04/2023

Technical application guide
PrevaLED® Core Z6
LED modules

Zhaga

OSRAM

Contents

Please note:

1 Introduction

1.1 System overview

Building an LED-based luminaire poses a set of technical challenges, among them optical requirements, providing adequate thermal management for stable operation and dealing with the improving performance of LEDs. Nevertheless, LED technology also provides an unknown number of possibilities, opening up unprecedented levels of performance. PrevaLED® Core LED modules, which are compatible with Zhaga Book 3 standards, offer one of the best and easiest ways to outfit luminaires with LED technology.

Focusing on the continuous improvement of performance and costs, we have introduced our new generation of Zhaga spotlight LED modules: PrevaLED® Core Z6. Together with the dedicated on/off and intelligent OPTOTRONIC® LED driver ranges, it offers a complete and reliable system.

Future-proof concept

To allow for a smooth transition to this new generation of the PrevaLED® Core series, crucial features have remained the same:
- Complete portfolio in terms of luminous flux, color temperature and color rendering
- Easy upgrade from Z5 thanks to identical housing
- Same form factor and mechanical/optical interfaces as PrevaLED® Core Z4 Style and Z5
- Compatible with off-the-shelf Zhaga Book 3 accessories
- High driver flexibility allows for cost-effective and intelligent systems
- 5-year guarantee (for more information on system release with our LED drivers, please refer to our website www.inventronics-light.com/oem)
- Selection of dimmable and non-dimmable LED drivers

Of course, important improvements have been realized as well:
- Easy design-in
  - Only one reflector size for 2 000, 3 000 and 5 000 lm with 3 x LES 19
- Lifetime (L80B50) at t_c = 65 °C: 60 000 hours
- Improved poke-in connector for stranded and solid wires
- Very good light quality
- Very high efficiencies for smaller heat sinks and easier thermal management
- Typical module efficacy: up to 160 lm/W
- t_c max: 90 °C
- Thermal protection
  - Thermal derating with OTi
  - Thermal shutdown

Applications

The PrevaLED® Core series of LED modules is ideally suited for use in reflector-based, rotation-symmetric luminaires in applications such as:
- Spotlighting and tracklighting in retail stores
- Downlighting and wall lighting in offices, corridors, meeting rooms and workplaces
- Decorative and functional lighting in the hospitality industry
- High-end museum lighting

1.2 Ordering information

PrevaLED® Core Z6 LED modules

Product reference	Product number (EAN 10)	Product number (EAN 40)	Color temperature [K]	Luminous flux [lm]
PL-CORE-Z6-**2000**-827	4052899**436954**	4052899**436961**	2700	2000
PL-CORE-Z6-**2000**-830	4052899**436978**	4052899**436985**	3000	2000
PL-CORE-Z6-**2000**-835	4052899**436992**	4052899**437005**	3500	2000
PL-CORE-Z6-**2000**-840	4052899**437012**	4052899**437029**	4000	2000
PL-CORE-Z6-**2000**-930	4052899**437036**	4052899**437043**	3000	2000
PL-CORE-Z6-**2000**-940	4052899**437050**	4052899**437067**	4000	2000
PL-CORE-Z6-**3000**-827	4052899**437074**	4052899**437081**	2700	3000
PL-CORE-Z6-**3000**-830	4052899**437098**	4052899**437104**	3000	3000
PL-CORE-Z6-**3000**-835	4052899**437111**	4052899**437128**	3500	3000
PL-CORE-Z6-**3000**-840	4052899**437135**	4052899**437142**	4000	3000
PL-CORE-Z6-**3000**-930	4052899**437159**	4052899**437166**	3000	3000
PL-CORE-Z6-**3000**-940	4052899**437173**	4052899**437180**	4000	3000
PL-CORE-Z6-**5000**-827	4052899**437197**	4052899**437203**	2700	5000
PL-CORE-Z6-**5000**-830	4052899**437210**	4052899**437227**	3000	5000
PL-CORE-Z6-**5000**-835	4052899**437234**	4052899**437241**	3500	5000
PL-CORE-Z6-**5000**-840	4052899**437258**	4052899**437265**	4000	5000
PL-CORE-Z6-**5000**-930	4052899**437272**	4052899**437289**	3000	5000
PL-CORE-Z6-**5000**-940	4052899**437319**	4052899**437326**	4000	5000

1.3 Nomenclature
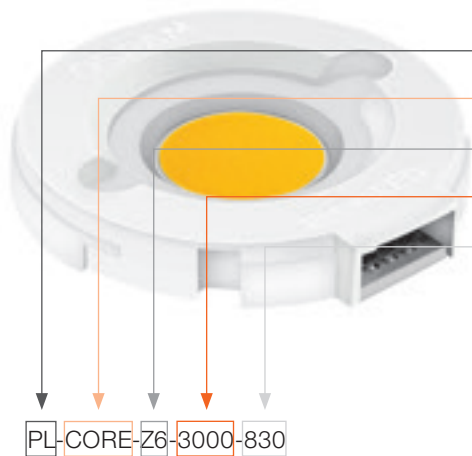
PL: PrevaLED® LED module

CORE: Round LED module

Z6: Generation 6

3000: 3000 lm

830: Color rendering index (CRI) + color temperature (CCT) = >80 + 3000 K

PL-CORE-Z6-3000-830

2 Optical considerations

2.1 Light distribution
The light distribution of the LED module is shown in the graph below. PrevaLED® Core Z6 LED modules create a beam angle of 114° FWHM (full width at half maximum).
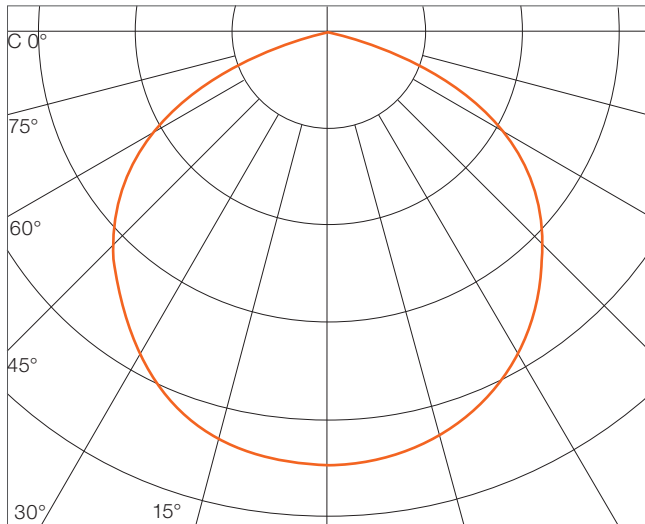
2.2 Reflector design
High luminances are the key factor for LED-based lamps and luminaires in the area of reflector applications, such as spotlights. For this purpose, light sources with small light-emitting surfaces and a high luminous flux – as realized in the PrevaLED® Core Z6 – are required, because in such combinations, the light can be collimated particularly well with reflectors.

The PrevaLED® Core Z6 is equipped with a surface that emits light evenly and makes the use of diffuser materials unnecessary due to its high level of homogeneity. The minimized light-emitting surface (LES) and a positioning of the reflector close to the LES allow for an improved optical handling. Generally, the properties of the PrevaLED® Core Z6 help to avoid roughness and facets, allowing for very small total beam angles of 10° or less.

We provide mechanical (3D files) and optical simulation data (ray files) to support customized reflector designs. Ray file data and mechanical files are available for download via the "Tools & Services" portal at www.inventronics-light.com.

2.3 Photobiological safety
According to IEC/EN 62471, all PrevaLED® Core Z6 LED modules are within risk group (RG) 1 at their nominal operating conditions.

Notes:
For the PL-CORE Z6-5000-840 module, the photobiological safety class RG 1 might not be achieved when using a significantly higher current than the nominal module current. This may result in risk group classifications up to RG 2

To avoid any adverse effects on sensitive materials, it is recommended to consider the distance between the LED light source and the illuminated object, depending on the light intensity of the LED source. If in doubt, material compatibility checks should be conducted.

2.4 Theoretical considerations for possible reflectors

PrevaLED® Core Z6, 2000 lm, LES 19, OCA C*

Reflector height [mm]	Reflector output diameter [mm]			
	80	100	120	140
100		15°; 17000 cd; 88 %; 4200 lx; 8.4 cd/lm	12°; 22000 cd; 89 %; 5600 lx; 11.2 cd/lm	11°; 28000 cd; 90 %; 7100 lx; 14.3 cd/lm
80		15°; 16000 cd; 89 %; 3900 lx; 7.9 cd/lm	12°; 21000 cd; 91 %; 5200 lx; 10.4 cd/lm	10°; 25000 cd; 92 %; 6400 lx; 12.8 cd/lm
60	19°; 10000 cd; 90 %; 2600 lx; 5.2 cd/lm	15°; 14000 cd; 91 %; 3500 lx; 7.0 cd/lm	12°; 18000 cd; 93 %; 4400 lx; 8.9 cd/lm	10°; 21000 cd; 94 %; 5200 lx; 10.5 cd/lm
40	19°; 8000 cd; 93 %; 2100 lx; 4.2 cd/lm	14°; 11000 cd; 95 %; 2600 lx; 5.3 cd/lm	11°; 12000 cd; 96 %; 3100 lx; 6.1 cd/lm	8°; 13000 cd; 97 %; 3300 lx; 6.5 cd/lm

PrevaLED® Core Z6, 3000 lm, LES 19, OCA C*

Reflector height [mm]	Reflector output diameter [mm]			
	80	100	120	140
100		15°; 25000 cd; 88 %; 6300 lx; 8.4 cd/lm	12°; 34000 cd; 89 %; 8400 lx; 11.2 cd/lm	11°; 43000 cd; 90 %; 10700 lx; 14.3 cd/lm
80		15°; 24000 cd; 89 %; 5900 lx; 7.9 cd/lm	12°; 31000 cd; 91 %; 7800 lx; 10.4 cd/lm	10°; 38000 cd; 92 %; 9600 lx; 12.8 cd/lm
60	19°; 16000 cd; 90 %; 3900 lx; 5.2 cd/lm	15°; 21000 cd; 91 %; 5200 lx; 7.0 cd/lm	12°; 27000 cd; 93 %; 6600 lx; 8.9 cd/lm	10°; 32000 cd; 94 %; 7900 lx; 10.5 cd/lm
40	19°; 13000 cd; 93 %; 3100 lx; 4.2 cd/lm	14°; 16000 cd; 95 %; 4000 lx; 5.3 cd/lm	11°; 18000 cd; 96 %; 4600 lx; 6.1 cd/lm	8°; 20000 cd; 97 %; 4900 lx; 6.5 cd/lm

PrevaLED® Core Z6, 5000 lm, LES 19, OCA C*

Reflector height [mm]	Reflector output diameter [mm]			
	80	100	120	140
100		15°; 42500 cd; 88 %; 10500 lx; 8.4 cd/lm	12°; 55000 cd; 89 %; 14000 lx; 11.2 cd/lm	11°; 70000 cd; 90 %; 17750 lx; 14.3 cd/lm
80		15°; 40000 cd; 89 %; 9750 lx; 7.9 cd/lm	12°; 42500 cd; 91 %;13000 lx; 10.4 cd/lm	10°; 62500 cd; 92 %; 16000 lx; 12.8 cd/lm
60	19°; 25000 cd; 90 %; 6500 lx; 5.2 cd/lm	15°; 35000 cd; 91 %; 8750 lx; 7.0 cd/lm	12°; 45000 cd; 93 %; 11000 lx; 8.9 cd/lm	10°; 52500 cd; 94 %; 13000 lx; 10.5 cd/lm
40	19°; 20000 cd; 93 %; 5250 lx; 4.2 cd/lm	14°; 27500 cd; 95 %; 6500 lx; 5.3 cd/lm	11°; 30000 cd; 96 %; 7750 lx; 6.1 cd/lm	8°; 32500 cd; 97 %; 8250 lx; 6.5 cd/lm

* Parabolic reflector, 85 % specular reflectance, lux in 2 m distance

The above-mentioned estimations are based on the following assumptions:

— A parabolic reflector shape is used.
— A fine facet structure is applied as it should always be used for CoB LEDs. The impact on the narrowest possible beam angle is small.
— A purely specular reflectance of 85 % is assumed.
— The collimation strength values (cd/lm) refer to the luminous flux of the LED module.
— Data values in orange correspond to a reflector with an extremely large diameter/height ratio D/H > 2 (cut-off angle > 45°). This is not recommended with respect to glare.
— Illuminance values are the maximum values in the spot center in a distance of 2 m to the reflector.

The PrevaLED® Core Z6 can be used with secondary optics. Zhaga-compliant off-the-shelf solutions can be used with the LED module. Support for optics can be found, for example, at the following suppliers:

ACL-Lichttechnik GmbH
Hans-Boeckler-Strasse 38 A
40764 Langenfeld, Germany
+49 2173 9753 0
info@reflektor.com
www.reflektor.com

Almeco S.p.A.
Via della Liberazione, 15
20098 San Giuliano Milanese (Mi), Italy
+39 02 988963 1
info.it@almecogroup.com
www.almecogroup.com

Ledil Oy
Salorankatu 10,
24240 Salo, Finland
+358 2 7333804
ledil@ledil.com
www.ledil.com

Jordan Luxar GmbH & Co. KG
Schneiderstrasse 76
40764 Langenfeld, Germany
+49 2173 279 0
sales@jordan-luxar.de
www.jordan-luxar.de

Jordan Reflektoren GmbH & Co. KG
Schwelmer Strasse 161
42389 Wuppertal, Germany
+49 202 60720
info@jordan-reflektoren.de
www.jordan-reflektoren.de

Nata Lighting Co., Ltd.
380 Jin Ou Road, Jiang Hai District
Jiang Men City, Guangdong, China
+86 750 377 0000
info@nata.cn
www.nata.cn

Widegerm Lighting Ltd.
Flat A, 3/F., Tak Wing Ind. Building
3 Tsun Wen Rd., Tuen Mun, N.T., Hong Kong
+85 224 655 679
henry@widegerm.com.hk
www.widegerm.com.hk

2.5 Reflector mounting

The LED modules have a clearly defined optical contact area (OCA), which provides a defined surface for attaching the reflector. In this configuration, the mounting and mechanical support of the reflector must be ensured by the luminaire body or by suitable structures for reflector mounting.

The following has to be considered when mounting the reflector: Due to the creepage and clearance distances specified in the norm (IEC 61347-1/U935, among others),

Allowed compression: 20 N
Allowed tension: 20 N
Allowed torque: 1 Nm

it is recommended to stay within the OCA values of the corresponding category (see product datasheet). Additionally, a bayonet base option is provided, with the help of which the reflector can be attached directly to the PrevaLED® Core Z6.

PrevaLED® Core Z6 3D files including the bayonet base for design-in and an exemplary reflector compatibility overview are available at www.inventronics-light.com.

2.6 Color temperature

The PrevaLED® Core Z6 series is currently available in 2 700 K, 3 000 K, 3 500 K and 4 000 K. The color coordinates within the CIE 1931 color space are given below.

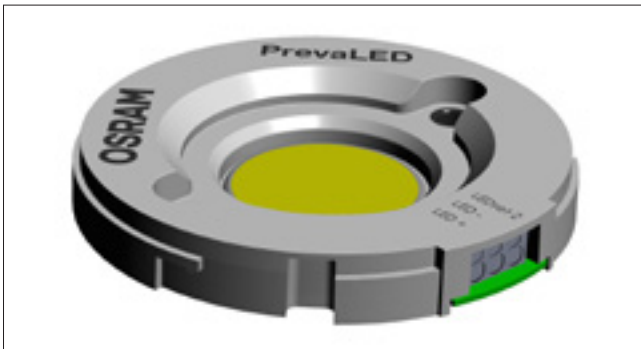|	2700 K	3000 K	3500 K	4000 K
Cx	0.4579	0.4339	0.4077	0.3823
Cy	0.4092	0.4020	0.3908	0.3790

Values measured at $t_p = 65\,°C$

Within each available color temperature, the PrevaLED® Core Z6 series provides a maximum color variation of three threshold value units (MacAdam steps). The following diagram shows these threshold values within the CIE 1931 color space.

Chromaticity coordinate groups:

Chromaticity coordinates are measured during a current pulse of typically 25 ms, with an internal reproducibility of ±0.005 and an expanded uncertainty of ±0.01 (acc. to GUM with a coverage factor of k = 3). For testing, the chromaticity coordinate ellipses are approximated with polygons.

## 2.7 Color rendering

PrevaLED® Core Z6 LED modules provide a color rendering index (CRI) of either > 80 or > 90. The table below shows the individual R_a values from R1 to R14 for the available color temperatures.

R_a values (average guiding values for reference only)

	Dusky pink	Mustard yellow	Yellowish green	Light green	Turquois	Azure	Aster violet	Lilac violet	Red, saturated	Yellow, saturated	Green, saturated	Blue, saturated	Pink, skin color	Leaf green	General CRI	FCI	TM30	TM30
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R_a		R_f	R_g
CCT = 2700 K	80	91	96	80	81	90	82	57	6	80	79	77	83	98	82	107	83	97
CCT = 3000 K	81	91	97	81	81	88	82	61	10	78	80	73	83	99	83	106	84	96
CCT = 3500 K	81	90	96	81	81	86	85	62	8	76	80	68	83	98	83	103	82	96
CCT = 4000 K	80	88	94	82	81	84	86	65	8	72	80	63	82	97	82	100	82	96
CCT = 3000 K	97	97	94	96	96	96	96	92	80	91	96	86	97	96	96	121	93	102
CCT = 4000 K	94	94	91	94	93	90	95	91	75	83	93	75	94	95	93	114	91	101

2.8 Spectral distribution

The typical spectral distribution of the PrevaLED® Core Z6 LED modules is shown in the following diagram.

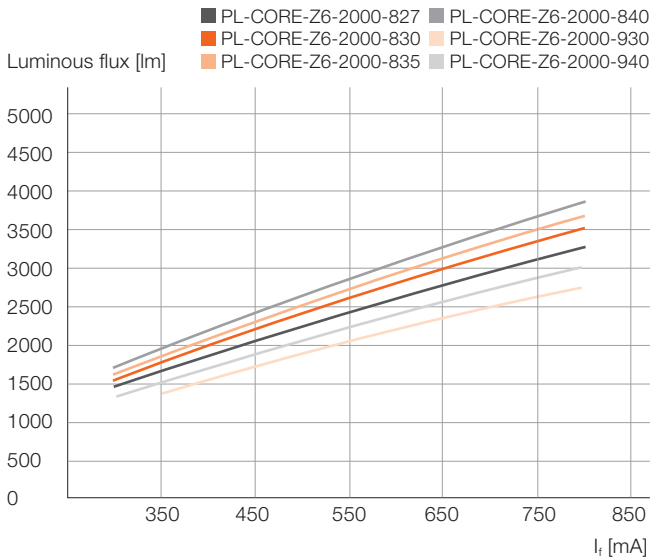Relative luminous intensity   827 830 835 840 930 940
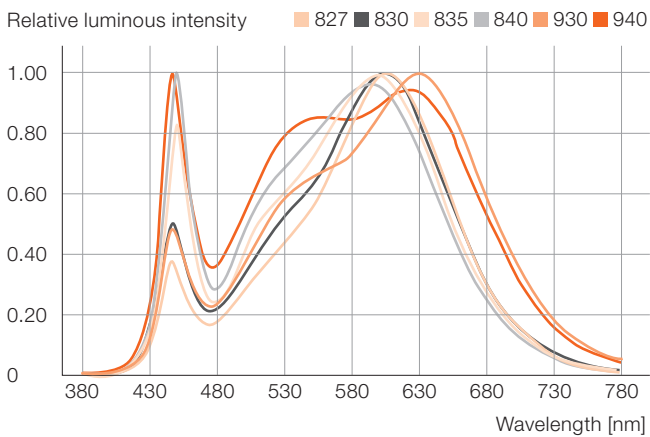
Values measured at t_p = 65 °C

2.9 Luminous flux behavior

The following diagrams show the luminous flux as a function of the operating current for PrevaLED® Core Z6 LED modules with 2 000, 3 000 and 5 000 lm. Data related to the operating current is derived from a t_p temperature of 65 °C.
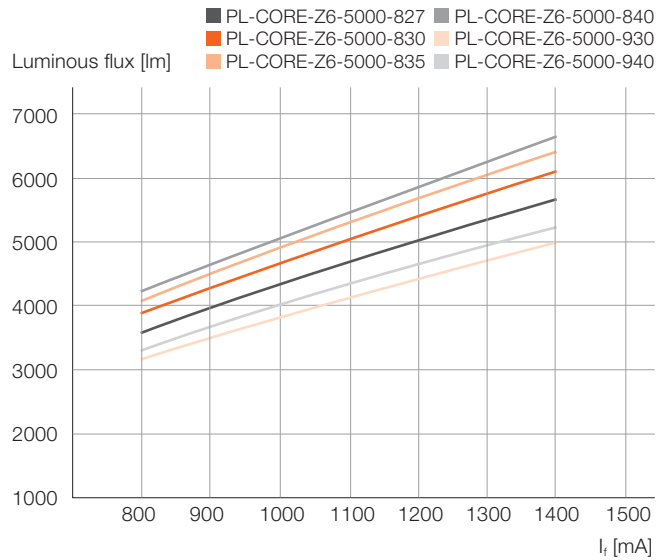
PL-CORE-Z6-2000-XXX
Luminous flux as a function of forward current (I_f)

■ PL-CORE-Z6-2000-827	■ PL-CORE-Z6-2000-840
■ PL-CORE-Z6-2000-830	■ PL-CORE-Z6-2000-930
■ PL-CORE-Z6-2000-835	■ PL-CORE-Z6-2000-940

Luminous flux [lm]

I_f [mA]

PL-CORE-Z6-5000-XXX
Luminous flux as a function of forward current (I_f)

■ PL-CORE-Z6-5000-827	■ PL-CORE-Z6-5000-840
■ PL-CORE-Z6-5000-830	■ PL-CORE-Z6-5000-930
■ PL-CORE-Z6-5000-835	■ PL-CORE-Z6-5000-940

Luminous flux [lm]

I_f [mA]

PL-CORE-Z6-3000-XXX
Luminous flux as a function of forward current (I_f)

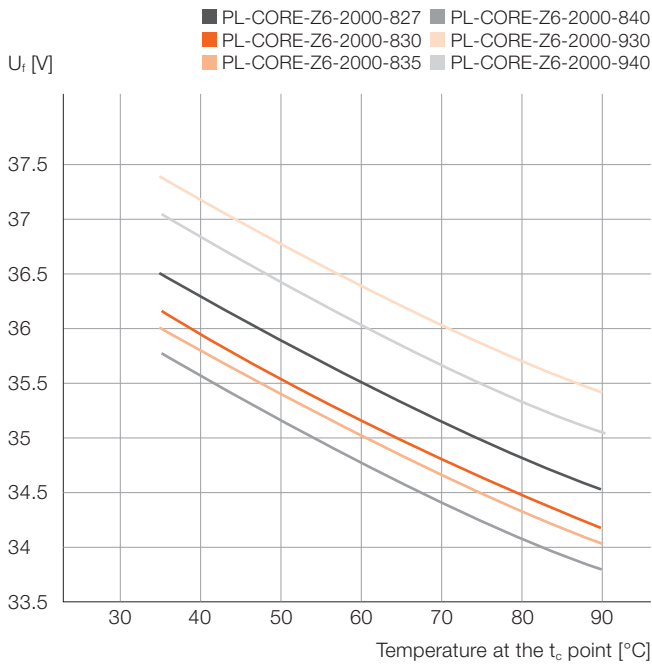| ■ PL-CORE-Z6-3000-827	■ PL-CORE-Z6-3000-840
■ PL-CORE-Z6-3000-830	■ PL-CORE-Z6-3000-930
■ PL-CORE-Z6-3000-835	■ PL-CORE-Z6-3000-940

Luminous flux [lm]

I_f [mA]
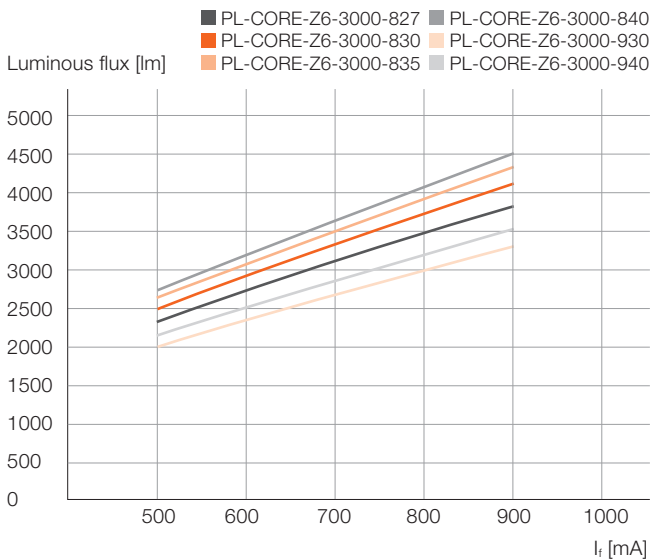
3 Electrical considerations

3.1 Forward voltage as a function of temperature

PL-CORE-Z6-2000-XXX
Forward voltage (U_f) as a function of temperature at the t_c point

■ PL-CORE-Z6-2000-827 ■ PL-CORE-Z6-2000-840
■ PL-CORE-Z6-2000-830 ■ PL-CORE-Z6-2000-930
■ PL-CORE-Z6-2000-835 ■ PL-CORE-Z6-2000-940

U_f [V]

Temperature at the t_c point [°C]

PL-CORE-Z6-5000-XXX
Forward voltage (U_f) as a function of temperature at the t_c point

■ PL-CORE-Z6-5000-827 ■ PL-CORE-Z6-5000-840
■ PL-CORE-Z6-5000-830 ■ PL-CORE-Z6-5000-930
■ PL-CORE-Z6-5000-835 ■ PL-CORE-Z6-5000-940

U_f [V]

Temperature at the t_c point [°C]
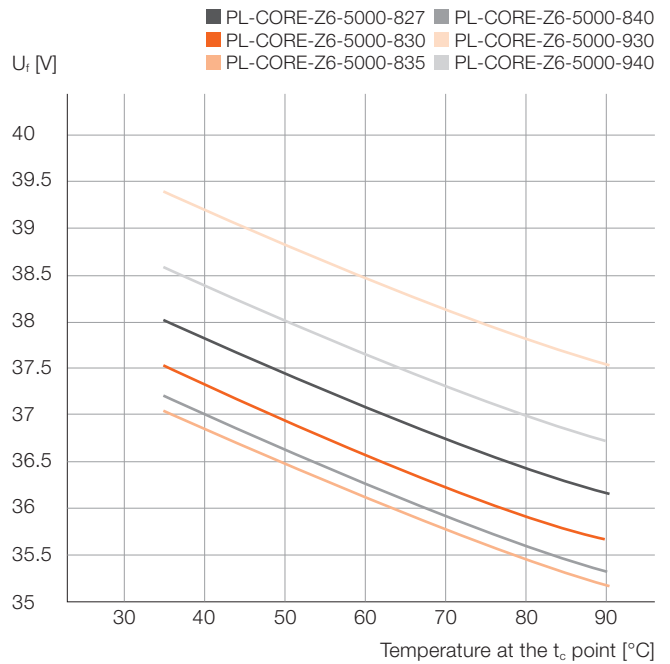
PL-CORE-Z6-3000-XXX
Forward voltage (U_f) as a function of temperature at the t_c point

■ PL-CORE-Z6-3000-827 ■ PL-CORE-Z6-3000-840
■ PL-CORE-Z6-3000-830 ■ PL-CORE-Z6-3000-930
■ PL-CORE-Z6-3000-835 ■ PL-CORE-Z6-3000-940

U_f [V]

Temperature at the t_c point [°C]
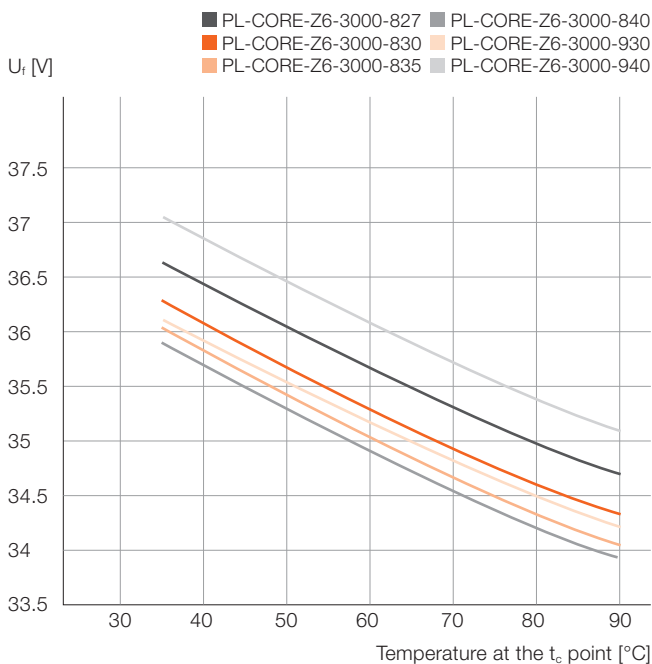
3.2 LED driver/LED module combination

PrevaLED® Core Z6 LED modules can either be used with non-dimmable or intelligent, dimmable OSRAM LED drivers (e.g. OTi DALI).

Please refer to the matrix table below for a quick OSRAM LED driver/LED module combination check:
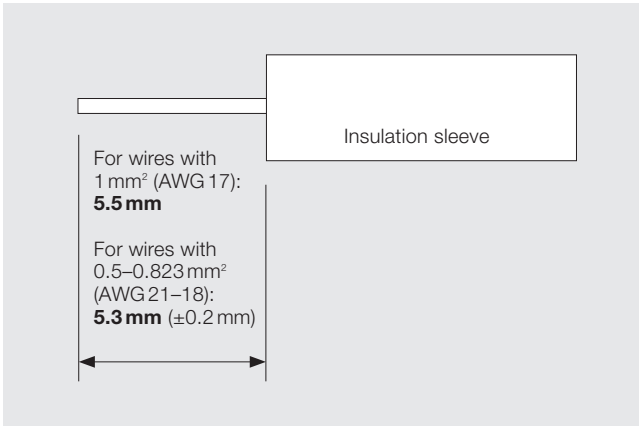
LED driver/LED module combination

	Current setting [mA]	PL-CORE-Z6-2000-827	PL-CORE-Z6-2000-830	PL-CORE-Z6-2000-835	PL-CORE-Z6-2000-840	PL-CORE-Z6-2000-930	PL-CORE-Z6-2000-940	PL-CORE-Z6-3000-827	PL-CORE-Z6-3000-830	PL-CORE-Z6-3000-835	PL-CORE-Z6-3000-840	PL-CORE-Z6-3000-930	PL-CORE-Z6-3000-940	PL-CORE-Z6-5000-827	PL-CORE-Z6-5000-830	PL-CORE-Z6-5000-835	PL-CORE-Z6-5000-840	PL-CORE-Z6-5000-930	PL-CORE-Z6-5000-940
OTe 25/220-240/420 CS	290	■	■	■	■	■	■	■	■	■	■	■	■						
	350	■	■	■	■	■	■	■	■	■	■	■	■						
	420	■	■	■	■	■	■	■	■	■	■	■	■						
OTe 35/220-240/700 CS	500							■	■	■	■	■	■						
	600							■	■	■	■	■	■						
	700							■	■	■	■	■	■						
OTe 50/220-240/1A0 CS	800	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	925													■	■	■	■	■	■
	1050													■	■	■	■	■	■
OTi DALI 15/220-240/1A0 LT2		■	■	■	■														
OTi DALI 25/220-240/700 LT2		■	■	■		■	■	■	■	■	■								
OTi DALI 35/220-240/1A0 LT2												■	■						
OTi DALI 50/220-240/1A4 LT2 FAN														■	■	■	■	■	■
OT FIT 15/220-240/500 LT2 S			■	■	■														
OT FIT 25/220-240/700 LT2 S		■				■	■	■	■	■	■								
OT FIT 40/220-240/1A0 LT2 S												■	■	■	■	■	■	■	■
OT FIT 20/220-240/500 CS	250		■	■	■	■	■	■											
	350	■	■	■	■	■	■	■											
	450	■	■	■	■	■	■	■											
	500	■	■	■	■	■	■	■											
OT FIT 30/220-240/700 CS	500	■	■	■	■	■	■	■	■	■	■	■	■						
	600	■	■	■	■	■	■	■	■	■	■	■	■						
	650	■	■	■	■	■	■	■	■	■	■	■	■						
	700	■	■	■	■	■	■	■	■	■	■	■	■						
OT FIT 40 /220-240/1A0 CS	800	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■
	900							■	■	■	■	■	■	■	■	■		■	■
	950													■	■	■		■	■
	1050													■	■	■		■	■
Element 15/220–240/350		■	■	■	■	■													
Element 20/220–240/500								■	■	■	■	■							
Element 30/220–240/700														■	■	■	■	■	■

3.3 Wiring

PrevaLED® Core Z6 LED modules are equipped with a three-terminal "poke-in" connector. The input clamps used in PrevaLED® Core Z6 can handle solid wires with a cross section of 0.5 – 1.0 mm² (AWG 21-17).

Example: H05V-U 1x 0.5 mm²

Wire preparation

Insulation sleeve

For wires with 1 mm² (AWG 17): **5.5 mm**

For wires with 0.5–0.823 mm² (AWG 21–18): **5.3 mm** (±0.2 mm)

Please note:

— The connector is designed for three "poke-in" and release cycles.
— The installation of LED modules has to be carried out in compliance with all applicable electrical and safety standards. Only qualified personnel should be allowed to perform installations.
— If you cannot use solid wires, you can use stranded wires with a diameter of 0.5 to 0.75 mm and tin-coat the wire ends before inserting them into the connection clamp. Depending on the wire and/or cable type, other suitable preparations may also be necessary (e.g. cable end contacts).
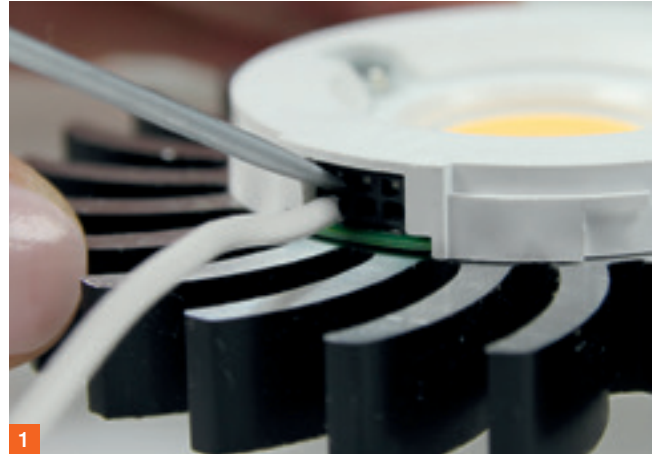
Insert and release

Insert

Insert wire directly

Release

1 Use a suitable screwdriver and push gently into the release hole

**2** Push in the screwdriver below the release spring

3 Pull out the wire and afterwards the screwdriver

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3.4 OTi DALI LED drivers

If you use the PrevaLED® Core Z6 series in combination with the OSRAM OTi DALI LED driver series, you will get the best results and the full functionality of the LED module.

The system includes a one-wire communication interface, using the LEDset2 communication standard between the LED driver and the LED module. A thermal derating and a luminous flux calibration are included. Therefore, please connect all three terminals of the LED module to the LED driver.

Connection detail
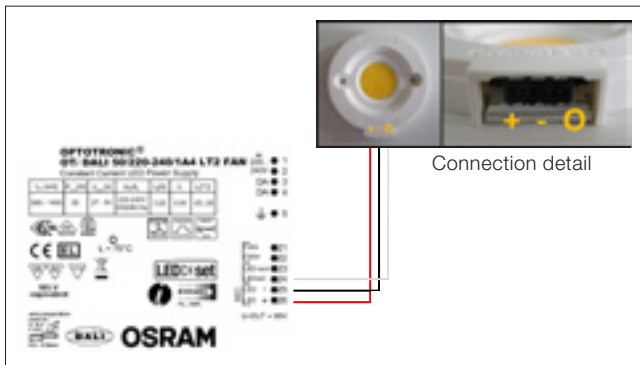
OTi DALI 50/220-240/1A4 LT2 FAN

3.6 OTe LED drivers

If you want to use the OSRAM OTe series, please connect the terminal LED+ to the LED module and select the desired current by connecting it to only one of the output terminals 21, 22 or 23.

Connection detail

Select only one connection terminal
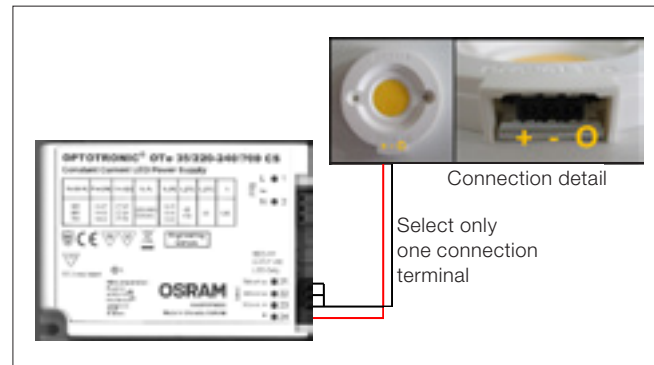
OTe 35/220-240/700 CS

3.5 OT FIT LED drivers

It is also possible to use the PrevaLED® Core Z6 series with a constant-current LED driver. The OT FIT series offers different available currents. To wire the LED module to the LED driver, please connect the terminals LED+ and LED- to the LED module as shown in the image below. The current is selected by a DIP switch (four different current settings possible).

Connection detail
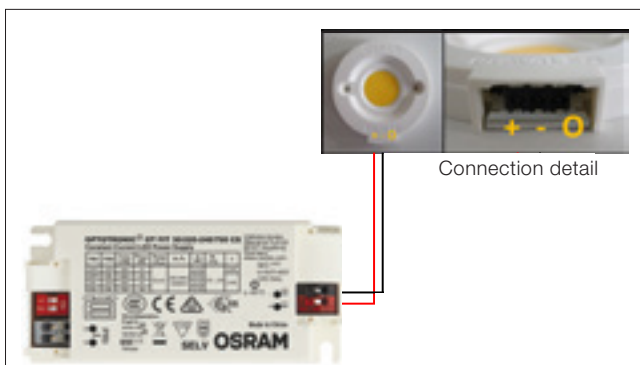
OT FIT 30/220-240/700 CS

3.7 LEDset and LEDset2 (LT2)

LEDset helps you to meet important market requirements:
— Future-proof solutions in terms of luminous flux
— Long-life operation
— Luminaire customization
— Energy and cost saving

In combination with our LED drivers, the LEDset interface offers full flexibility and a future-proof system with the following features and benefits:
— Simplified wiring for easy setting of the LED driver current, suitable for the connected LED module
— Versatile connectivity of several LED modules, either in parallel or in series (or a mix of both)
— Thermal protection for LED modules

LEDset2 (LEDset generation 2) is the enhanced interface between OPTOTRONIC® LED drivers and LED modules (such as OSRAM PrevaLED®). It can be identified by the product name of the LED driver, including the letters "LT2" at its end – while LEDset (generation 1) ends with "LT" only. LEDset interface behavior has been changed in order to obtain the following advantages:
— To add the parallel LED modules operation, especially for linear and area SSL systems, while optimizing the operating range with spot and downlight systems
— To simplify assembly (only one additional wire instead of three as before)

The table below shows the improvements of the LEDset2 compared to the previous version.

LEDset2 is a low-cost analog interface based on a three-wire connection between the LED driver and one or more LED modules. Only one additional wire – besides the two LED current supply wires (LED+, LED-) – is used for transferring information from the LED module/s to the LED driver. This interface is designed to allow communication between the LED module and the LED driver, performing LED current setting and thermal protection functionality.

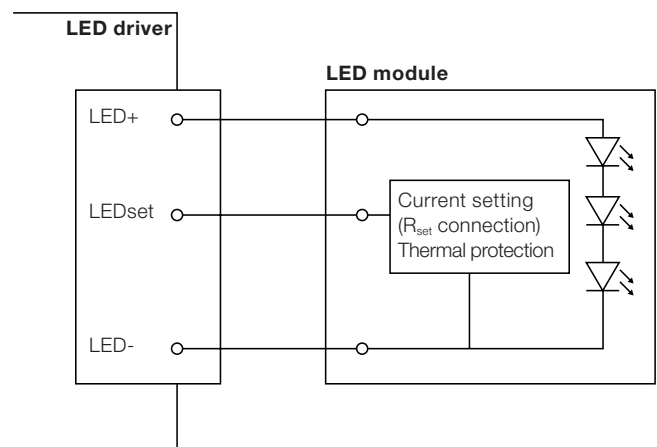The interface supports the following functionalities:
— Absolute output current setting of the constant-current LED driver (LED module self-recognition)
— Handling of parallel/serial LED module connection
— Thermal protection of the LED module

Typical applications of this interface are single or parallel or serial LED module connections, offering a wider choice of modular capabilities and low-cost thermal protection circuits. In case of multiple module connection, all connected LED modules must be identical (with the same current set and with matched forward voltages).

The relationship I_{out} vs. R_{set} is defined by the following formula:

$$I_{out} \, [A] = \frac{5\,V}{R_{set}\,[\Omega]} \times 1000$$

What's changed in LEDset2?

	LEDset (generation 1)	LEDset2
Current setting method	R_{set} resistor	R_{set} resistor with new coding
Current coding	Relative (in % of the maximum output current of the LED driver)	Absolute (within the range of 0.1 A to 5 A)
Typical number of LED modules in the system	1	From 1 up to many (series and parallel combinations)
Number of wires for LEDset	3	1
Multivendor	No (provided by OSRAM products only)	Yes (being adopted by other vendors)

LEDset2 interface wiring (block diagram)

LEDset2 allows a stepless selection of the output current through the simple selection of the proper R_{set} resistor value and the connection of a potentiometer or a fixed standard resistor to the LEDset line. The table below shows the output current values in the entire valid LEDset range if the standard resistor series E24 is used.

**Output current values using standard E24 resistor values**

R_{set} E24 [Ω]	Output current [mA]	R_{set} E24 [Ω]	Output current [mA]	R_{set} E24 [Ω]	Output current [mA]	R_{set} E24 [Ω]	Output current [mA]	R_{set} E24 [Ω]	Output current [mA]
51000	100	22000	227	9100	549	3900	1282	1600	3125
47000	106	20000	250	8200	610	3600	1389	1500	3333
43000	116	18000	278	7500	667	3300	1515	1300	3846
39000	128	16000	313	6800	735	3000	1667	1200	4167
36000	138	15000	333	6200	806	2700	1852	1100	4545
33000	151	13000	385	5600	893	2400	2083	1000	5000
30000	166	12000	417	5100	980	2200	2273		
27000	185	11000	455	4700	1064	2000	2500		
24000	208	10000	500	4300	1163	1800	2778		

Two output ports (LED+ and LED-) are used for the connection of the LED string/s. LEDset2 is a one-wire interface and uses the LED- line as the reference ground. The interface is intended for the control of a single-channel, constant-current LED driver with a single or multiple LED string load.

LED driver output terminal configuration and color code (view from above)

3.8 Maximum allowed number of LED drivers per circuit breaker
For the maximum allowed number of LED drivers per circuit breaker, please refer to the corresponding LED driver datasheet.
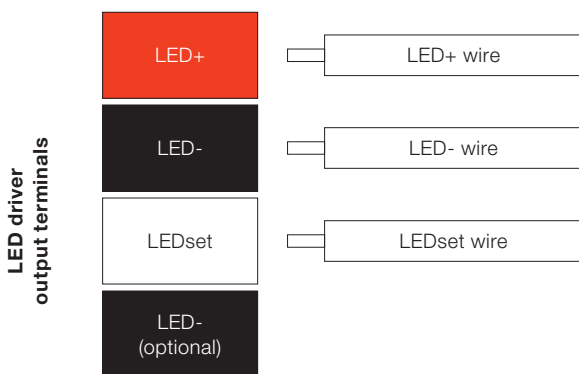
3.9 ESD
It is not necessary to handle PrevaLED® Core Z6 LED modules in electrostatic protected areas (EPAs). To protect a PrevaLED® Core Z6 LED module from electrostatic damage, do not open it. The LED module fulfills the requirement of the immunity standard IEC/EN 61547.

More detailed information about the possibilities of LEDset2 interfaces can be found in the corresponding application guidelines of this interface.

4 Thermal considerations

The proper thermal design of an LED luminaire is critical for achieving the best performance and ensuring the longest lifetime of all components. Due to the high efficacy of PrevaLED® Core Z6 LED modules, only a partial amount of the introduced electrical power has to be dissipated through the back of the LED module. The thermal power that has to be dissipated for PrevaLED® Core Z6 LED modules is given below.

4.1 Thermal power values

Product	Typ. thermal power [W][1]	Max. thermal power [W] at nominal current[1]
PL-CORE-Z6-2000-827	8.9	9.9
PL-CORE-Z6-2000-830	7.5	8.5
PL-CORE-Z6-2000-835	6.7	7.6
PL-CORE-Z6-2000-840	6.0	6.8
PL-CORE-Z6-2000-930	12.8	14.1
PL-CORE-Z6-2000-940	10.7	11.8
PL-CORE-Z6-3000-827	14.1	15.6
PL-CORE-Z6-3000-830	11.9	13.3
PL-CORE-Z6-3000-835	10.5	11.8
PL-CORE-Z6-3000-840	9.6	10.9
PL-CORE-Z6-3000-930	18.3	21.3
PL-CORE-Z6-3000-940	16.7	18.4
PL-CORE-Z6-5000-827	27.8	30.7
PL-CORE-Z6-5000-830	23.4	25.9
PL-CORE-Z6-5000-835	20.7	23.1
PL-CORE-Z6-5000-840	19.0	21.3
PL-CORE-Z6-5000-930	37.5	40.9
PL-CORE-Z6-5000-940	33.2	36.4

1) Value measured at the t_c point at a reference temperature (t_r) of 65 °C

To achieve the best possible lifetime of the LED module and to save it from damage by overheating, a thermal protection feature has been integrated.

The thermal protection of the PrevaLED® Core Z6 LED module consists of two parts: The first part is an on-board reversible thermal fuse that protects the module from damage by overheating. The characteristic of the thermal fuse is shown at the top right.

Note: If the thermal fuse is triggered, the module is shut off completely. The thermal fuse can be reset by disconnecting the mains and repowering the LED module.

The second part of the thermal protection is a thermal de-rating function that works in combination with LED drivers with LEDset2 funcionality. It protects the LED module from overheating by communicating with the LED driver (the LED-set port of the LED module must be connected). The system reduces the current of the LED module if critical tempera-tures are reached at the t_c point. This results in the best possible performance and lifetime of the LED module. The characteristic of the thermal derating function is shown at the bottom right.

Thermal fuse characteristic

Current [% of minimal LED driver current]
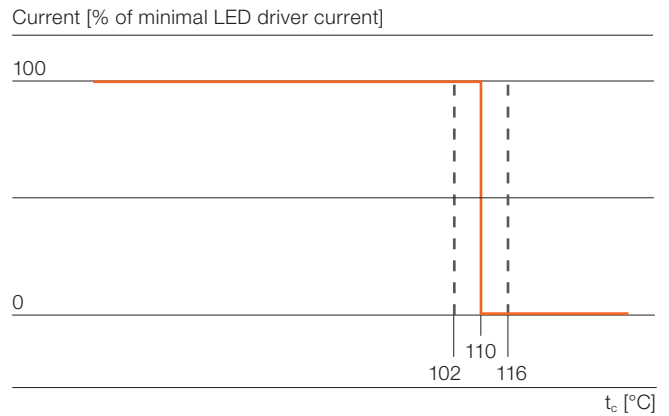
Thermal derating with LEDset2

Current [% of minimal LED driver current]
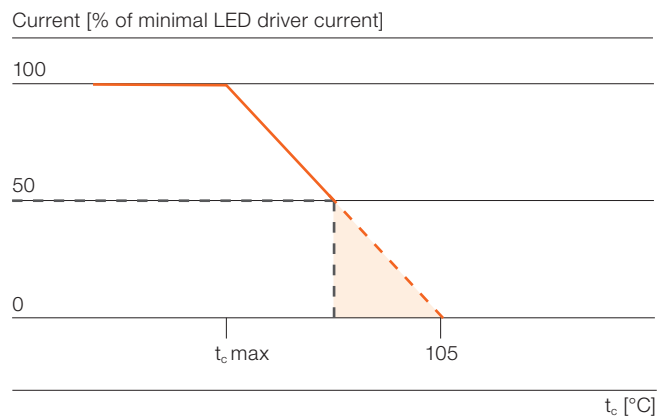
The behavior below 50 % of the system current depends on the nominal system current and the applied LED driver.

4.2 TIM and other accessories

When mounting a PrevaLED® Core Z6 LED module within a luminaire, it is mandatory to use thermal interface material (TIM) between the back of the LED module and the luminaire housing or heat sink. It is recommended to use thermal paste or phase-change material (PCM) because they perform better than thermal foil or pads. In order to balance possible unevenness, the material should be applied with a thickness between 0.15 and 0.30 mm (0.25 mm is recommended) and a maximum size of 25 x 25 mm. In this way, air inclusions, which may otherwise occur, are replaced by TIM and the required heat conduction between the back of the LED module and the contact surfaces of the luminaire housing is achieved. For this purpose, the roughness of the surface should be minimized and the planarity as well as the cleanness of the surface (free from burrs, chips or any other particles) should be optimized.
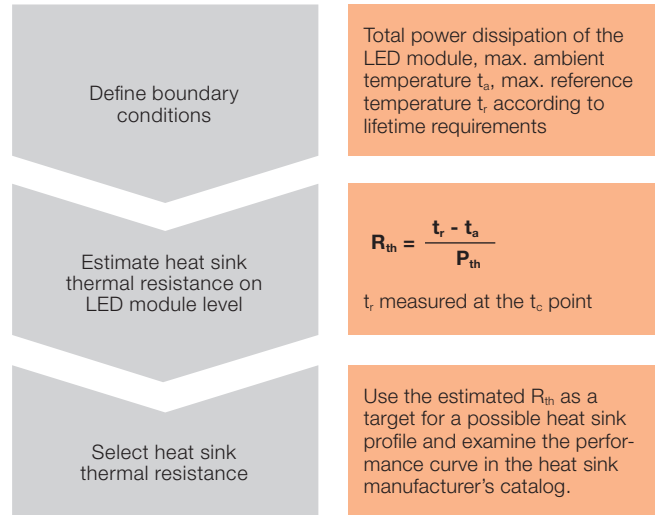
The list below is a selection of suppliers of thermal interface materials.

Thermal interface materials

Alfatec	www.alfatec.de
Kerafol	www.kerafol.de
Laird	www.lairdtech.com
Bergquist	www.bergquistcompany.com
Arctic Silver	www.arcticsilver.com
Wakefield	www.wakefield.com

4.3 Cooling system and heat sink

For the selection of a suitable heat sink, several points regarding thermal resistance have to be considered. The selection is usually carried out through the following necessary steps.

Define boundary conditions	Total power dissipation of the LED module, max. ambient temperature t_a, max. reference temperature t_r according to lifetime requirements
Estimate heat sink thermal resistance on LED module level	$$R_{th} = \frac{t_r - t_a}{P_{th}}$$ t_r measured at the t_c point
Select heat sink thermal resistance	Use the estimated R_{th} as a target for a possible heat sink profile and examine the performance curve in the heat sink manufacturer's catalog.

Please note:

A thermal design must always be confirmed by performing a thermal measurement in steady-state condition. The whole area of the metal-core PCB must be in full contact with the heat sink.

The list below is a selection of suppliers of different cooling solutions.

Cooling systems

Nuventix	www.nuventix.com
Sunon	www.sunoneurope.com
Cooliance	www.cooliance.eu
AVC	www.avc-europa.de
SEPA	www.sepa-europe.com
Fischer Elektronik	www.fischerelektronik.de
Wakefield	www.wakefield.com
MechaTronix	www.mechatronix-asia.com

4.4 t_c point location and temperature measurement

The t_c point is the location where to check if the chosen cooling solution (heat sink and TIM) is sufficient to ensure the LED module performance. The t_c point is located on the back of the LED module under the center of the light-emitting surface (see following image).

Location of the t_c point
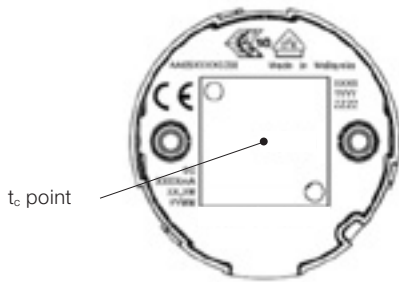
t_c point

To enable a lifetime of 60 000 hours (L80B50), the reference temperature (t_r) at the t_c point must not exceed 65 °C. The maximum temperature reached at the t_c point must not exceed 90 °C. A correct temperature measurement can, for example, be performed with a thermocouple.

4.5 Thermocouple

Use a thermocouple that can be glued onto the LED module. Make sure that the thermocouple is fixed with direct contact to the t_c point. Examples of suitable thermocouples:

Thermo wire NiCr–Ni

Miniature connector "K"

K-type thermocouple with miniature connector

Different thermocouples

Illustration	Description	Temperature range [°C]
	PVC-insulated thermocouple	-10 … +105
	PFA-insulated thermocouple	-75 … +260
	Sprung thermocouple	-75 … +260

To measure the temperature and to ensure a good thermal coupling between the LED module and the heat sink, you should drill a hole into the heat sink and push the thermocouple through it. To ensure a direct contact between the thermocouple and the PCB, it is recommended to glue the thermocouple onto the PCB. You can, for example, use an acrylic adhesive (e.g. type Loctite 3751).
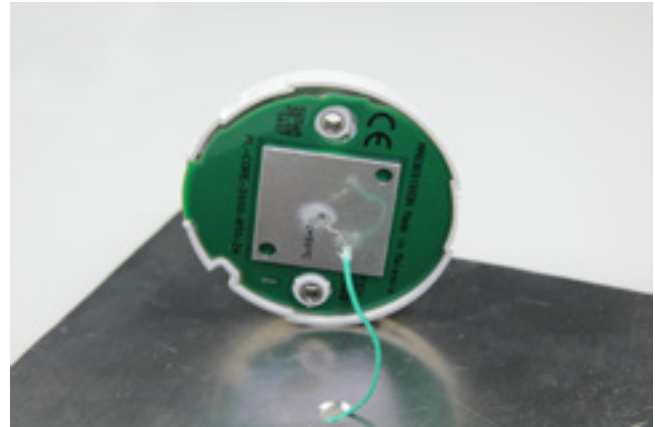
Mounting of a thermocouple through a hole in the heat sink

It is also possible to use a sprung thermocouple. A suitable type is: Electronic Sensor FS TE-4-KK06/09/2m. Please note that a good thermal contact between the thermocouple and the PCB is required. Please refer to the datasheet and the application guideline of the manufacturer to ensure correct handling.

Another possible way is to create a small groove along the top surface of the heat sink and run the thermocouple to the t_c point inside the groove.

Mounting of a thermocouple by means of a groove

Notes:
Please keep in mind that you need a direct contact between the thermocouple and the PCB.

If you use TIM, you should cut out a small area where the thermocouple has direct contact to the metal-core PCB.

5 Lifetime and thermal behavior

5.1 Luminous flux as a function of temperature

The luminous flux of a PrevaLED® Core Z6 LED module depends on its temperature. 100 % of the luminous flux is usually achieved at the performance temperature of 65 °C. The following exemplary diagram shows the behavior of the luminous flux output as a function of the temperature at the t_c point for PrevaLED® Core Z6.
The following exemplary diagram shows the behavior of the luminous flux output as a function of the temperature at the t_c point for PrevaLED® Core Z6.

Luminous flux as a function of temperature (average guiding values for reference only)

■ PL-CORE-Z6-2000-XXX
■ PL-CORE-Z6-3000-XXX
■ PL-CORE-Z6-5000-XXX
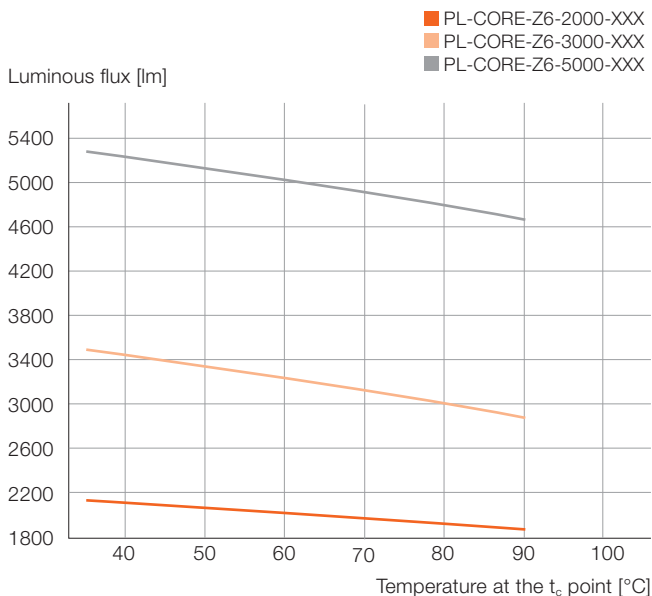
5.2 Lifetime

OSRAM PrevaLED® Core Z6 LED modules have a lifetime of 60 000 hours (L80B50) at a performance temperature (t_p) of 65 °C. This means that after 50 000 hours, a minimum of 50 % of the utilized LED modules will have at least 80 % of the initial luminous flux. If you operate the module at a lower temperature, the lifetime of the module is going to rise significantly. For more details, please refer to the product datasheet.

Note: Higher t_c temperatures lead to a shorter lifetime of the PrevaLED® Core Z6 LED module. Moreover, the failure rate will also increase.

6 Mechanical considerations

The following schematic drawing provides further details on the dimensions of PrevaLED® Core Z6 LED modules. For 3D files of the LED modules, please go to www.inventronics-light.com.
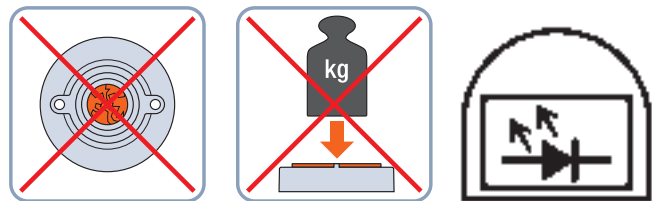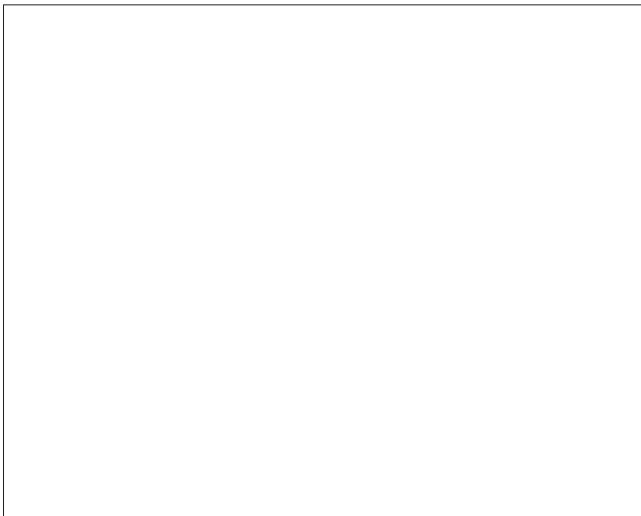
6.1 Outline drawing

All dimensions in mm

6.2 3D drawing

Move me!
Movable 3D PrevaLED® Core Z6 LED module
(works with Adobe Acrobat 7 or higher)

6.3 Mechanical protection of the PrevaLED® Core Z6 LED module

The housing of a PrevaLED® Core Z6 LED module should not be exposed to strong mechanical stress. Please apply force only to the dedicated mounting positions. Strong mechanical stress can lead to irreversible damage of the LED module.

Note: Please do not touch or mechanically stress the yellow chip-on-board (CoB) surface. This could damage the module.


For operation in damp, wet or dusty environments, the user has to make sure that an adequate ingress protection (IP) is chosen. The LED module has to be protected by a suitable IP rating of the luminaire housing. Please observe the luminaire standard IEC 60598-1 as well as the different requirements.

6.4 Mounting

To fix a PrevaLED® Core Z6 LED module onto a heat sink, you can use M3 cylinder head screws according to DIN 7984. If you cannot use DIN screws, please use the following specification: Height of head not more than 2.6 mm, diameter of head below 5.5 mm. The allowed torque using pre-tapped holes is 0.4 to 0.6 Nm.
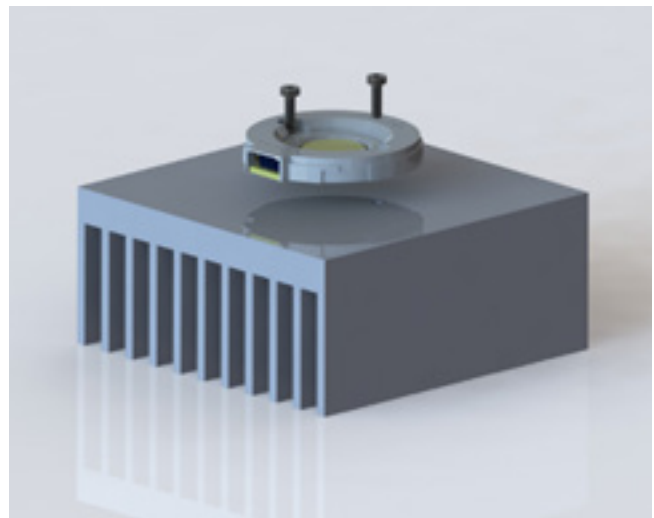
7 Norms and standards

Safety: IEC/EN 62031

Photobiological safety: IEC/EN 62471

Risk group: RG1

Ingress protection: –

Flammability of plastics: UL 8750 Class 2/UL 94 850 °C glow wire test

Approvals: CE, UL, VDE, ENEC

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