B35 indicates an operating temperature in the range of 95…100 °C, and a thermal power in the range of 34…35 W.*

The thermal fit code defined in this Annex will be replaced by a P^* based thermal fit code.

E.2 LLE Thermal Fit Code construction

The Product Data Set of a LLE shall list a single Thermal Fit Code, which shall be determined as follows:

- Encode the Rated Operating Temperature $t_{\mathrm{r,max}}$ as defined in Table E-1.
- Round the Rated thermal power $P_{\mathrm{th,rear}}$, expressed in watts, up to the nearest two-digit integer.

(Informative) *Examples:*

- *A Rated Operating Temperature* $t_{\mathrm{r,max}} = 66$ *°C and Rated thermal power* $P_{\mathrm{th,rear}} = 12{,}60$ *W yield a Thermal Fit Code H13.*
- *A Rated Operating Temperature* $t_{\mathrm{r,max}} = 89$ *°C and Rated thermal power* $P_{\mathrm{th,rear}} = 17{,}10$ *W yield a Thermal Fit Code D18.*

E.3 Luminaire Thermal Fit Code construction

The Product Data Set of a Luminaire shall list one or more Thermal Fit Codes, which shall be determined as follows:

- Determine the maximum ambient temperature $t_{\mathrm{a,max}}^{\mathrm{exp}}$, which is expected to occur during operation of the Luminaire in its intended environment. The Product Data Set of the Luminaire shall list the value of $t_{\mathrm{a,max}}^{\mathrm{exp}}$.

The thermal fit code defined in this Annex will be replaced by a P^* based thermal fit code.

- Determine the expected maximum operating temperature $t_{\mathrm{r,max}}^{\mathrm{exp}}$ at the Thermal Interface Surface as a function of $P_{\mathrm{th,rear}}$, using the one-dimensional thermal model of the LLE-Luminaire system defined in [Book 1]:

  $$t_{\mathrm{r,max}}^{\mathrm{exp}}(P_{\mathrm{th,rear}}) = t_{\mathrm{a,max}}^{\mathrm{exp}} + R_{\mathrm{th}}(P_{\mathrm{th,rear}}) \cdot P_{\mathrm{th,rear}}.$$

  Note that in this model, the $P_{\mathrm{th,rear}}$ dependency of the Luminaire thermal resistance R_{th} should be taken into account.

- Let $P_{\mathrm{th}}^{(fit)}$ represent the lowest operating temperature and the highest thermal power associated with a Thermal Fit Code. (Informative) *For example, Thermal Fit Code G22 has* $t_{\mathrm{r}}^{\mathrm{G22}} = 70$ *°C and* $P_{\mathrm{th}}^{\mathrm{G22}} = 22$ *W.*

  The Product Data Set of the Luminaire shall list one or more of the Thermal Fit Codes *(fit)*, which satisfy the relation $t_{\mathrm{r}}^{(fit)} > t_{\mathrm{r,max}}^{\mathrm{exp}}(P_{\mathrm{th}}^{(fit)})$.

  Note that it is not necessary to list all Thermal Fit Codes, which satisfy the above relation. See the matching rules in Annex E.4

(Informative) *Figure E-1 provides an example construction of a Luminaire Thermal Fit Code.*

Step 1. *Determine the maximum expected ambient temperature; in this case ta (max) = 33 °C.*

Step 2. *Design the heat sink is designed, and determine its thermal Resistance* R_{th} *as a function of the applied thermal power (column at the left hand side of Figure E-1).*

Step 3. *Determine the set of all applicable Thermal Fit Codes, i.e. the set of Thermal Fit Codes for which the expected maximum operating temperature is below the lowest temperature associated with the Thermal Fit Code (see Table E-1). This set is shown on the right hand side of Figure E-1.*

Step 4. *Determine which Thermal Fit Codes to list in the Product Data Set of the Luminaire. In order to include the complete set, is necessary to list the italicized Thermal Fit Codes only i.e. J7, I10, H13, …; see also the thermal compatibility verification rules defined in Annex E.4). However, to avoid a long list, it is possible to include a subset only, e.g. H13—which represents all Thermal Fit Codes in the drawn box—and/or E21—which represents all Thermal Fit Codes in the dashed box. Note that a drawback of including a subset only is that—according to the thermal compatibility verification rules defined in Annex E.4—at a first glance some LLEs can appear to be not thermally compatible with the Luminaire—e.g. LLEs that are classified as I8, F16, B27, ….*

ta (max) [°C]: 33

Tr,max [°C]

Rth [°C/W]	Pth [W]	K	J	H	G	F	E	D	C	B	A
3.09	5	K5	J5	H5	G5	F5	E5	D5	C5	B5	A5
2.96	6	K6	J6	H6	G6	F6	E6	D6	C6	B6	A6
2.84	7	*K7*	J7	H7	G7	F7	E7	D7	C7	B7	A7
2.75	8		J8	H8	G8	F8	E8	D8	C8	B8	A8
2.67	9		J9	H9	G9	F9	E9	D9	C9	B9	A9
2.60	10		*J10*	H10	G10	F10	E10	D10	C10	B10	A10
2.54	11			H11	G11	F11	E11	D11	C11	B11	A11
2.49	12			H12	G12	F12	E12	D12	C12	B12	A12
2.44	13			***H13***	G13	F13	E13	D13	C13	B13	A13
2.40	14				G14	F14	E14	D14	C14	B14	A14
2.36	15				*G15*	F15	E15	D15	C15	B15	A15
2.32	16					F16	E16	D16	C16	B16	A16
2.28	17					F17	E17	D17	C17	B17	A17
2.25	18					*F18*	E18	D18	C18	B18	A18
2.22	19						E19	D19	C19	B19	A19
2.20	20						E20	D20	C20	B20	A20
2.17	21						***E21***	D21	C21	B21	A21
2.14	22							D22	C22	B22	A22
2.12	23							D23	C23	B23	A23
2.10	24							D24	C24	B24	A24
2.08	25							*D25*	C25	B25	A25
2.06	26								C26	B26	A26
2.04	27								C27	B27	A27
2.02	28								*C28*	B28	A28
2.00	29									B29	A29
1.99	30									*B30*	A30

Figure E-1: Example Luminaire Thermal Fit Code

If a Luminaire is expected to be used in environments, which have different expected maximum ambient temperatures $t_{a,max}^{exp}$, the Product Data Set of the Luminaire may list multiple $t_{a,max}^{exp}$ values and the associated Thermal Fit Codes. However, this is not recommended.

E.4 Thermal compatibility verification

Verification of the thermal compatibility of a LLE and a Luminaire using the Thermal Fit Codes proceeds by means of a simple matching rule:

A LLE is thermally compatible with a Luminaire if

- the Luminaire is used in an environment, which has an ambient temperature that does not exceed the Rated expected maximum ambient temperature; *and*
- the letter of the LLE Thermal Fit Code is less than—i.e. comes alphabetically before—or equal to the letter of the Luminaire Thermal Fit Code; *and*
- the number of the LLE Thermal Fit Code is less than or equal to the number of the Luminaire Fit Code.

If the above matching rule does not yield a positive result—i.e. the LLE is thermally compatible with the Luminaire—the procedure defined in [Book 1] can be used as an alternative method to verify thermal compatibility. In particular, if the Luminaire is used in an environment, which has an expected maximum ambient temperature that differs from the Rated expected maximum ambient temperature, the method defined in [Book 1] should be used.

If the Product Data Set of a Luminaire lists multiple Thermal Fit Codes, the above matching rule applies to each Luminaire Thermal Fit Code individually.

(Informative) *Suppose that the Product Data Set of a Luminaire lists the Thermal Fit Codes H13 and F18, and an expected maximum ambient temperature of 40 °C. According to the above matching rules, D9, E18, and H11 LLEs are thermally compatible with the Luminaire; and G17, I20, and J14 are not thermally compatible.*

The thermal fit code defined in this Annex will be replaced by a *P** based thermal fit code.

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