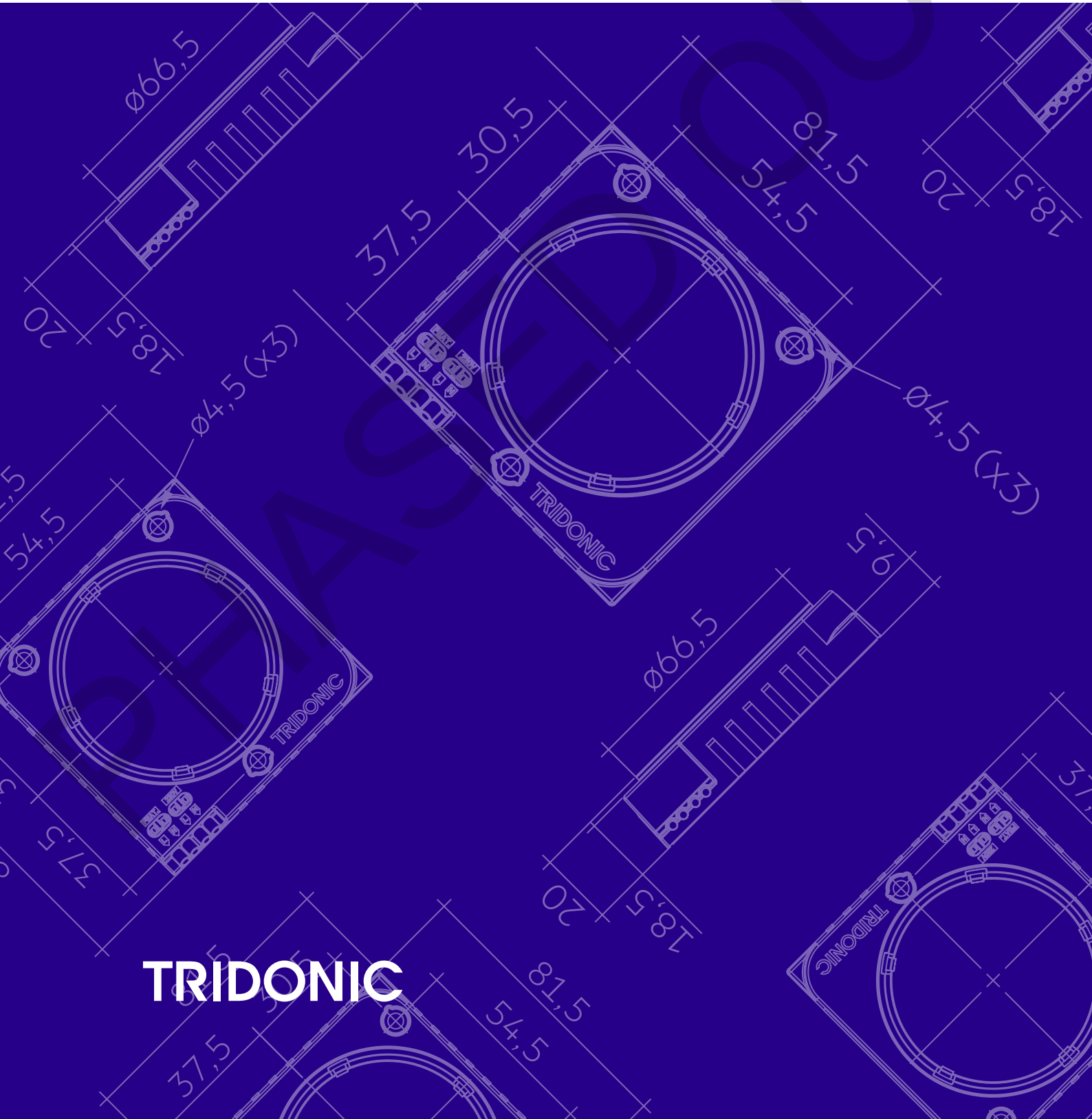
LED Engine

Engine DLE AC G3 ADV / PRE

Technical Design-in Guide



TRIDONIC

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Introduction

This design-in-Guide covers the DLE AC G3 downlight system from Tridonic.
The DLE AC G3 provides energy efficient lighting solutions with high quality light for retail, catering and other downlight applications.

The market-tested and extremely reliable DLE portfolio is being further expanded. The compact system solutions for your downlights with innovative driver-on-board technology in two different versions. The DLE AC G3 ADV is the non-dimmable version and the DLE AC G3 o4a PRE is the dimmable version. The dimming range for DLE AC G3 o4a PRE is 1 - 100 %.

The system consists of SMD module with driver-on-board technology and mount or only SMD module in three versions with colour temperatures of 3,000 K and 4,000 K.

The Design-in guide provides all the information needed to build a luminaire with the DLE AC G3 downlight system and adapt it to the desired needs. This includes:

- Dimensioning of the heat sink and reflector
- Selection of compatible LED driver
- Designing the luminaire with respect to thermal and mechanical needs

System Overview

The use of LEDs in general lighting has many advantages: LEDs are versatile in their application, highly energy efficient and virtually maintenance-free. With the DLE AC G3 you get a complete system solution for spot and downlights, consisting of perfectly matched components: LED module and LED Driver.

NOTICE

All information in this guide has been created with great care. Errors, additions and omissions excepted. For any resulting damage Tridonic accepts no liability. The latest version of this guide can be found at led.tridonic.com or at your sales partner.

2.1. Module variants

NOTICE

The DLE AC G3 series comprises different layers of modules:

- ADV (non-dimmable)
- PRE (dimmable)

The following variants are available:

Module name	Dimmable
with affix "ADV", e.g. DLE AC G3 60mm 3000lm 830 ADV	nein
with affix "PRE", e.g. DLE AC G3 60mm 3000lm 830 o4a PRE	ja

System Overview

The system DLE AC G3 is available in different variants:

	DLE AC G3
Key features	Consequent plain _ Static White with a CRI > 80 _ long lifetime _ high efficacy
Available variants	Available in 2 variants: _ dimmable (PRE) _ non-dimmable (ADV)
Colour temperature	3,000 K, 4,000 K
Luminous flux(1)	2,000 lm / 3,000 lm
colour rendering / colour tolerance	CRI 80 MacAdam 3 SDCM
System efficiency(1)	up to 114 lm/W
Energy classification	up to A+
Lifetime up to(2)	50,000 h
Warranty	5 year

(1) Values at tp = 65 °C, all values apply to Tp rated
(2) relating to L70/F10

The following type code is used to identify the modules:

Type code for modules for DLE AC G3 60mm 2000/3000lm 830 ADV

Reference	DLE AC G3	-	60mm	-	2000/3000lm	-	830	-	ADV
Meaning	Form: Downlight Engine		Size		Luminous flux without plug: 2000 lm Luminous flux with plug: 3000 lm		CRI 80 3000 K		Layer: ADV

2.1.1. Layer in detail

The LED-Module with driver-on-board technology are available in two different layers:

		PRE	ADV
Dimming	Dimming interface	o4a	no dimming
	Dimming range	1 - 100 %	

System Overview

	DALI DT6 / DSI / switchDIM / corridorFUNCTION	yes	no
Output current	via resistor or plug	no	yes, plug will be delivered
Adjustment	via DALI	yes	
Functions & Performance	THD	< 17 %	< 20 %
	Flicker	< 10 %	< 10 %
	Typ. power input on stand-by	< 0,5 W	
	ta range	25 °C up to +45 °C	25 °C up to +45 °C
	typical tp temperature	65 °C	65 °C
	max tc point temperature	80 °C	80 °C
	Lifetime up to	50,000 h	50,000 h
	Warranty	5 years	5 years

2.2. Standards and directives

2.2.1. Standards and directives for modules

The following standards and directives were taken into consideration in designing and manufacturing the modules:

CE

Standard	Description
2006/95/EG	Low-voltage directive: Directive relating to electrical equipment for use within certain voltage limits
2004/108/EG	EMC directive: Directive relating to electromagnetic compatibility

RoHS

Standard	Description
2002/95/EC	RoHS(1) directive: Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

(1) RoHS: Restriction of (the use of certain) hazardous substances

System Overview

Safety

Standard	Description
DIN IEC 62031:2008	Safety requirements for LED modules
EN 60598-1:2008 und A11:2009	General requirements and tests for luminaires
EN 60598-2-2:1996 und A1:1997	Luminaires - Part 2. Special requirements; Main section 2: Recessed luminaires
EN 62471:2008	Photo-biological safety of lamps and lamp systems

Safety and performance

Standard	Description
EN 61347-1:2009	General and safety requirements
EN 61347-2-13:2007	Special requirements for dc and ac powered electronic operating equipment for LED modules
EN 62384:2007 IEC 62384 A1:2009	Operational requirements

Energy labelling

Standard	Description
EU Regulation No: 874/2012	"Energy labelling of electrical lamps and luminaires"

2.2.2. Standards and directives for LED Drivers

The following standards and directives were taken into consideration in designing and manufacturing the LED Driver:

System Overview

EMI

Standard	Description
EN 55015 2008	Limit values measurement methods for radio interference properties of electrical lighting equipment and similar electrical devices
EN 61000-3-2:2005 A1: 2008 und A2:2009	Limit values for harmonic currents (equipment input current < 16 A per conductor)
EN 61000-3-3:2005	Limit values for voltage fluctuations and flicker in low-voltage systems for equipment with an input current < 16 A per conductor that are not subject to any special connection conditions
EN 61547:2001	EMC(1) requirements

(1) EMC: Electromagnetic compatibility

Safety

Standard	Description
EN 50172 2005	Safety lighting systems

DALI

Standard	Description
IEC 62386-101:2009	General requirements, system
IEC 62386-102:2009	General requirements, controller
IEC 62386-207:2009	Special requirements, controller; LED modules

Mechanical Aspects

3.1. Guideline for installation

The DLE AC G3 modules were tested with severity level 4. The guideline for installation can be taken from the ESD document.

NOTICE

EOS/ESD safety guidelines
The device/module contains components that are sensitive to electrostatic discharge and may only be installed in the factory and on site if appropriate EOS/ESD protection measures have been taken. No special measures need be taken for devices/modules with enclosed casings (contact with the pc board not possible), just normal installation practice.
Please note the requirements set out in the document EOS/ESD guidelines (Guideline_EOS_ESD.pdf) at:

- http://www.tridonic.com/com/de/download/technical/Richtlinie_EOS_ESD_de.pdf
- http://www.tridonic.com/com/en/technical-docs.asp

Product photo

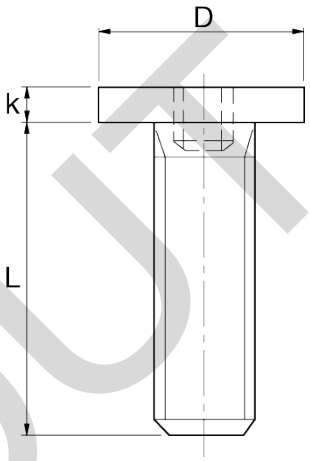
3.2. Installation of the modules

The modules are mounted on a heat sink with 3 bolts per module. In order not to damage the modules only raised head bolts should be used. The bolts should be selected on the basis of the following dimensions:

Mechanical Aspects

Dimensions of the fastening bolts

Variable	Value
Bolt size	M4 (1)
Min. length L	10 mm
Max. length L	Depending on the design of the luminaire and the heat sink
Diameter of bolt head	Dmax = 7.2 mm
Max. torque	1.2 Nm



(1) Use M3 bolts according to DIN 84 (ISO 1207, UNI 6107).

Mechanical Aspects

3.3. Requirements and protection measures against damage

Depending on the installation situation for the LED control gear and the modules, the following requirements must be met:

- Sufficient distance to active conducting materials
- Sufficient strain relief when the LED control gear cover is closed
- Sufficient cooling of the modules (the max. temperature at the tc point must not be exceeded)
- Unrestricted exit of light from the modules
- The module's push-in terminals allow easy wiring. They can be released via the trigger

3.3.1. Mechanical stress

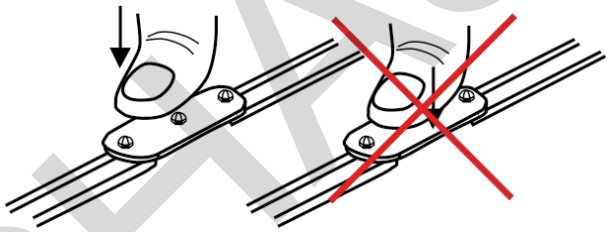
LED modules contain electronic components that are sensitive to mechanical stress. Such stress should be kept to an absolute minimum. In particular the following mechanical stresses should be avoided as these may cause irreversible damage:

- Pressure
- Drilling
- Milling
- Breaking
- Sawing
- and similar mechanical processing.

Compressive stresses

The components of the LED modules (circuit boards, glob-top, lenses, electronic components etc.) are sensitive to compressive stresses. The components must not be exposed to compressive stresses.

- If glass or Plexiglas shields are used make sure that pressure is not exerted on the glob-top.
- Only touch the LED modules at the edges



correct (left) and incorrect (right)

3.3.2. Chemical compatibility

LED modules can be damaged by other materials, if these materials have certain chemical properties. The cause for these damages are different gaseous compounds, which penetrate into the encapsulant of the LED and thereby attack the encapsulant, the colour conversion phosphor or the LED chips and can affect the electrical contacts or the substrate.

Application areas for chemical substances

The following are known areas in which chemical substances are used:

Mechanical Aspects

- use of protective coating in applications with high relative humidity (outdoor applications),
- encapsulation of LED modules,
- cementing of LED modules,
- sealing of luminaires.

The following materials must be checked for their safety:

- All components and auxiliaries used in the assembly of the luminaire:
  - Solvents of adhesives and coatings
  - Other so-called VOC ("volatile organic compounds")
- All other additional substances present in the atmosphere:
  - Outgassing of adhesives, sealants and coatings
  - Cleaning agents and processing aids (e.g. cutting oils and drilling coolants)

NOTICE

Contact your LED manufacturer for questions about the materials used and possible interactions and risks.

Putting together a "safe list" is not possible due to the complexity of the topic. The following table lists possible contaminants for LED modules, the classes of compounds and examples of possible sources.
The list shows the most commonly used materials but does not claim to be complete.

Class of compounds	Chemical names	Occurs in
Acids	- hydrochloric acid - sulfuric acid - nitric acid - phosphoric acid	- cleaner - cutting oils
Organic acids	- acetic acid	- RTV silicones - cutting oils - degreaser - adhesives
Alkalis	- ammonia - amines - sodium hydroxide	- detergents - cleaner

Mechanical Aspects

Organic solvents	_ ethers (e.g. glycol) _ ketones (e.g. Methylethylketon) _ aldehydes (e.g. formaldehyde) _ aromatic hydrocarbons (e.g. xylene and toluene)	_ cleaner _ benzine _ petroleum _ paints and varnishes
VOC (volatile organic compounds)	_ acetate _ acrylates _ aldehydes _ serve	_ super glue _ all-purpose glue _ screw locking varnish _ coatings _ paints and varnishes
Mineral oils	_ hydrocarbons	_ machine oil _ lubricants
Vegetable oils and synthet. oils	_ siloxanes _ fatty acids	_ silicone oils _ linseed oil _ fats
Harder, vulcanizer	_ sulfur compounds	_ seals _ sealants _ colours

Protection measures for the glob top material

The following guidelines must be observed to avoid damage to the glob-top:

- Make sure that the chemicals used in LED applications are not solvent-based, condensation crosslinked or acetate crosslinked (acetic acid). These give rise to reagents (e.g. solvent vapors, acetic acid) that may damage LED modules or the encapsulant. This applies to chemicals that are used not in the immediate vicinity of the modules (e.g. seals) and also to chemicals that come into direct contact with the modules (e.g. insulating coatings, adhesives).
- To ascertain the chemicals used and the type of cross linking a technical data sheet containing a list of substances must be requested from the manufacturer.

Example of damaged encapsulant material, recognizable by the change of the chromaticity coordinates:

powerLED P211, original	powerLED P211, damaged by dissolver waste gas
	

Mechanical Aspects

Protection measures in regards to sealing

The points above also apply to chemicals used for sealing luminaire casings. If however the LED module is not installed in the luminaire until after the sealing compound has been completely cured (see relevant material information) the above points can be ignored.

If the LED modules have already been installed in the luminaire, possible damage to the encapsulant can be reduced to a minimum by ensuring adequate spacing (>10 cm) and ventilation (open casing and air circulation, extraction / fan) during the curing process.

Protection measures in regards to cementing

To avoid damaging the LED modules you must not use any tools or exert any pressure on the electronic components or the encapsulant.

- If glass or Plexiglas shields are used make sure that pressure is not exerted on the encapsulant.
- Only touch the LED modules at the edges

3.3.3. Cleaning the LED module

⚠ CAUTION!

It is not permitted to clean LED modules during operation. It is necessary to disconnect the power supply. This means for example removing the spotlight from the supply rail only after that it is allowed to clean the module.

There are two options for cleaning the LED module:

Cleaning with compressed air

Procedure

- Apply compressed air at an angle of appr. 45° and a distance of 5 cm

Cleaning with Isopropyl alcohol

⚠ CAUTION!

Mechanical stress may damage the LED module's bond wires, compound or other fragile parts.

- Don't apply mechanical stress onto the LED module while cleaning

ⓘ NOTICE

The product's warranty expires in case the LED module was damaged as a result of mechanical stress .

Mechanical Aspects

Procedure

- Moisten cotton pads with isopropyl alcohol, make sure that it doesn't get wet!
- Clean the LED module with the moist cotton pads
- Use new and dry cotton pads to remove remaining isopropyl alcohol from the LED module

3.3.4. Cementing the LED module

Preparation

Clean and durable bonding of two materials requires special attention.
The following cleaning agents are recommended:

- Isopropanol / Water 50/50
- Acetone
- Heptane

Important aspects

- Carrier material
  The carrier material must have adequate thermal conductivity (e.g. aluminium). The size of the cooling surface depends on the power of the LEDs, among other things. For information on the cooling surface required, see the appropriate product data sheet.
- Adhesive material
  The carrier material itself plays an important role in selecting the adhesive material. The crucial factors are the coefficient of expansion and compatibility with the base material of the LED module board (plastic or aluminium). This must be checked in the application in terms of long-term stability, surface contamination and mechanical properties.
- Surface quality
  The carrier material must be uncoated (thermal transport, adhesion) and level at the connection points.
- Installation temperature
  To achieve optimum adhesion we recommend you carry out this work at room temperature.
- Duration, optimum adhesive strengths
  Maximum adhesion is achieved within 48 hours at room temperature; the process is accelerated by heat. In actual practice this means that at the maximum t_c temperature (approx. 75-85 °C, product-specific) maximum adhesion is reached after about 12 hours. During the curing period make sure that there is no tensile load on the adhesive connection of the LED module.

Additional information

LED modules must not be stuck and restuck time and again without replacing the adhesive tape. Damaged adhesive tapes must be completely removed and replaced by new tapes.

3.3.5. Packaging and transport

LED products from Tridonic are delivered in appropriate packaging. The packaging provides special protection against mechanical damage and ESD (electrostatic discharge). If you need to transport LED products you should use this packaging.

Electrical Aspects

4.1. Electrical connections

4.1.1. Electrical safety

Basic classification of protection classes

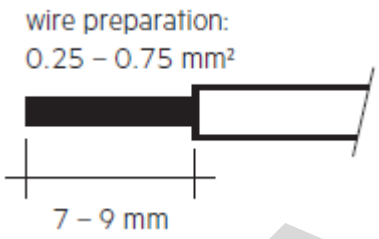
Depending on the design of the luminaire, the requirements of different electrical protection classes are satisfied:

- In case DLE AC G3 o4a PRE modules are mounted into a protection class I luminaire, heat sink and lamp housing must be earthed. In case DLE AC G3 o4a PRE modules are mounted into a protection class II luminaire, the LED module and all conductive parts in electric connection (like heat sink, etc.) must be untouchable.
- DLE AC G3 o4a PRE from Tridonic which have to be installed on a heat sink have to be connected with heat-conducting paste or heat conducting adhesive film and fixed with M4 screws. The fixing/cooling surface must be cleaned before installing the LED to remove all dirt, dust and grease. None of the components of the DLE AC G3 o4a PRE (substrate, LED, electronic components etc.) may be exposed to tensile or compressive stresses.

4.1.2. Wiring

Wiring type and cross section

The wiring can be solid or stranded wires with a cross section of 0.25 to 0.75 mm². For the push-wire connection you have to strip the insulation7 – 9 mm. Loosen wire through twisting and pulling.

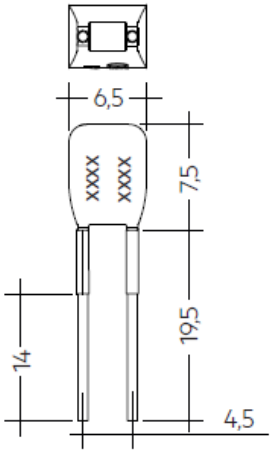


4.1.3. Connections

Connections on DLE AC G3 ADV

Pin	Connection on the LED control gear	Design
L	Power input 230 – 240 V AC	push-in terminal
N	Power input 230 – 240 V AC	push-in terminal
FEAT	optional for the delivered plug	push-in terminal
FEAT	optional for the delivered plug	push-in terminal

Electrical Aspects

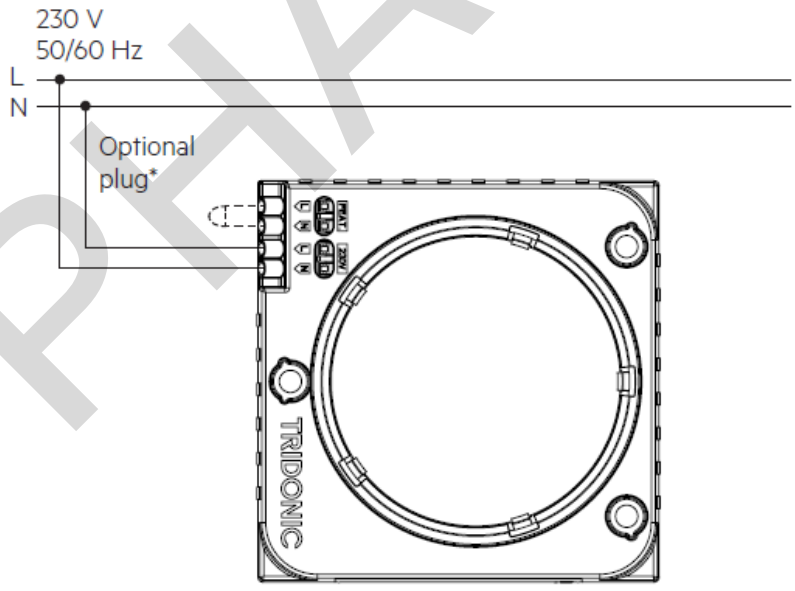


Connections on DLE AC G3 PRE

Pin	Connection on the LED control gear	Design
L	Power input 230 – 240 V AC	push-in terminal
N	Power input 230 – 240 V AC	push-in terminal
FEAT	Control input for DALI / switchDIM	push-in terminal
FEAT	Control input for DALI / switchDIM	push-in terminal

4.2. Wiring diagrams

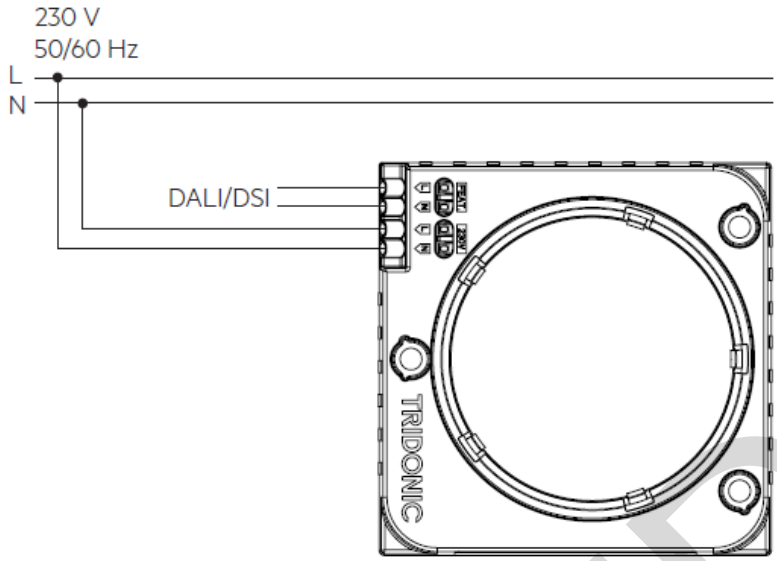
4.2.1. Wiring diagram for DLE AC G3 ADV



Electrical Aspects

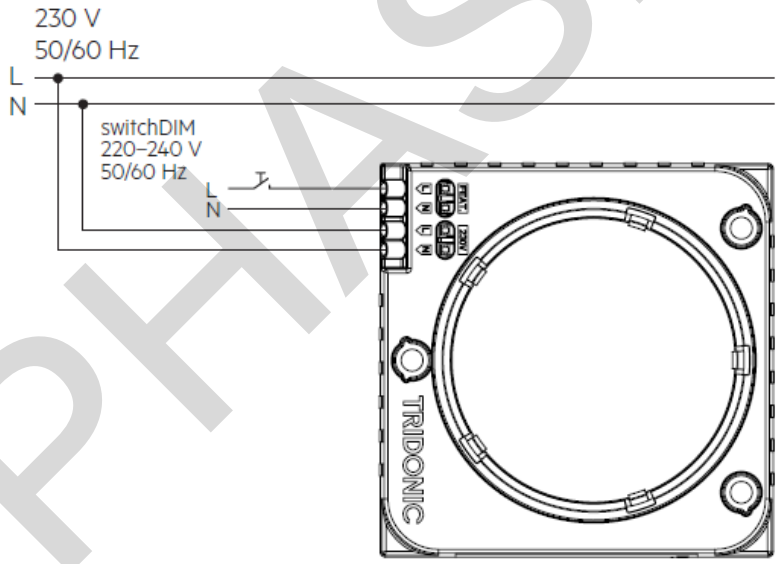
The wiring diagram shows the connection between a LED control gear and the LED module DLE AC G3 ADV and the connection between the LED control gear and the power supply.

4.2.2. Wiring diagram for DALI for DLE AC G3 PRE



The wiring diagram shows the connection between a LED control gear with dimming function and the LED module DLE AC G3 PRE and the connection between the LED control gear and the power supply and the digital DALI signal.

4.2.3. Wiring diagram for switchDIM for DLE AC G3 PRE



The wiring diagram shows the connection between a LED control gear without the dimming function and the LED module DLE AC G3 PRE and the connection between the LED control gear and the power supply.
The integrated switchDIM function is operated via an appropriate momentary-action switch.

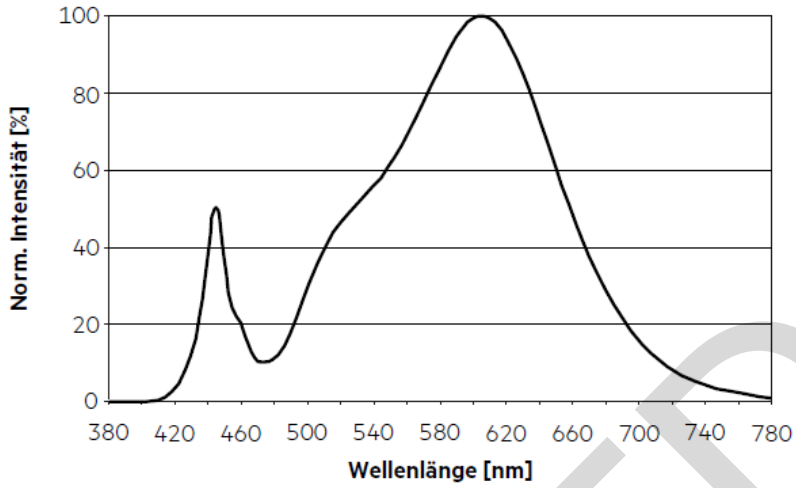
Optical Aspects

5.1. Colour spectrum

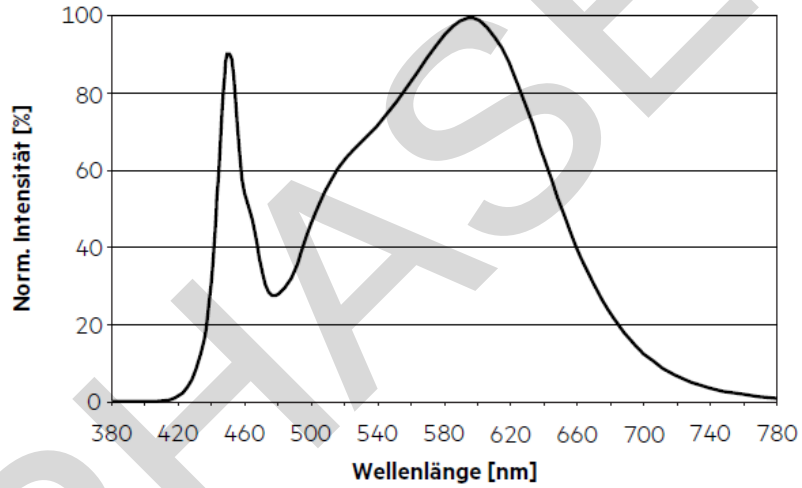
The technology used in the LED products enables LEDs to be produced in special light colours or colour temperatures. This means that lighting systems can be created that are not only energy-efficient but also have excellent colour rendering.

The diagram shows the normalised intensity in percent over the wavelength in nm at different colour temperatures.

3,000 K



4,000 K



5.2. CRI, Ra and Ri - different colour rendering values

The CRI (colour rendering index) and Ra (arithmetic average) value are different names for the same thing. They are defined as the “effect of an illuminant on the colour appearance of objects by conscious or unconscious comparison with their colour appearance under a reference illuminant”.

CRI and Ra are determined by a test procedure. In this procedure eight colour samples (R1-R8) are illuminated both by the light in question and by a reference light source and the appearance of the samples under the different lights is compared.

Optical Aspects

If there is no perceivable difference the light in question will be rated with a maximum value of 100. Differences in appearance result in a deduction from the maximum value. The resulting number is the Ri value and describes the colour rendering for one specific colour sample. The average of all eight Ri values is the CRI or Ra value and describes the general colour rendering of the tested light source.

The eight colour samples consist of different pastel colours and can be found in the table below as TCS (test colour samples) 01-08.

There are six more colour samples: R9 to R14 or TCS09 to 14. They consist of different saturated colours and are not used for the calculation of the Ri, Ra and CRI value. However, these colours, especially R9, do have a special importance in the illumination of meat, fish, vegetables and fruit in retail areas.

Name	Appr. Munsell	Appearance under daylight	Swatch
TCS01	7,5 R 6/4	Light greyish red	
TCS02	5 Y 6/4	Dark greyish yellow	
TCS03	5 GY 6/8	Strong yellow green	
TCS04	2,5 G 6/6	Moderate yellowish green	
TCS05	10 BG 6/4	Light bluish green	
TCS06	5 PB 6/8	Light blue	
TCS07	2,5 P 6/8	Light violet	
TCS08	10 P 6/8	Light reddish purple	
TCS09	4,5 R 4/13	Strong red	
TCS10	5 Y 8/10	Strong yellow	
TCS11	4,5 G 5/8	Strong green	
TCS12	3 PB 3/11	Strong blue	
TCS13	5 YR 8/4	Light yellowish pink	
TCS14	5 GY 4/4	Moderate olive green (leaf)	

In the production of modules chips with different wavelengths and chip performances are used.

Because of this, different phosphor mixtures are needed to achieve the required target coordinates and single Ri values can differ between orders. This is not problematic. What is decisive for the overall impression of the LED module is its CRI value. But if specific single Ri values are required for an application, it must be made clear that these values may change for the reasons stated above. It is also not possible to specify tolerances.

Special LED modules are optimised to illuminate a particular product group (for example, MEAT+ is designed for the illumination of beef). In this case, specifying the CRI or single Ri values does not make sense. For special LED modules the subjective human perception is the most important factor. The colour coordinates for GOLD, GOLD+, Fresh Meat and MEAT+ are the result of appropriate tests. Single Ri values or the CRI value are not assessed.

Optical Aspects

5.3. Standard deviation

The human eye can not only recognise different colours along the black body curve, but also deviations above or below this line. If an LED has a colour temperature of 2,700 K , but is not directly located on the black body curve, it can be perceived as different from another LED with the same colour temperature. To prevent such differences and to assign an LED unambiguously, the chromaticity coordinate must be specified using the x, y coordinates in the colour space chromaticity diagram .

An even more accurate approach is to specify the standard deviation from the target colour, based on levels of MacAdam ellipses. The unit for this is called "SDCM" (abbreviation for "Standard Deviation of colour Matching"). When looking directly into a light source, these differences are perceived more strongly than in a "normal" situation where light is mainly perceived because of its reflections from illuminated surfaces.

Colour differences within one level of the MacAdam ellipses are not visible even when looking directly into the light source. Deviations of two to three levels (<= 3 SDCM) are considered barely perceptible. A value of 3 SDCM is good for LED light sources. For most applications a value of 5 SDCM is still sufficient .

5.4. Binning

Chips and packages from the same production can still show small variations in colour temperature and forward voltage . If the chips are used without pre-selection, these differences can be noticeable and interfere with the appearance.

Binning means that the chips and packages are classified according to their colour temperature and forward voltage. This leads to groups of chips or packages that fall into a very narrow window of tolerance. If LED modules are equipped with such chips and packages differences in appearance can be prevented.

5.5. Secondary Optics

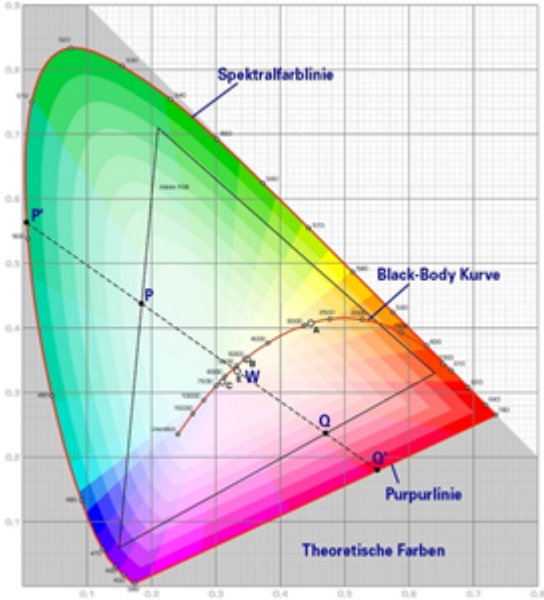
The term Secondary Optics refers to additional optical elements that shape the light output in different forms. Secondary Optics include e.g. reflectors, lenses or covers.

5.6. Coordinates and tolerances (according to CIE 1931)

As before, the production process for LED LEDs does without binning. As a result, white LEDs can be produced with normal distribution in the range of a MacAdam-Ellipse 3. Thanks to the proximity to the Planckian curve there are no annoying colour discrepancies.
Every module is automatically tested at the final inspection stage to ensure that all the supplied products fall within the agreed specification.

Optical Aspects

5.6.1. Chromaticity coordinate



LEDs exhibit variations in terms of their exact shade of colour. This means that different “white” LEDs will all shine in a colour that is within the white colour spectrum. But the colours won’t be exactly the same.

These colour differences between LEDs are problematic in areas where the lighting must produce a specified and uniform colour and deviations from that can impair the visual appearance of an installation. Using the chromaticity coordinate helps to avoid such problems by defining the exact shade of colour of an LED.

Technically speaking, the chromaticity coordinate is defined by its three coordinates (x, y, z) within the so called CIE 1931 colour space chromaticity diagram.
The CIE 1931 colour space chromaticity diagram represents all the colours that are discernible for humans. Since the three coordinates sum up to 1, two coordinates are sufficient to define a colour and so one one coordinate is sometimes left out.

5.6.2. Colour temperature and Black Body Curve

The Black Body Curve within the colour space chromaticity diagram represents the colours that show when a so-called "black body" is slowly heated.

A "black body" is an "idealised" body which absorbs all light and has no reflected radiation.
If a "black body radiator" is slowly heated, it passes through a colour scale from dark red, red, orange, yellow, white to light blue. The definition for the colour temperature of a light source is the temperature where the “black body radiator” shows the same colour.

The colour temperature is measured in Kelvin (K). The most common luminaires have colour temperatures below 3,300 Kelvin (warm white), between 3,300 and 5,300 Kelvin (neutral white) or above 5,300 Kelvin (daylight white).

5.7. Eye safety

The human eye can be damaged if it is directly exposed to a light source. Different light sources pose a hazard:

Optical Aspects

Risk group	Evaluation
Actinic UV E_S (200 - 400 nm)	Risk group 0 (1)
Near UV E_{UVA} (315 - 400 nm)	Risk group 0 (1)
Blue light L_B (300 - 700 nm)	Risk group 0 (1)
Retina, thermal L_R (380 - 1,400 nm)	Risk group 0 (1)
IR radiation, eye E_{IR}(780 - 3,000 nm)	Risk group 0 (1)

(1) The evaluation of eye safety is based on EN 62471:2008 (photo-biological safety of lamps and lamp systems):

- Risk-free (risk group 0): The LEDs do not pose any photo-biological risk.
- Low risk (risk group 1): The LEDs pose a small risk because of normal limitations.
- Medium risk (risk group 2): The LEDs pose a small risk because of reactions to bright light sources or thermal discomfort.
- High risk (risk group 3): The LEDs pose a risk even with just momentary or temporary exposure.

The risk depends on the size of the light source and its intensity. The risk increases with smaller light sources and higher light intensity.

Optical Aspects

According to the classification of the LED into certain risk groups luminaire manufacturers must consider different requirements:

Necessary measures	RG 0	RG 1	RG 2	RG 3
Indication of risk group in the data sheet of the LED	n.a.	✅	n.a.	n.a.
Stating at what distance the LED module falls back into risk group 1	n.a.	n.a.	n.a.	n.a.
Positioning of the luminaire so that direct exposure to the light can be prevented	n.a.	n.a.	n.a.	n.a.
Labeling the luminiare with the following symbol: 	n.a.	n.a.	n.a.	n.a.

The risk group classification for the luminaire is the same as that of the installed LED module.

5.8. Reflector design

The mechanical and optical properties of the modules DLE AC G3 offer the best conditions for using reflectors. The overall efficiency of the system can be optimised by choosing a reflector that directs the light appropriately.

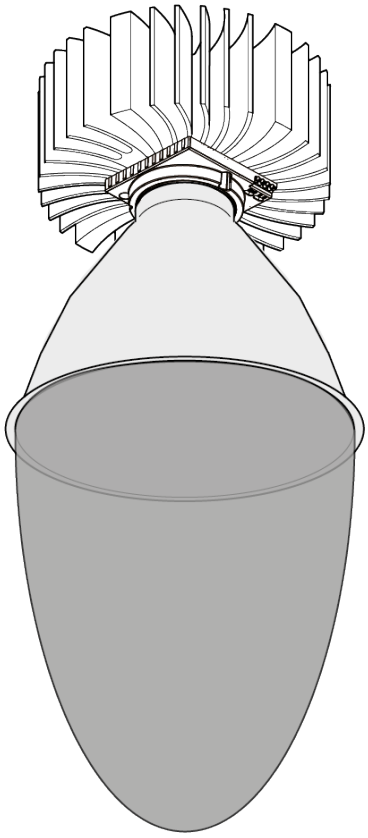
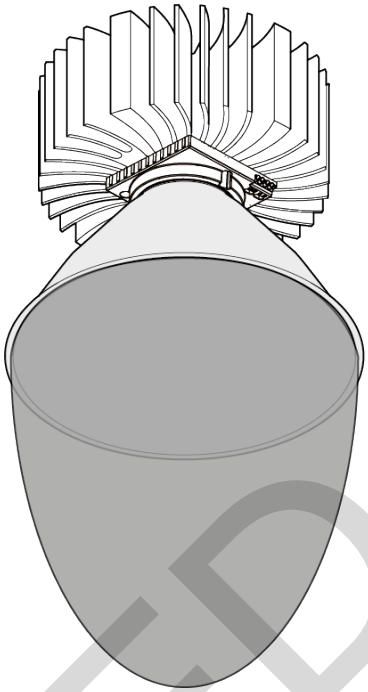
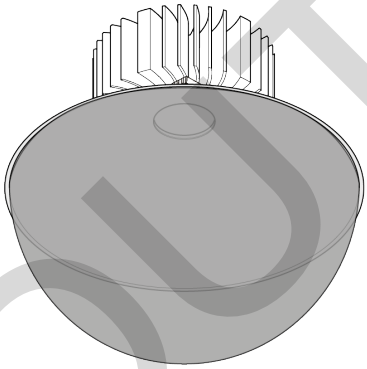
The optical properties (e.g. beam angle) and the dimensions of the reflector play a crucial role.

The overall height of the luminaire can be reduced by selecting a low-profile reflector, depending on the beam angle required. This may improve the thermal output of the luminaire by increasing the height available for the heat sink.

To achieve uniform illumination a reflector withy an integrated diffuser is recommended for LED modules with multicolour LEDs. This ensures that the colours are properly mixed. Some reflectors have the option of faceting for the reflector wall. Depending on the position of the homogenising element, different efficiencies and different colour mixing results can be achieved.

Optical Aspects

Examples of reflectors with different beam angles

Spot	Medium	Flood
		

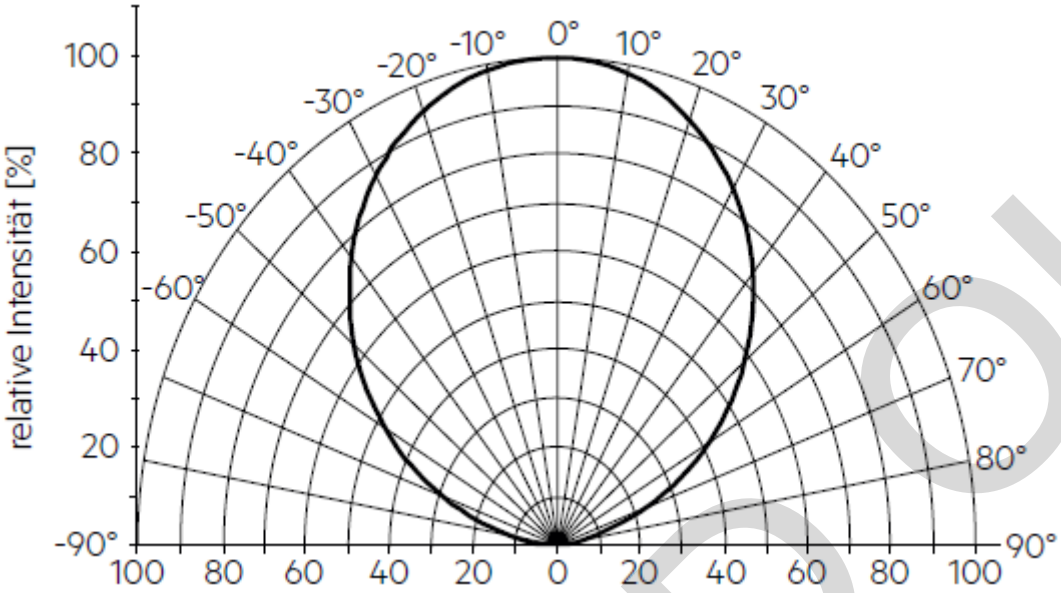
NOTICE

To help create customised designs and to carry out optical simulations CAD data and Rayfiles are available for download from the Tridonic website.

- Go to the produkt page on the Tridonic homepage at http://www.tridonic.com/com/en/products.asp.
- Choose the desired product
- Click on CAD/RAY slide at bottom of the page

Optical Aspects

5.8.1. Beam characteristics



Optical Aspects

5.8.2. Photometric code

Key for photometric code, e.g. 830 / 359

1st digit		2nd + 3rd digit	4th digit	5th digit	6th digit	
		Colour temperature In Kelvin x 100	McAdam initial	McAdam after 25 % of the life time (max. 6,000 h)	Luminous flux after 25 % of the life time (max. 6,000 h)	
Code	CRI				Code	Luminous flux
7	70 – 79				7	>= 70 %
8	80 – 89				8	>= 80 %
9	>= 90				9	>= 90 %

Thermal Aspects

6.1. Decrease of luminous flux

6.1.1. Lifetime, luminous flux and failure rate

The luminous flux of an LED module decreases over lifetime. The L value describes this behaviour.

L70 means that the LED-module delivers 70 % of the initial luminous flux. This value is always linked to a certain operation time and defines the lifetime of the LED module.

The L value is a statistical value. The actual reduction of the luminous flux may vary within the supplied LED modules. For this reason, the B value specifies how many modules fall below the given L value, e.g. L70B10 means that 10 % of the LED modules fall below 70 % of the initial value (or 90 % of the LED modules stay above 70 % of the initial value).

Additionally, C value specifies the percentage of total failures.

The F value describes the linkage of B and C value and takes both total failures and degradation into account. L70F10 means that 10 % of the LED modules have either shown total failure or fallen below 70 % of the initial value.

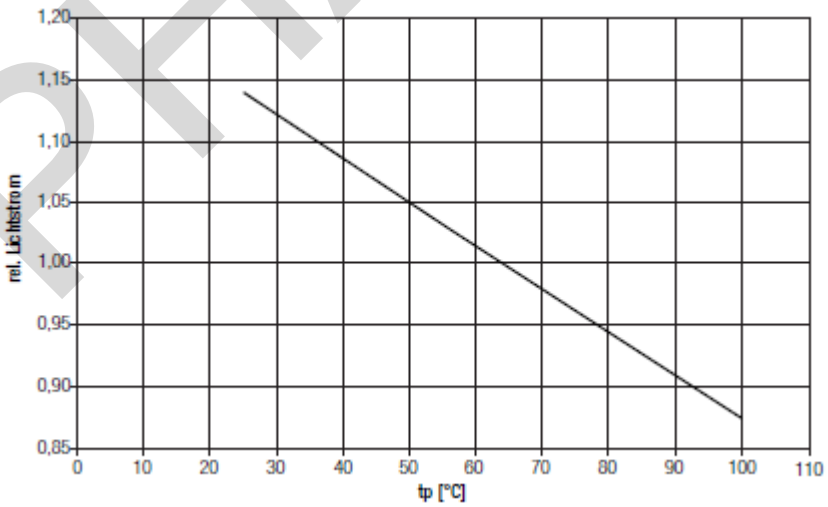
There are two reasons for the limitation of the lifetime data with 50,000 h:

1. The LED modules have been tested for 9,000 hours. According to LM80, it is possible to make a 6-fold extrapolation. The lifetime of the LED modules is by no means limited to 50,000 h. But due to the diversity and the rapid generational changes it is not possible to conduct tests over a period of several hundred hours. Before the tests had been completed, the tested chips were no longer available on the market. Due to the tested data, we can specify 50,000 h. The LED lifetime is certainly higher!
2. The switching cycles of the LED modules must be tested according to standard IEC 62717 / 10.3.3. If a lifetime of 50,000 h is communicated, the LED modules must have been tested for at least 25,000 switching cycles. Our LED modules meet the requirements of standard IEC 62717 / 10.3.3 and have been tested for 25,000 switching cycles.

6.1.2. Effect of cooling on the life of the modules

The life of the module depends to a large extent on the operating temperature. The more that the operating temperature can be reduced by cooling, the longer the expected life of the module. If the permitted operating temperature is exceeded, however, the life of the module will be significantly reduced.

Figure: Lifetime characteristic



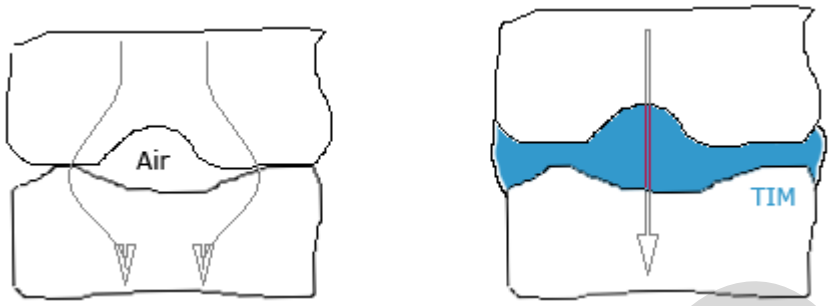
Thermal Aspects

NOTICE

Please check the information on the operating temperature and the requirements for cooling in the module data sheets.

6.1.3. Thermal Interface Material

Figure: Heat transfer without TIM (left) and with TIM (right) (magnified illustration)



Thermal Interface Material (TIM) helps to reduce the thermal impedance between LED module and heat sink and thus improves the heat transfer between the two components.

When LED module and heat sink are joined together, uneven surfaces can be the cause for trapped air. Since air is a thermal insulator trapped air obstructs the heat transfer. TIM replaces the trapped air and improves the heat transfer.

In general:

- The lower the thermal impedance, the better the heat transfer and thus the cooling of the modules.
- The thickness of the TIM relates to the unevenness of the surfaces: the more uneven the surface is, the thicker the TIM must be.

6.1.4. Rth

The lifetime of LED products is highly dependent on the operating temperature. Exceeding the permissible temperature limits results in a significantly reduced lifetime or the destruction of the LED module DLE AC G3. Therefore, it is necessary to mount the LED module DLE AC G3 on an appropriate heat sink, which do not exceed the Rth_{max} value. The Rth values can be found in the data sheet of the respective products. The data sheets can be found on the Tridonic website at the following link: http://www.tridonic.com/com/en/data-sheets.asp

6.1.5. tp point, ambient temperature and lifetime

The temperature at the tp point is crucial for the luminous flux and the lifetime of a LED product.

The thermal limits can be checked at the tp/tc point and the tr point.

- tp is the temperature at which the rated values are obtained.
- tc is the threshold temperature which ensures the security of the module and must not be exceeded under normal conditions.
- tr_{max} specifies the thermal connection of the heat sink and the luminaire for the interchangeability with other Zhaga products.

Thermal Aspects

For the DLE AC G3 tp a temperature of 65 °C must be maintained in order to achieve an optimum between heat sink requirements, luminous flux and lifetime.

Adherence to the permitted tp temperature must be checked under operating conditions in a thermally stable state. For this the max. ambient temperature of the relevant application must be taken into account.

Explanatory note

The actual cooling may deviate due to the material, the design, external and situative influences. A thermal compound between DLE AC G3 and heatsink using thermal paste or thermally conductive adhesive foil is absolutely necessary.

Additionally, in order to optimize the thermal connection, the DLE AC G3 has to be mounted on the heat sink with M4 screws.

The calculation of the heat sink information is based on the use of thermally conductive paste with a thermal conductivity of > 1 W / mK and a thickness of max. 50 µm or a thermally conductive adhesive foil with b <50 µmmK/W.

6.1.6. Requirements for the heat sink

Although the operating temperature of the modules is continually monitored during operation and the power is automatically reduced in the event of excess temperature, the modules should not be operated without a heat sink.
The heat sinks must be dimensioned to provide adequate cooling capacity.
The R_{th} value is important for selecting an appropriate heat sink. This value depends on the light output of the module and on the ambient temperature in which the module is to be operated. The R_{th} value of the heat sink must be smaller than the required R_{th} value.

NOTICE

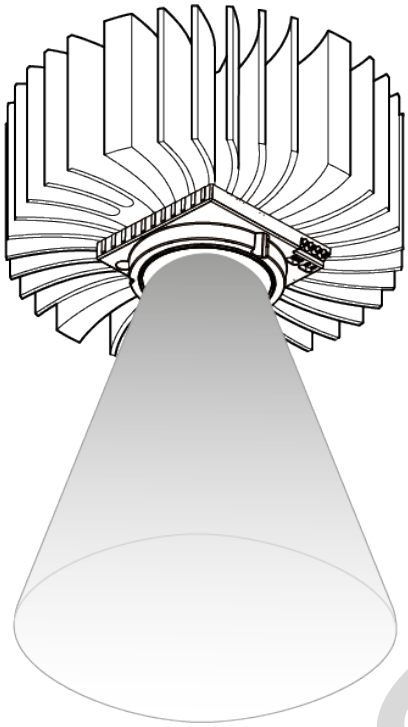
Please check the information on heat sinks in the module data sheets.

Thermal Aspects

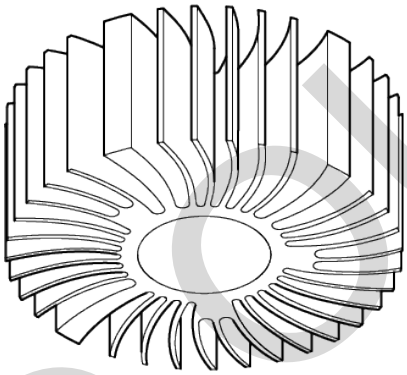
6.2. Passive and active cooling

6.2.1. Passive cooling

Example of passive cooling for the module



Passive cooling module



Heat transfer from a heat source to the surrounding cooling medium (e.g. air) depends primarily on the difference in temperature, the effective surface area and the flow rate of the cooling medium. The function of a heat sink is to increase the surface area over which the heat can be dissipated. This lowers the thermal resistance.

A passive heat sink works mainly by convection. The surrounding air is heated, which makes it rise, and is replaced by cooler air. Heat pipes can be used as an alternative to cooing with fans. If space is particularly tight, the heat is first conveyed away. The actual heat sink is located at the other end of the heat pipe.

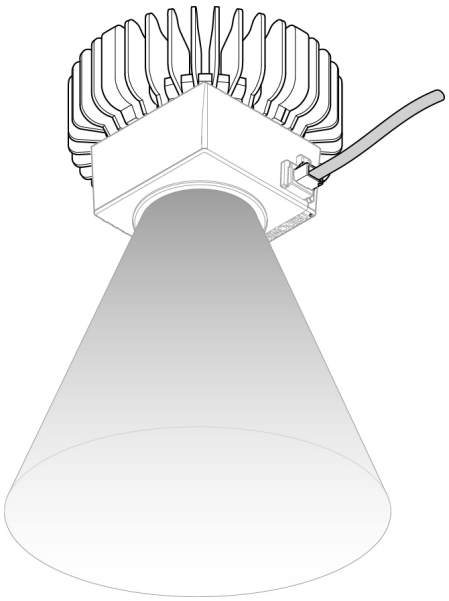
Benefits of passive cooling

- Energy savings
- Silent
- No mechanical wear
- No maintenance

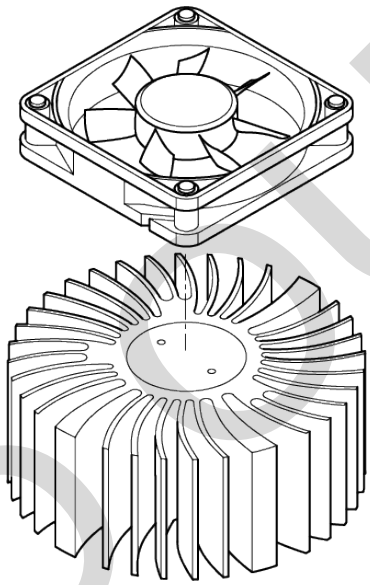
Thermal Aspects

6.2.2. Active cooling

Example of active cooling for the module



Round active cooling module



An active heat sink consists of the heat sink itself and an electrically powered fan. The fan dissipates heat from the heat sink by blowing a sufficient quantity of air along the surface of the heat sink. To reduce the power draw and noise, the fan speed can be controlled from the active cooling system on the basis of temperature.(1) A diaphragm can be used as an alternative to fans to produce active air movements.

Active heat sinks with fan cooling achieve around six times the performance of passive heat sinks for the same amount of material used. Active heat sinks can therefore be made very compact.

(1) The fan speed is not controlled from the LED engine system.

Benefits of active cooling

- Space savings
- Effective cooling
- Professional design

6.3. Fan connection and temperature measurement

6.3.1. Fan driver

Fan drivers drive active heat sinks in order to make sure that the LED modules are sufficiently cooled.

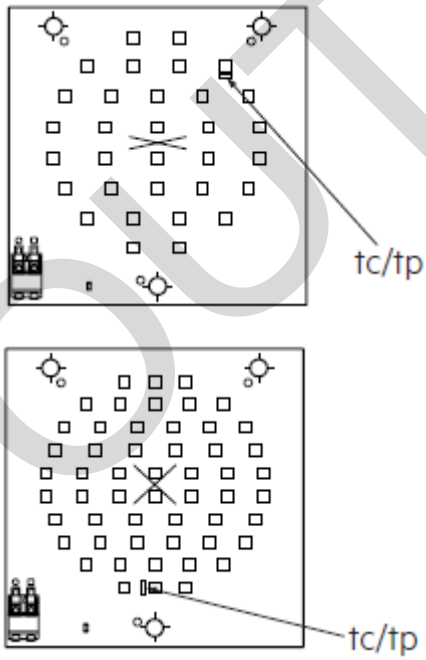
Thermal Aspects

6.3.2. Temperature measurement on the module

The temperature of the module must be measured at the t_c/t_p point. As shown in the drawing of the DLE AC G3 beside the t_c/t_p point is marked on the module.

The temperature can be measured with a simple temperature probe. In actual practice, thermocouples (e.g. B & B Thermotechnik thermocouple, K-type) have been successfully used for taking measurements. Such thermocouples can be attached directly to the t_c/t_p point with heat-resistant adhesive tape or a suitable adhesive. The measured values are recorded by an electronic thermometer (e.g. "FLUKE 51", VOLTCRAFT K202 data logger).

The maximum possible temperature must be determined under worst-case conditions (ambient temperature of the luminaire, installation of the luminaire) for the relevant application. Before the measurement is taken the luminaire should be operated for at least 4 hours in a draught-free room.



6.3.3. ta, tp rated, tc max

- ta ... ambient temperature: The ta temperature is the ambient temperature at which the LED module is operated.
- tp rated ... performance temperature: The tp rated temperature is the temperature at which the photometric and electrical data are given. This is the temperature that the LED module has when it is in operation.
- tc max ... max. case temperature: Tc max temperature is the max. temperature that the LED module is allowed to have. The tc max temperature is safety relevant. This is the max. temperature at which the LED module can be operated without compromising security.

Ordering information and sources

7.1. Article numbers

NOTICE

The DLE AC G3 series comprises different layers of modules:

- ADV (non dimmable)
- PRE (dimmable)

The following variants are available:

Module name	Dimmable
with affix "ADV", e.g. DLE AC G3 60mm 2000/3000lm 830 ADV	no
with affix "PRE", e.g. DLE AC G3 60mm 3000lm 830 o4a PRE	yes

7.1.1. DLE AC G3

Type	Article number	Colour temperature	Dimming
DLE AC G3 60mm 2000/3000lm 830 ADV	89602988	3.000 K	no
DLE AC G3 60mm 2000/3000lm 840 ADV	89602989	4.000 K	no
DLE AC G3 60mm 2000lm 830 o4a PRE	89602990	3.000 K	yes
DLE AC G3 60mm 2000lm 840 o4a PRE	89602991	4.000 K	yes
DLE AC G3 60mm 3000lm 830 o4a PRE	89602992	3.000 K	yes
DLE AC G3 60mm 3000lm 840 o4a PRE	89602993	4.000 K	yes

NOTICE

Go to www.tridonic.com to see the current range of products and the latest software updates.

Ordering information and sources

7.2. Product application matrix

Whether you are looking for wide-area lighting or focused accent lighting, our wide range of LED products will help you create an individual atmosphere and highlight specific areas exactly as you want. Our product portfolio includes individual light points, round, rectangular and strip versions. Specially matched operating equipment such as LED control gear, amplifiers and sequencers round off the components for a perfect system solution: They guarantee ideal operation and maximum efficiency.

7.2.1. Luminaire application LED engine

LED engine	Downlight	Spotlight	Linear / rectangular	Decorative	Surface	Outdoor (street)
LED engine DLE	✅					
LED engine SLE	✅	✅		✅	✅	

7.2.2. Luminaire application LED-Module

LED module	Downlight	Spotlight	Linear / rectangular	Decorative	Surface	Outdoor (street)
LED module SPOT	✅	✅		✅	✅	
LED module RECTANGULAR						✅
LED module EOS	✅	✅	✅	✅	✅	✅

For more information and technical data on the entire LED product portfolio go to led.tridonic.com or see our LED catalogue.

Ordering information and sources

7.3. Partners

7.3.1. Heat sinks

Heat sinks with **active and passive cooling** to match the module can be obtained from the following manufacturers:

BRYTEC AG Brytec GmbH
Vierthalerstrasse 5
AT-5020 Salzburg
T +43 662 87 66 93
F +43 662 87 66 97
info@brytec.at

Cooliance GmbH
Im Ferning 54
76275 Ettlingen
Germany
Tel: +49 7243 33 29 734
Fax. +49 7243 33 29 735
info@cooliance.eu

MechaTronix
4 to 6F, No.308 Ba-De 1st Rd.,
Sinsin district, Kaohsiung City 80050,
Taiwan
Tel: +886-7-2382185
Fax: +886-7-2382187
sales@mechatronix-asia.com
www.mechatronix-asia.com

Nuventix
Vertrieb Österreich
EBV Distributor
Schonbrunner Straße 297-307
1120 Wien
T +43 1 89152-0
F +43 1 89152-30
www.ebv.com

SUNON European Headquarters
Sales area manager
Direct line: 0033 1 46 15 44 98
Fax: 0033 1 46 15 45 10
Mobile: 0033 6 24 07 50 49
andreas.rudel@sunoneurope.com

Heat sinks with **active cooling** can be obtained from the following manufacturers:

Francois JAEGLE
NUVENTIX EMEA Sales and Support Director

Ordering information and sources

+33 624 73 4646
PARIS
fjaegle@nuventix.com

Heat sinks with **passive cooling** can be obtained from the following manufacturers:

AVC
Asia Vital Components Europa GmbH
Willicher Damm 127
D-41066 Mönchengladbach
T +49 2161 5662792
F +49 2161 5662799
sales@avc-europa.de

FrigoDynamics GmbH
Bahnhofstr. 16
D-85570 Markt-Schwaben
Germany
+49-8121-973730
+49-8121-973731
www.frigodynamics.com

7.3.2. Heat-conducting foil and paste

Heat-conducting **foil** (e.g. Transtherm® T2022-4, or Transtherm® Phase Change) for thermal connection between the module and a heat sink is available from the following partner:

BALKHAUSEN Division of Brady GmbH
Rudolf-Diesel-Straße 17
28857 Syke
Postfach 1253, 28846, Syke
T +49 4242 692 0
F +49 4242 692 30
angebot@balkhausen.de

Kunze Folien GmbH
Raiffeisenallee 12a
D-82041 Oberhaching
Tel: +49 89 66 66 82-0
Fax: +49 89 66 66 82-10
info@heatmanagement.com

3M Electro&Communications Business
4C, 3M House, 28 Great Jackson St
Manchester, M15 4PA
Office: +44 161 237 6182
Fax: +44 161 237 1105
www.3m.co.uk/electronics

Heat-conducting **paste** (e.g. Silicone Fluid Component) for thermal connection between the module and a heat sink is available from the following partner:

Ordering information and sources

Shin-Etsu Chemical Co. Ltd.
6-1, Ohtemachi 2-chome
Chiyoda-ku
Tokyo 100-0004
Japan

7.3.3. LED housing

LED housing is available from the following partner:

A.A.G. STUCCHI s.r.l. u.s.
Via IV Novembre, 30/32
23854 Olginate LC
Italy
Tel: +39.0341.653.204
Mob: +39.335.611.44.85
www.aagstucchi.it

7.3.4. Reflector solutions and reflector design

Reflector solutions and support for reflector design are available from the following partners:

ALMECO S.p.A.
Via della Liberazione 15
Tel: +39 02 988963.1
Fax: +39 02 988963.99
info.it@almecogroup.com

Alux-Luxar GmbH & Co. KG
Schneiderstrasse 76
40764 Langenfeld
Germany
T +49 2173 279 0
sales@alux-luxar.de

Jordan Reflektoren GmbH & Co. KG
Schwelmerstrasse 161-171
42389 Wuppertal
Germany
T +49 202 60720
info@jordan-reflektoren.de

KHATOD
OPTOELECTRONIC
Via Monfalcone, 41
20092 Cinisello Balsamo (Milan)
ITALY
Tel: +39 02 660.136.95
Fax: +39 02 660.135.00
Christian Todaro
Mobile: +39 342 8593226

Ordering information and sources

Skype: todaro_khatod
c.todaro@khatod.com
www.Khatod.com

LEDIL OY
Tehdaskatu 13
24100 Salo, Finland
F +35 8 2 7338001

7.3.5. Tridonic sales organisation

The complete list of the global Tridonic sales organisation can be found on the Tridonic homepage at address list.

7.3.6. Additional information

Go to www.tridonic.com to find your personal contact at Tridonic.

Further information and ordering data:

- LED catalogue at www.tridonic.com menue Services > Literature > Catalogue
- Data sheets at www.tridonic.com menue Technical data > Data sheets
- Certificates at www.tridonic.com menue Technical data > Certificates