

Designers Lighting Forum

Connectivity Vision for Smart Cities
and Smart Buildings

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General Assembly Chair

March 15, 2022



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material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

At the end of this course, participants will be able to:

1. Understand the value and importance of specifying standardized lighting and control devices for indoor and outdoor luminaires.
2. Know the benefits and flexibility available through interoperable products that are supplied from multiple manufacturers.
3. Recognize how to future proof your digital lighting and control luminaire installations.
4. Understand how the lighting standards from Zhaga better enable connected lighting, buildings and cities while driving future digital innovation



AGENDA

Useful Terms & Definitions

Introductions

Value of Zhaga Interoperable Products

Connectivity Vision for Smart Cities

Connectivity Vision for Smart Buildings

Collaboration with Standards Development Organizations

USEFUL TERMS & DEFINITIONS

interface¹: boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics as appropriate

interoperability²: ability of systems or systems components to transmit, receive, interpret, and/or react to data and/or power and function in a specified manner

standard³: document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context

interface standard³: standard that specifies requirements concerned with the compatibility of products or systems at their points of interconnection

1 Source: IEC 60050-351-42-25

2 Source: IEC TS 63105:2021

3 Source: ISO/IEC Guide 2:2004



INTRODUCTIONS

Mark Duffy
General Assembly Chair of Zhaga

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Technical Advisor to USTAG for IEC TC 34 and SC 34A
Senior VP of Technology for CIE-USNC
Former ANSI Lighting Group Chair
Former NEMA Light Source TC Chair
35 years with GE Lighting and Current Lighting Solutions LLC

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ZHAGA CONSORTIUM



An open global industry consortium with >400 members from the lighting industry



20 Regular Members



>120 Associate Members



>270 Community Members

NEW MISSION

Create interface specifications for components of LED luminaires to

- enable multi-vendor eco-systems of interoperable products
- create trust in interoperability through a certification and logo program executed by third party test houses
- support sustainable lighting for smart cities and buildings
- promote formal standardization by offering Zhaga Specifications to a Standard Development Organization

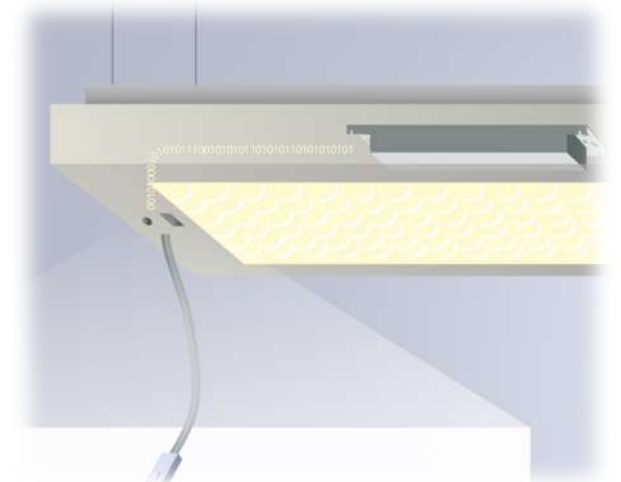
NEW MISSION



Old Zhaga: Facilitate
OEMs and manufacturers



New Zhaga: Enable new markets for
connected and serviceable lighting



ZHAGA INTERFACE SPECIFICATIONS

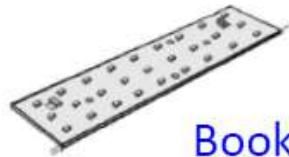
What is the market need? Smart, future-proof LED luminaires that are easily upgradeable to keep pace with rapid developments in digital networking technology.

What interfaces are standardized? Zhaga is standardizing interfaces of components of LED luminaires, including LED light engines, LED modules, LED arrays, holders, electronic control gear (LED drivers), sensors, communication modules and connectivity fit systems.

Why enable interoperability? This helps to streamline the LED lighting supply chain, and to simplify LED luminaire design and manufacturing.

Zhaga Books: Zhaga develops specifications, called books, based on the inter-related themes of interoperable components, smart and connected lighting, and serviceable luminaires.

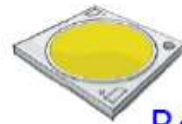
INTERFACE SPECIFICATIONS FOR COMPONENTS OF LED LUMINAIRES



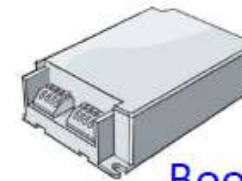
Book 7



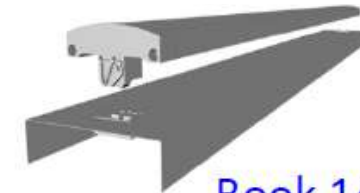
Book 10



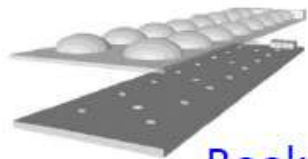
Book 12



Book 13



Book 14



Book 15



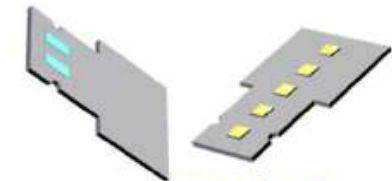
Book 18



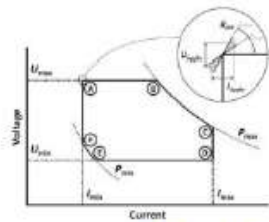
Book 19



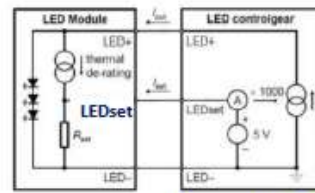
Book 20



Book 21



Book 22



Book 23



Book 24



Book 25



Book 26

VALUE OF ZHAGA INTEROPERABLE PRODUCTS

Benefits for Specifiers and End-users

Reduced risk and future-proofing

Zhaga-based luminaires are future-proof because light sources can be purchased from multiple suppliers. Customer is not reliant on original supplier if maintenance and/or replacement is required.

Easier upgrades

Latest-generation technology can be adopted easily. Luminaires are future-proofed against rapid LED technology evolution.

Avoiding installation/ specification of obsolete luminaires

Luminaires can be specified for future projects in the knowledge that a current, up-to-date LED light source can be fitted when the project is installed.

Easier procurement

If maintenance or upgrades are necessary, standardized parts will be in stock from numerous suppliers.

Unprecedented flexibility

Socketable LED light sources enable tool-free interchangeability in the field. This allows different options for color temperature, CRI, and – in some cases – lumen levels

VALUE OF ZHAGA INTEROPERABLE PRODUCTS

Zhaga-D4i Certification

A joint program from **Zhaga** and **DALI Alliance**

Certification of interoperable luminaires and sensing and/or communication modules

Based on complementary specifications from Zhaga and DALI Alliance

Zhaga **Book 18** or **Book 20** plus **D4i** specifications

Product certification will allow for use of Zhaga and D4i logos

For **luminaires, sensing** and **communication modules**

Logos indicate multi-vendor product interoperability

LED drivers are eligible for D4i certification from DALI Alliance

Book 18 and Book 20 **connectors** are eligible for certification from Zhaga



Look for
the logo!

VALUE OF ZHAGA INTEROPERABLE PRODUCTS

Zhaga-D4i Certification Features

Easy to add or upgrade sensors and/or communication modules:

Enables future-proof luminaires that can keep pace with rapid developments in digital networking and sensing technology.

Intra-luminaire DALI-2 bus:

Enables bi-directional communication between sensors and/or communication modules and LED drivers using the well-established and standardized DALI-2 protocol.

D4i drivers are smart:

Able to report operational and diagnostic data to an external network, can provide inventory-related information about luminaires.

IoT connectivity:

With a suitable wireless communication module, the luminaire can interact with an external lighting-control network and to become part of the IoT.

CONNECTIVITY VISION – SMART CITIES

Luminaire

Control

- Power
- ON/OFF operation
- Dimming function

Add networking...

- Connection to IoT
- City-wide communication
- Energy usage monitoring/reporting

Add senses...

- Environmental sensing (weather, air quality, smoke)
- Area security monitoring (surveillance cameras, noise detection)
- Vehicular and pedestrian traffic detection
- Emergency response
- Parking space assistance

Give your city common senses!!



CONNECTIVITY VISION – SMART CITIES

Sustainability

Interoperable products...

- Standardized interfaces for sensors and communication modules
- Many sensors... one common interface
- Multi-vendor eco-system of products

Repairability...

- Replaceable components instead of discarding complete luminaires at end-of-life
- Prevent or reduce landfill material

Upgradeability...

- Keep pace with the latest innovations in sensors
- Rapid developments in digital networking and smart city technology
- Increased luminaire life cycle

Zhaga solution – Book 18!!

ZHAGA BOOK 18 ED 3.0 (APRIL 2021)

Smart interface between outdoor luminaires and sensing / communication modules

What interfaces are standardized? Zhaga Book 18 defines a standardized interface between a LED Luminaire and a sensing/communication module. Edition 3.0 includes the addition of hybrid luminaires incorporating the ANSI C136.41 *Interface between an External Locking Type Control Device and Ballast or Driver*

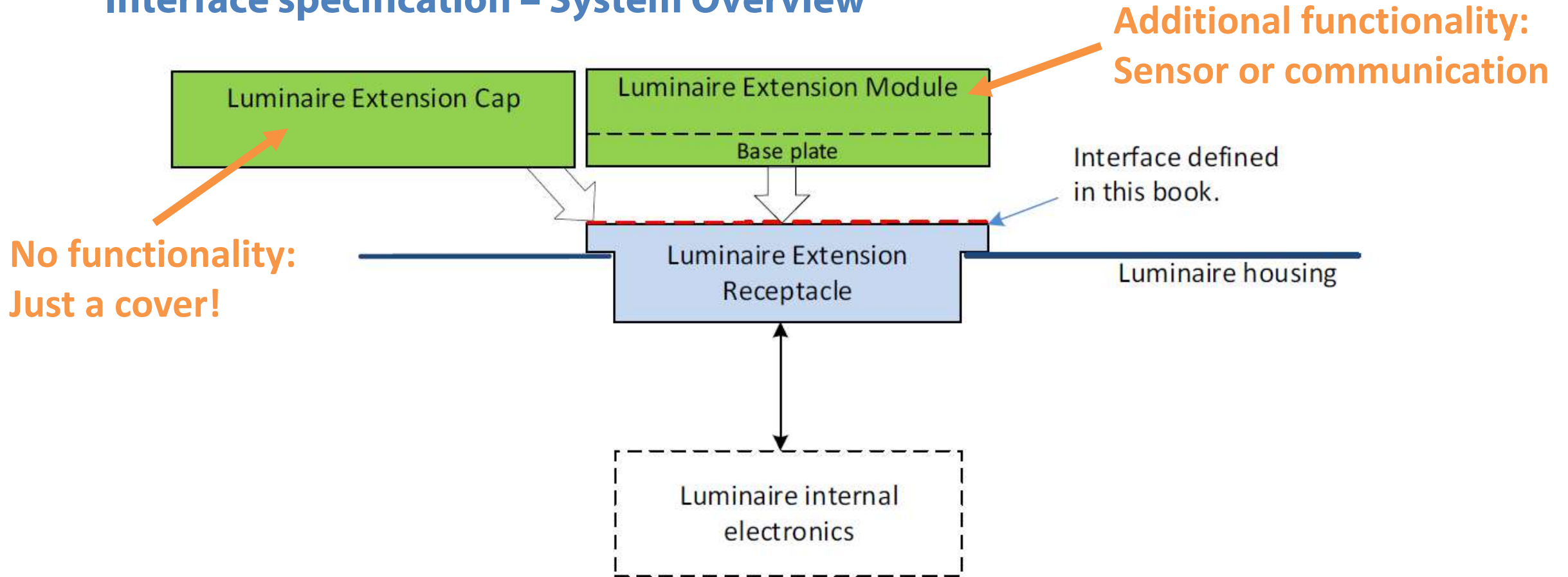
Why enable interoperability? The interfaces are intended to be used in outdoor applications with high IP rating. The Luminaire Extension Module (LEX-M) may provide sensory inputs to the Luminaire or communication between the Luminaire and a network.



Plug-and-Play
with Book 18!!

ZHAGA BOOK 18 – A CLOSER LOOK

Interface specification – System Overview



ZHAGA BOOK 18 – A CLOSER LOOK

Interface specification – form factor Z (Zhaga)

General

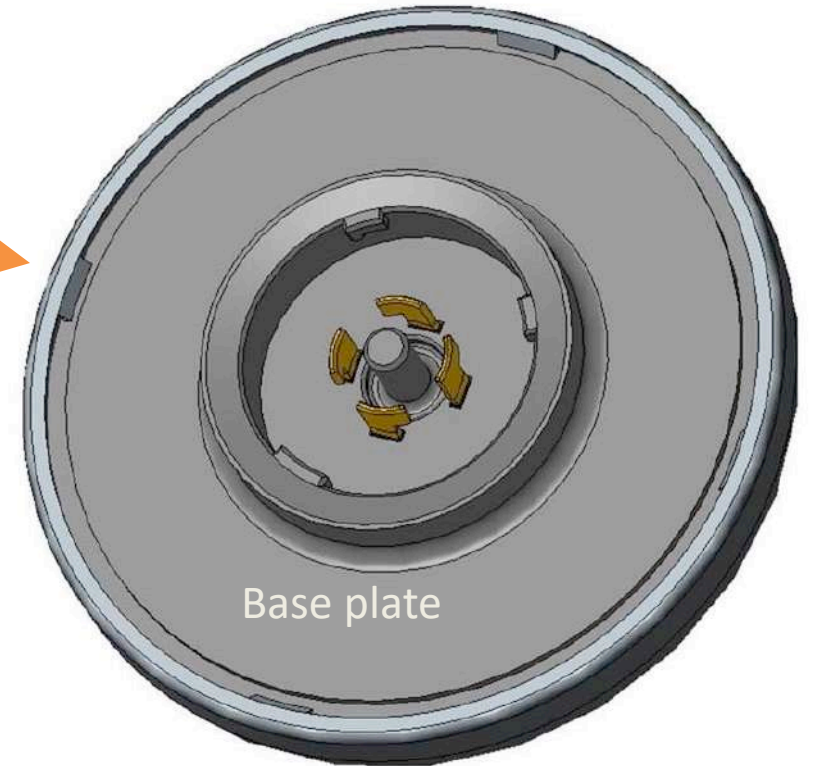
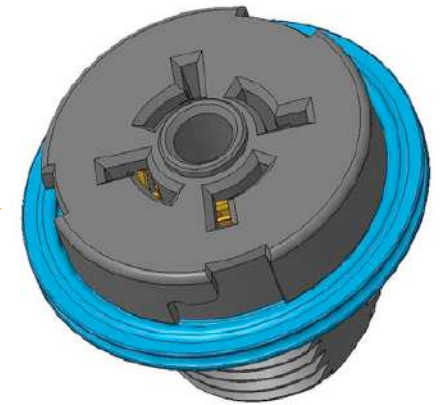
Luminaire Extension Receptacle (Z-LEX-R)

Luminaire Extension Module (Z-LEX-M)

Luminaire Extension Cap (Z-LEX-C)

High IP rating for outdoor use

Twist-lock coupling



ZHAGA BOOK 18 – A CLOSER LOOK

Interface specification – form factor N (ANSI C136.41)

General

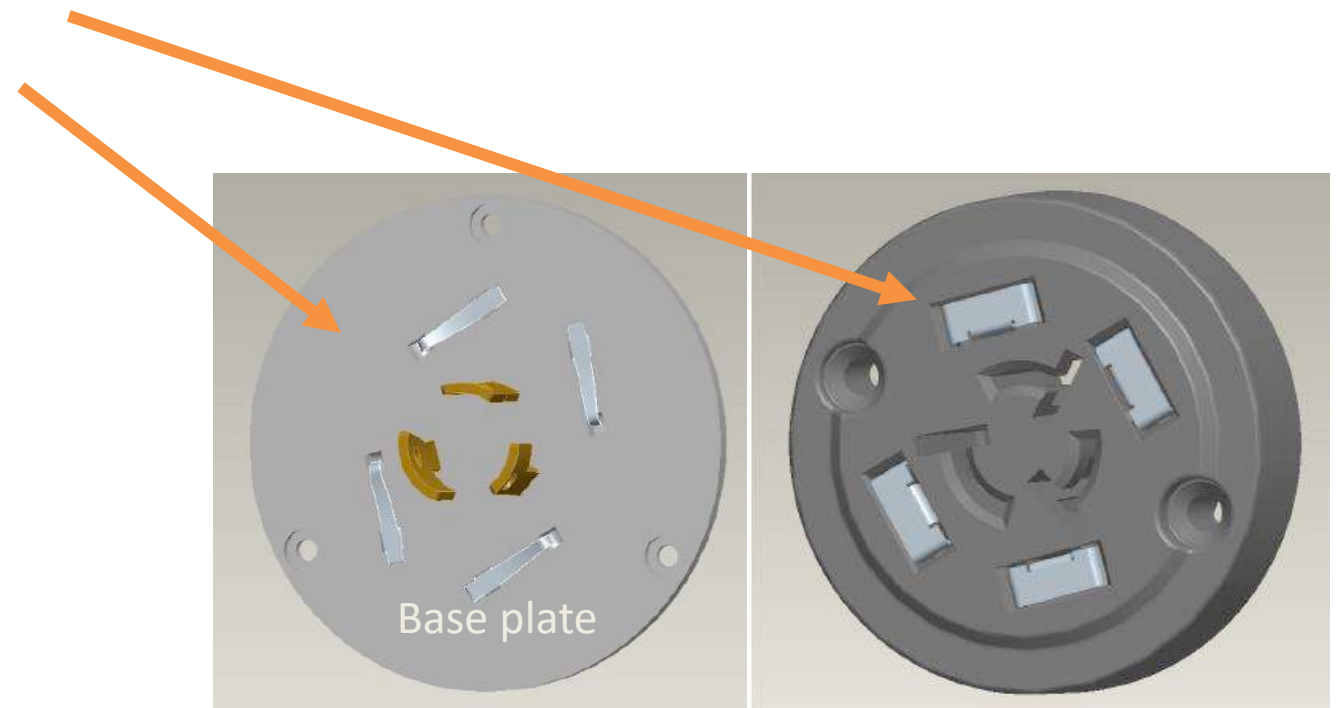
Luminaire Extension Receptacle (N-LEX-R)

Luminaire Extension Module (N-LEX-M)

Luminaire Extension Cap (N-LEX-C)

High IP rating for outdoor use

Twist-lock coupling



ZHAGA BOOK 18 – A CLOSER LOOK

Mechanical – Form factor Z (Zhaga)

Base Plate (Z-LEX-BP)

Outer diameter < 89 mm (~3.5 in)

Locking ring: 30 mm (~1.2 in)

4-contact inner ring diameter: 12 mm (~0.5 in)

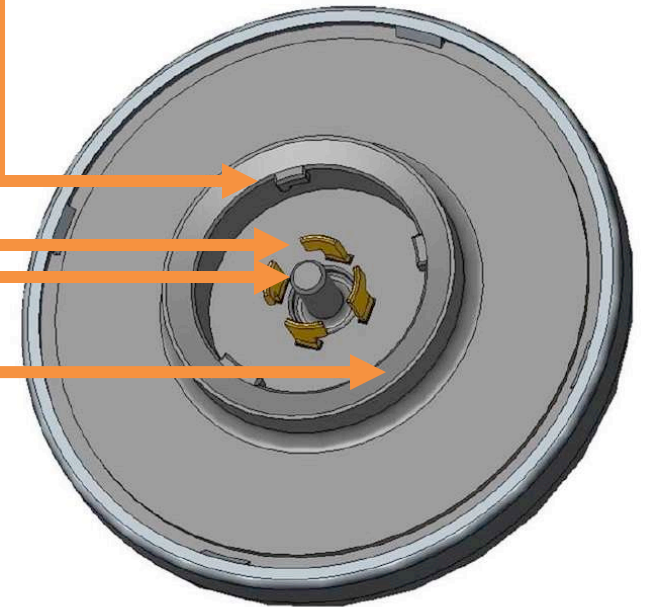
Center locator pin 4.9 mm (~0.2 in)

Tin-plated contacts

Mechanical stop features withstand 5.0 Nm torque

Mating surface

Gasket on LEX-R ensures locking and provides ingress protection



ZHAGA BOOK 18 – A CLOSER LOOK

Mechanical – Form factor Z (Zhaga)

Receptacle (Z-LEX-R)

Outer diameter: 30 mm (~1.2 in)

4-contact openings ring diameter: 12 mm (~0.5 in)

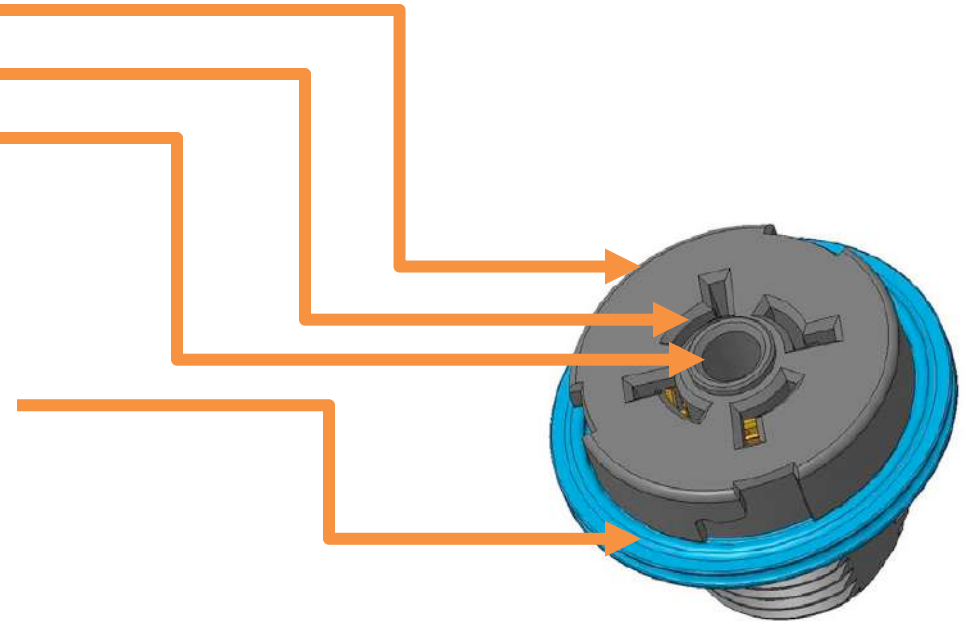
Center locator hole 5.35 mm (~0.2 in)

Tin-plated contacts

Mechanical stop withstands 5.0 Nm torque

Locking ramp feature: Un-mating torque > 1 Nm

Gasket ensures locking and provides ingress protection



ZHAGA BOOK 18 – A CLOSER LOOK

Mechanical – Form factor Z (Zhaga)

Keep-in area

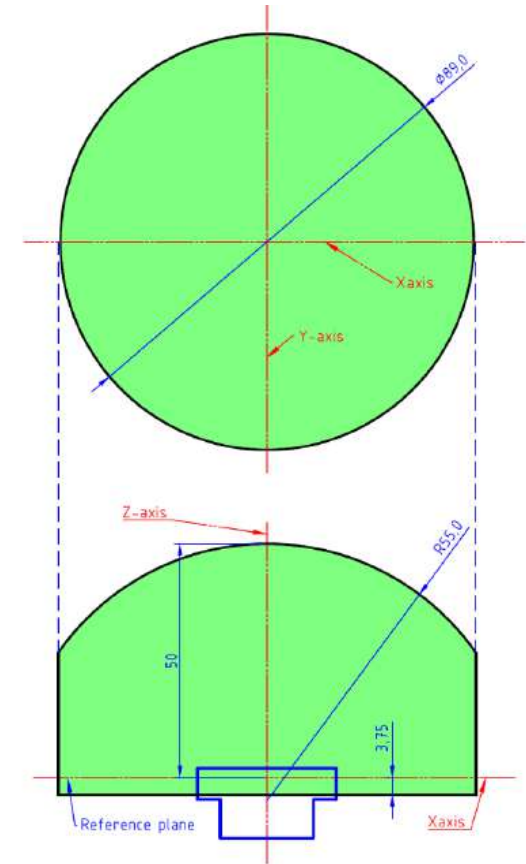
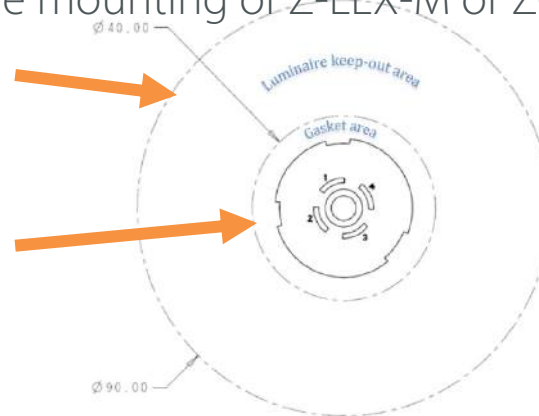
Luminaire Extension Module (Z-LEX-M) – ***recommended limits for module size ensuring mechanical fitting without mechanical or illumination interference***

Keep-out area

Luminaire volume dedicated to ensure mounting of Z-LEX-M or Z-LEX-C

Luminaire keep-out area

Gasket area



ZHAGA BOOK 18 – A CLOSER LOOK

Mechanical – Form factor N (ANSI C136.41)

Luminaire Extension Module (N-LEX-M)

Compliance with ANSI C136.41-2013, clause 6.1 for Plug Type

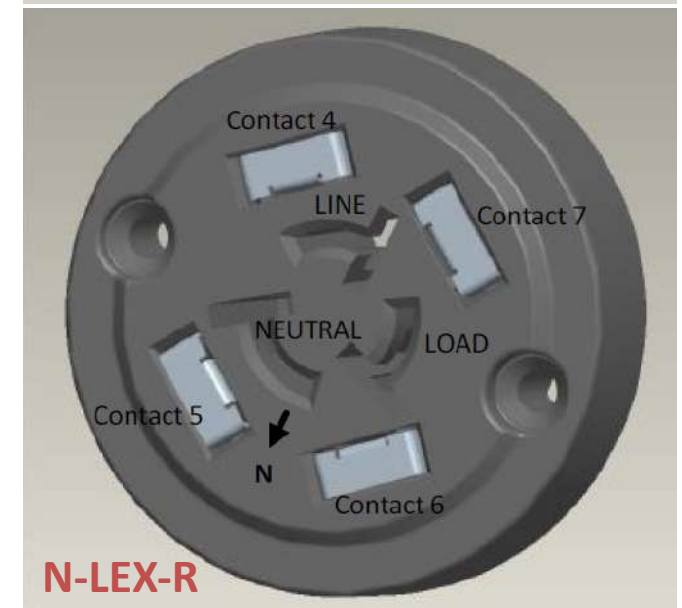
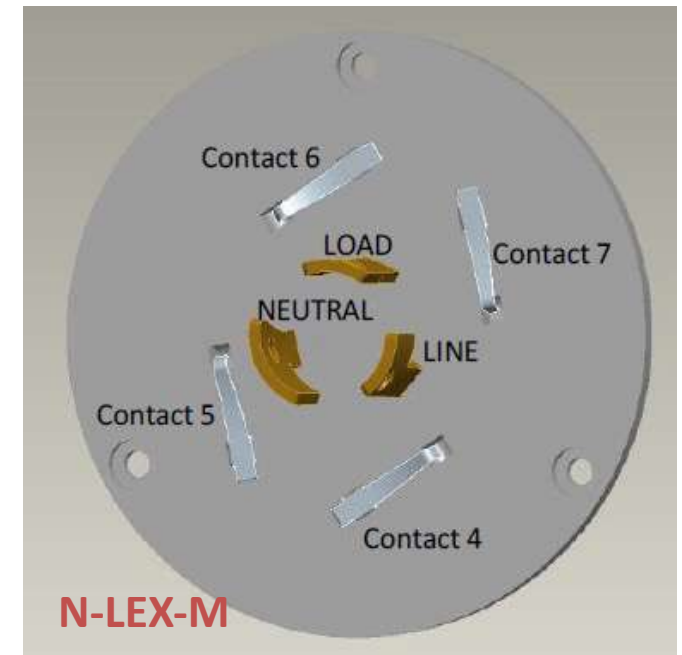
Required contacts: NEUTRAL, LINE, LOAD, Contacts 4 and 5

Optional contacts: Contacts 6 and 7

Luminaire Extension Receptacle (N-LEX-R)

Compliance with ANSI C136.41-2013, clause 6.2 for Receptacle Type

Required contacts: NEUTRAL, LINE, LOAD, Contacts 4, 5, 6 and 7 (All)



ZHAGA BOOK 18 – A CLOSER LOOK

Electrical and Communication – Overview

Electronic Control Gear (ECG) – Drivers

One to four in a luminaire

Driving LED modules or receptacles

AUX Power Supply

DALI Bus Power Supply

Luminaire Extension Modules/Receptacles

Form factor Z

Form factor N

DiiA Specifications

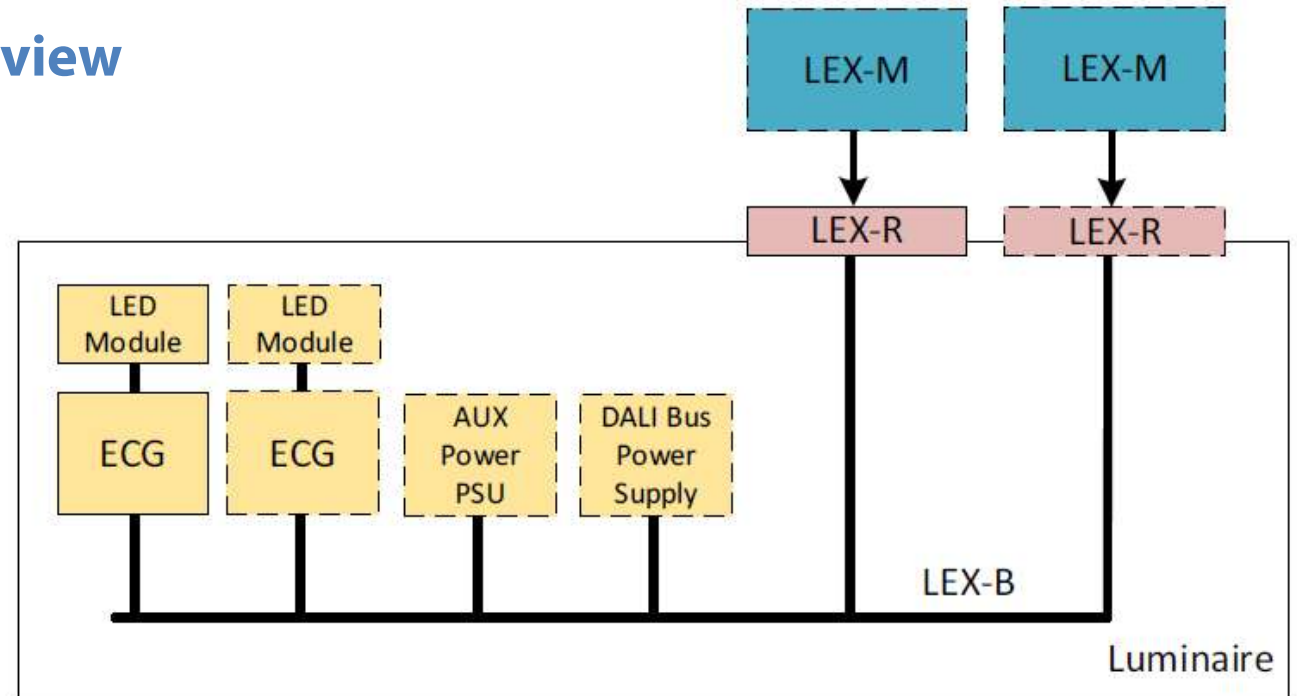
LEX Modules (specified in DALI – Part 351 *Luminaire-mounted Control Devices*)

Type A – AUX power (2W avg; 5W peak), 2 mA maximum DALI bus current (e.g. communication devices)

Type B* – AUX power (1W avg; 1W peak), 2 mA maximum DALI bus current (e.g. sensors)

Type B* – Bus power, 46 mA maximum DALI bus current (e.g. sensors)

* Any Type B device that contains either a motion sensor or ambient light sensor shall include an application controller.



ZHAGA BOOK 18 – A CLOSER LOOK

Electrical and Communication – Overview

Plug-and-Play means the total system functions as specified in the datasheets of the Luminaire and the LEX-Ms.

LEX-Ms attached to the Luminaire	Luminaire with single LEX-R	Luminaire with double LEX-R	
One Type A	Plug-and-Play	Plug-and-Play	
One Type B with integrated Application Controller	Plug-and-Play	Plug-and-Play	
One Type B w/o integrated Application Controller	LEX-M cannot control the ECG	LEX-M cannot control the ECG	
One Type A & One Type B	n.a.	For Type A LEX-M:	Plug-and-Play
		For Type B LEX-M:	May work depending on the specific combination of LEX-Ms. Check datasheets of both LEX-Ms.

ZHAGA BOOK 18 – A CLOSER LOOK

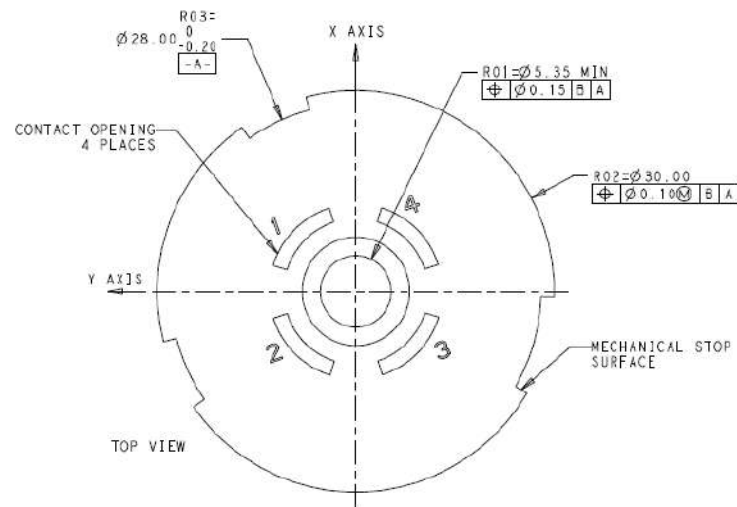
Electrical and Communication – Pin Assignments

Form factor Z (Zhaga)

Low voltage power supply +24 VDC (Pin 1)

DALI communication or sensor data (Pins 2 & 3)

Disconnected (for future standardization) (Pin 4)



Contacts	Assignment
1	+24 V AUX Power Supply
2	DA- (Negative pole for the DALI communication and power) GND for +24 V AUX Power Supply
3	DA+ (Positive pole for the DALI communication and power)
4	Not connected ¹

1 This requirement allows for a standardized definition of the functionality of this pin in future editions of this specification.

ZHAGA BOOK 18 – A CLOSER LOOK

Electrical and Communication – Pin Assignments



If it fits... it functions!

Form factor N (ANSI C136.41)

Modified Type D6 Contact Designation C136.41-202X

Main power (Pins 1, 2 & 3: Line, Neutral and Load)

Rated for > 1800 VA

DALI communication (Pins 4 & 5)

Aux power supply +24 VDC (Pin 6)

Disconnected (for future standardization) (Pin 7)

Contacts	Assignment
LINE	Mains - line
NEUTRAL	Mains – neutral
LOAD	Load
4	DA+ (Positive pole for the DALI communication and power)
5	DA- (Negative pole for the DALI communication and power) GND for +24 V AUX Power Supply
6	+24 V AUX Power Supply
7	Not connected ¹

1 This requirement allows for a standardized definition of the functionality of this pin in future editions of this specification.

ZHAGA BOOK 18 – A CLOSER LOOK

Electrical and Communication – DALI requirements

Form factor Z (Zhaga)

Z-LEX-M

Type A or Type B control device: DALI – Part 351 ***Luminaire mounted control devices***

D4i certification and listed in the DiiA database

If pin 1 is connected, the Z-LEX-M shall comply with “Electrical specification of AUX supply consumption” as specified in DALI – Part 351 to ensure sufficient AUX power

Occupancy or daylight sensing: Application controller specified in DALI – Part 103

Form factor N (ANSI C136.41)

N-LEX-M

Type A control device: DALI – Part 351 ***Luminaire mounted control devices***

D4i certification and listed in the DiiA database

If pin 6 is connected, the N-LEX-M shall comply with “Electrical specification of AUX supply consumption” as specified in DALI – Part 351 to ensure sufficient AUX power

CONNECTIVITY VISION – SMART BUILDINGS

Luminaire

Control

- Power
- ON/OFF operation
- Dimming function

Add networking...

- Building CMS
- Energy monitoring and reporting
- Illumination control (spectrum, scenes, etc.)

Add senses...

- Presence sensing
- Daylight harvesting
- Security
- Emergency response
- Hazard detection



Wake up the senses of your smart building!!

CONNECTIVITY VISION – SMART BUILDINGS

Application Spaces

- Multi-family housing
- Commercial hospitality
- Elderly facilities
- Smart homes

Sustainability

- Interoperable products – Standardized interfaces for sensors and communication modules
- Repairability – Replace components easily instead of discarding complete luminaires
- Upgradeability – Keep pace with rapid developments in sensors and smart building technology

Zhaga solution – Book 20!!

ZHAGA BOOK 20 ED 1.1 (MAY 2021)

Smart interface between indoor luminaires and sensing / communication modules

What interfaces are standardized? Book 20 defines a smart interface between an indoor LED luminaire and a sensing/communication module. The module connects to the LED driver and control system, and typically can provide sensory inputs or enable communication between network components.

Why enable interoperability? Key benefits are provided for

- luminaire makers, as certified sensors with many different functions are available from multiple suppliers
- installers, as interoperability of components is certified, and modules can be installed and replaced in the field.
- end-users, as the luminaire can be adapted with modules for different functions, like air quality, presence detection, light levels etc.

ZHAGA BOOK 20 ED 1.1 (MAY 2021)

Smart interface between indoor luminaires and sensing / communication modules

Why Book 20 interfaces?

Book 20 interfaces support the following U.S. Department of Energy programs:

- L-Prize – One point will be awarded for luminaires that incorporate a standardized sensor port and power/data connections in compliance with Zhaga Book 20 established by the Zhaga Consortium.
- IoT Upgradeable Lighting Challenge

Is Book 20 available?

Yes!! Zhaga has committed to make and keep Book 20 as a publicly available specification.



**Download Book 20
Today!!**

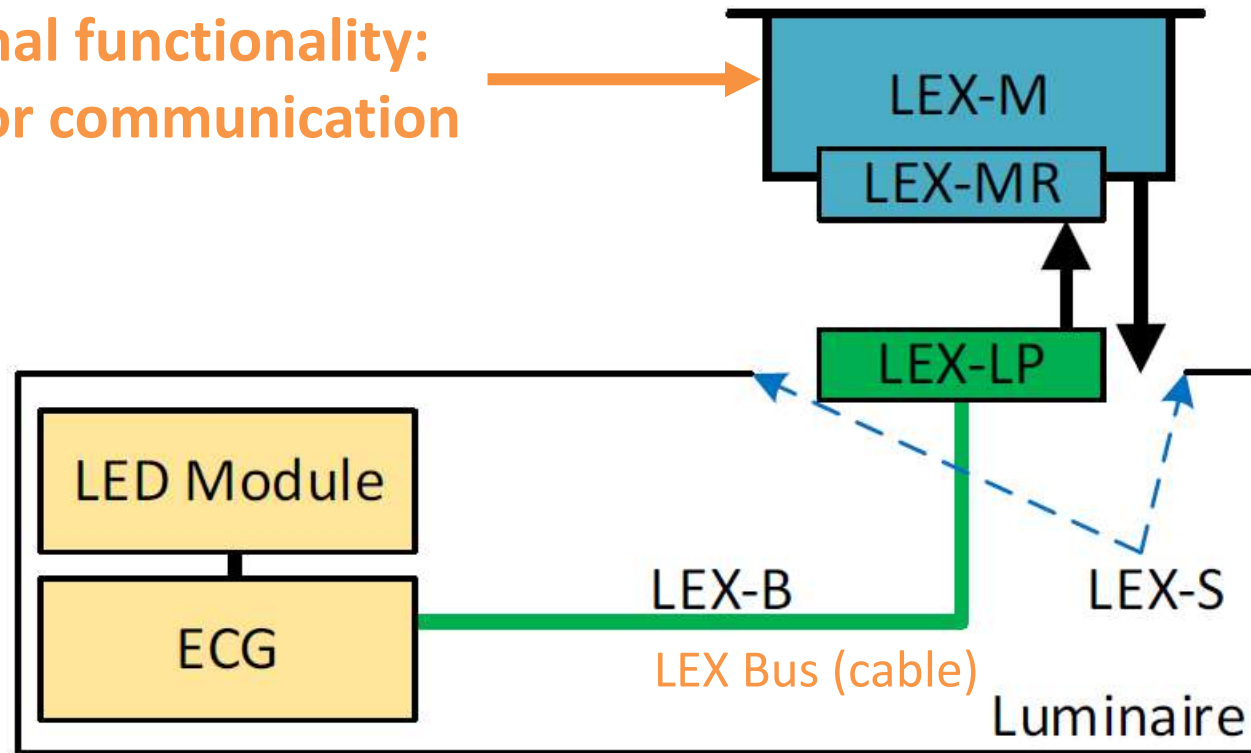
Check out the video: <https://youtu.be/qAF4FymbUJw>

ZHAGA BOOK 20 – A CLOSER LOOK

Indoor Connectivity System Overview

Additional functionality:
Sensor or communication

Electronic Control Gear
(Driver)



Luminaire Extension (LEX)

LEX Module

LEX Module Receptacle

LEX Luminaire Plug

LEX Slot

ZHAGA BOOK 20 – A CLOSER LOOK

Interface specifications

LEX Module to LEX Slot (Luminaire)

Mechanical interfaces (5 categories)

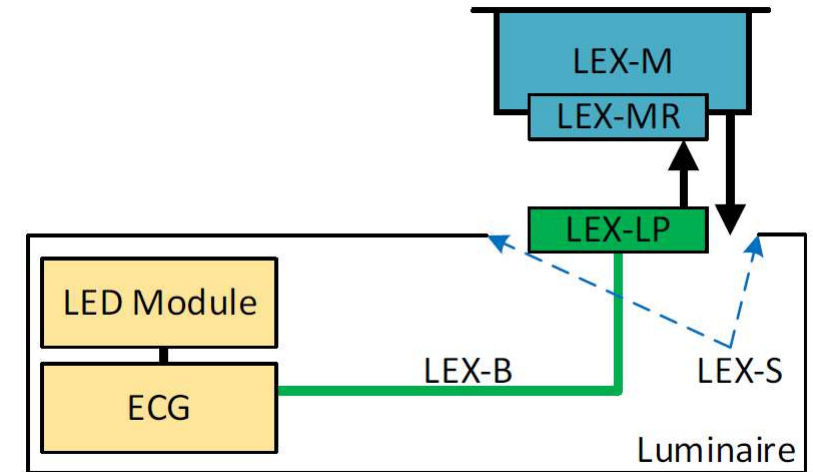
R44x17 (rectangular 44x17 mm)

R60x22 (rectangular 60x22 mm)

C22-T1A (round Ø 22 mm)

C22-T1B (round Ø 22 mm)

C22-T2 (round Ø 22 mm)

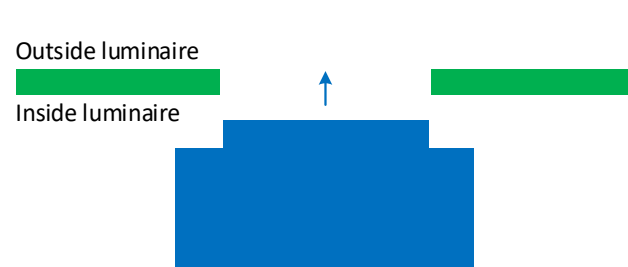


LEX Luminaire Plug to Module Receptacle – Mechanical interface of LEX-LP and LEX-MR

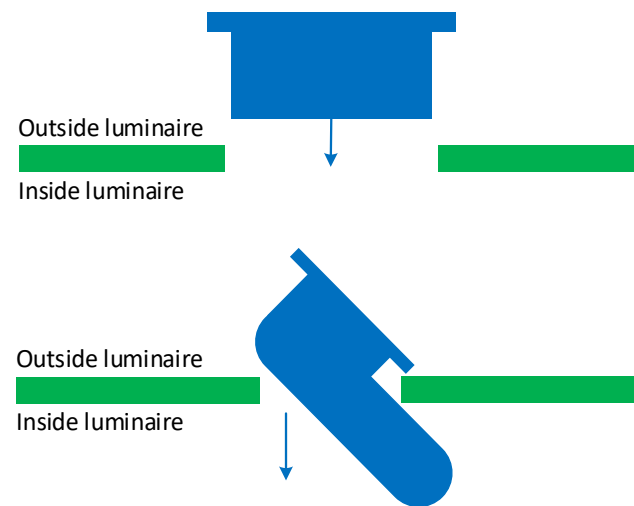
LEX Bus – Electrical and communication interface of the LEX-B at the LEX-LP and LEX-MR

ZHAGA BOOK 20 – A CLOSER LOOK

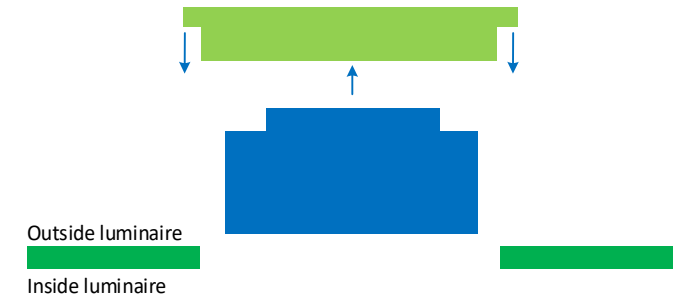
Fitting system configurations – LEX Module to LEX Slot



Module is mounted from the inside of the luminaire into the slot



Module is mounted from the outside of the luminaire into the slot



Module is mounted from the outside of the luminaire using a bracket fitting into the slot

ZHAGA BOOK 20 – A CLOSER LOOK

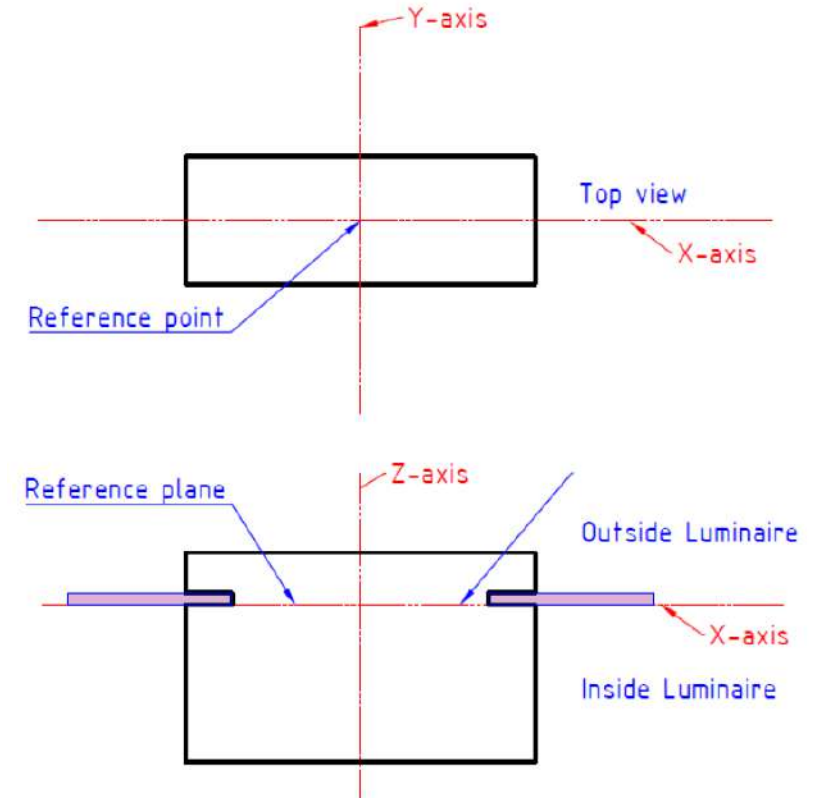
LEX Module to LEX Slot – Mechanical Interfaces

R44x17 (44 x 17 mm) (~1.7 x 0.7 in)

→ Rectangular modules with small volumes and indifferent orientation

R60x22 (60 x 22 mm) (~2.4 x 0.9 in)

→ Rectangular modules requiring more volume and surface, e.g., gas detectors or complex presence detectors



ZHAGA BOOK 20 – A CLOSER LOOK

LEX Module to LEX Slot – Mechanical Interfaces

C22-T1A (Ø 22 mm) (~0.9 in)

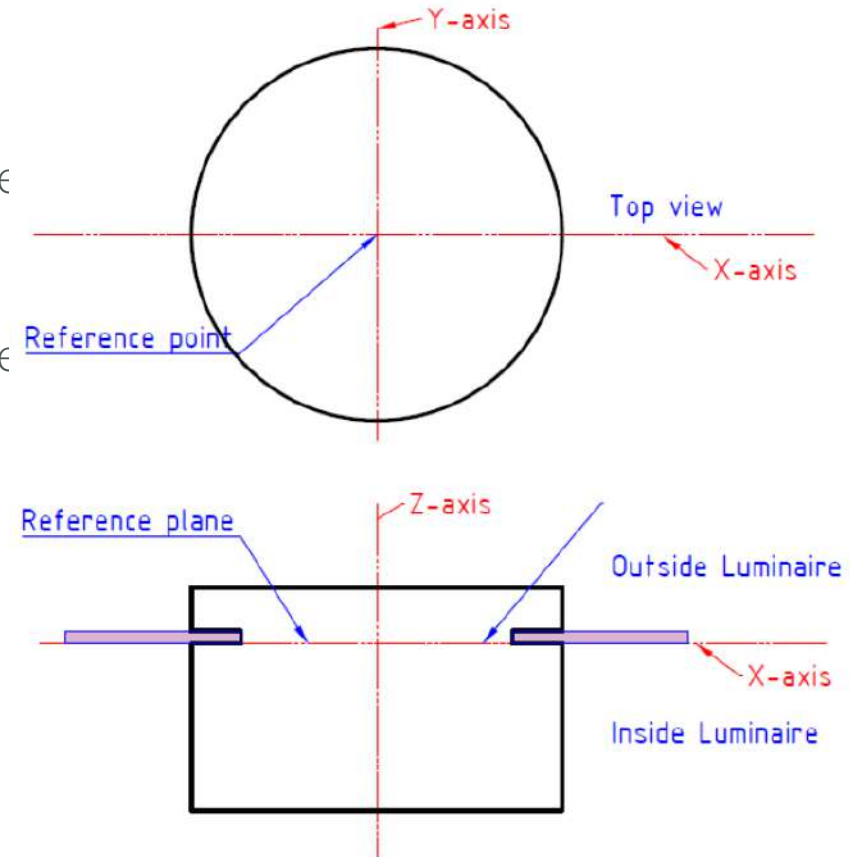
→ Cylindrical modules as already widely used in the field, adjustable orientation, minimum surface

C22-T1B (Ø 22 mm) (~0.9 in)

→ Cylindrical modules as already widely used in the field, adjustable orientation, larger lenses

C22-T2 (Ø 22 mm) (~0.9 in)

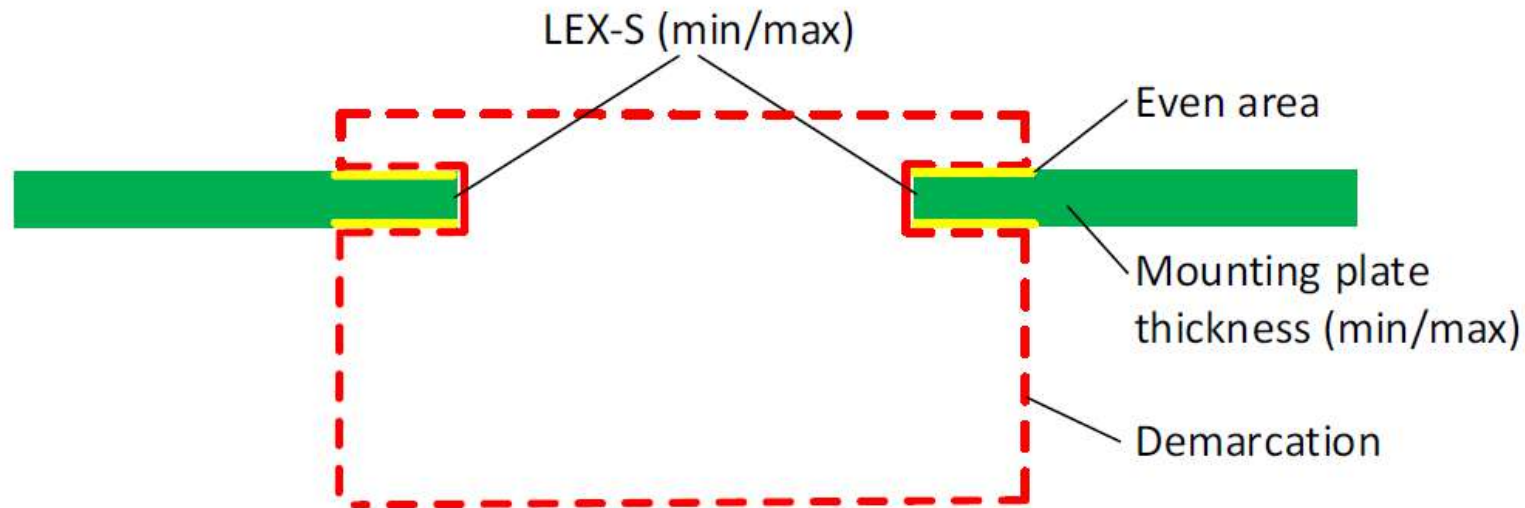
→ L-shaped modules enable ultra-flat luminaire designs



ZHAGA BOOK 20 – A CLOSER LOOK

LEX Module to LEX Slot – Method of specification

- The LEX-S with nominal dimensions + tolerances
- The thickness of the mounting plate with lower and upper limit.
- Border area around the LEX-S where the mounting surface shall be even.
- The demarcation inside the Luminaire and outside the Luminaire

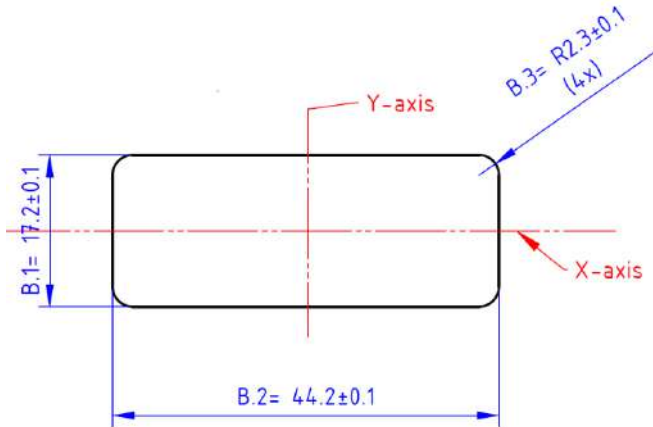


ZHAGA BOOK 20 – A CLOSER LOOK

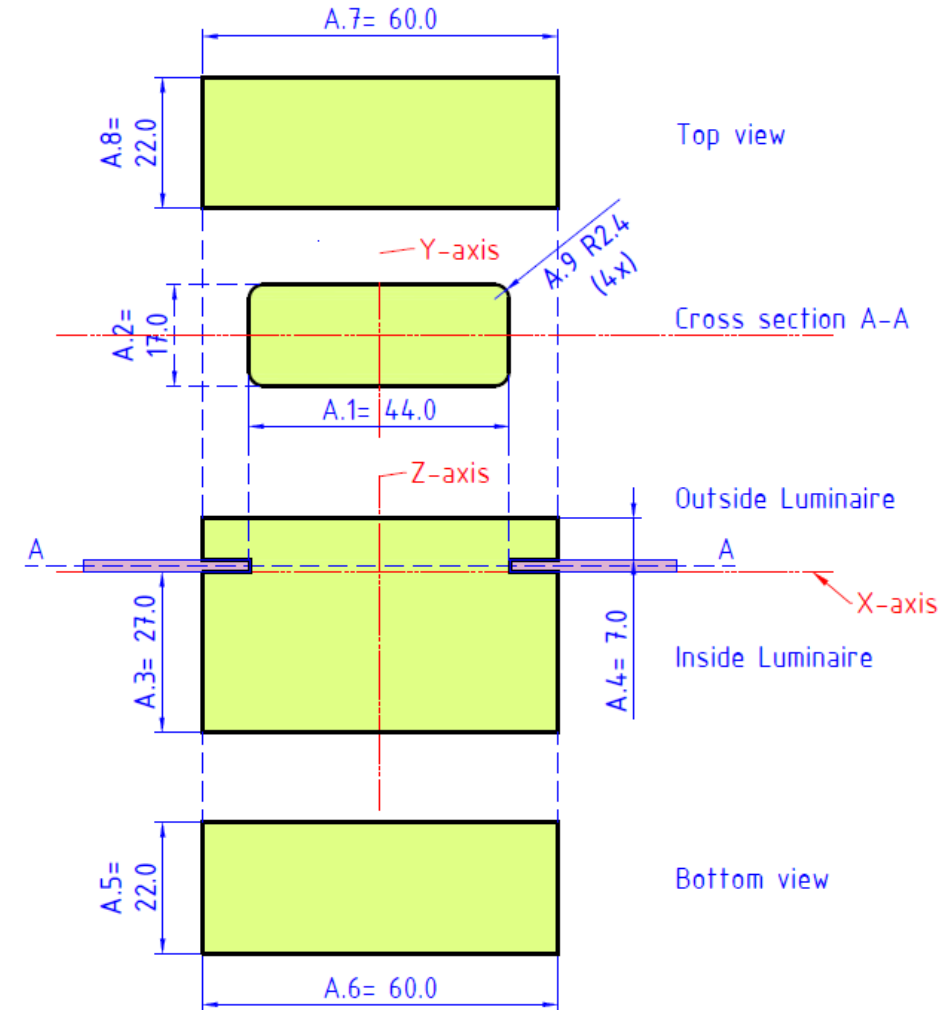
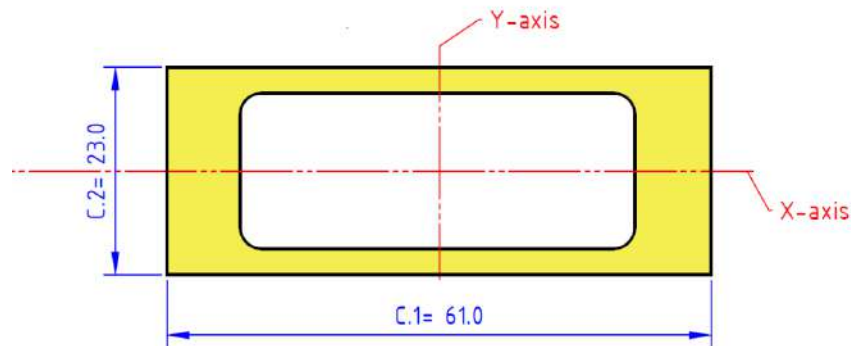
Category R44x17

LEX Module Demarcation

LEX Slot



LEX Slot Border

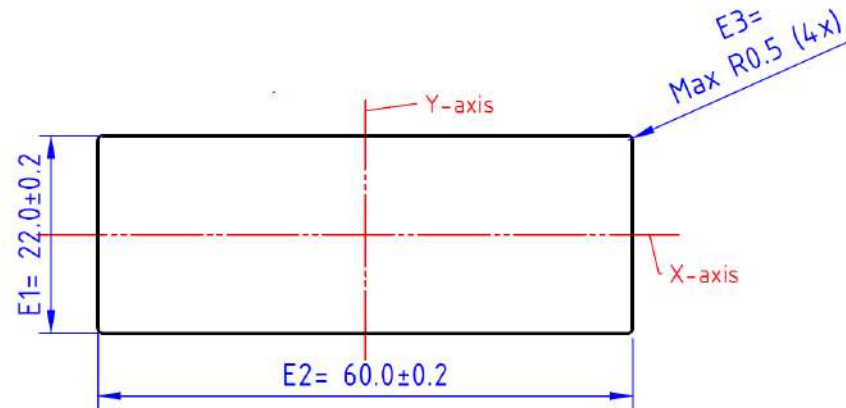


ZHAGA BOOK 20 – A CLOSER LOOK

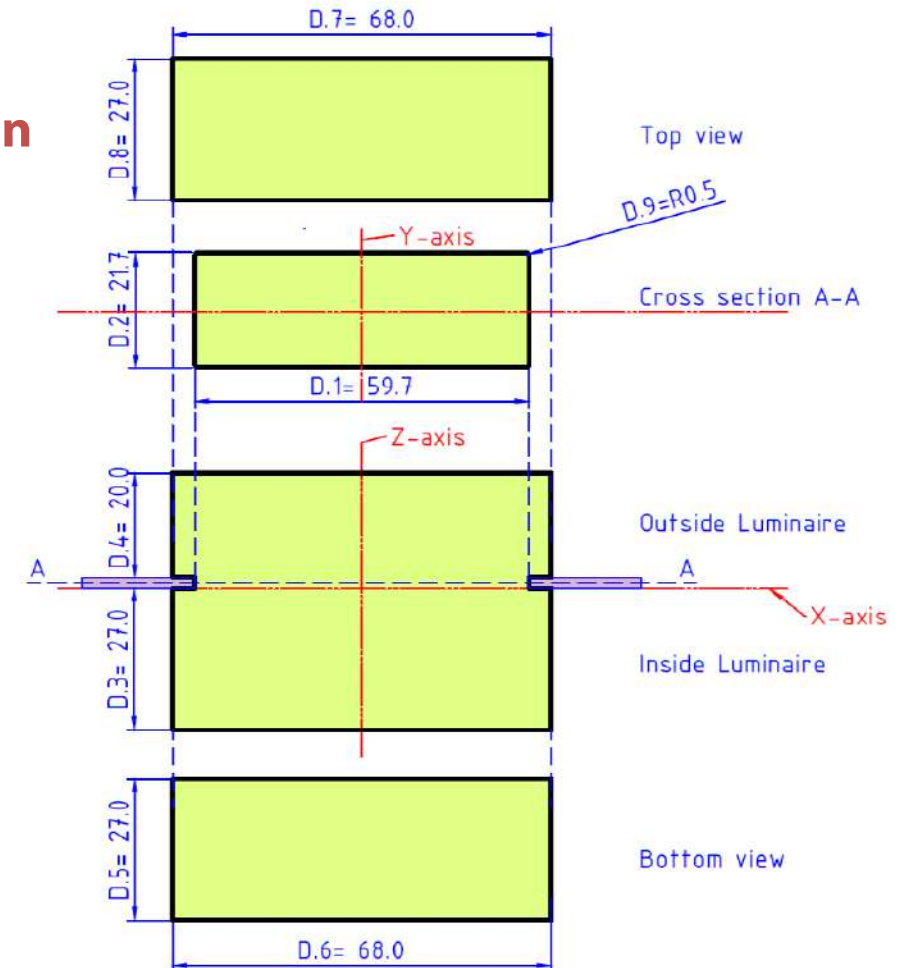
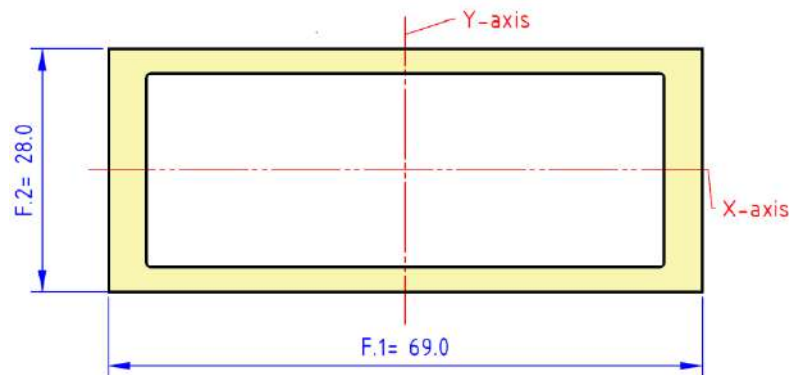
Category R60x22

LEX Module Demarcation

LEX Slot



LEX Slot Border

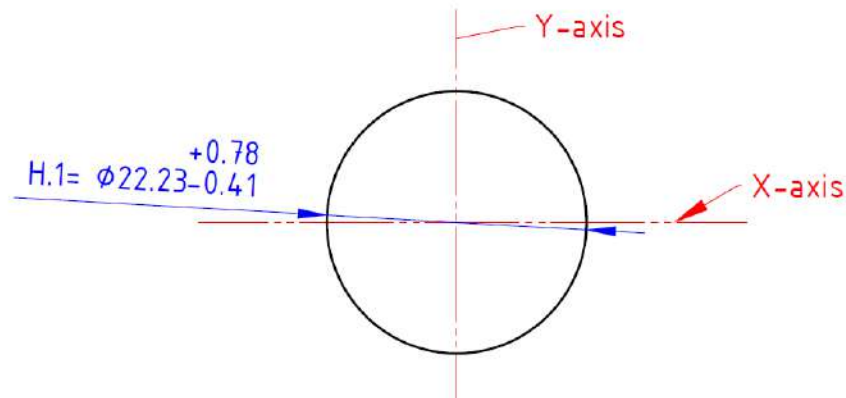


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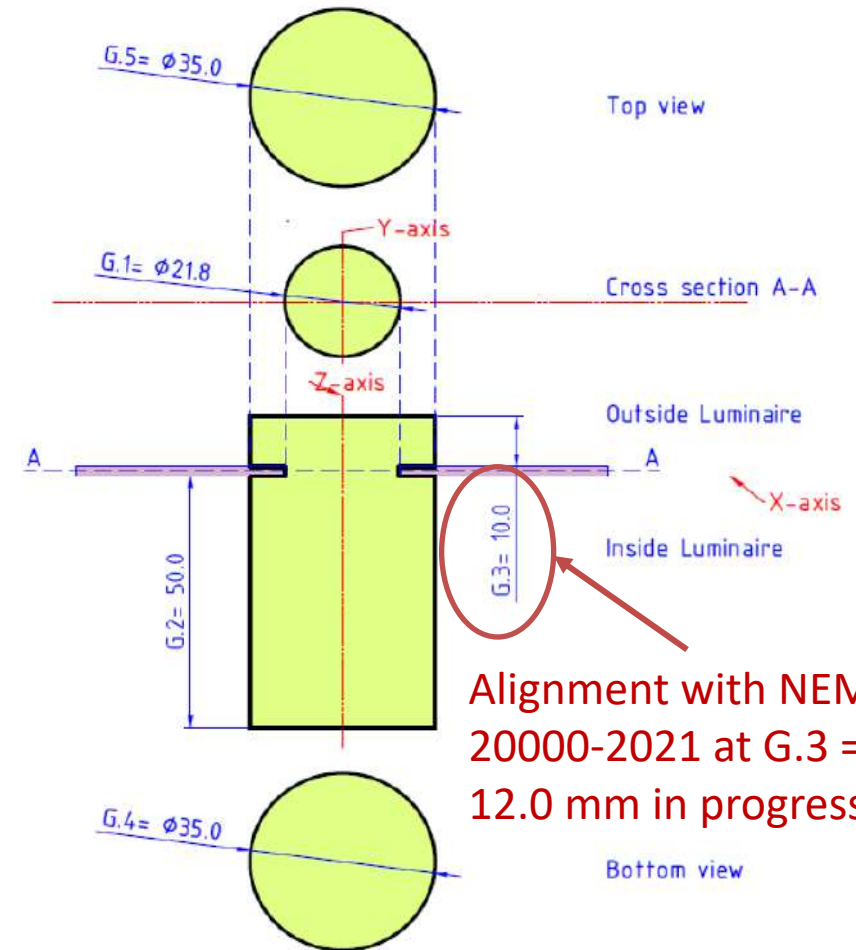
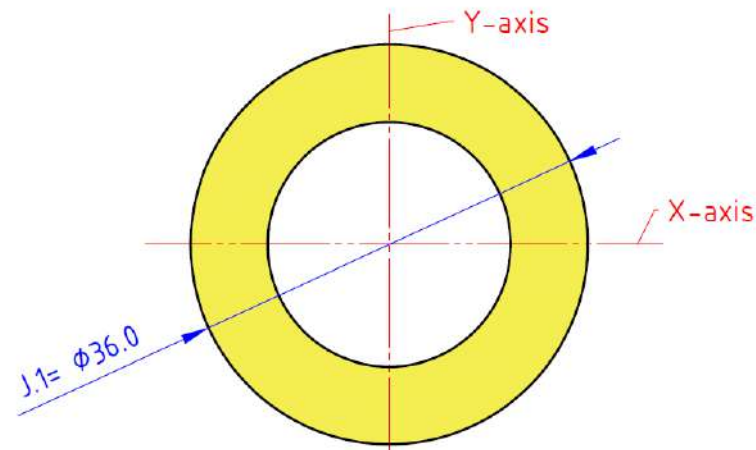
Category C22-T1A

LEX Module Demarcation

LEX Slot



LEX Slot Border



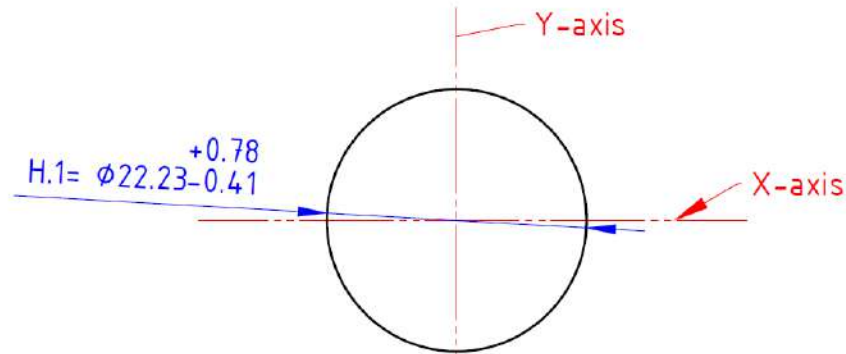
Alignment with NEMA 20000-2021 at $G.3 = 12.0$ mm in progress

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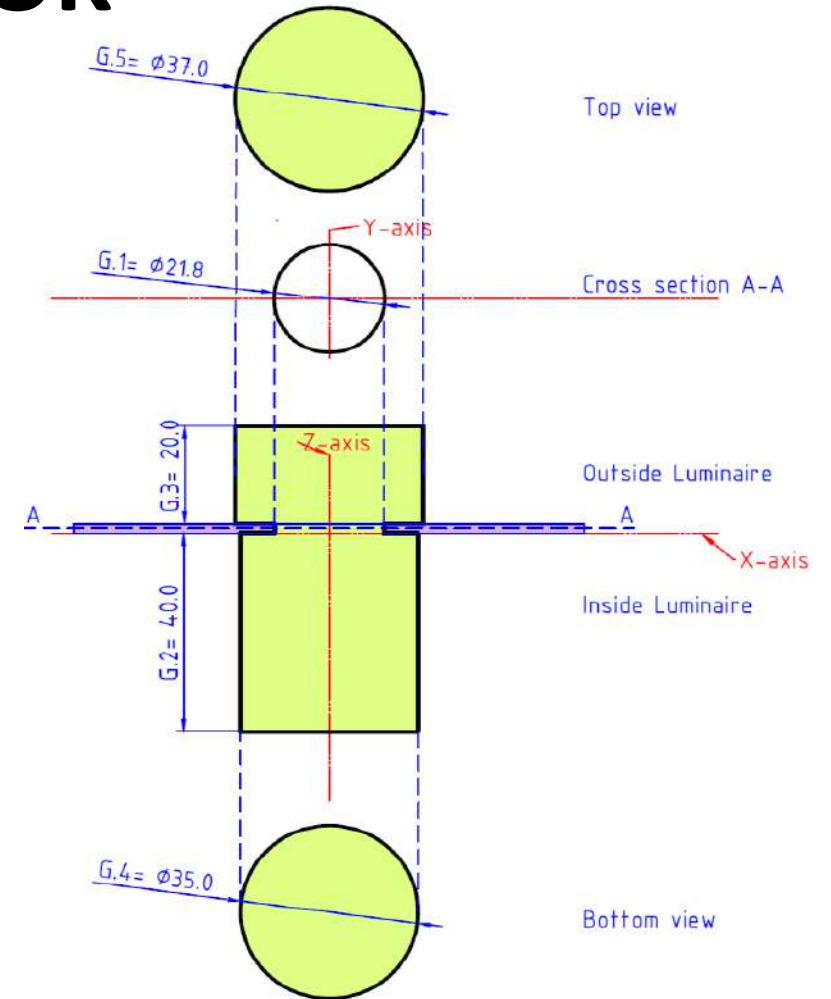
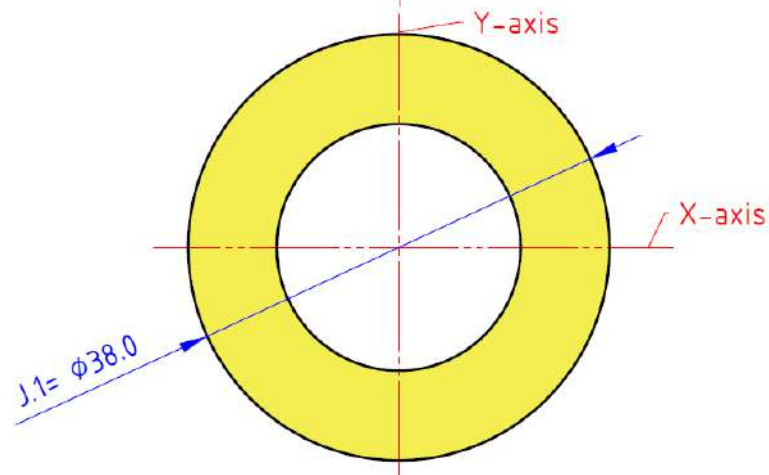
Category C22-T1B

LEX Module Demarcation

LEX Slot



LEX Slot Border

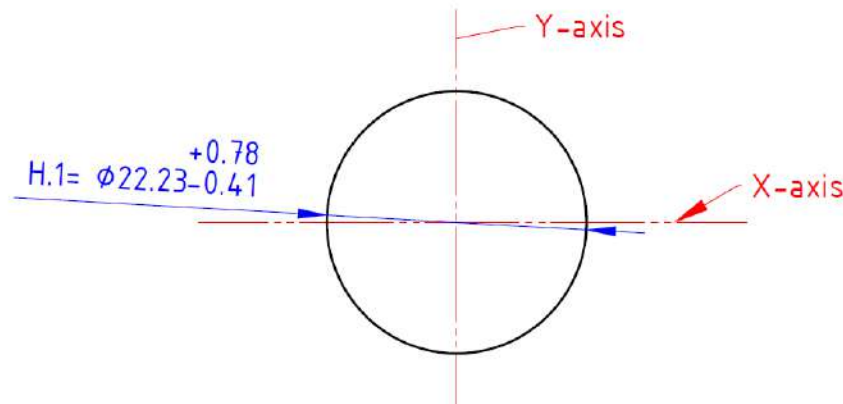


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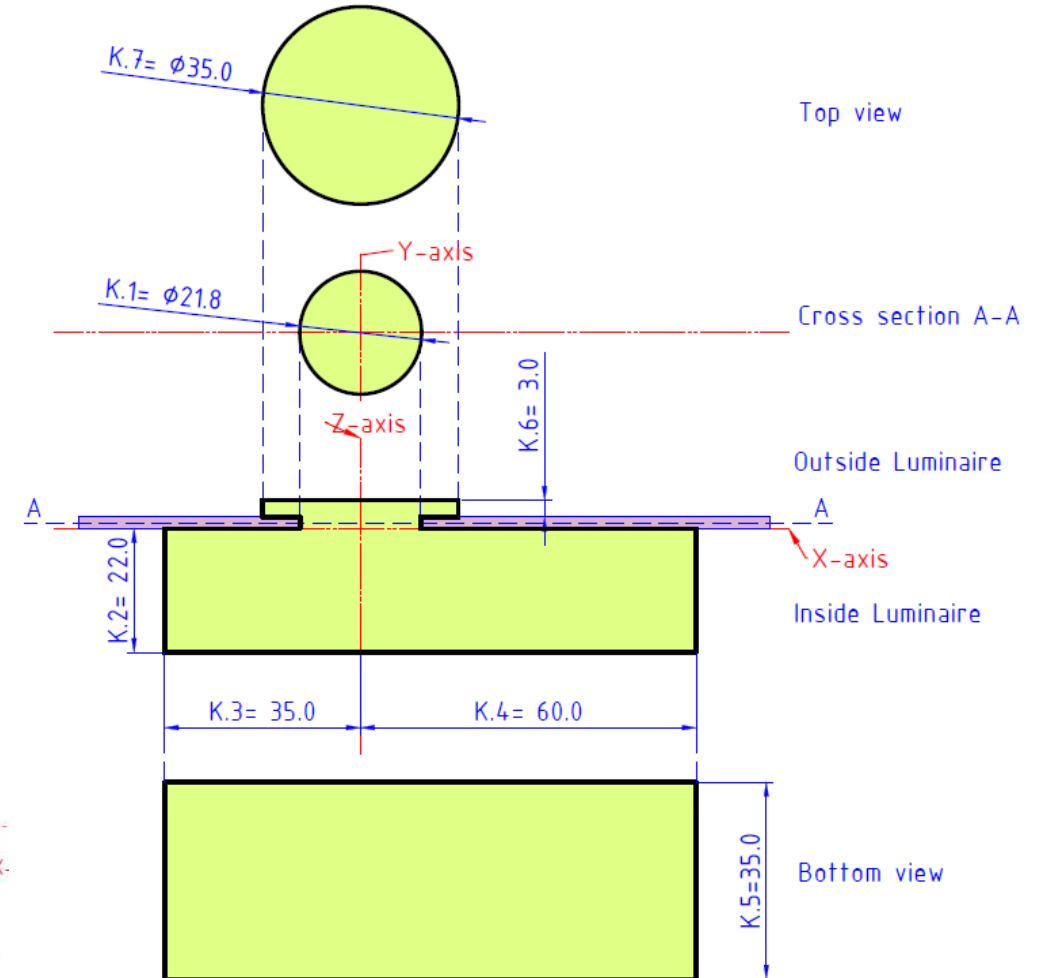
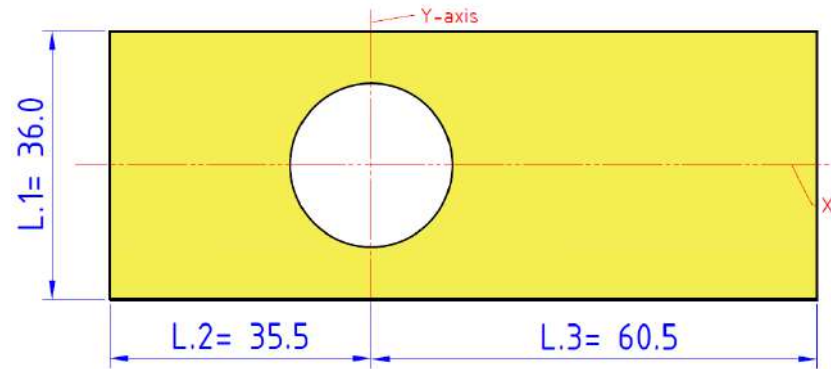
Category C22-T2

LEX Module Demarcation

LEX Slot

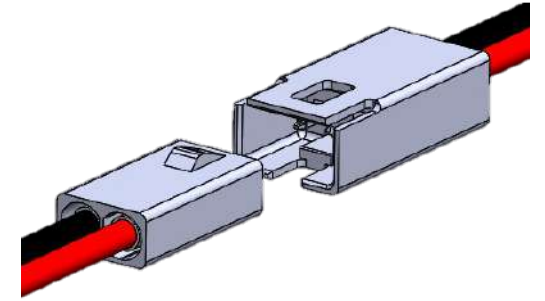


LEX Slot Internal Border*



* LEX Slot external border is the same as category C22-T1A

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Connector Features

Two position plug and receptacle interface

Easy to use separable connection provides reliable DALI connectivity

Poka Yoke features prevent incorrect mating.

Enables connection with polarity ensured

Connector provides finger proof protection

Housing provides touch proof protection for separable contacts

Plug & play functionality can be installed by a generalist

Does not require a specialist to upgrade luminaire functionality

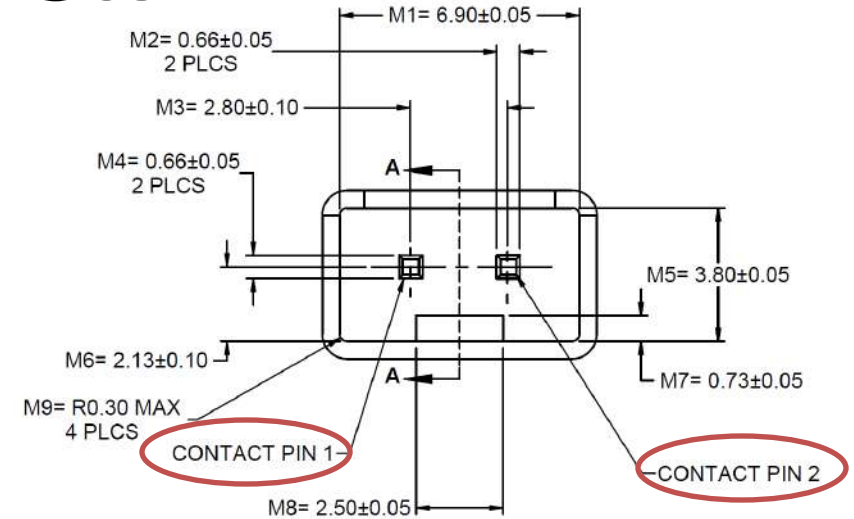
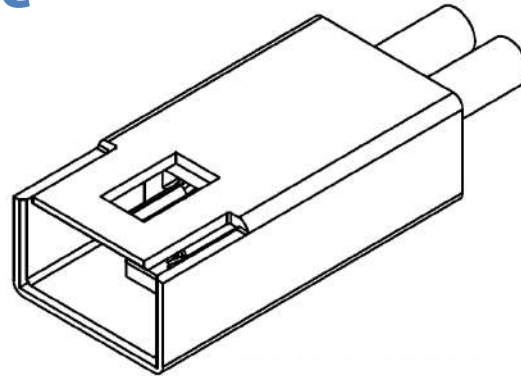
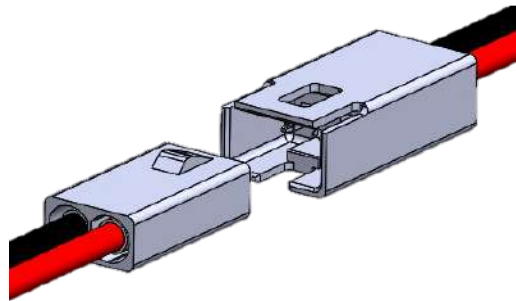
Integrated latch feature provides 5N minimum retention when mated

Slim profile latch ensures that connectors remain intact over its lifetime

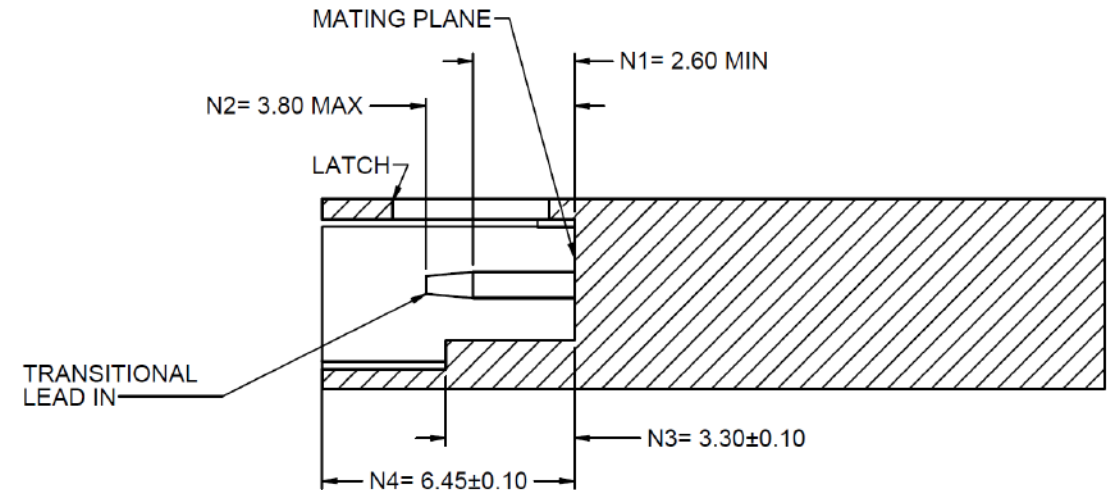
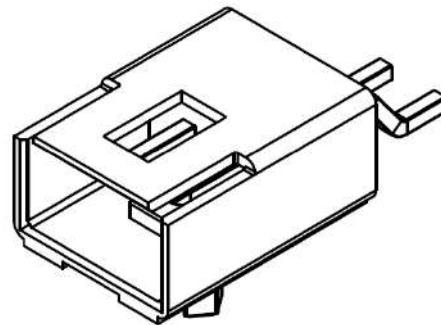
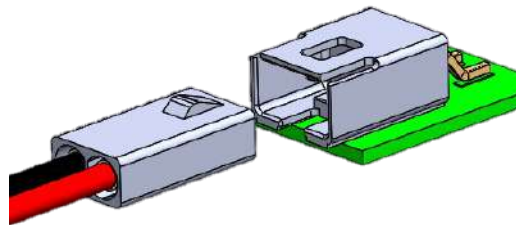
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LEX Module Receptacle

Wire-to-wire

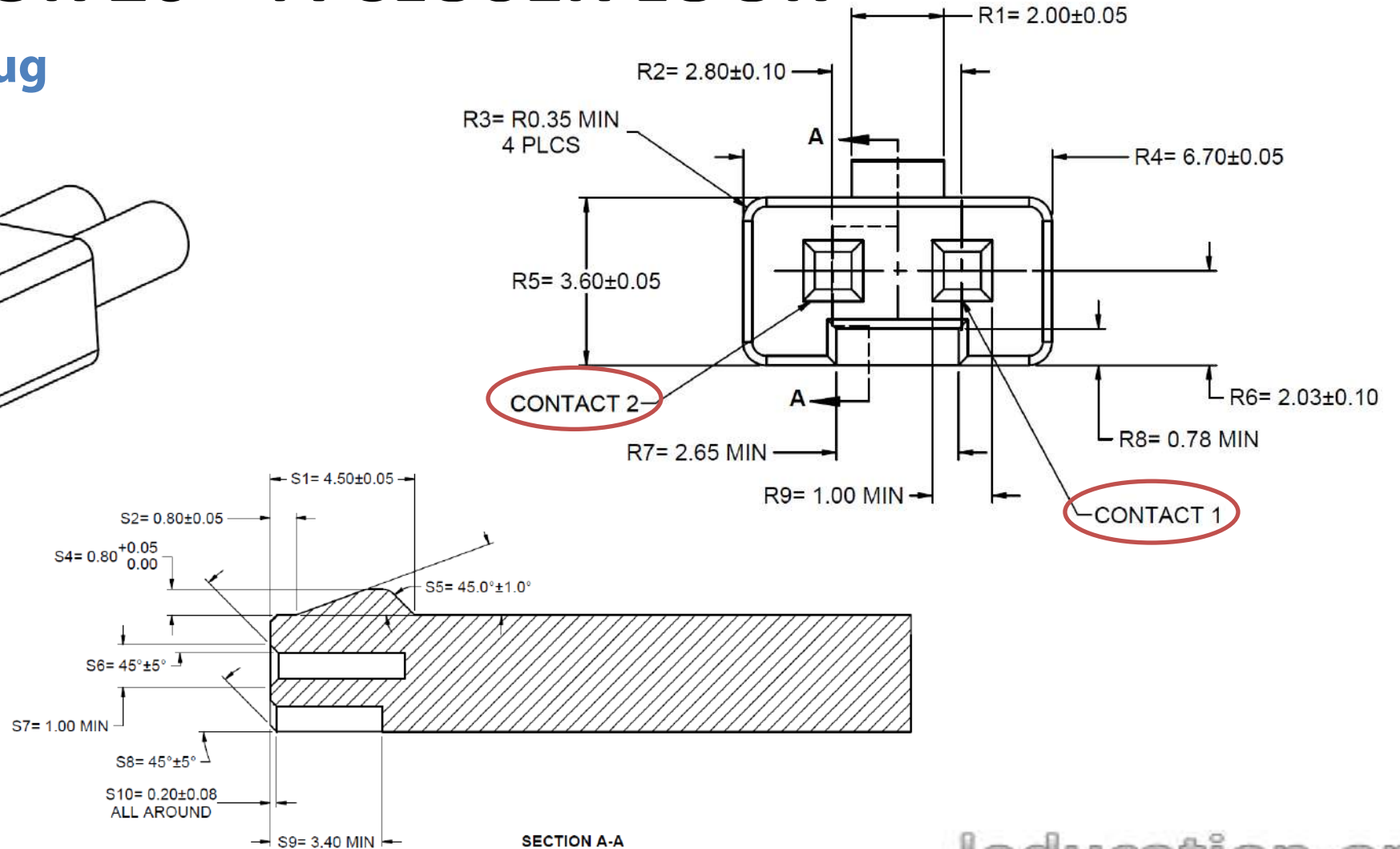
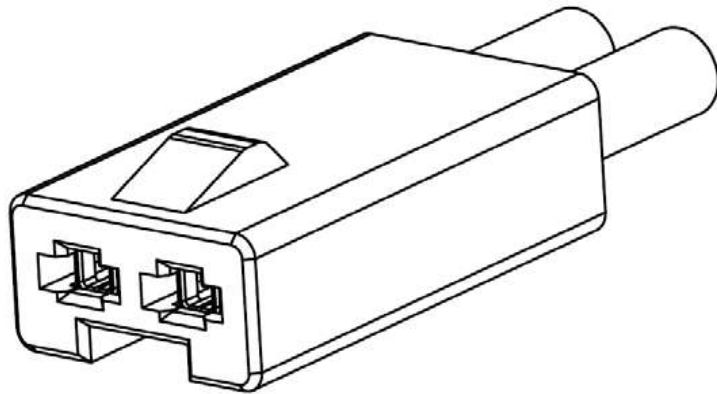


Wire-to-board



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LEX Luminaire Plug



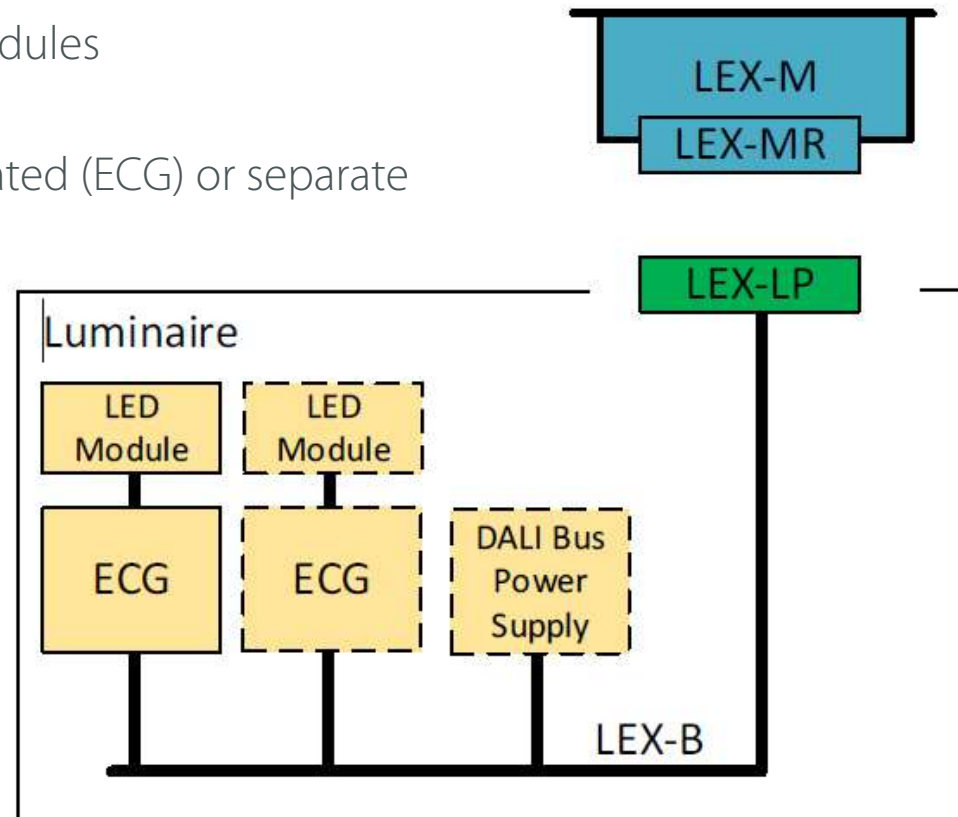
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Electrical & Communication Interface

Luminaire Features

- One to four ECG driving LED modules
- LEX Luminaire Plug
- DALI bus power supply – integrated (ECG) or separate
- Plug-and-Play Interoperability
- Optional multiple sections

Electronic Control Gear
(Drivers)



LEX Bus (cable)

Luminaire Extension (LEX)

LEX Module

LEX Module Receptacle

LEX Luminaire Plug

In edition 1.1 of the specification, the system is restricted to Luminaires without internal DALI application controllers or input devices and to Luminaires that do not provide provisions for connection to an external DALI bus.

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Electrical & Communication Interface

Pin Assignments for LEX Module Receptacle and LEX Luminaire Plug

LEX-MR Contact Number	LEX-LP Contact Number	Assignment
1	1	DA- (Negative pole for the DALI communication and bus power)
2	2	DA+ (Positive pole for the DALI communication and bus power)



Plug-and-Play
with Book 20!!

ZHAGA BOOK 20 – A CLOSER LOOK

Electrical & Communication Interface

DALI Communication & DALI Bus Power

LEX Luminaire Plug

Installed non-emergency ECGs connect to the LEX-B.

No DALI application controllers or DALI input devices as specified in DALI - Part 103

No provisions for connection to an external DALI bus. However, terminals allowing for connection to segments that enable a modular assembly of a luminaire are permitted if there are a maximum of 4 segments connected via DALI, each containing one LED driver.

At the LEX-LP interface, the guaranteed supply current provided shall be at least 48 mA and the maximum supply current shall not exceed 250 mA.

LEX Module

The LEX-M shall meet the requirements for a Type C control device, or a bus powered Type D control device as specified in DALI-part 351 (Luminaire mounted control devices).

The LEX-M shall be listed as D4i certified in the DiiA database.

For additional requirements and information see Book 20

ZHAGA – SDO COLLABORATION

Standards Development Organizations

NEMA

NEMA *Physical Interface of Luminaire-Integrated Control Devices* – Recently published!

Zhaga Book 20 *Smart interface between indoor luminaires and sensing/communication modules*

Zhaga and NEMA cooperated to align their specifications

Collaboration supports **smart homes and buildings**

ANSI ASC C136

ANSI C136.41 *Interface between an External Locking Type Control Device and Ballast or Driver*

ANSI C136.58 *Luminaire Four-Pin Extension Module and Receptacle—Physical and Electrical Interchangeability and Testing*

Book 18 Ed 3.0 *Smart interface between outdoor luminaires and sensing/communication modules*

Zhaga adoption of the ANSI C136.41 interface in Book 18 Ed 3.0 supports outdoor luminaires with hybrid architectures

Collaboration supports **smart cities**

IEC TC 34

Copyright Agreements between Zhaga and IEC

Transfer of Zhaga Books 7, 10, 12, 14, 18 and 20 to TC/SC 34 for maintenance

Collaboration supports **international standardization**

THANK YOU → JOIN ZHAGA!!

Website: <https://www.zhagastandard.org/>

Zhaga creates interface standards for components in LED luminaires

Zhaga interface standards future proof your luminaire through interoperability for connected, serviceable and sustainable lighting

Multiple membership options available

Regular
Associate
Community



Mark Duffy
General Assembly Chair of Zhaga

lightingmd35@gmail.com

This concludes The American Institute of Architects Continuing
Education Systems Course