04/2023

Technical application guide

PrevaLED® Core AC G2 light engines

OSRAM

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Please note:
All information in this guide has been prepared with great care. INVENTRONICS, however, does not accept liability for possible errors, changes and/or omissions. Please check www.inventronics-light.com or contact your sales partner for an updated copy of this guide. This technical application guide is for information purposes only and aims to support you in tackling the challenges and taking full advantage of all opportunities the technology has to offer. Please note that this guide is based on own measurements, tests, specific parameters and assumptions. Individual applications may not be covered and need different handling. Responsibility and testing obligations remain with the luminaire manufacturer/ OEM/application planner.

1 Introduction

1.1 System overview

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 lastly dealing with the ever-improving performance of LEDs. Nevertheless, LED technology also provides an unknown wealth of possibilities, opening up unprecedented levels of performance in addition to improved ways of integration. Continuing down this path of integration and innovation, we present a revolutionary solution: PrevaLED® Core AC G2 light engines have an integrated driver and can therefore be connected directly to line voltage.

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

The PrevaLED® Core AC G2 series of light engines is ideally suited for use in reflector-based, rotation-symmetric luminaires (such as spotlights and downlights) in shop, hospitality, decorative or office applications.

Benefits

- PrevaLED® Core AC G2 offers an integrated system solution with the LED source and the electronic control circuitry together on the same board, packaged into a uniquely compact light engine that can be directly connected to 230 V_{AC}.
- Omitting the driver allows for smaller, simpler, slimmer and – last but not least – more cost-efficient luminaire designs.
- Logistics and manufacturing will be simplified drastically thanks to the lack of the driver and cables, and also the reduced housing and fixation materials.
- The PrevaLED® Core AC G2 family is easy to integrate since the light engines are compatible with “Zhaga book 3” heat sinks and reflectors. Currently, there is no standard available for AC spotlight engines. The LES sizes, diameters and positioning of mounting holes, however, meet the Zhaga standards, similar to the PrevaLED® Core Z4 and Z5 product ranges.
- The engines are outfitted with a Wago connector which allows for an easy “poke-in” of stranded and solid wires.
- The protective cover glass ensures safety for installers and avoids damaging the COB. The reversible thermal shutdown protects the light engine from breaking down when overheated.
- The entire PrevaLED® Core AC G2 family is certified according to CE and VDE/ENEC standards.
- COB technology ensures great homogeneity where no additional diffuser is required.

Product features

- PrevaLED® Core AC G2 is available in 800 and 2 000 lm, in three color temperatures (2 700, 3 000 and 4 000 K) and CRI > 80.
- The LED light engine operates directly at a line voltage of 230 V_{AC}, 50–60 Hz.
- System efficacy (including driver losses) of up to 109 lm/W with a power factor of > 0.9.
- Lifetime is 50 000 hours ($L_{70}B_{30}$) at t_r of 65 °C, with t_c max. = 80 °C.

PrevaLED® Core AC G2 800 lm

PrevaLED® Core AC G2 2 000 lm

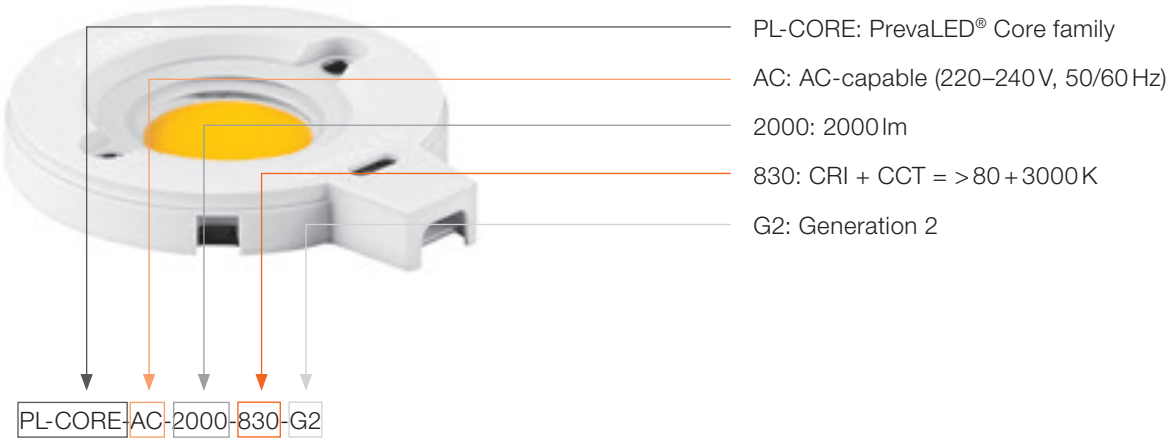
Move me!
Movable 3D PrevaLED® Core AC G2 800 lm light engine
(works with Adobe Acrobat 7 or higher)

1.2 Ordering information

PrevaLED® Core AC G2

Product data	800 lm, 2700 K	800 lm, 3000 K	2000 lm, 3000 K	2000 lm, 4000 K
Product reference	PL-CORE AC-800-827-G2	PL-CORE AC-800-830-G2	PL-CORE AC-2000-30-G2	PL-CORE AC-2000-40-G2
Product number	EAN 10: 40528999**52751**	EAN 10: 40528999**52768**	EAN 10: 40528999**52775**	EAN 10: 40528999**52782**

1.3 Nomenclature



2 Optical considerations

The PrevaLED® Core AC G2 can be applied in spotlights and downlights.

2.1 Modulation of light

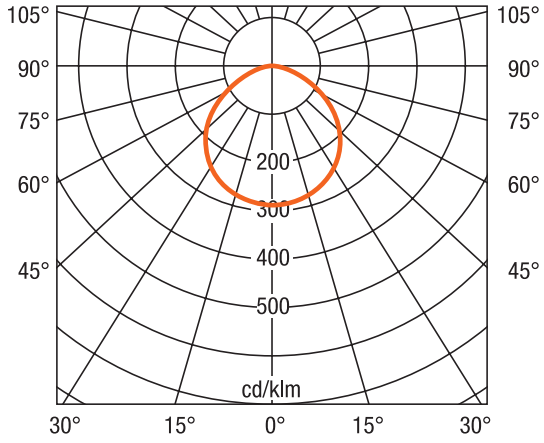
Due to the limited geometry of the PrevaLED® Core AC G2, there is no capacitance placed in the light engine. The result is a light modulation which has a frequency of 100 Hz. The light output goes down to 0 %.

Warning: This light modulation might influence the perception of moving or rotating parts. Do not use the light engine in critical applications such as turnery. The light engine might also cause interference with monochrome LCDs (twisted nematic displays). Due to the modulation, the light is not suitable for photography and filming (e.g. cellphone camera).

2.2 Light distribution

The light distribution of the light engine is shown in the graph below. The PrevaLED® Core AC G2 creates a beam angle of 110° FWHM (full width at half maximum).

Light distribution curve



The light-emitting surface (LES) of the light engine is covered by a clear glass to protect the user from mains voltage.

Note: Please ensure that the light engine is only used with an undamaged cover glass.

2.3 Reflector design

The PrevaLED® Core AC G2 can also be used with secondary optics. The diameter of the light-emitting surface and the optical contact area (OCA) are shown in the table below.

LES and OCA

	Light-emitting surface (LES) category [mm]	Real LES diameter [mm]	Optical contact area (OCA) category [mm]
800 lm	14	14	B/19
2000 lm	19	19	C/23

The LES dimensions of PrevaLED® Core AC G2 light engines meet Zhaga book 3 standards. Therefore, the PrevaLED® Core AC G2 can be used in combination 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

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

Nata Lighting Co., Ltd.
380 Jinou Road, Gaoxin Zone
Jiangmen City, Guangdong, China
+86 750 377 0000
info@nata.cn
www.nata.cn

We provide mechanical (3D files) and optical simulation data (ray files) to support customized reflector designs. Mechanical files can be downloaded at www.inventronics-light.com. Ray file data are available upon request through your sales partner. Available ray file formats are ASAP, SPEOS, LightTools and Photopia (all binary).

2.4 Color temperature

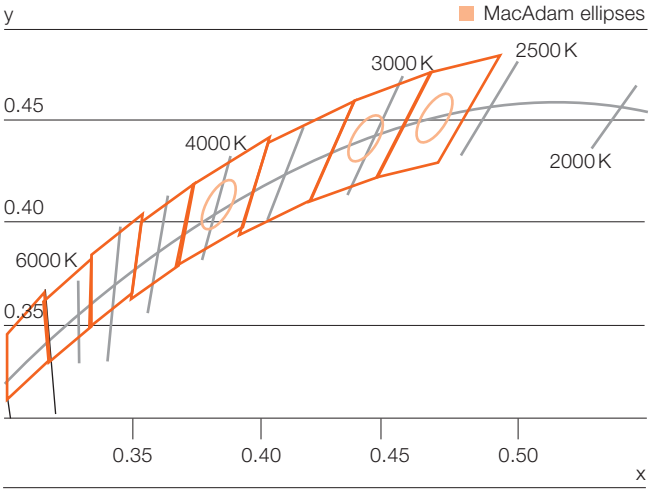
The PrevaLED® Core AC G2 series is currently available in 2 700 K, 3 000 K and 4 000 K. The color coordinates within the CIE 1931 color space are given in the table below.

Initial color values of the CCT

	2700 K	3000 K	4000 K
C_x	0.4578	0.4338	0.3818
C_y	0.4101	0.4030	0.3797

Within each available color temperature, the PrevaLED® Core AC G2 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



2.5 Color rendering

PrevaLED® Core AC G2 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.

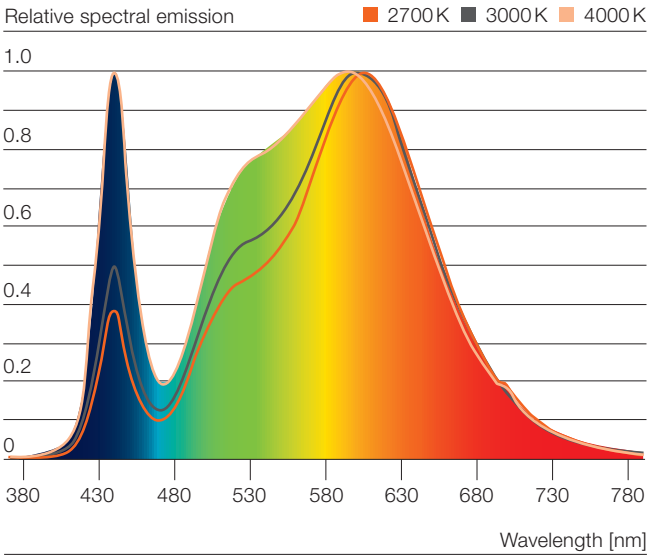
R_a values (note: All values measured at t_c = 65 °C)

	Dusky pink	Mustard yellow	Yellowish green	Light green	Turquois	Azure	Aster violet	Lilac violet	Red, saturated	Yellow, saturated	Green, saturated	Blue, saturated	Blue, saturated	Leaf green	General CRI
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R_a
CCT = 2700 K	79	90	97	79	79	88	82	56	3	76	78	71	81	99	81
CCT = 3000 K	80	90	97	80	80	87	83	59	8	76	79	69	83	98	82
CCT = 4000 K	82	89	94	82	81	85	87	66	13	73	81	63	83	97	83

2.6 Spectral distribution

The typical spectral distribution of PrevaLED® Core AC G2 light engines is shown in the following diagram.

Wavelength spectrum



Note: Do not stare directly into the beam or view directly with optical instruments (risk group I according to IEC 62471).

3 Ingress protection

The PrevaLED® Core AC G2 has an ingress protection rating of IP20. Please ensure that the housing of your luminaire provides the IP 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 from www.inventronics-light.com.

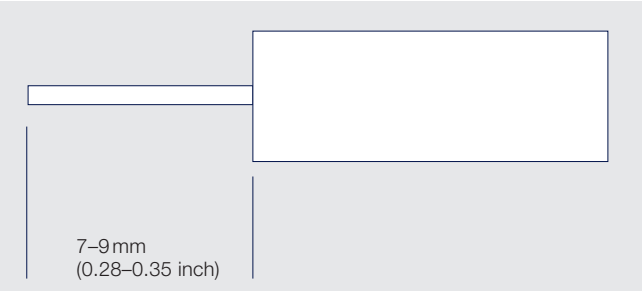
4 Electrical considerations

4.1 Wiring information

The PrevaLED® Core AC G2 can be directly connected to mains voltage (220–240 V, 50/60 Hz).

The used input clamps can handle solid wire or flexible wire with a cross-section of 0.2 to 0.75 mm² (AWG24–18).
The use of solid wire is recommended.

Wire preparation



Notes:
- The connector is designed for three poke-in and release cycles.
- Due to the fact that you are handling 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.

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

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: 233-335), a ballpoint pen or a small screwdriver.

4.2 Insulation requirements

The PrevaLED® Core AC G2 can be used in class I luminaires without further action. The creepage distance and clearance are fulfilled. The protective cover glass is tested according to a spring hammer test and provides class I insulation. It prevents the user from touching the light-emitting surface which is connected directly to 220–240 V_{AC}.

The PrevaLED® Core AC G2 has basic insulation. In class II luminaires, additional care needs to be taken in the area of the input connector, the metal core PCB and the metal bushings. Between connection wires with basic insulation and touchable metal parts or the heat sink, a second insulation layer is required. The light engine must be mounted in an electrically insulated way. You can, for example, use an electrically insulating thermal foil which must overlap the PrevaLED® Core AC G2 light engine by at least 2.5 mm in all directions. To mount the light engine, you must use non-conductive screws or attach the light engine by a clamping mechanism. Please note that force must be applied to the metal bushings only.

4.3 Inrush current and system installation

Due to its electronic construction, the PrevaLED® Core AC G2 has a minimum inrush current. In system installations, the number of light engines which can be attached to one circuit is limited by the voltage drop regulations and the used diameter of the connecting wire.

4.4 Electrostatic discharge (ESD)

It is not necessary to handle the PrevaLED® Core AC G2 in electrostatic protected areas (EPAs).

To protect the light engine from electrostatic damage, the module must not be opened. The light engine fulfills the requirement of the immunity standard IEC/EN 61547.

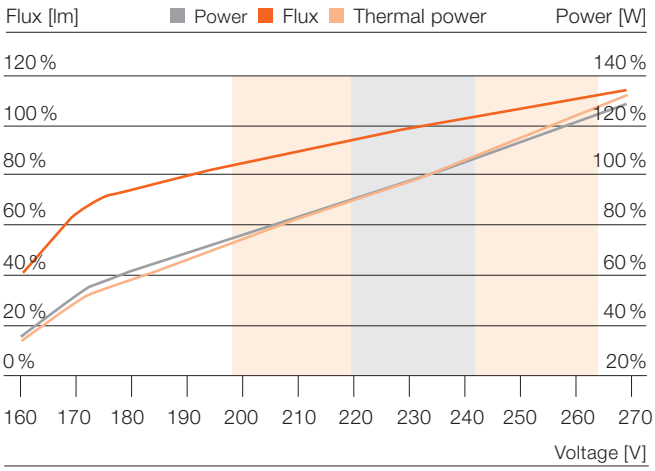
4.5 Controllability

Due to the integrated drive electronics, a good compatibility with all available phase-cut dimmers cannot be ensured.

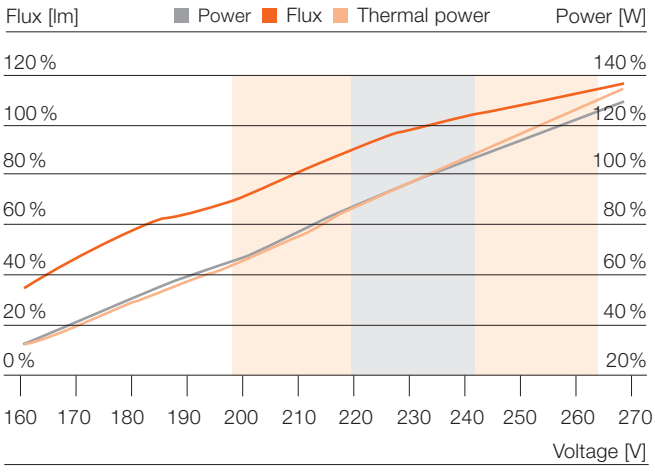
4.6 Power as a function of voltage

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® Core AC G2 800 lm



PrevaLED® Core AC G2 2000 lm



Note: According to EN 60598-1, luminaires have to be tested with 1.06 times the rated voltage or the maximum of the rated voltage range. This will also have implications on the thermal power of the light engine.

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 the PrevaLED® Core AC G2, 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® Core AC G2 is given below.

Thermal power to be dissipated*

	Typical	Maximum
PL-CORE AC-800-827-G2	8.9 W	9.8 W
PL-CORE AC-800-830-G2	8.6 W	9.6 W
PL-CORE AC-2000-830-G2	19.6 W	21.6 W
PL-CORE AC-2000-840-G2	18.4 W	20.2 W

* Values measured at the t_c point, at a reference temperature (t_r) of 65 °C

5.1 Thermal power over voltage

Please note that the thermal power of the module is related to the line voltage. Please refer to the diagrams in chapter 4.6.

5.2 Thermal shutdown

To ensure the best performance and a long lifetime of all components, the PrevaLED® Core AC G2 features integrated electronics which switch off the light engine when the temperature at the t_c point reaches the critical value of 83 °C (±5 °C). The light engine switches back on as soon as the temperature has cooled down below 60 °C (±5 °C).

5.3 Thermal interface material and other accessories

When mounting a PrevaLED® Core AC G2 within a luminaire, it it is highly 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, but thermal foil can also be used.

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 smoothness of the surface should be optimized.

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

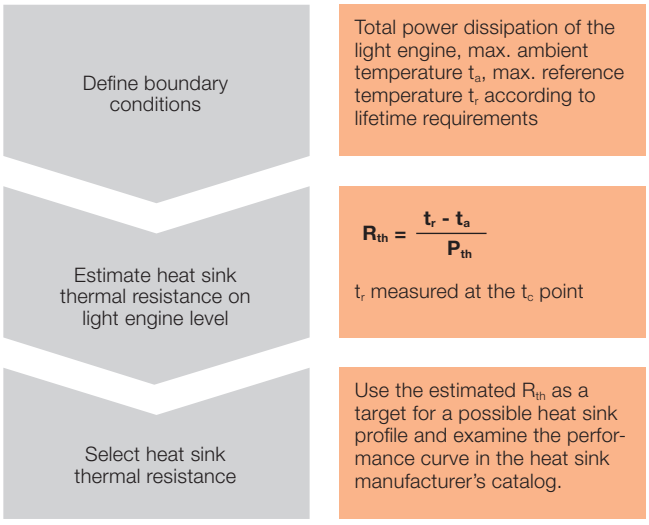
Thermal interface materials

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

5.4 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 done through the following necessary steps:



Selection of a heat sink

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® Core AC G2 light engine is in contact with the solid material of the heat sink.

Note: The positioning of the mounting holes is compatible with Zhaga book 3. Therefore, off-the-shelf heat sinks developed for these modules are also suitable for PrevaLED® Core AC G2 light engines.

Two examples of how to cool a PrevaLED® Core AC G2:

Example 1:
Light engine: PL-CORE AC-800-830-G2
Heat sink: Nuventix HP30S-CALBL-001 A01
TIM: Kerafoil 86/82
$t_{ambient}$: 22 °C
Temperature at the t_c point: 65 °C

Example 2:
Light engine: PL-CORE AC-2000-830-G2
Heat sink: AVC ST05300001
TIM: Kerafoil 86/82
$t_{ambient}$: 23 °C
Temperature at the t_c point: 48 °C

Please note that the solutions shown above are just examples. 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:

Cooling systems

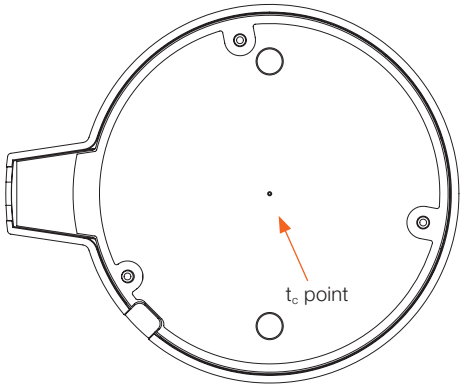
Nuventix	www.nuventix.com
Sunon	www.sunoneurope.com
Cooler Master	www.coolermaster.com
AVC	www.avc-europa.de
SEPA	www.sepa-europe.com
Fischer Elektronik	www.fischerelektronik.de
Meccal	www.meccal.com
Wakefield	www.wakefield.com
R-Theta	www.r-theta.com
Cool Innovations	www.coolinnovations.com

5.5 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, in the center of the PCB (see image above).

To ensure a lifetime of 50 000 hours ($L_{70}B_{30}$), 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 80 °C.

Location of the t_c point



Note: t_c according to IEC 62031 stands for **c**ase **t**emperature, which is the highest permissible temperature measured at the t_c point. The t_c point is the location where the t_c is measured (in the center of the back of the light engine).

t_p (**p**erformance **t**emperature) = t_r (**r**eference **t**emperature) is the reference temperature at which the datasheet values are applicable.

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

5.5.1 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.

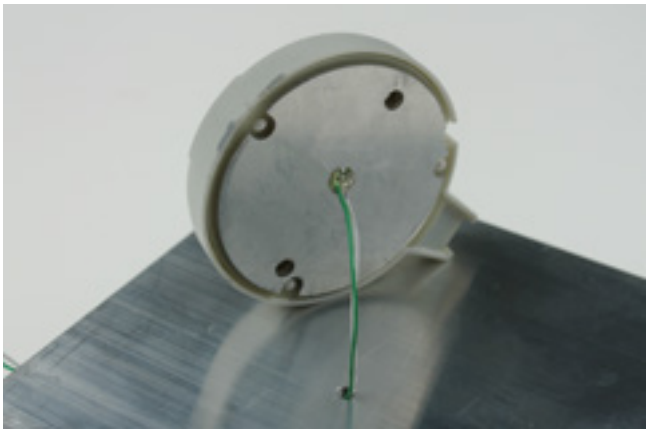
Examples of suitable thermocouples:

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

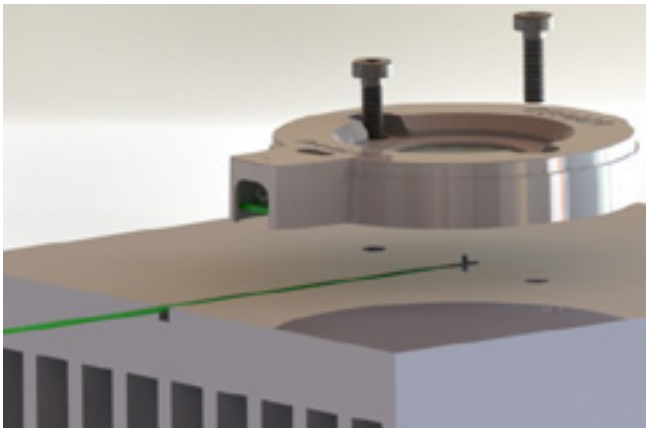
To measure the temperature and to ensure a good thermal coupling between the light engine and the heat sink, drill a hole into the heat sink and push the thermocouple through it. To ensure a direct contact between the thermocouple and the PCB, it is recommended to glue the thermocouple onto the PCB. 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 inside the groove to the t_c point.



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.

5.5.2 Thermal sticker

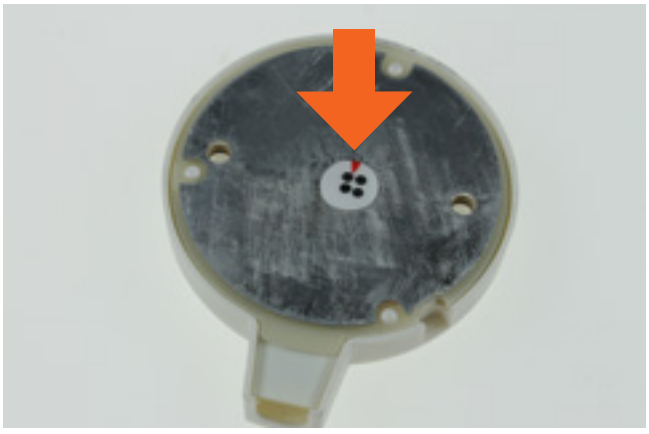
You can also use thermal stickers to indicate the reference temperature (t_r) at the t_c point of the light engine.

Attach the sticker to the light engine at the t_c point (see image below).

Thermal sticker before temperature measurement

Note: If you use a TIM, please do not apply thermal paste to the sticker. In case you use thermal foil, please cut out the area of the sticker.

Mount the light engine onto the heat sink and operate it until a stable temperature has been reached. Dismount the light engine and check the thermal sticker. For the interpretation of the test result, refer to the datasheet of the thermal sticker.



Thermal sticker after temperature measurement

OMEGA BUA2-140/60-30 is a suitable thermal sticker, which covers a temperature range between 60 and 77 °C.

5.5.3 Thermal dummy

On request, a Zhaga-specified thermal test dummy for design-in tasks is available from your sales partner.

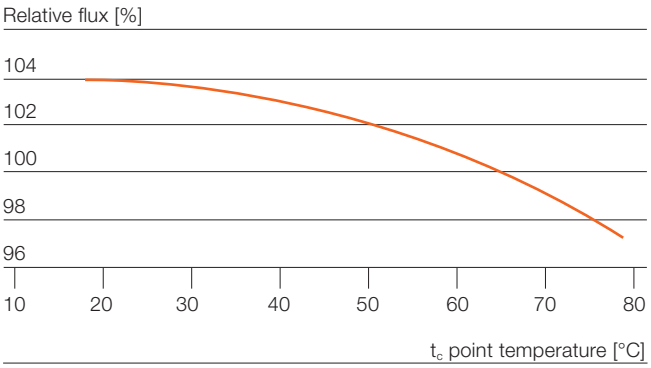
6 Lifetime and thermal behavior

6.1 Flux as a function of temperature

The luminous flux of the PrevaLED® Core AC G2 light engine depends on its temperature. 100 % of the luminous flux is achieved at the reference temperature of 65 °C (t_r = 65 °C). This temperature has to be measured at the t_c point. If the reference temperature increases, the light output decreases.

The luminous flux changes in relation to the reference temperature according to the following diagram:

Flux as a function of t_c temperature



6.2 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):

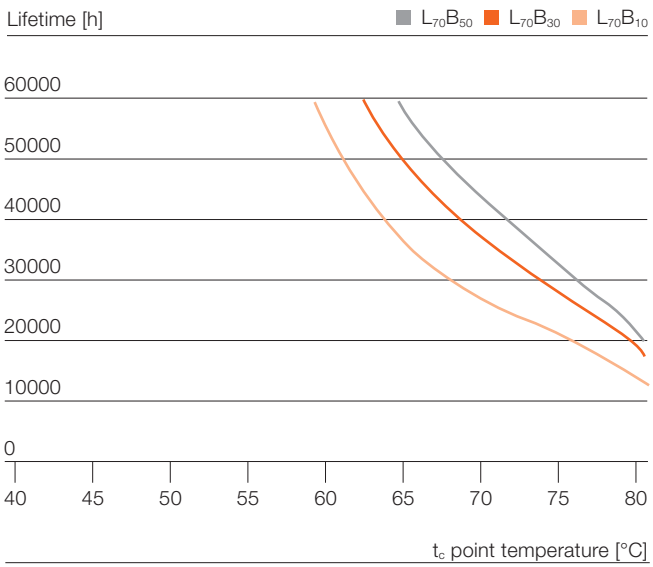
- L_0C_{10} is the lifetime where the light output is 0 % for 10 % of the light engines.
- $L_{70}F_{50}$ is the lifetime where the light output is ≥ 70 % for 50 % of the light engines. F value includes reduction of lumen output over time including abrupt degradation (flux = 0).
- $L_{70}B_{50}$ is the 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 flux degradation).

If the reference temperature (t_r) of 65 °C is maintained, PrevaLED® Core AC G2 light engines have an average lifetime of 50 000 hours ($L_{70}B_{30}$). The maximum temperature measured at the t_c point must not exceed 80 °C.

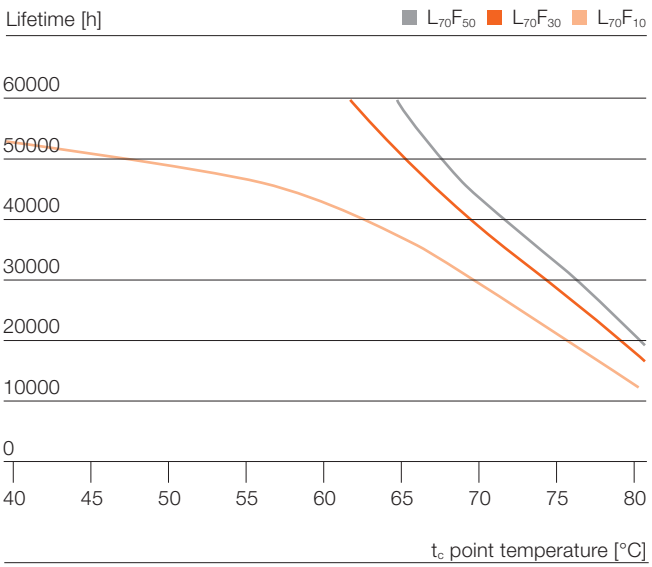
Note: Higher tc temperatures lead to a shorter lifetime of the PrevaLED® Core AC G2 light engines. Moreover, the failure rate will also increase.

The tables on page 13 show the lifetime of a PrevaLED® Core AC G2 light engine in relation to the temperature measured at the t_c point.

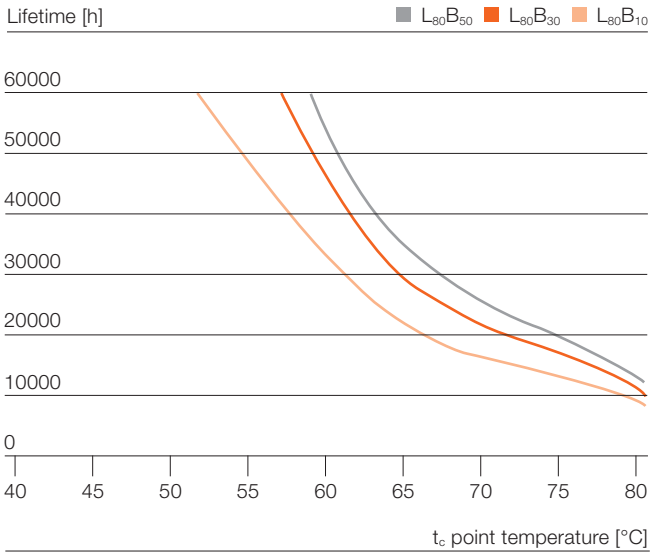
Lifetime $L_{70}B_{xx}$



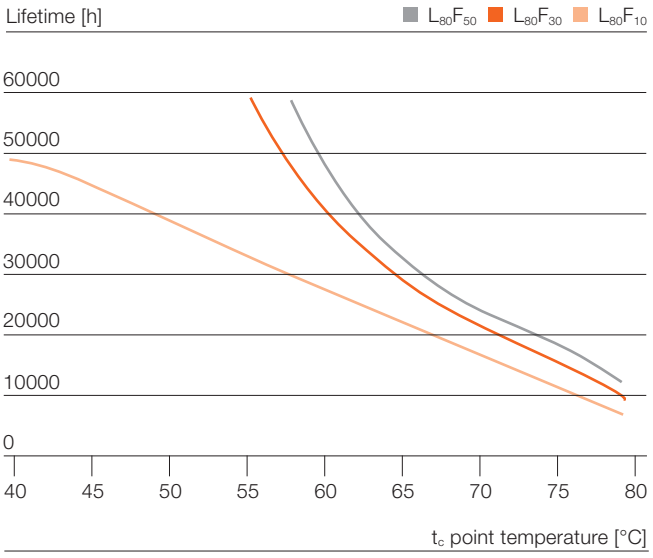
Lifetime $L_{70}F_{xx}$



Lifetime $L_{80}B_{xx}$



Lifetime $L_{80}F_{xx}$

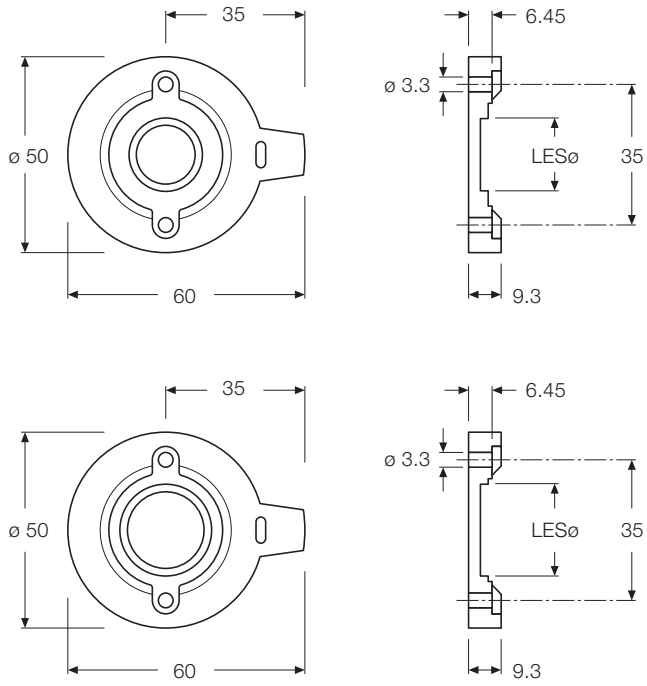


7 Mechanical considerations

7.1 Outline drawing

The following schematic drawing provides further details on the dimensions of PrevaLED® Core AC G2 light engines. For 3D files of the light engines, please go to: www.inventronics-light.com.

Technical drawing



All figures in mm

7.2 3D drawing

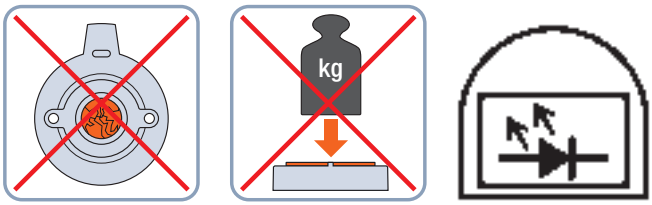
Move me!
Movable 3D PrevaLED® Core AC G2 2000 lm light engine (works with Adobe Acrobat 7 or higher)

7.3 Mechanical protection of the light engine

Note: The housing of a PrevaLED® Core AC G2 light engine must 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 protection glass 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!

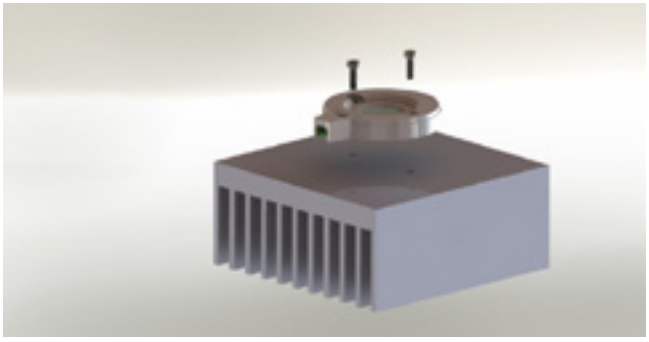
For operation in damp, wet or dusty environments, the user has to make sure that an adequate ingress protection is chosen. The light engine has to be protected by a suitable IP classification of the luminaire housing. Please consider the luminaire standard IEC 60598-1 as well as the different requirements.



1. Don't connect the module when the glass cover is broken.
2. Do not mechanically stress the module.
3. The LED light engine has to be built into a luminaire.

7.4 Mounting

To fix a PrevaLED® Core AC G2 light engine to 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 is 0.4 to 0.6 Nm.



Mount the light engine from the top

8 Assembly in a reference luminaire

To show you how easy it is to equip a luminaire with a PrevaLED® Core AC, the following example guides you through all necessary steps. In this case, the luminaire housing is used as the heat sink.

8.1 Preparation

The first step is to drill the holes and threads to mount the light engine according to chapter 7.4.

For the first test luminaire, drill an additional hole exactly at the location of the t_c point to connect the thermocouple with the PCB.

Drill the mounting holes and a hole for the thermocouple

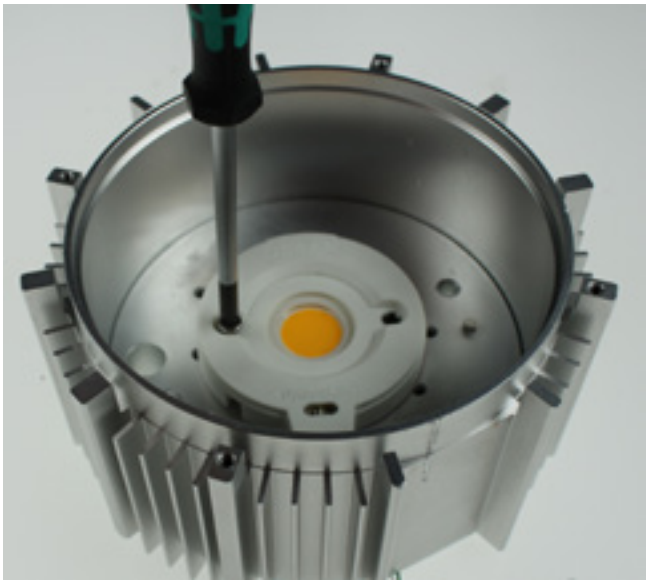
8.2 Attachment of the thermocouple

Run the thermocouple through the hole under the t_c point. Here, a thermal foil is used. In this case, please cut out a hole in the area where you attach the light engine to the PCB to ensure best possible thermal contact.

Run the thermocouple through the hole and cut out the TIM

8.3 Mounting of the light engine

Before you can screw the light engine to the housing, you need to glue the thermocouple to the PCB at the t_c point. Use the specified screws and do not apply more torque to them than allowed in order to protect the light engine from damage.



Screw the light engine to the housing

8.4 Wiring

In this case, a protection class I luminaire is designed. All metal parts have to be connected to earth. So the earth is connected to the housing of the luminaire, the phase and neutral conductors are connected to the light engine. Then you can close the luminaire and you are ready to run the thermal test.

Wire the luminaire

Close the luminaire

8.5 Temperature measurement

To check the maximum temperature at the t_c point, please operate the luminaire in the orientation of its application until a stable temperature is reached. Ensure that the maximum t_c temperature is not exceeded in the ambient temperature of its application.

Perform a steady-state thermal test

9 Norms and standards

Safety:	IEC/EN 62031
Photobiological safety:	IEC/EN 62471 Risk group 1
Electromagnetic compatibility:	IEC/EN 61547 IEC/EN 61000-3-2 IEC/EN 61000-3-3 EN 55015
Ingress protection:	IP20
Approvals:	CE, VDE, ENEC, VDE EMC mark

10 More information

Technical datasheets and downloads:	www.inventronics-light.com

Use our contact form

www.inventronics-light.com/contact-us

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