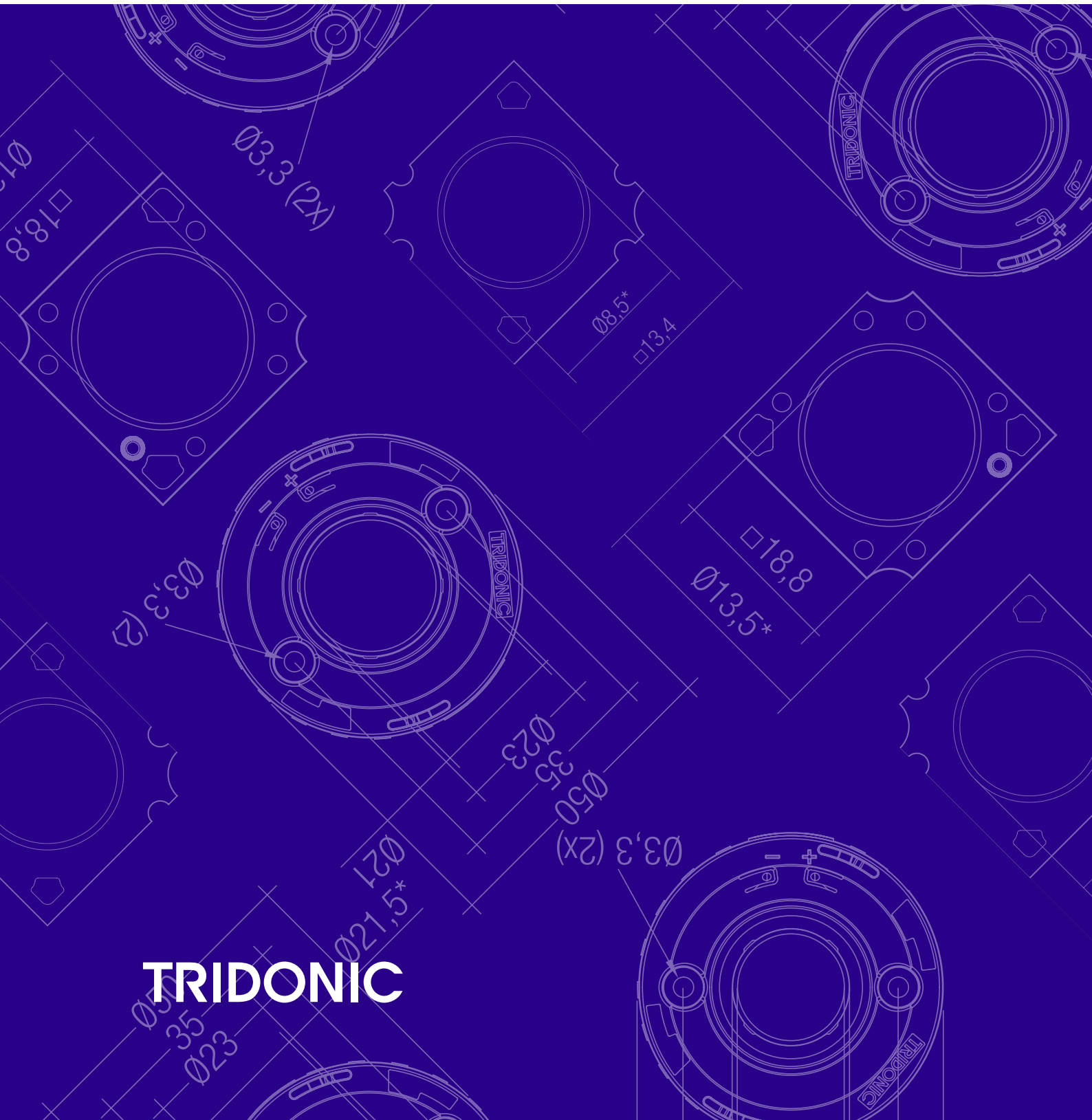
LED Module

Module SLE G6

Technical Design-In Guide



TRIDONIC

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Introduction

This Design-in Guide covers the SLE G6 Spotlight system from Tridonic.
The SLE G6 provides energy efficient lighting solutions with high quality light for retail, catering and other spotlight and downlight applications.

The system consists of chip-on-board module and mount, chip-on-board module with pre-tinned wires or chip-on-board module without cable in four versions:

- Standard version with different lumen packages and different light colours (2,700 K, 3,000 K, 3,500 K, 4,000 K)
- Three special versions that are optimised for specific applications:
  - SLE FOOD:
    LED modules specifically for FOOD applications display foods in the very best light – white elements remain white, colours are more true-to-life and are perceived more intensively. Stronger brown tones for example make baked goods appear more crispy, and the red of meats is emphasised to greater effect.
  - SLE ART:
    This new LED module offers the high quality of light that is needed for displaying high value exhibits. Unique Tridonic full spectrum technology provides excellent colour rendering. The average value for all the products in the SLE ART series is CRI 98, a truly impressive figure. And you can also rely on outstanding colour consistency (MacAdam 2) for your applications.
  - SLE FASHION:
    The modern FASHION LED light is ideal for the sparkling display of fashion. The technology conceals several years of intensive research targeted specifically for lighting in the retail sector. SLE FASHION generates brilliant colours with pleasant warm tones and high saturation, and completely without UV light, as well as intensive and friendly white tones thanks to the specific blue light component, for the display of goods in perfect, colour-true light.

The Design-in guide provides all the information needed to build a luminaire with the SLE G6 Spotlight system and adapt it to the desired needs.
This includes:

- Dimensioning of the heat sink and reflector
- Selection of compatible LED Drivers

Introduction

- Designing the luminaire with respect to thermal and mechanical needs

System Overview

2.1. Complete system solution

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 Engine SLE G6 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.

2.2. Zhaga

Zhaga is a consortium, initiated in 2010, which takes care of the needs of LED lighting and its standardisation. It is active worldwide and has more than 200 member companies (as of 2012).

The aim of the Zhaga consortium is to ensure interchangeability and compatibility of LED luminaires between different manufacturers. To this end, Zhaga defines standards for the interfaces of the various lighting fixtures and holders. This includes the physical dimensions of the lamp base, as well as the photometric, electrical and thermal behaviour of LED luminaires. These standardizing measures help to make products comparable, a step that both the manufacturing industry and the consumers benefit from.

The Zhaga logo verifies compatibility with Zhaga standards. Only certified devices are allowed to bear this logo.

The SLE G6 modules meet the mechanical requirements of the Zhaga guidelines from book number 3. Products that meet the Zhaga standards in physical, electrical and thermal points are listed on the website of Zhaga: www.zhagastandard.org

2.3. Module variants

NOTICE

The SLE G6 series comprises different variants of modules:

- with housing
- with housing and thermal interface material
- without housing, with or without connection cable

Modules without housing or connection cable have a certain affix in their name:

- Modules without housing have the affix "H" in their name
- Modules with housing and thermal interface material have the affix "H" and "T" in their name
- Modules with connection cable have the affix "C" in their name
- Modules without connection cable have the affix "R" in their name

Modules without housing or connection cable have a certain affix in their name:

- Modules without housing have the affix "PURE" in their name
- Modules without connection cable have the affix "W/O-C" in their name

Abbreviations:

- H ... housing; T ... thermal interface material; C ... cable; R ... raw

The following variants are available:

Module name	Housing	Thermal interface material	Connection cable
with affix "H", e.g. SLE G6 19mm 5000lm 830 H ADV	✅	❌	❌
with affix "H" and "T", e.g. SLE G6 19mm 5000lm 830 H ADV T	✅	✅	❌
with affix "C", e.g. SLE G6 19mm 5000lm 830 C ADV	❌	❌	✅
with affix "R", e.g. SLE G6 19mm 5000lm 830 R ADV	❌	❌	❌

System Overview

The system Engine STARK SLE GEN4 is available in different variants:

	SLE G6 ADV
Main qualities	Simplicity itself: _ Static White with CRI > 80 and CRI > 90 _ long life-time _ high lm/W output
Available variants	Available in 4 variants: _ with housing, without thermal interface material _ with housing, with thermal interface material _ without housing, without thermal interface material _ without housing, with thermal interface material
Light Emitting Surface (LES)	10 mm, 15 mm, 17 mm, 19 mm, 23 mm
Colour temperature	2,700 K, 3,000 K, 3,500 K, 4,000 K
Luminous flux (1)	up to 9,960 lm
Colour rendering / colour tolerance	CRI 80, CRI 90 MacAdam 3 SDCM
System efficiency (1)	up to 154 lm/W
Module efficiency	up to 180 lm/W
Energy efficiency class	up to A++
Life time (2)	> 60,000 h
Warranty	5 years

(1) Values at t_p=65°C, all values apply to tp rated
(2) relating to L70/B50

2.3.1. Type code for modules

The following type code is used to identify the modules:

Type code for modules for SLE G6 19mm 5000lm 830 H ADV T for example

Reference	SLE G6	19mm	5000lm	830	H	ADV	T
Meaning	Form: Spotlight Engine	Size	Type: Luminous flux at nominal current	CRI 80 3000K	with housing	ADV	with thermal interface material (TIM)

2.4. Accessories

2.4.1. LED Drivers

LED Drivers are available in different variants:

		PRE	EXC
Dimming	Amplitude	✅	✅
	Dimming range	100 to 1 %	100 to >= 15 % **NOTICE** The exact minimum value depends on the used device and the load. _ For certain devices, the minimum value may be higher _ When operating with lower load, the minimum value is generally higher More information can be found in the data sheet of the device.
	DALI V2-DT6	✅	
	DSI	✅	
	switchDIM	✅	
	corridorFUNCTION V2	✅	
	ready2mains	✅	✅
DC operation	supporting EN 50172	✅	✅
	DC level fixed		✅
	DC level adjustable	✅	
Current adjustment	Adjustable	✅	✅
	Via resistor or plug	✅	✅

	Via DALI V2-DT6	✅	
	ready2mains	✅	✅
	current resolution	1 mA	1 mA
	current tolerances	± 3-10 %	see data sheet
Functions & Performances	CLO function	✅	
	Intelligent temperature guard	✅	✅
	Standby losses	<0.2 W	
	Rated supply voltage	220-240 V	220-240 V

2.4.2. Possible combinations

Possible combinations of LED Drivers and LED modules can be found in the LED system matrix:
www.tridonic.com/com/en/lamp-matrix.asp

Some typical combinations are listed here:

SLE G6 10mm: Operating current: 350mA

- Dimmable: LCA 25W 350-1050mA one4all C PRE (28000665)
- Dimmable/Fixed Output: LC 17W 250-700mA flexC SC EXC (28000705)
- Fixed Output: LC 15W 350mA fixC SC ADV (87500448)
- Fixed Output: LC 15W 350mA fixC C SNC (87500565)

SLE G6 15mm: Operating current: 500mA

- Dimmable: LCA 25W 350-1050mA one4all C PRE (28000665)
- Dimmable/Fixed Output: LC 25W 350-1050mA flexC SC EXC (28000706)
- Fixed Output: LC 20W 500mA fixC SC ADV (87500449)
- Fixed Output: LC 20W 500mA fixC C SNC (87500566)

SLE G6 17mm: Operating current: 900mA

- Dimmable: LCA 45W 500-1400mA one4all SC PRE (28000676)
- Fixed Output: LC 40W 900mA fixC SC ADV (87500344)
- Fixed Output: LC 40W 900mA fixC C SNC (87500560)

SLE G6 19mm: Operating current: 1050mA

- Dimmable: LCAI 55W 900-1750mA ECO C (28000128)
- Fixed Output: LC 47W 1050mA fixC SC ADV (87500451)
- Fixed Output: LC 45W 1050mA fixC C SNC (87500564)

System Overview

SLE G6 23mm: Operating current: 1400mA

- Dimmable: LCAI 55W 900-1750mA ECO C (28000128)
- Fixed Output: LC 60W 1400mA fixC C SNC (87500570)

Type codes for LED Drivers

The following type code is used to identify LED Drivers:

Type code for LED Drivers LCA 45W 500-1400mA one4all SR PRE

Reference	LCAI	45W	500-1400mA	one4all	SR / C / SC	PRE
Meaning	Dimmable LED Driver	Power	Output current range	Interface	Housing form: SR: Strain Relief, C: Compact, SC: Stretch Compact	Type

The exact type designation of the LED Driver can be found on the label of the LED Driver.

2.5. Compatibility between LED module and LED Driver

⚠ CAUTION!

LED modules SLE G6 are basic isolated against ground up to 75 V (for LES10, LES15 and LES17: 50 V) and can be mounted directly on earthed metal parts of the luminaire.
If the max. output voltage of the LED Driver (also against earth) is above 75 V (for LES10, LES15 and LES17: 50 V), an additional isolation between LED module and heat sink is required (for example by isolated thermal pads) or by a suitable luminaire construction.

At voltages > 60 V an additional protection against direct touch (test finger) to the light emitting side of the module has to be guaranteed. This is typically achieved by means of a non removable light distributor over the module.

There are two stages involved in the check for compatibility between the LED module and the LED Driver.

- The requirements for operating together can be checked by comparing the data sheets
- Subsequent practical tests can ensure that there are no unexpected problems during actual operation

2.5.1. Comparison of data sheet values with a 5-point guideline

Different values for the two devices need to be considered when comparing the data sheets. The following table shows which values are involved and which requirements they must meet.

Comparison of...	Value in LED module		Value in LED Driver	Detailed procedure
(1) Current	I_{max}	=	Output current	- Determine forward current of LED module - Check whether LED Driver can be operated with the same output current - Check whether max. DC forward current of LED module is greater than or equal to output current of LED Driver (including tolerances) **⚠ CAUTION!** The max. DC forward current can be temperature dependent! Refer to the derating curve of the LED module data sheet.
	Max. DC forward current	>=	Output current + tolerances	

continue...

System Overview

<table>
<tr><th>Comparison of...</th><th>Value in LED module</th><th></th><th>Value in LED Driver</th><th>Detailed procedure</th></tr>
<tr><td rowspan="3">(2) Voltage</td><td>Min. forward voltage</td><td>></td><td>Min. output voltage</td><td rowspan="2">_ Check whether voltage range of LED module is completely within the voltage range of LED Driver</td></tr>
<tr><td>Max. forward voltage</td><td><</td><td>Max. output voltage</td><td>⚠ CAUTION!

The forward voltage is temperature dependent!
Refer to the Vf/t_p diagram in the data sheet.</td></tr>
<tr><td>Min. forward voltage @ min. dim level</td><td>></td><td>Min. output voltage</td><td>ⓘ NOTICE

To ensure full dimming performance the forward voltage of the LED module at min. dim level must be greater than or equal to the min. output voltage of the driver.

_ Determine the forward voltage of the LED module at lowest dim level
_ In case there is no data available for the LED module at lowest dim level: take the min. forward voltage minus 20 % as an approximation
_ Check whether the forward voltage of the LED module is greater than or equal to the min. output voltage of the driver</td></tr>
<tr><td>(3) LF current ripple</td><td>Max. permissible LF current ripple</td><td>>=</td><td>Output LF current ripple (<120 Hz)</td><td>_ Check whether max. permissible LF current ripple of LED module is greater than or equal to output LF current ripple of LED Driver</td></tr>
<tr><td>(4) Max. peak current</td><td>Max. permissible peak current</td><td>></td><td>Max. output current peak</td><td>_ Check whether max. permissible peak current of LED module is greater than max. output current peak of LED Driver</td></tr>
<tr><td rowspan="2">(5) Power (pertinent for multi channel LED Driver)</td><td>Min. power consumption</td><td>></td><td>Min. output power</td><td rowspan="2">_ Check whether power range of LED module is completely within output power range of LED Driver</td></tr>
<tr><td>Max. power consumption</td><td><</td><td>Max. output power</td></tr>
</table>

2.5.2. Practical tests

CAUTION!

Following the comparison of the data sheet values a practical test is required. Only a practical test can ensure that the system components (luminaire, LED Driver, LED module, wiring) are coordinated and working properly.

The following aspects must be checked:

Technical aspects

- Transient behaviour
- Colour shift
- Connection during operation
- Parasitic capacitance

Visual aspects

- Flickering
- Stroboscopic effect (video applications)
- Dimming behaviour
- Colour change/stability
- Luminous flux

When conducting the tests the following conditions must be considered:

Conditions

- All tolerances
- Entire temperature range
- Different output voltage ranges (incl. no load)
- Entire dimming range
- Short circuit

HINWEIS

If the values are slightly over or under the specified threshold values or if there are any other concerns or questions please contact Technical Support:
techservice@tridonic.com

2.6. Standards and directives

2.6.1. Standards and directives for modules

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

CE

Name	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

Name	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

Safety

Name	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

Name	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

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

2.6.2. Standards and directives for LED Drivers

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

EMI

Name	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

Name	Description
EN 50172 2005	Safety lighting systems

DALI

Name	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

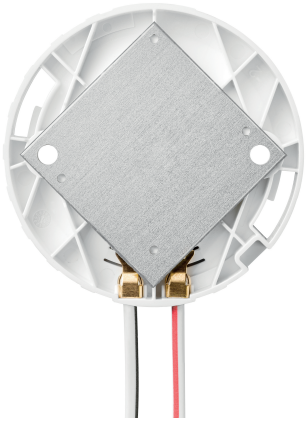
3.1. Installation

The SLE G6 modules were tested with severity level 4. The guideline for installation can be taken from the ESD document .

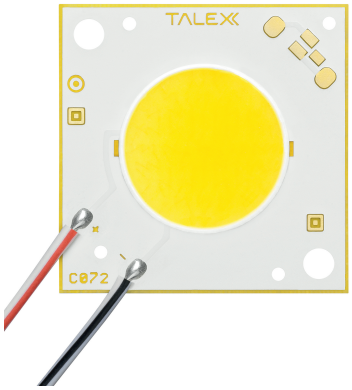
NOTICE

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

Image	Description
	Integrated terminal for a time-saving assembly
	Back of the module for thermal connection to the heat sink

Mechanical Aspects



Version without housing for individual integration in the light

⚠ CAUTION!

LED module and the associated housings are crimped together by sleeves.

Trying to separate LED module and housing will destroy the LED module!
All warranty and guarantee claims are void if LED module and housing are separated or if the LED module is altered, modified or disassembled in any form.

3.1.1. Notes on installation

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

- Sufficient distance to active conducting materials
- Sufficient strain relief when the LED Driver 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

Protection measures against damage

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:

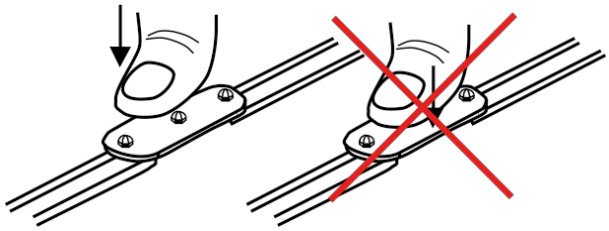
- Pressure
- Drilling
- Milling
- Breaking
- Sawing
- and similar mechanical processing.

Mechanical Aspects

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)

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:

- 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.

Mechanical Aspects

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
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

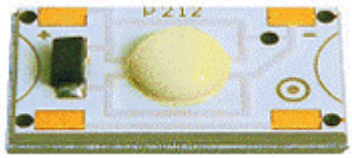
Mechanical Aspects

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:

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

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

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.

Mechanical Aspects

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.

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

Instructions for cementing LED modules

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.

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.

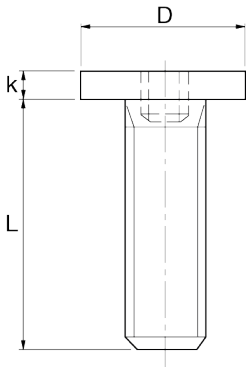
3.1.2. Installing the modules

The modules are mounted on a heat sink with 2 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

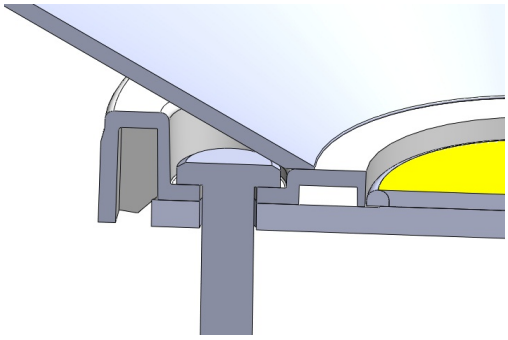
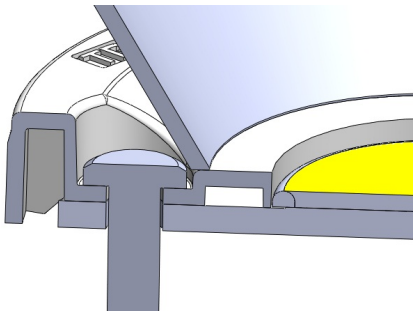
Dimensions of the fastening bolts

Paramter	Value
Bolt size	M3 (1)
Max. diameter D	5.8 mm
Min. length L	10 mm
Max. length L	Depending on the design of the luminaire and the heat sink
Max. bolt head height k	1.3 mm for flat reflectors, higher values for steep reflectors
Max. torque	0,5 Nm



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

Different bolt head heights

Image	Description
	Flat Reflector: The bolt head height of flat reflectors must not exceed a maximum of 1.3 mm.
	Steep Reflector: The bolt head height of steep reflectors can be more than 1.3 mm.

3.1.3. Procedure for hand soldering

The following describes how a solder joint must be made and checked. Tridonic components are tested according to IPC-A-610 E Class 2. For this reason, the measures described below are defined for hand soldering and the visual inspection of the parts.

Mechanical Aspects

Important specifications in accordance with IPC-A-610 E

Magnification aids

Magnification aids that are used for testing, must be suitable for the inspected object.

Insulation

Insulation must be separated cleanly from stranded wires. The insulation must not be charred and the insulation must not be fused into the strands.

It is allowed for the insulation to be slightly melted after soldering. Generally, the distance between the end of the wire insulation and the solder of the solder joint should be one wire diameter, max. two wire diameters. Additionally the minimum electrical isolation distance to adjacent non-connected conductors can't be too low.

Lines – tin coating

Strand wires should be evenly coated with a thin layer of solder, so that individual wires are still visible. Areas of the wire that need to be flexible shall not be tin-coated.

General guidelines and tips

- It is recommended that only trained and experienced personnel perform hand soldering tasks.
- It is recommended to use a soldering iron with at least 75 W.
- The size of the soldering tip should fit the soldering joint. It is recommended to use a tip with a width of 2 mm.
- The soldering material should be a SnAgCu (Pb free) alloy with flux core. It is recommended to use soldering material with a diameter of 0.5 - 0.8 mm. Thinner soldering material dissipates less energy from the solder joint.
- Adding flux is not necessary.
- It is strongly advised against soldering the solder joint more than two times.
- Preheating with a heating plate is not recommended.
- It is recommended to choose a soldering temperature between 250 °C and 300 °C and a soldering time of 5 seconds. The solder pad can be tin-coated.

Alignment of the cables

Figure: Alignment of the cables on solder pad LES10, LES15, LES17 (soldering points on opposite corners of the solder pad)

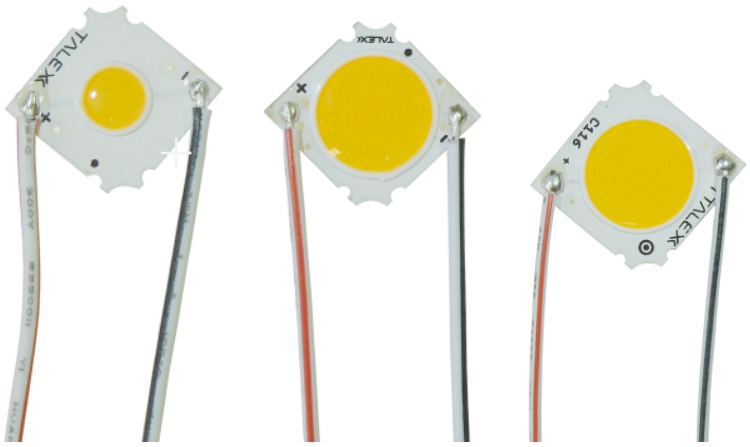
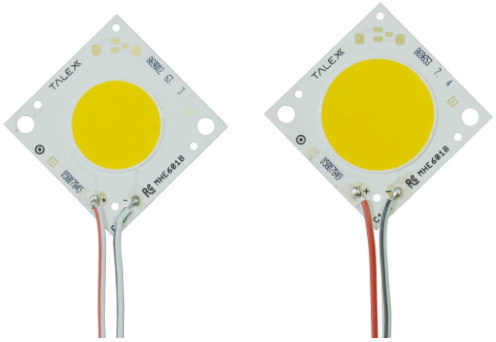


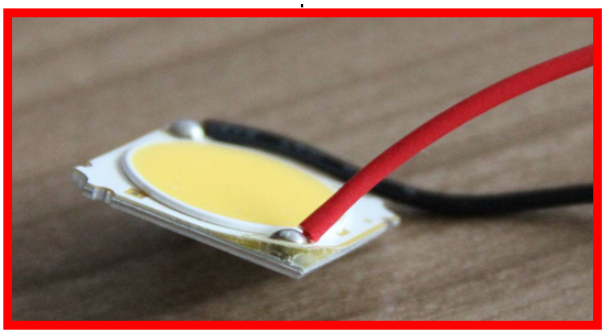
Figure: Alignment of the cables on solder pad LES19, LES23 (soldering points in one corner of the solder pad)



Handling after soldering

Mechanical stress (e.g. pulling the cable) is not allowed. This could lead to delamination of the bonded aluminum on the FR4 board, which negatively affects the quality of the module.

Figure: Delamination of the bonded aluminum



The modules should be treated with extreme caution!

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:

- Luminaires in protection class III (also SELV which stands for Safety Extra Low Voltage) have such low internal voltages that a shock current would be inconsequential. AC voltages with an effective value of up to 35 V AC and direct currents up to 60 V DC are referred to as low voltage.
- Protection class II (non-SELV) applies for luminaires with double insulation, with no protective earth, between the mains circuit and the output voltage or metal casing. Even if the luminaires have electrically conductive surfaces, thanks to their insulation they are protected against contact with other live parts.
- Protection class I (non-SELV) applies for luminaires with basic insulation and protective earth. All the electrically conductive casing components are connected via a protective conductor system which is at earth potential.

Electrical Aspects

Basic insulation LED-Modul SLE G6

The LED module SLE G6 features basic insulation against earth, i.e., a clearance/creepage distance greater or the same as 3 mm and can be directly assembled on an earthed metal part of the luminaire.

Luminaire with SELV level

When using the LED module SLE G6 in combination with a LED Driver in protection class SELV, the SELV level for the luminaire is achieved.
Thanks to SELV voltage, the luminaire can be replaced by an expert without risk.

NOTICE

Classification of the LED Driver in SELV and NON-SELV protection classes can be found in the LED Driver matrix.

Protection class II luminaires

When using a LED Driver with NON-SELV level, the following measures are essential in order to achieve protection class II:

- Reinforced insulation between LED module SLE G6 and the luminaire casing, e.g., by means of plastic casing or an additional insulating foil between the luminaire casing and the module.
- Reinforced insulation between the LED Driver and luminaire casing, e.g., by means of plastic casing
- Use of double-insulated lines
- Protect all electrical contacts against mechanical contact, this can typically be achieved with optics which cannot be removed

Protection class I luminaires

When using an LED Driver with NON-SELV level, the following measures are essential in order to achieve protection class I:

- Use of metal casing for the luminaire
- Assembly of the LED module SLE G6 directly on the casing
- Grounding of the LED Driver, LED module SLE G6 and the luminaire itself
- Protect all electrical contacts against mechanical contact, this can typically be achieved with optics which cannot be removed

DANGER!

The following measures must be followed in order to avoid life-threatening situations:

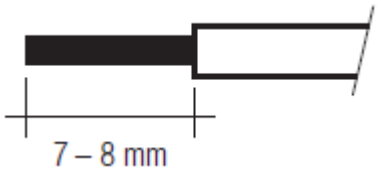
- Electrical work on a luminaire with protection class I or II (non-SELV) must only be carried out by an electrically skilled person.
- The luminaire must be disconnected from the mains before starting work on it.
- Check the luminaire for damage. If there are any signs of damage, the luminaire must be replaced.

4.1.2. Connections on the LED Driver

Wiring type and cross section

The wiring has to be solid cable with a cross section of 0.5 to 0.75 mm² or with flexible cable with soldered ends with a cross section of 0.5 mm².
For the push-wire connection you have to strip the insulation (7-8 mm).

Wire preparation:



Connections on the LED Driver for LED module SLE G6

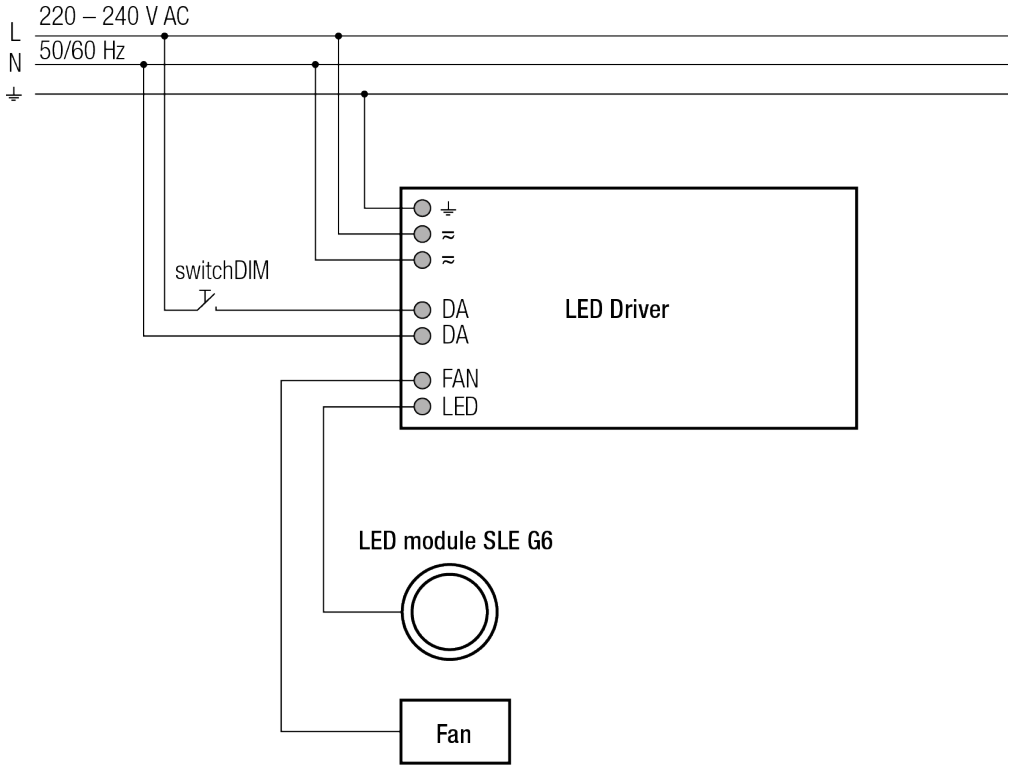
Pin	Connection on the LED Driver	Design
⏚	Function earth	Screw terminal
~	Power input 230 – 240 V AC	Screw terminal
~	Power input 230 – 240 V AC	Screw terminal
DA(1)	Control input for DALI / switchDIM	Screw terminal
DA(1)	Control input for DALI / switchDIM	Screw terminal
+FAN	Feed for active cooling	Screw terminal
-FAN	Feed for active cooling	Screw terminal
+LED	LED module STARK SLE G6	Screw terminal
-LED	LED module STARK SLE G6	Screw terminal
ITM(2)	Temperature monitoring	Screw terminal
ITM(2)	Temperature monitoring	Screw terminal

(1) Only for LED Drivers with dimming function
(2) Only for LED Drivers of the TOP and ECO series from 35 W on

Electrical Aspects

4.2. Wiring diagrams

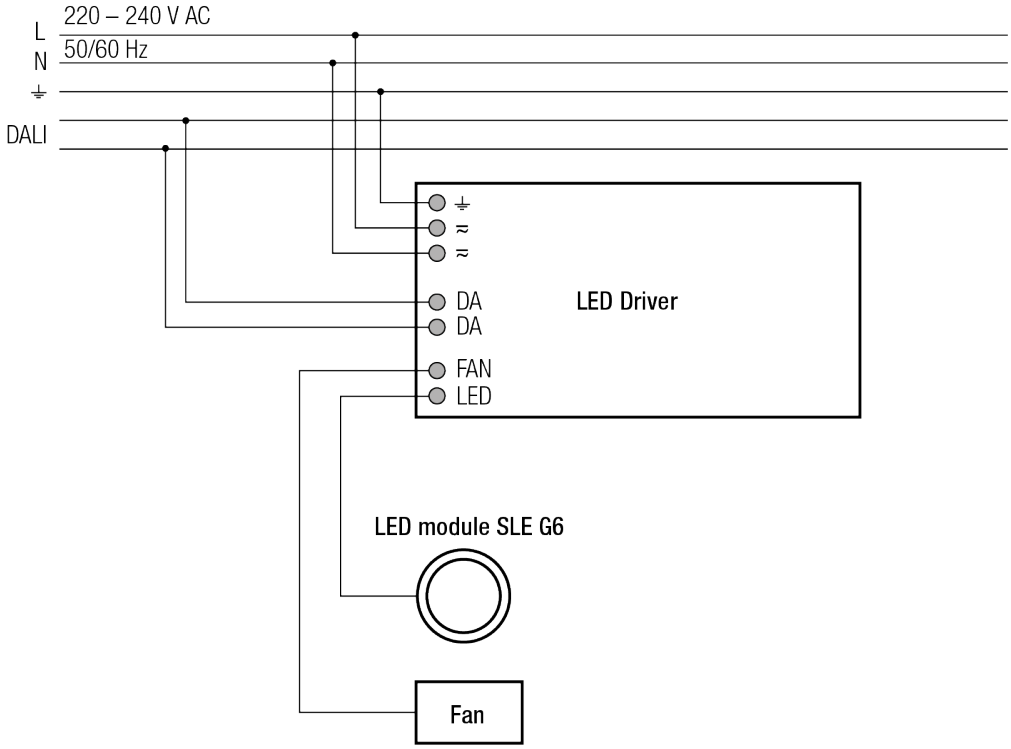
4.2.1. Wiring diagram for switchDIM for Engine SLE G6



The wiring diagram shows the connection between a LED Driver and a LED module SLE G6 and the connection between the LED driver and the power supply.
The integrated switchDIM function is operated via an appropriate momentary-action switch.

Electrical Aspects

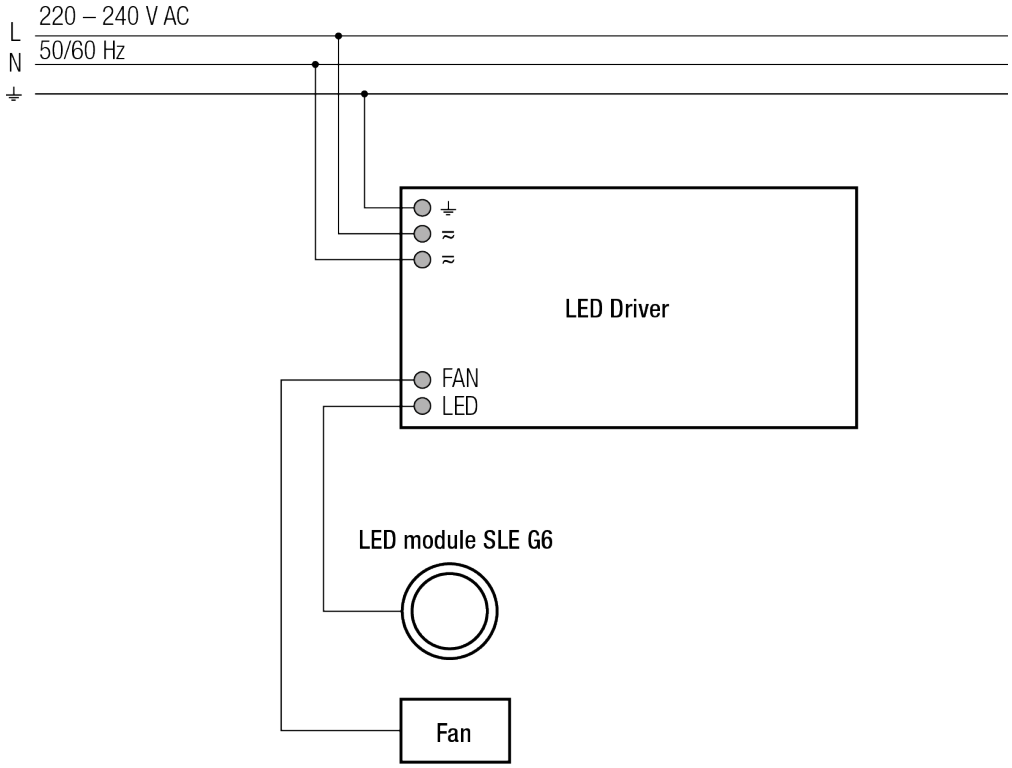
4.2.2. Wiring diagram for DALI for Engine SLE G6



The wiring diagram shows the connection between a LED Driver with dimming function and a LED module SLE G6 and the connection between the LED Driver and the power supply and the digital DALI signal.

Electrical Aspects

4.2.3. Wiring diagram for ON/OFF via mains for Engine SLE G6



The wiring diagram shows the connection between a LED Driver without the dimming function and a LED module SLE G6 and the connection between the LED Driver and the power supply.

Optical Aspects

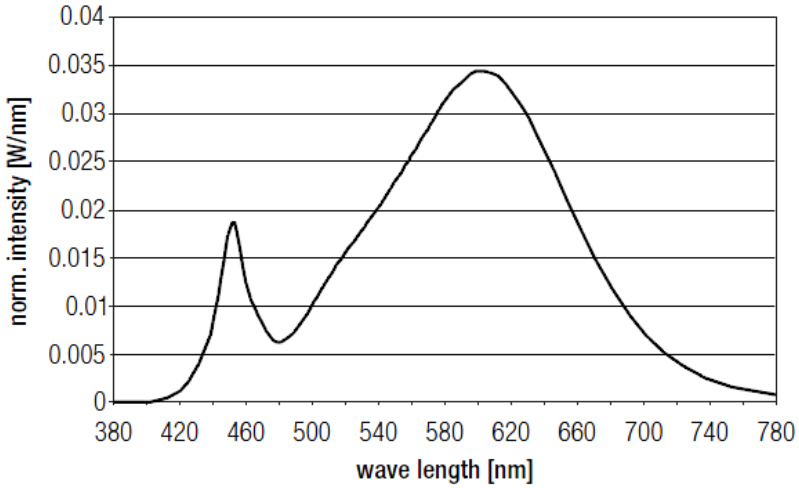
5.1. Colour spectrum

The Dam&Fill technology used in chip on board (COB) 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.

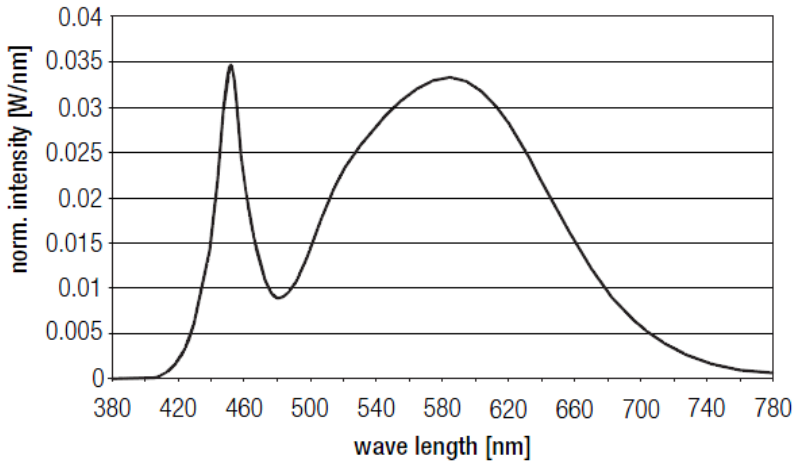
5.1.1. Colour spectrum at different colour temperatures

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”.

Optical Aspects

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.

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, specifiying 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.

5.3. SDCM

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 noticable 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

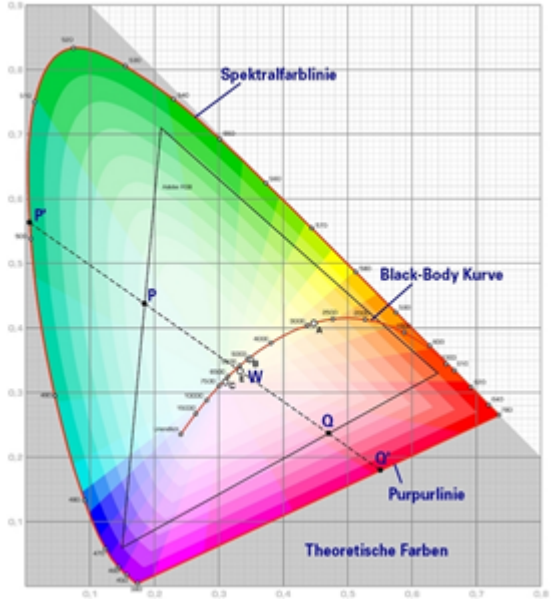
The term Secondary Optics refers to additional optical elements that shape the light output in different forms. Secondary Optics include e.g. reflectors, lenses or covers.

5.6. Coordinates and tolerances (to CIE 1931)

As before, the production process for 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.

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	x	x	x	x
Indication of risk group on the LED module itself	-	-	x	x
Stating at what distance the LED module falls back into risk group 1	-	-	x	x
Positioning of the luminaire so that direct exposure to the light can be prevented	-	-	x	x
Labeling the luminiare with the following symbol: 	-	-	x	x

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

Optical Aspects

5.8. Reflector design and beam characteristics

5.8.1. Reflector design

The mechanical and optical properties of the modules of the Engine SLE G6 system offer the best conditions for using reflectors. The new design of the SLE G6 housing with its recesses allows for a quick and easy connection of the reflectors via snap-on. 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.

Using a reflector can guarantee a uniform illumination and that the colours are mixed properly. Some reflectors have the option of faceting for the reflector wall.

Reflector installation

SLE G6 and reflector are connected securely via snap-on. The housing of the SLE G6 has two lateral recesses (see image above), compatible reflectors have matching knobs. Compatible reflectors are listed on the product page of the module.

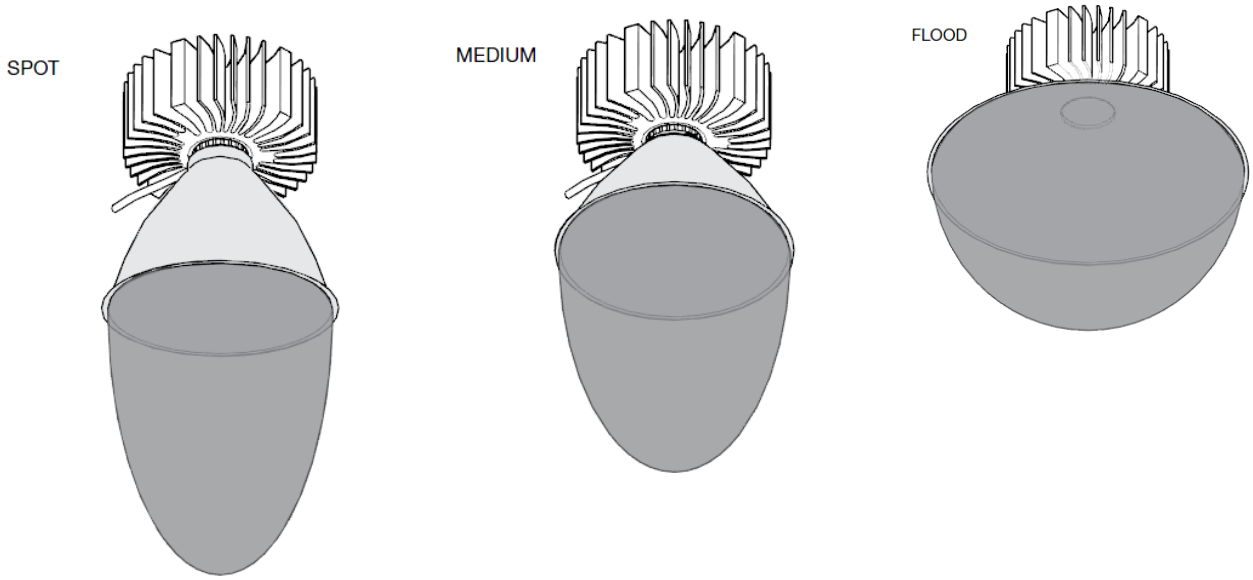
If you want to use a reflector which is not compatible with the SLE G6 housing, you can alternatively use an adapter for the connection of the reflector. The adapter is mounted on the housing of the SLE G6 module.
We recommend the adapter from TE connectivity with article number 2213194-1. The adapter can be ordered from TE connectivity.
Distribution via Tridonic is not possible.

⚠ CAUTION!

Make sure that your reflector is compatible with the adapter.

Optical Aspects

Examples of reflectors with different beam angles



NOTICE

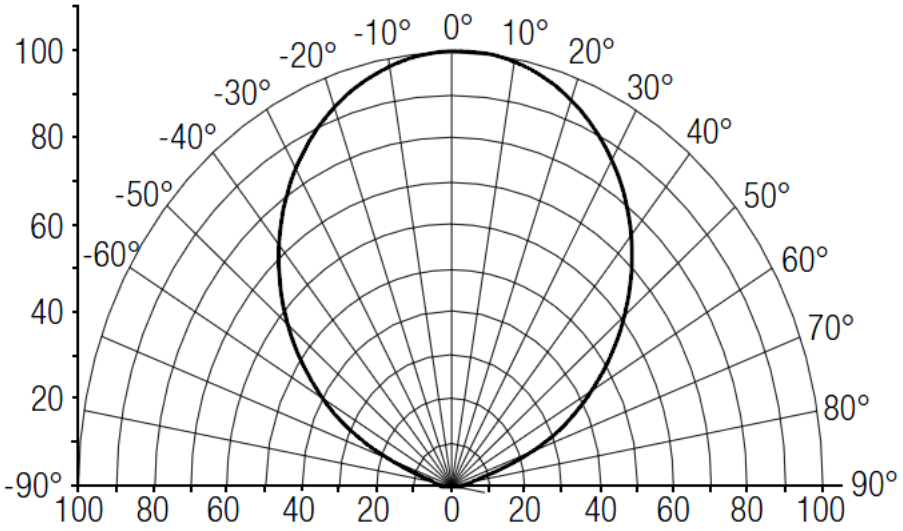
To help create customised designs and to carry out optical simulations CAD data and Rayfiles are available for download from the Tridonic website.

- Go to the produkt page on the Tridonic homepage
- Choose the desired product
- Click on CAD/RAY slide at bottom of the page

Optical Aspects

5.8.2. Beam characteristics

Maximum relative light intensity Iv/v



5.8.3. Photometric code

Key for photometric code, e. g. 930 / 369

1st digit		2nd + 3rd digit	4th digit	5th digit	6th digit	
		Colour temperature in Kelvin x 100	MacAdam initial	MacAdam 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% 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 60,000 h:

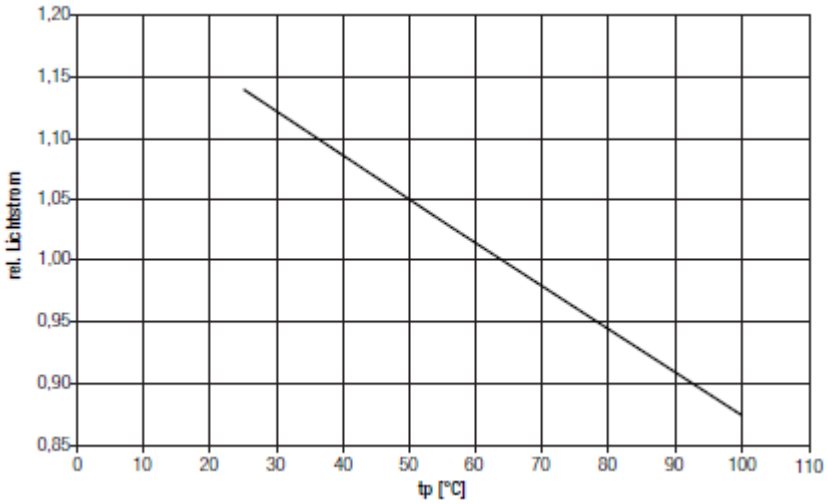
1. The LED modules have been tested for 10,000 hours. According to LM80, it is possible to make a 6-fold extrapolation. The lifetime of the LED modules is by no means limited to 60,000 h. But due to the diversity and the rapid generational changes it is not possible to conduct tests over a period of 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 60,000 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 60,000 h is communicated, the LED modules must have been tested for at least 30,000 switching cycles. Our LED modules meet the requirements of standard IEC 62717 / 10.3.3 and have been tested for 30,000 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.

Thermal Aspects

Figure: Lifetime characteristic

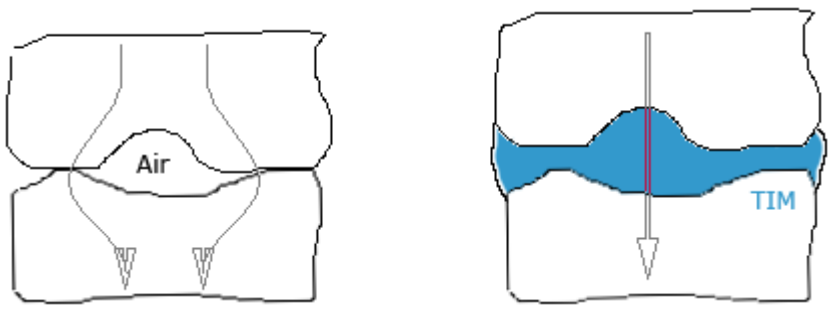


NOTICE

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

Thermal Aspects

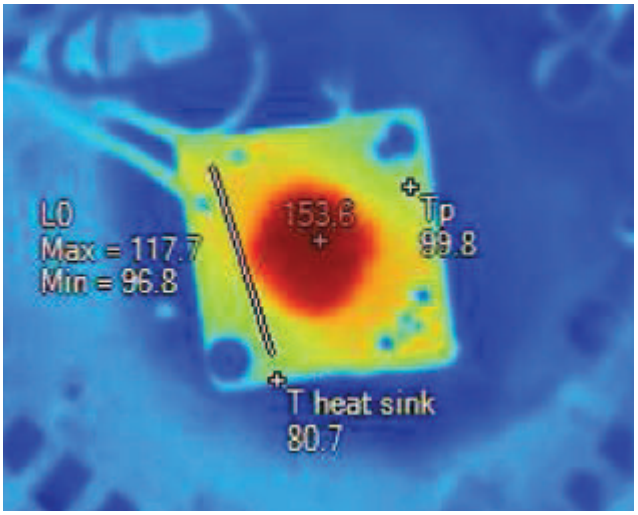
SLE G6 modules with affix "T" will be delivered with pre-assembled thermal pad Tgard 3000.
The bottom side of the thermal pad is glued to the module, the upper side is not adhesive. This makes it easier to position the module when it is connected to the heat sink.

⚠ CAUTION!

The thermal pad is an integral part of the "T" module and must not be confused with a protective foil.
The thermal pad must not pulled off!

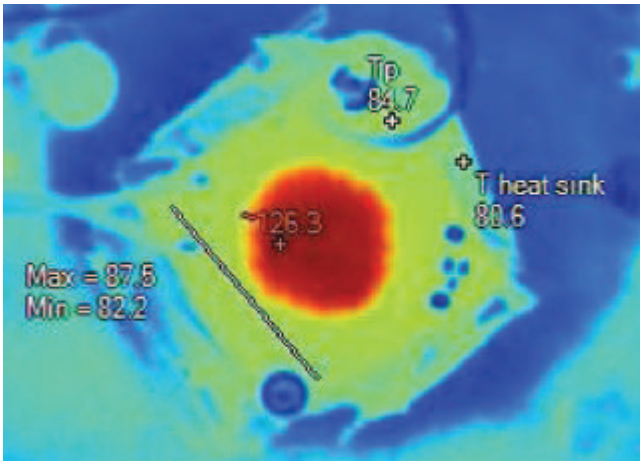
Impact of bending on the thermal behaviour

If the thickness of the thermal interface material is in the range of 200µm (which is a common value for TIMs used in general illumination) a moderate torque (0,5nm) applied on the screws, may lead to a bending of the module resulting in a lateral variation of the thermal resistance.



As a result of the bending an offset temperature on the module of more than 20°C is possible.

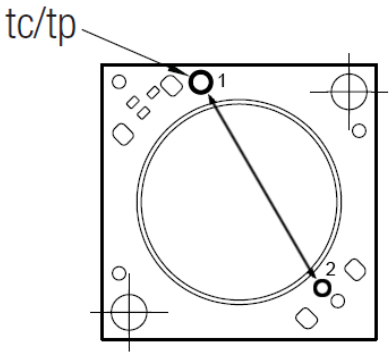
The same torque applied on a module with a thermal conductive paste as thermal interface material (thickness below 50µm) leads to a significantly decreased bending and a therefore lower silicone temperature.



Thermal Aspects

Recommendation (for application notes)

Mounting quality of the LED-module can be tested by measuring the temperature on opposite points as marked below.



A temperature difference of more than 10°C between Point 1 and Point 2 signifies a bend in the module.

In which ways can Tridonic SLE modules be mounted to achieve good performance?

- Usage of thin and flexible thermal interface materials. Usage of thermal paste (1W/mK @ 50µm thickness) is strongly recommended.
- Don´t exceed the recommended torque of 0,5nm
- Use heat sinks with smooth surfaces
- Check temperature homogeneity as described above.
- Take maximum silicone temperature as application advice into consideration.

Conclusion

With the increasing power density of LED-modules the thermal management gets more important.

Intelligent heat management can increase the performance and lifetime of an LED-spot-module significantly.

6.1.4. Rth

The lifetime of LED modules 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 SLE G6. Therefore, it is necessary to mount the LED module SLE G6 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 an 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.

For the LED module SLE G6 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 the SLE G6 module and the heatsink using thermal paste or thermally conductive adhesive foil is absolutely necessary.

Additionally, in order to optimise the thermal connection, the SLE G6 module has to be mounted on the heat sink with M3 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.

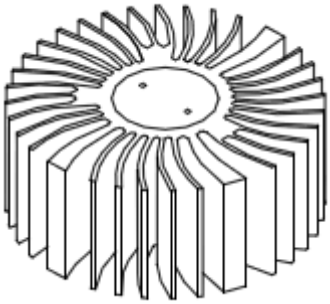
NOTICE

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

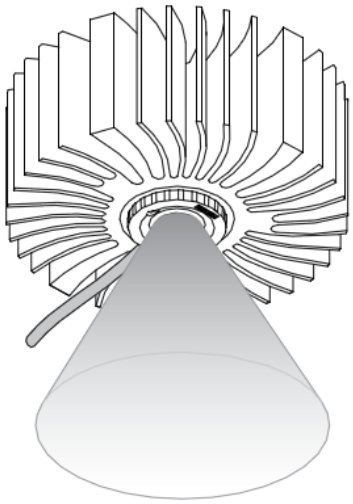
Thermal Aspects

6.2. Passive and active cooling

6.2.1. Passive cooling



Passive cooling module



Example of passive cooling for the module

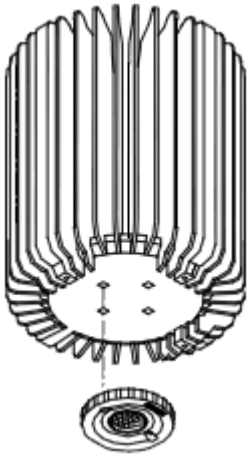
Heat transfer from a heat source to the surrounding cooling medium (e.g. air) depends primarily on the difference in temperature, the effective surface area and the flow rate of the cooling medium. The function of a heat sink is to increase the surface area over which the heat can be dissipated. This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

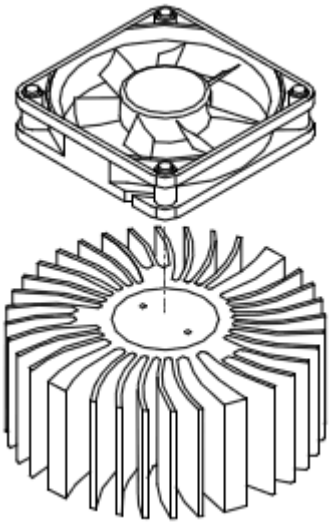
- Energy savings
- Silent
- No mechanical wear
- No maintenance

Thermal Aspects

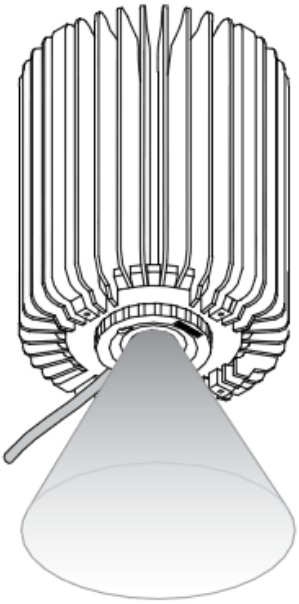
6.2.2. Active cooling



Round active cooling module round



Square active cooling module



Example of active cooling for the 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 is not controlled by the LED module.

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

NOTICE

The fan driver must be operated with suitable KTY sensors and wiring!
For more information please consult the corresponding LED Driver data sheet.

6.3.2. KTY sensor

(Only in connection with LED Drivers of the TOP and ECO series from 35 W on).

The Intelligent Temperature Management (ITM) function protects the LED light modules against short-term thermal overloads.

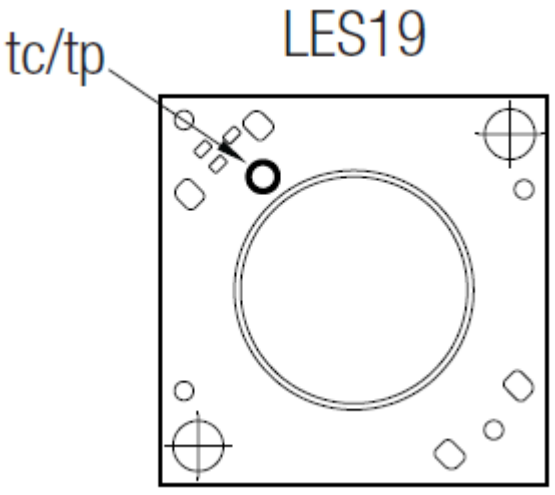
To monitor the temperature of the LED, a silicon-based temperature sensor (KTY81-210, KTY82-210) can be connected to the LED Driver.

If certain temperature thresholds are exceeded the LED output is gradually reduced or completely switched off. As a result of this, the dimm level and the temperature decreases. If the temperature falls below the the threshold temperature, the LED Driver automatically returns to nominal operation.

The use of an NTC or PTC resistor is not possible. The device can also be operated without sensor (default setting). The function can be adjusted via the masterCONFIGURATOR.

6.3.3. 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 LES 19 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.



6.3.4. 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.

6.3.5. Temperature management of the LED Driver

To protect the LED module from thermal damage, LED Drivers with integrated temperature management automatically dim down if a certain temperature is exceeded.
The temperature at the t_c point on the LED Driver can be measured with a simple temperature probe. The t_c point on the LED Driver is indicated by a sticker on the casing.

NOTICE

Measurement conditions, sensors and handling are described in detail in standard EN 60598-1 “General requirements and tests for luminaires”.

Ordering information and sources

7.1. Article numbers

NOTICE

The LED module SLE G6 series comprises different variants of modules:

- with housing
- with housing and thermal interface material
- without housing, with or without connection cable

Modules without housing or connection cable have a certain affix in their name:

- Modules without housing have the affix "H" in their name
- Modules with housing and thermal interface material have the affix "H" and "T" in their name
- Modules with connection cable have the affix "C" in their name
- Modules without connection cable have the affix "R" in their name

Modules without housing or connection cable have a certain affix in their name:

- Modules without housing have the affix "PURE" in their name
- Modules without connection cable have the affix "W/O-C" in their name

Abbreviations:

- H ... housing; T ... thermal interface material; C ... cable; R ... raw

The following variants are available:

Module name	Housing	Thermal interface material	Connection cable
with affix "H", e.g. SLE G6 19mm 5000lm 830 H ADV	✅	❌	❌
with affix "H" and "T", e.g. SLE G6 19mm 5000lm 830 H ADV T	✅	✅	❌
with affix "C", e.g. SLE G6 19mm 5000lm 830 C ADV	❌	❌	✅
with affix "R", e.g. SLE G6 19mm 5000lm 830 R ADV	❌	❌	❌

Ordering information and sources

7.1.1. LED module SLE G6 ADV

Type	Article number	CCT	CRI	Housing	Packaging	Weight per pc.
SLE G6 10mm 1200lm 830 R ADV	28001680	3,000 K	> 80	no	36 pc(s).	0.001 kg
SLE G6 10mm 1200lm 840 R ADV	28001681	4,000 K	> 80	no	36 pc(s).	0.001 kg
SLE G6 10mm 1200lm 930 R ADV	28001682	3,000 K	> 90	no	36 pc(s).	0.001 kg
SLE G6 10mm 1200lm 940 R ADV	28001683	4,000 K	> 90	no	36 pc(s).	0.001 kg
SLE G6 15mm 3000lm 827 R ADV	89602627	2,700 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 830 R ADV	89602628	3,000 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 835 R ADV	89602629	3,500 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 840 R ADV	89602630	4,000 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 927 R ADV	89602631	2,700 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 930 R ADV	89602632	3,000 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 935 R ADV	89602633	3,500 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 940 R ADV	89602634	4,000 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 827 R ADV	89602712	2,700 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 830 R ADV	89602713	3,000 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 835 R ADV	89602714	3,500 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 840 R ADV	89602715	4,000 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 927 R ADV	89602716	2,700 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 930 R ADV	89602717	3,000 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 935 R ADV	89602718	3,500 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 17mm 4000lm 940 R ADV	89602719	4,000 K	> 90	no	20 pc(s).	0.001 kg
SLE G6 19mm 5000lm 827 R ADV	89602647	2,700 K	> 80	no	20 pc(s).	0.003 kg

Ordering information and sources

SLE G6 19mm 5000lm 830 R ADV	89602648	3,000 K	> 80	no	20 pc(s).	0.003 kg
SLE G6 19mm 5000lm 835 R ADV	89602649	3,500 K	> 80	no	20 pc(s).	0.003 kg
SLE G6 19mm 5000lm 840 R ADV	89602650	4,000 K	> 80	no	20 pc(s).	0.003 kg
SLE G6 19mm 5000lm 927 R ADV	89602651	2,700 K	> 90	no	20 pc(s).	0.003 kg
SLE G6 19mm 5000lm 930 R ADV	89602652	3,000 K	> 90	no	20 pc(s).	0.003 kg
SLE G6 19mm 5000lm 935 R ADV	89602653	3,500 K	> 90	no	20 pc(s).	0.003 kg
SLE G6 19mm 5000lm 940 R ADV	89602654	4,000 K	> 90	no	20 pc(s).	0.003 kg
SLE G6 23mm 6000lm 827 R ADV	89602676	2,700 K	> 80	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 830 R ADV	89602677	3,000 K	> 80	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 835 R ADV	89602678	3,500 K	> 80	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 840 R ADV	89602679	4,000 K	> 80	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 927 R ADV	89602680	2,700 K	> 90	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 930 R ADV	89602681	3,000 K	> 90	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 935 R ADV	89602682	3,500 K	> 90	no	20 pc(s).	0.009 kg
SLE G6 23mm 6000lm 940 R ADV	89602683	4,000 K	> 90	no	20 pc(s).	0.009 kg
SLE G6 10mm 1200lm 830 C ADV	28001666	3,000 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 10mm 1200lm 840 C ADV	28001692	4,000 K	> 80	no	20 pc(s).	0.001 kg
SLE G6 15mm 3000lm 830 C ADV	89602639	3,000 K	> 80	no	20 pc(s).	0.004 kg
SLE G6 15mm 3000lm 840 C ADV	89602640	4,000 K	> 80	no	20 pc(s).	0.004 kg
SLE G6 15mm 3000lm 930 C ADV	89602641	3,000 K	> 90	no	20 pc(s).	0.004 kg
SLE G6 15mm 3000lm 940 C ADV	89602642	4,000 K	> 90	no	20 pc(s).	0.004 kg
SLE G6 17mm 4000lm 830 C ADV	89602724	3,000 K	> 80	no	20 pc(s).	0.004 kg
SLE G6 17mm 4000lm 840 C ADV	89602725	4,000 K	> 80	no	20 pc(s).	0.004 kg

Ordering information and sources

SLE G6 17mm 4000lm 930 C ADV	89602726	3,000 K	> 90	no	20 pc(s).	0.004 kg
SLE G6 17mm 4000lm 940 C ADV	89602727	4,000 K	> 90	no	20 pc(s).	0.004 kg
SLE G6 19mm 5000lm 827 C ADV	89602663	2,700 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 830 C ADV	89602664	3,000 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 835 C ADV	89602665	3,500 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 840 C ADV	89602666	4,000 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 927 C ADV	89602667	2,700 K	> 90	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 930 C ADV	89602668	3,000 K	> 90	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 935 C ADV	89602669	3,500 K	> 90	no	20 pc(s).	0.008 kg
SLE G6 19mm 5000lm 940 C ADV	89602670	4,000 K	> 90	no	20 pc(s).	0.008 kg
SLE G6 23mm 6000lm 830 C ADV	89602692	3,000 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 23mm 6000lm 835 C ADV	89602693	3,500 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 23mm 6000lm 840 C ADV	89602694	4,000 K	> 80	no	20 pc(s).	0.008 kg
SLE G6 23mm 6000lm 930 C ADV	89602695	3,000 K	> 90	no	20 pc(s).	0.008 kg
SLE G6 23mm 6000lm 935 C ADV	89602696	3,500 K	> 90	no	20 pc(s).	0.008 kg
SLE G6 23mm 6000lm 940 C ADV	89602697	4,000 K	> 90	yes	20 pc(s).	0.008 kg
SLE G6 15mm 3000lm 830 H ADV	89602635	3,000 K	> 80	yes	50 pc(s).	0.003 kg
SLE G6 15mm 3000lm 830 H ADV D50	89602643	3,000 K	> 80	yes	50 pc(s).	0.009 kg
SLE G6 15mm 3000lm 840 H ADV	89602636	4,000 K	> 80	yes	50 pc(s).	0.003 kg
SLE G6 15mm 3000lm 840 H ADV D50	89602644	4,000 K	> 80	yes	50 pc(s).	0.009 kg
SLE G6 15mm 3000lm 930 H ADV	89602637	3,000 K	> 90	yes	50 pc(s).	0.003 kg
SLE G6 15mm 3000lm 930 H ADV D50	89602645	3,000 K	> 90	yes	50 pc(s).	0.009 kg
SLE G6 15mm 3000lm 940 H ADV	89602638	4,000 K	> 90	yes	50 pc(s).	0.003 kg

Ordering information and sources

SLE G6 15mm 3000lm 940 H ADV D50	89602646	4,000 K	> 90	yes	50 pc(s).	0.009 kg
SLE G6 17mm 4000lm 830 H ADV D50	89602720	3,000 K	> 80	yes	50 pc(s).	0.003 kg
SLE G6 17mm 4000lm 840 H ADV D50	89602721	4,000 K	> 80	yes	50 pc(s).	0.003 kg
SLE G6 17mm 4000lm 930 H ADV D50	89602722	3,000 K	> 90	yes	50 pc(s).	0.003 kg
SLE G6 17mm 4000lm 940 H ADV D50	89602723	4,000 K	> 90	yes	50 pc(s).	0.003 kg
SLE G6 19mm 5000lm 827 H ADV	89602655	2,700 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 830 H ADV	89602656	3,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 835 H ADV	89602657	3,500 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 840 H ADV	89602658	4,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 927 H ADV	89602659	2,700 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 930 H ADV	89602660	3,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 935 H ADV	89602661	3,500 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 940 H ADV	89602662	4,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 827 H ADV	89602684	2,700 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 830 H ADV	89602685	3,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 835 H ADV	89602686	3,500 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 840 R ADV	89602687	4,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 927 H ADV	89602688	2,700 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 930 H ADV	89602689	3,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 935 H ADV	89602690	3,500 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 940 R ADV	89602691	4,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 830 H ADV T	89602672	3,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 840 H ADV T	89602673	4,000 K	> 80	yes	50 pc(s).	0.007 kg

Ordering information and sources

SLE G6 19mm 5000lm 930 H ADV T	89602674	3,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 19mm 5000lm 940 H ADV T	89602675	4,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 830 H ADV T	89602699	3,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 840 H ADV T	89602700	4,000 K	> 80	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 930 H ADV T	89602701	3,000 K	> 90	yes	50 pc(s).	0.007 kg
SLE G6 23mm 6000lm 940 H ADV T	89602702	4,000 K	> 90	yes	50 pc(s).	0.007 kg

Ordering information and sources

7.1.2. Suitable controllers

Tridonic offers a comprehensive range of DALI-compatible products. All the devices specified here support DALI Device Type 6 and therefore guarantee effective use of Engine SLE G6.

Product name	Article number
DALI MSensor 02	28000896
DALI SC	24034263
DALI MC	86458507
DALI TOUCHPANEL 02	28000022
DALI x/e-touchPANEL 02	28000005
DALI PS	24033444
DALI USB	24138923

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 Driver, amplifiers and sequencers round off the components for a perfect system solution: They guarantee ideal operation and maximum efficiency.

7.2.1. Luminaire application

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

7.2.2. Luminaire application

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

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

+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