04/2023

Technical application guide

PrevaLED® Cube AC G3 light engines

OSRAM

Contents

Please note:
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1 Introduction

1.1 System overview

The brightness levels of today's LEDs are opening the door for the use of LEDs in general lighting applications that require high lumen output levels. Building an LED-based luminaire poses a new set of technical challenges, among them new optical requirements, providing adequate thermal management for stable operation and dealing with the ever-improving performance of LEDs. Nevertheless, LED technology also offers an unknown wealth of possibilities, providing access to unprecedented levels of performance and new ways of integration.

Our PrevaLED® family of LED light engines addresses the challenges of LED-based lighting while providing users with great performance and flexibility at the same time. Enabled by the application of LED technology, PrevaLED® is aiming to push the envelope of what is possible in terms of performance and simplicity.

The PrevaLED® Cube AC G3 series of light engines is ideally suited for use in a broad range of wide-reflector-based applications such as downlights.

PrevaLED® Cube AC G3 incorporates two main features into one light engine:
1 LED module
2 LED driver

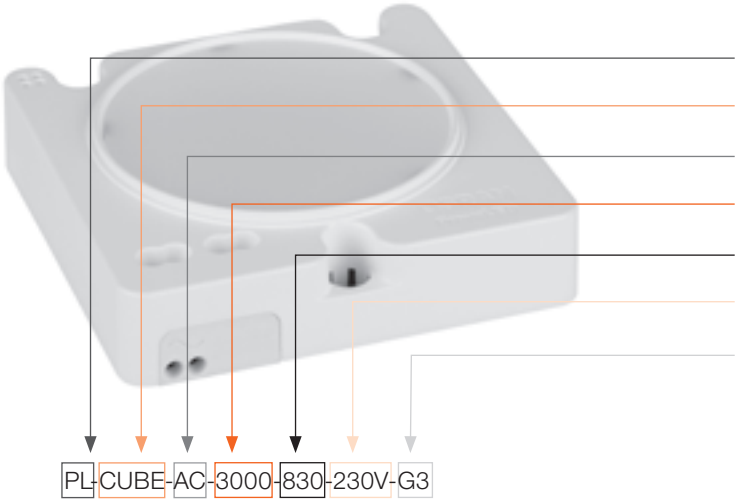
The luminaire manufacturer benefits from reduced complexity inside the luminaire. The reduced amount of components reduces the logistical efforts and eases the manufacturing process. In addition, it enables the development of innovative miniaturized designs.

PrevaLED® Cube AC G3 light engines provide several specific benefits:
- With the LED sources and the electronic control circuitry placed on the same board and packaged into a compact design, they offer an integrated system solution.
- Little design-in effort is required due to the integration of the electronic control circuitry into the light engine, offering a new level of simplicity.
- High performance in terms of both the complete system efficiency and the quality of light (small color deviation, no recognizable light modulation).
- Due to the low height of only 18.6 mm as well as the established footprint and means of mechanical fixation, a large number of existing accessories (optics, heat sinks etc.) can be easily adapted.
- All in all, PrevaLED® Cube AC G3 light engines not only offer a low threshold for the adaption of LEDs, but also a significant increase in flexibility for applications already adapted to LED technology.

At present, the PrevaLED® Cube AC G3 series is available as a 1 100-lm, 2 000-lm or 3 000-lm package in two light colors (3 000 K and 4 000 K) with a color reproduction of CRI > 80.

Dummy of a PrevaLED® Cube AC G3 light engine

1.2 Nomenclature



PL: PrevaLED® light engine

CUBE: Cube-shaped module

AC: AC-capable (220–240 V, 50/60 Hz)

3000: 3000 lm

830: CRI + CCT = > 80 + 3000 K

230V: 230 V mains capable

G3: Generation 3 of the PrevaLED® Cube family

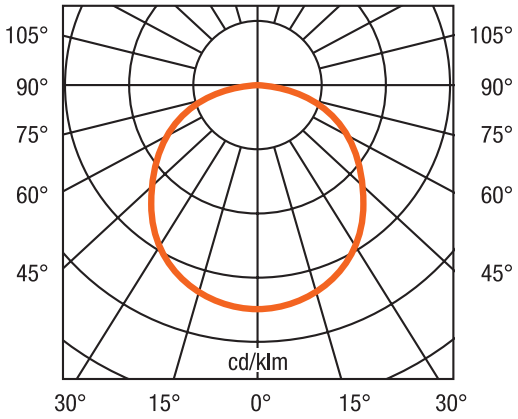
2 Optical considerations

PrevaLED® Cube AC light engines can be applied in diffuse wall-mounted and ceiling-mounted luminaires without the need for further optical accessories.

2.1 Light distribution

The light distribution of PrevaLED® Cube AC light engines is shown below. They create a beam angle of 110° FWHM.

Light distribution curve



The light-emitting surface of the light engines is covered by a diffuser to ensure a homogeneous, smooth light distribution.

2.2 Reflector design

PrevaLED® Cube AC light engines can also be used with secondary optics. As their optical interface has the same dimensions as common downlight modules on the market, they can be combined with available off-the-shelf secondary optics.

Support for optics can be found, for example, at the following suppliers:

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

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

Jordan Luxar GmbH & Co. KG
Schneiderstrasse 76 d, 40764 Langenfeld, Germany
Phone: +49 (0)2173 279-0, Fax: +49 (0)2173 279-250
sales@jordan-luxar.de
www.jordan-luxar.de

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

Nata Lighting Co., Ltd.
380 Jinou Road, Gaoxin Zone,
Jiangmen 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

We provide mechanical (3D files) and optical simulation data (ray files) to support customized reflector design. Ray file data are available upon request through your sales partner.

2.3 Color temperature

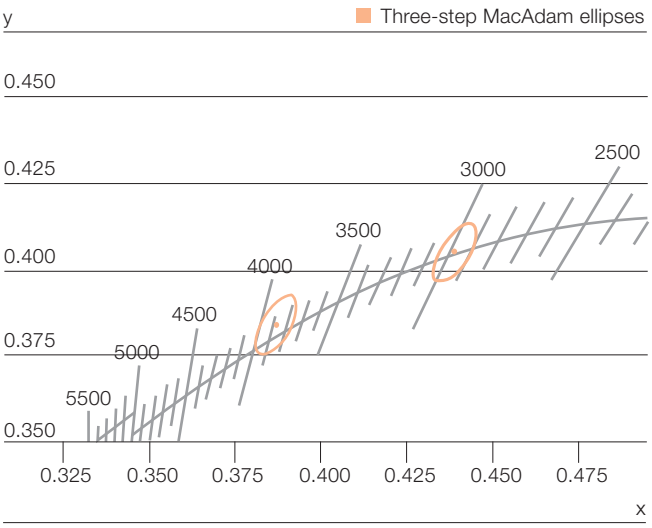
The PrevaLED® Cube AC G3 series is currently available in 3000 K and 4000 K (for other CCT, please contact your sales partner). The color coordinates within the CIE 1931 color space are given below.

Initial color values of the CCT

	3000 K	4000 K
C_x	0.439	0.387
C_y	0.405	0.384

Within each available color temperature, the PrevaLED® Cube AC G3 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.

Color coordinates



2.4 Color rendering

PrevaLED® Cube AC G3 light engines provide a color rendering index (CRI) of >80. The table below shows the individual R_a values from R1 to R14 for the available color temperatures.

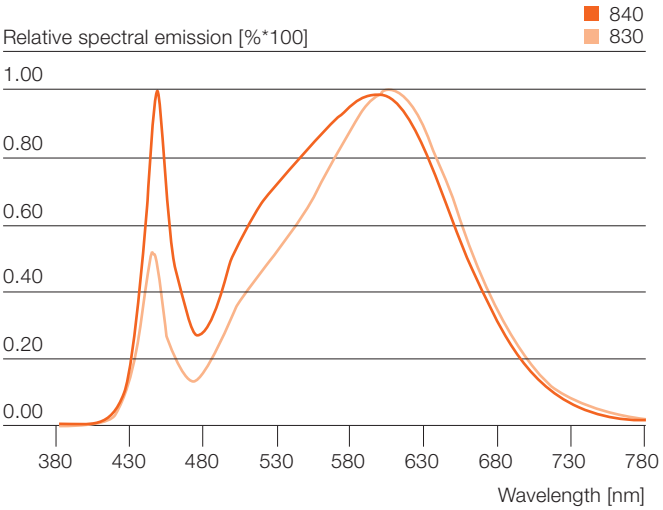
R_a values

	General CRI	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
	R_a	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
CCT = 3000K	85	83	90	95	84	82	85	89	70	22	75	83	65	85	97
CCT = 4000K	83	81	89	96	83	81	86	86	64	16	75	82	71	83	98

2.5 Spectral distribution

The typical spectral distribution of PrevaLED® Cube AC G3 light engines is shown in the following diagram.

Wavelength spectrum



3 Ingress protection

PrevaLED® Cube AC G3 light engines have an ingress protection rating of IP20. Please ensure that the housing of your luminaire provides the ingress protection required for your application.

For further information, please have a look at the technical application guide “IP codes in accordance with IEC 60529”, which can be downloaded at www.inventronics-light.com.

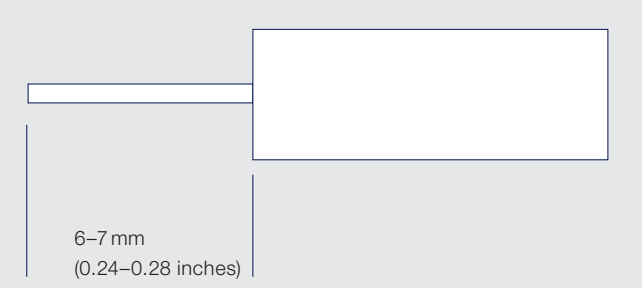
4 Electrical considerations

4.1 Wiring information

PrevaLED® Cube AC G3 light engines can be directly connected to mains voltage (220–240 V, 50/60 Hz).

The used input clamps can handle solid or flexible wire with a cross-section of 0.2 to 0.75 mm² (AWG 24–18). The use of solid wire is recommended.

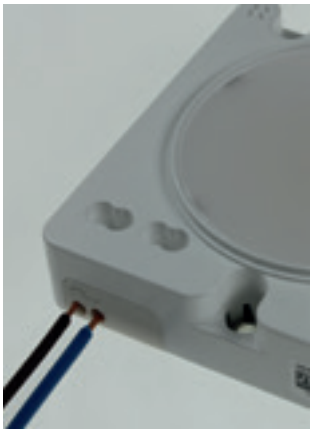
Wire preparation



Please insert the wires in 0° orientation to the PCB.

Notes:

- The connector is designed for three poke-in and release cycles.
- Due to the fact that you are dealing with mains voltage, you must not hot-plug the light engine.
- The installation of LED light engines needs to be carried out in compliance with all applicable electrical and safety standards. Only qualified personnel should be allowed to perform installations.



Solid wire:
Plug directly.

Flexible wire:

1. Lightly press the push button of the connection clamp.
2. Insert the flexible wire.

To press/release the clamps, please use an operating tool (Wago type: 206-860) or a small screw-driver.

4.2 Insulation requirements

PrevaLED® Cube AC light engines can be used in class I luminaires without further action. The creepage distance and clearance are fulfilled.

In class II luminaires, additional care needs to be taken only in the area of the input connector. Between connection wires with basic insulation and touchable metal parts or the heat sink, a second insulation layer is required. The light engine itself has double/reinforced insulation.

4.3 Inrush current and system installation

Due to their electronic construction, PrevaLED® Cube AC light engines have a minimum inrush current. In system installations, you can connect the following numbers of PrevaLED® Cube AC light engines to circuit breakers (e.g. B10 etc.) with different characteristics.

B10: 51 pcs
B16: 84 pcs
C16: 142 pcs

4.4 Electrostatic discharge (ESD)

It is not necessary to handle PrevaLED® Cube AC light engines in electrostatic protected areas (EPAs).

To protect a PrevaLED® Cube AC light engine from electrostatic damage, do not open it. The light engine fulfills the requirement of the immunity standard IEC/EN 61547.

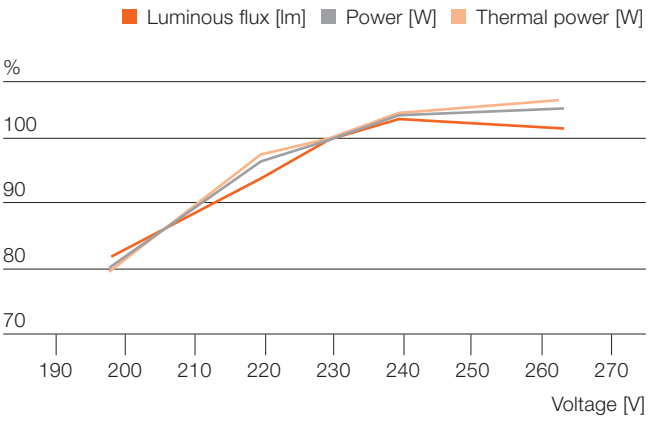
4.5 Controllability

PrevaLED® Cube AC is designed as a simple on/off device. For a fullly dimmable DALI version, please see PrevaLED® Cube AC DALI.

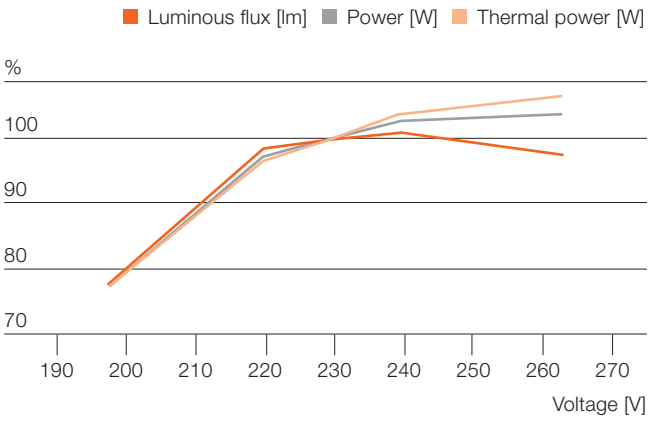
4.6 Power as a function of voltage

The nominal voltage of the light engine is 230 V. The operation range is 220–240 V. For voltage variations, the light engine is tested according to IEC/EN 61000-3-3. Please note that the power of the light engine changes over the voltage range. Please have a look at the diagrams below for the power as a function of voltage.

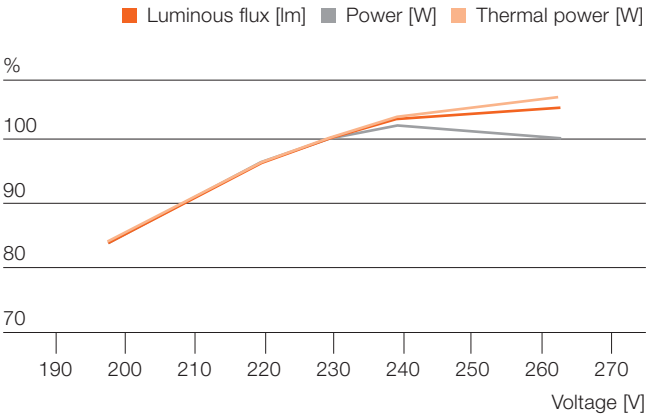
PrevaLED® Cube AC 3000 lm



PrevaLED® Cube AC 2000 lm



PrevaLED® Cube AC 1100 lm



5 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® Cube AC G3 light engines, only a partial amount of the introduced electrical power has to be dissipated through the back of the light engine. The thermal power that has to be dissipated for PrevaLED® Cube AC G3 light engines is given below.

Thermal power values

	Typical thermal power [W][1]	Max. thermal power [W][1]	Typical allowable thermal resistance R_{th} [K/W][2]	Max. allowable thermal resistance R_{th} [K/W][2]
PL-CUBE-AC-1100-8XX-230V-G3	8.2	9.7	5.5	4.7
PL-CUBE-AC-2000-8XX-230V-G3	12.9	15.5	3.5	2.9
PL-CUBE-AC-3000-8XX-230V-G3	21.3	25.3	2.1	1.8

5.1 Thermal interface material and other accessories

When mounting a PrevaLED® Cube AC G3 light engine within a luminaire, it is recommended to use thermal interface material (TIM) between the back of the light engine and the luminaire housing or heat sink. It is recommended to use thermal paste. In order to balance possible unevenness, the material should be applied as thinly as possible, but as thickly as necessary. In this way, air inclusions, which may otherwise occur, are replaced by TIM and the required heat conduction between the back of the light engine and the contact surfaces of the luminaire housing is achieved. For this purpose, the planarity and roughness of the surface should be optimized.

The following list is a selection of suppliers of thermal interface materials.

Suppliers of thermal interface materials

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

5.2 Cooling systems and heat sinks

For the selection of a suitable heat sink, several points regarding thermal resistance have to be considered.

The selection is usually carried out along the following necessary steps.

Selection of a heat sink

Define boundary conditions	Total power dissipation of the light engine, max. ambient temperature t_a, max. reference temperature t_r according to lifetime requirements
Estimate heat sink thermal resistance on light engine 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.

Note: A thermal design must always be confirmed by performing a thermal measurement in steady-state condition.

It is recommended that the whole area of the PCB of a PrevaLED® Cube AC G3 light engine is in contact with the solid material of the heat sink.

1) Value measured at the t_c point at a reference temperature (t_r) = t_p of 70 °C

2) Value measured at an ambient temperature of 25 °C; the R_{th} values apply to the light engine incl. the thermal interface material (TIM)

A thermal system always depends on many factors, such as airflow, ambient temperature etc. Please check your entire cooling system by performing a thermal measurement in steady-state condition.

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

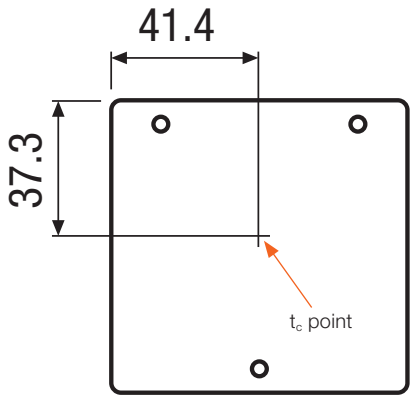
Suppliers of active and passive cooling systems

Nuventix	www.nuventix.com
Sunon	www.sunoneurope.com
Cooler Master	www.coolermaster.com
AVC	www.avc-europa.de
SEPA	www.sepa-europe.com
Fischer Elektronik	www.fischerelektronik.de
Wakefield	www.wakefield.com
Cooliance	www.cooliance.com

5.3 t_c point location and temperature measurement

The t_c point is the location to check if the chosen cooling solution (heat sink and TIM) is sufficient to ensure the light engine performance. The t_c point is located on the back of the light engine, under the center of the diffuser (see image below).

Location of the t_c point



All figures in mm

A correct temperature measurement can, for example, be performed with a thermocouple.

5.4 Thermocouple

Use a thermocouple that can be glued onto the light engine. Make sure that the thermocouple is fixed with direct contact to the t_c point.

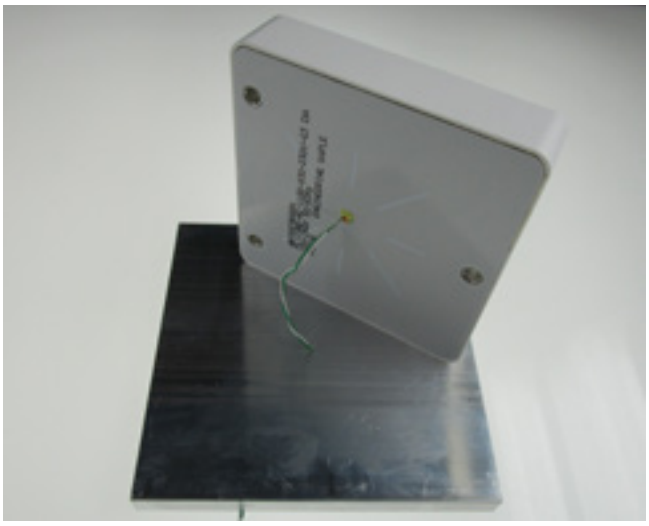
Examples of suitable thermocouples:

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

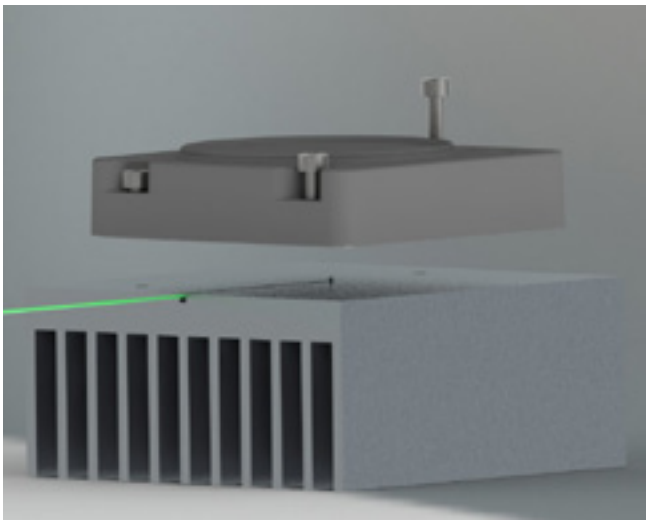
To measure the temperature and to ensure a good thermal coupling between the light engine and the heat sink, drill a hole into the heat sink and push the thermocouple through it. To ensure a direct contact between the thermocouple and the PCB, it is recommended to glue the thermocouple onto the PCB (e.g. with acrylic glue, e.g. Loctite 3751). The glue shall not influence the thermal coupling.



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.



Mounting of a thermocouple by means of a groove

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

6 Lifetime and thermal behavior

6.1 Cooling

To ensure a safe and reliable operation, the light engine must be attached to a suitable cooling solution (e.g. a heat sink).

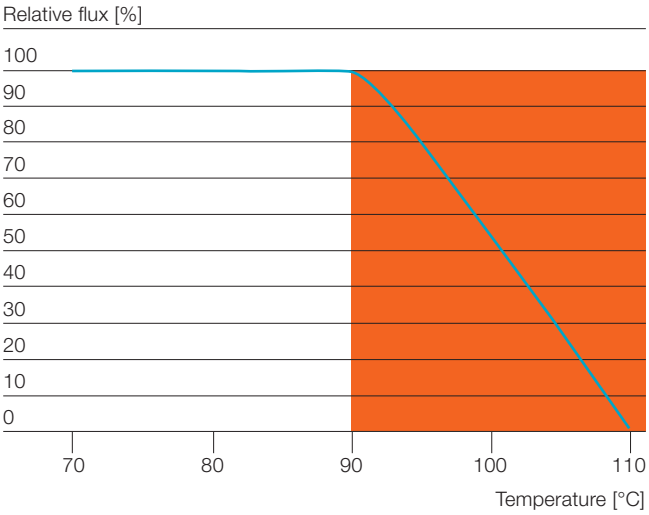
6.2 Luminous flux as a function of temperature

The luminous flux of PrevaLED® Cube AC G3 light engines depends on their temperature. 100 % of the luminous flux is achieved at the reference temperature of 70 °C (t_p = 70 °C). This temperature has to be measured at the t_c point. If the reference temperature increases, the light output decreases.

6.3 Thermal protection mechanism

To protect the light engine from damage by overheating, a thermal derating has been implemented. The derating starts at a t_c point temperature of > 90 °C. Please see the curve in the graph on the left.

Flux as a function of temperature at nominal power



6.4 Lifetime as a function of temperature

For the definition of the lifetime of a light engine, please refer to IEC/PAS 62717, where the following types are defined (examples):

- L0C10 is the lifetime where the light output is 0 % for 10 % of the light engines.
- L70F50 is the lifetime where the light output is ≥ 70 % for 50 % of the light engines. F value includes reduction of lumen output over time including abrupt degradation (flux = 0).
- L70B50 is the lifetime where the light output is ≥ 70 % for 50 % of the light engines. B value includes only gradual reduction of lumen output over time (not the abrupt degradation of flux).

If the performance temperature t_p of 70 °C is maintained, the PrevaLED® Cube AC G3 light engines have an average lifetime of 50 000 hours (L70B50). The maximum temperature measured at the t_c point must not exceed 90 °C.

Note: Higher temperatures lead to a shorter lifetime of the PrevaLED® Cube AC G3 light engines. Moreover, the failure rate will also increase.

The tables below show the lifetime of PrevaLED® Cube AC G3 light engines according to IEC 62717.

PL-CUBE-AC-1100-8x0-230V-G3

	L70B10	L70B50	L80B10	L80B50	L0C10	L0C50	L70F10	L70F50	L80F10	L80F50
Lifetime [h] at t_c point = 65 °C	41000	50000	26000	36000	104000	104000	39000	50000	26000	35000
Lifetime [h] at t_c point = 70 °C	38000	50000	24000	33000	73000	73000	36000	50000	23000	32000
Lifetime [h] at t_c point = 75 °C	35000	48000	23000	31000	52000	52000	33000	47000	22000	30000
Lifetime [h] at t_c point = 80 °C	33000	45000	21000	28000	36000	36000	30000	44000	20000	27000
Lifetime [h] at t_c point = 90 °C	31000	43000	20000	27000	18000	18000	28000	41000	18000	26000

PL-CUBE-AC-2000-8x0-230V-G3

	L70B10	L70B50	L80B10	L80B50	L0C10	L0C50	L70F10	L70F50	L80F10	L80F50
Lifetime [h] at t_c point = 65 °C	50000	50000	35000	50000	82000	82000	48000	50000	33000	50000
Lifetime [h] at t_c point = 70 °C	47000	50000	31000	44000	58000	58000	41000	50000	29000	44000
Lifetime [h] at t_c point = 75 °C	41000	50000	27000	39000	41000	41000	36000	50000	25000	38000
Lifetime [h] at t_c point = 80 °C	36000	50000	24000	34000	29000	29000	31000	50000	22000	33000
Lifetime [h] at t_c point = 90 °C	28000	41000	18000	26000	14000	14000	23000	40000	16000	26000

PL-CUBE-AC-3000-8x0-230V-G3

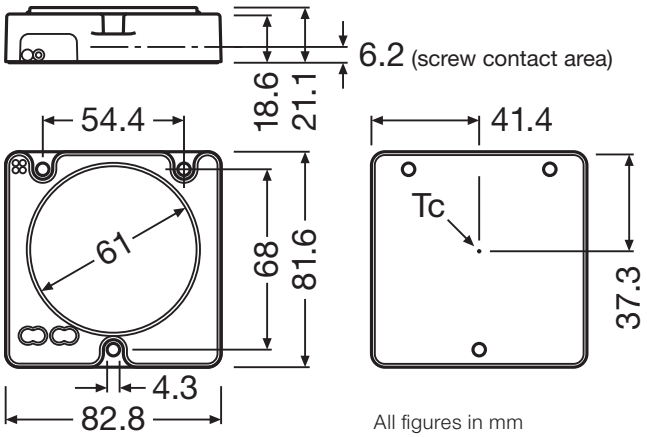
	L70B10	L70B50	L80B10	L80B50	L0C10	L0C50	L70F10	L70F50	L80F10	L80F50
Lifetime [h] at t_c point = 65 °C	42000	50000	28000	41000	82000	82000	38000	50000	26000	40000
Lifetime [h] at t_c point = 70 °C	37000	50000	24000	36000	58000	58000	33000	50000	23000	35000
Lifetime [h] at t_c point = 75 °C	33000	49000	21000	31000	41000	41000	28000	47000	20000	31000
Lifetime [h] at t_c point = 80 °C	29000	43000	19000	28000	29000	29000	24000	42000	17000	27000
Lifetime [h] at t_c point = 90 °C	23000	34000	15000	22000	14000	14000	18000	33000	13000	21000

7 Mechanical considerations

7.1 Outline drawing

The following schematic drawing provides further details on the dimensions of PrevaLED® Cube AC G3 light engines. For 3D files of the light engines, please go to: www.inventronics-light.com.

Outline drawing



All figures in mm

Note:
General mechanical tolerances according to ISO 2768 c.

7.2 3D drawing

Move me!
Movable 3D PrevaLED® Cube AC G3 light engine
(works with Adobe Acrobat 7 or higher)

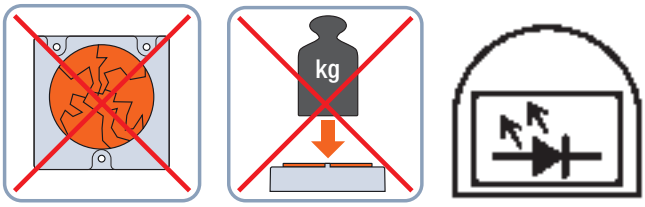
7.3 Mechanical protection of the light engine

The housing of a PrevaLED® Cube AC G3 light engine 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 light engine.

Note: If the diffuser material at the light-emitting surface or any other part of the housing or the PCB is broken or mechanically damaged, you must no longer operate the light engine. Please replace it immediately to avoid contact with parts of the light engine that conduct 230 V.

For operation in damp, wet or dusty environments, the user has to make sure that an adequate ingress protection is chosen. The light engine has to be protected by a suitable IP code of the luminaire housing. Please consider the luminaire standard IEC 60598-1 as well as the different requirements for indoor and outdoor application.

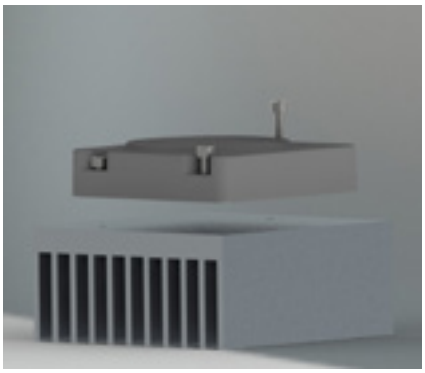
Note for France: Due to specific national regulations as defined in the standard EN 60598, it is not permitted to expose the light engine outside a luminaire housing.



Don'ts

7.4 Mounting

To fix a PrevaLED® Cube AC G3 light engine to a heat sink, use M4 cylinder head screws according to DIN 912 or ISO 4762.



Mount the light engine from the top

Note:
Good experiences were made with a torque of 1.0 ± 0.5 Nm, higher torque levels do not necessarily lead to significantly better heat transfer but may lead to damage of the light engine.

7.5 Protection from corrosion

To protect electronic parts (such as LEDs) from corrosion, a corrosive atmosphere around the components has to be avoided. In case of LEDs, H_2S, for example, is a highly corrosive substance which can lead to a drastically shortened product lifetime. The source for H_2S are sulfur-cross-linked polymers, such as rubber. To ensure the absence of H_2S, it is recommended to use peroxide-cross-linked materials, which are available on the market as an alternative to sulfur-cross-linked versions. Avoidance of corrosion by moisture has to be ensured by the appropriate protection of the luminaire housing (see chapter 3 "Ingress protection").

8 Norms and standards

Safety:	IEC/EN 62031 IEC 61347-1
Photobiological safety:	IEC/EN 62471 Risk group 1
Ingress protection:	IP20
Approval:	CE, ENEC, VDE, CB VDE

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