PHILIPS

LED Modules

Design-in Guide

Fortimo DLM Gen 5

Improve your total cost of ownership

Contents

Introduction to this guide

Thank you for choosing the Philips Fortimo LED downlight module (DLM) system. In this guide you will find all the information you require to design a luminaire based on these modules, as well as details of the necessary drivers and cables. As LED technology is continuously improving, we advise you to visit our website for the latest details: www.philips.com/ledmodulesna.

More information or support

If you require any further information or support please consult your local Philips sales representative. Your Philips sales representative can provide you more information around how to access design-in service from Philips.

UL SREC

The UL SREC function ensures safe operation of the module by dimming the module in the case that high temperatures are encountered. This functionality removes the need for an additional thermal protection device. In combination with the self-cooled functionality up to 2000lm this enables a very cost effective solution without compromising on safety or reliability. The SREC function will only be activated above 80°C Tcase, and, therefore, it is advised to design the luminaire such that Tcase would not exceed 80°C in typical conditions.

For performance calculations refer to the Easy Design-in Tool at https://www.na.easydesignintool.philips.com/.

Warnings and instructions

Safety warnings and instructions to be taken into account during design-in and manufacturing include:

- Avoid touching live parts!
- Luminaires must be installed and grounded in accordance with national and local electrical codes!
- Do not use damaged or defective driver. Do not use damaged or defective LED modules, including damaged connectors.
- Do not drop the LED module or let any object fall onto the LED module because this may damage the PCB, LEDs, glass diffuser and/or components. If the LED module has been dropped or an object has fallen onto the LED module, do not use it, even if there are no visible defects or signs of damage.

- The supplied LED driver should not be lifted or handled by pulling on the attached lead wires.
- The luminaire manufacturer is responsible for its own luminaire design and must comply with all relevant safety and performance standards.
- Cap off all unused wires to prevent accidental contact with live terminals.
- Do take into account the minimum required creepage and clearance distances.
- Do not apply mains power to the LED module directly.
- Connect all electrical components first before switching on mains.
- Do not service the luminaire when the mains voltage is connected; this includes connecting or disconnecting the LED module's cables.
- Recommended LED drivers are not suited for DC input operation.
- The Philips Fortimo DLM gen 5 is intended for built-in use and should not be exposed to the elements, such as snow, water or ice. It is the luminaire manufacturer's responsibility to prevent exposure. Fortimo DLM gen 5 products are specified for UL damp and dry locations.
- For optimal reliability of the LED module, we advise not to apply an AC electric strength test to the luminaire, as this might damage the LEDs. It is recommended instead to apply an insulation resistance measurement at 500 VDC.
- For support with any of these aspects, please contact your local Philips sales representative.

Introduction to the Philips Fortimo LED downlight module system

Applications

As the name suggests, the Philips Fortimo LED downlight module is designed to be integrated into downlight luminaires for indoor use. OEMs may explore other applications and luminaires as long as there is no design conflict and compliance is ensured with luminaire standards.

Can the module be used in outdoor luminaires?

Neither the module nor the driver have an IP classification. If these products are used in luminaires for outdoor applications, it is up to the OEM to ensure proper IP protection and approbation of the luminaire. Please consult the Philips design-in team if you wish to deviate from the design rules described in this guide.

Criteria for Philips Fortimo LED modules

Philips Fortimo LED modules stand for the following criteria:

1. High quality white light CRI>90 and R9>50

While LED technology gives the promise of high quality white light in terms of color rendition and color consistency, this does not happen automatically.

The Philips Fortimo downlight module gen 5 is designed to meet even higher requirements for white light applications than its previous generation[1], expressed by the improved CRI and R9 specifications. The unique remote phosphor technology enables great color consistency over life.

2. High energy efficiency

Philips Fortimo DLM gen 5 energy efficiency is maintained while improving light quality and color rendition.

3. Future-proof systems

As energy efficacy of LEDs advances and new bins become available, LED module upgrades are planned. The new generation of LEDs will be incorporated into the Fortimo LED modules, resulting in a higher efficacy, without changing the dimensions, shape or lumen output of the system. A really future-proof approach is to enable luminaire manufacturers to easily plan and design new luminaire ranges for the coming years. Additional mounting holes, matching, for example, the Philips Fortimo DLM flex module, enable the utilization of different modules in the same luminaire.

Figure 1. Fortimo LED downlight module.

4. Reliability

All Fortimo LED modules are subjected to these measures and are built for a long life of up to 50,000 hours.[2]

System approach

Fortimo LED modules are always designed and marketed together with a Philips Advance Xitanium LED driver, as Philips believes that a good system design is crucial to facilitate an easy design-in. There is a wide range of Philips Advance Xitanium LED drivers available for all Fortimo LED modules, offering plenty of flexibility and choice.

All modules are built-in versions for integration into luminaires. This is applicable for the drivers, too, except for Xitanium independent LED drivers that can be used remotely (independently) from the LED luminaire.

The modules have interfaces for:

- Cabling between LED module, driver and luminaire
- Secondary optics via mounting options in the LED module housing and reflector rim
- Heat sink design via heat spreader.

Nomenclature of Fortimo downlight modules

Figure 2. Philips Advance Xitanium LED driver 25W/36W/50W, 0-10V dimming.

The names of the modules are defined as follows. Fortimo LED DLM 2000 20W/940 gen 5 is used here as an example.

Fortimo	:	Our brand name for efficient, clear and reliable lighting
LED	:	The light source used
DLM	:	Downlight module
2000	:	2000 lumens
20W	:	20W typical module power consumption
/940	:	For a color rendering index of 90; 40 stands for a CCT of 4000K
Gen 5	:	Generation of product

Philips Advance Xitanium LED drivers

The highly efficient LED drivers are designed to operate high-power LEDs, which are integrated into the Philips Fortimo LED modules.

See footnotes on page 31.

Philips Fortimo LED DLM cables for Xitanium 25W, 36W and 50W drivers

Two cables, which are 50cm and 84cm in length and have a wire diameter of AWG24 (0.5mm), are available to connect with the driver. The functions of the cables connected to the driver are as follows:

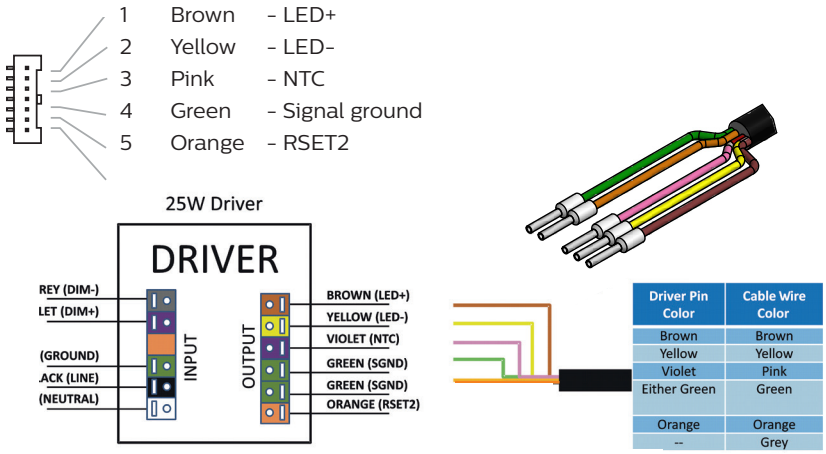


Figure 3. Wiring diagram for Fortimo DLM gen 5 systems and 25W, 36W and 50W Xitanium LED drivers.

The compatible cables:

DLM Cable 50cm 929000683903

DLM Cable 84cm 929000684003

OEM-developed cables

We recommend you use Philips Fortimo LED downlight module cables. However, if you prefer to develop your own cables, the specification must meet UL/CSA requirements. Please bear in mind that the approval for the Fortimo LED downlight module and Philips Advance Xitanium LED driver is based on a reference luminaire with a standard cable based on the maximum length of 84cm. Any luminaire design will require its own approval by a certification body, to be arranged by the relevant OEM, irrespective of the length of cable used.

An OEM-developed cable that is in accordance with the design-in rules to obtain system warranty should have the following specifications:

- Housing JST-PHR-7
- Contact JST SPH-002T-P0.5S
- Wago wire ferrule 216-201
- Wire 22 AWG UL style 1568 stranded or equivalent

Emergency application

All commercial and government buildings in the U.S. require emergency lighting in order to meet the Life Safety Code® NFPA 101®. Philips Emergency Lighting offers the BSL17-C2 and BSL17C-C2 emergency LED drivers specifically designed for Philips Fortimo downlight module gen 4 and gen 5. When AC power is lost, the BSL17-C2 and BSL17C-C2 take over operation of the LED module for 90 minutes to help comply with emergency code requirements. The BSL17-C2 and BSL17C-C2 are Class 2, UL Component Recognized and CSA Certified. Please check emergency driver datasheet for the latest wiring diagrams.

Figure 4. Philips Bodine emergency driver.

LED Module	Philips Bodine BSL17C-C2 Emergency Driver
Fortimo LED DLM 1100 lm Gen 5	Yes
Fortimo LED DLM 1500 lm Gen 5	Yes
Fortimo LED DLM 2000 lm Gen 5	Yes
Fortimo LED DLM 3000 lm Gen 5	Yes

Table 1. Emergency application.

For more information, please visit www.bodine.com/products/specs/bsl17cc2.html.

Emergency driver compatibility

The compatibility between the Philips Bodine emergency LED driver and Fortimo LED DLM gen 5 is as below:

Emergency driver wiring diagram with Fortimo LED DLM gen 5

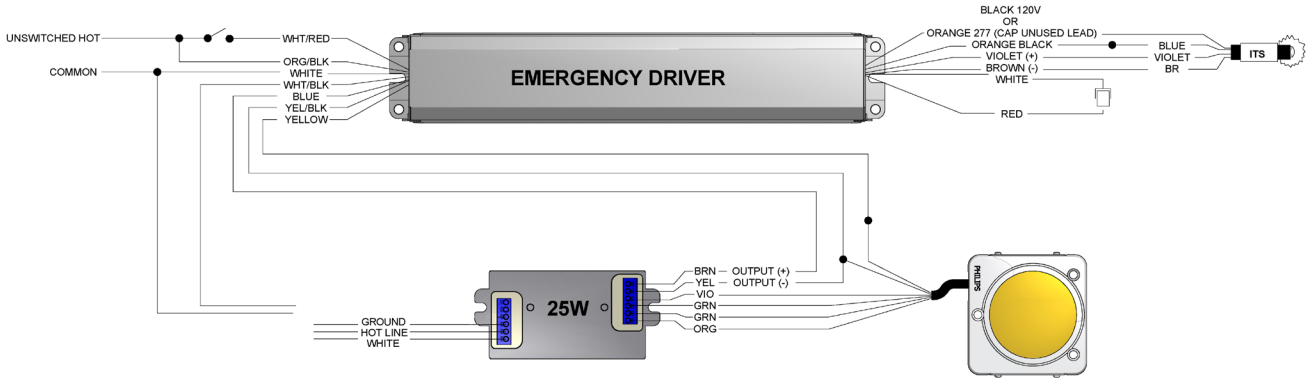


Figure 5. Emergency driver wiring diagram.

Fortimo LED downlight module gen 5

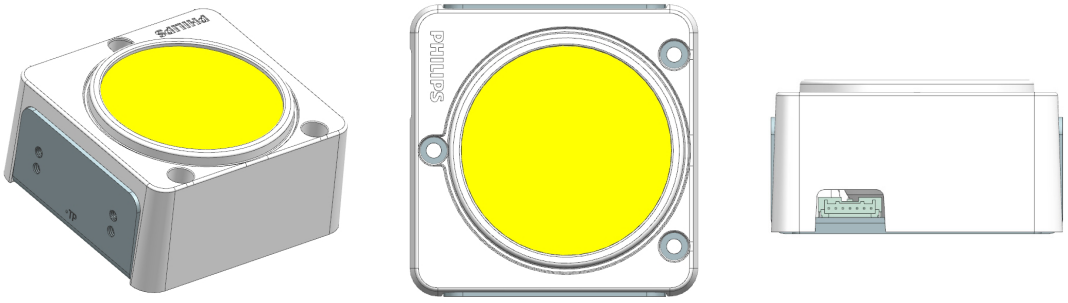


Figure 6. Fortimo LED downlight module gen 5 images.

Light technical design

Product binning in Philips Fortimo DLM gen 5

The Fortimo LED DLM gen 5 comes with a Color consistency of 95% within <2SDCM (not higher than 2,5SDCM). For higher accuracy level up to 2SDCM a bin structure is available, which is illustrated in the Figure 7.

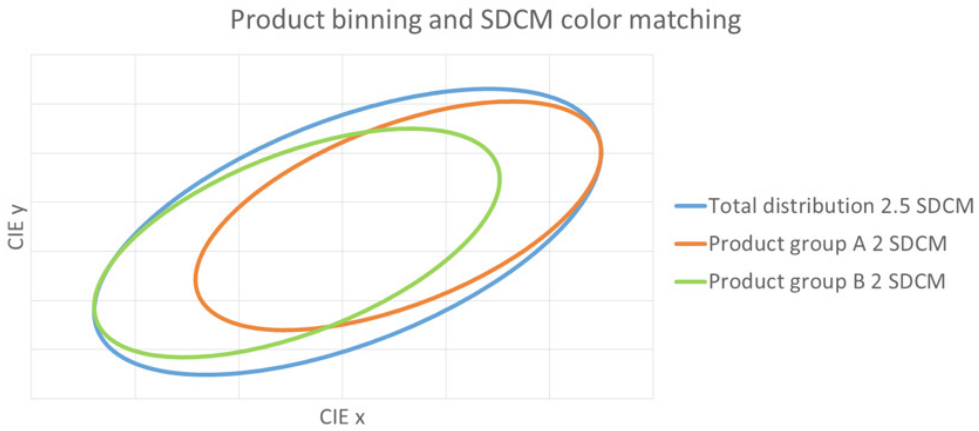


Figure 7. Example of Fortimo DLM gen 5 products that are binned into groups A and B, each 2 SDCM. Together they form a group within 2.5 SDCM.

Each box of Fortimo DLM gen 5 modules will contain a single bin of products. They are easily identified by the Identifier Color Bin: A or Color Bin: B on the box label. This information is also contained within the 2D barcode, which simplifies inventory management. The individual products are designated with the Identifier Color Bin: A or Color Bin: B printed on the product's label, as well. Figure 8 shows where this information can be found on the labels.

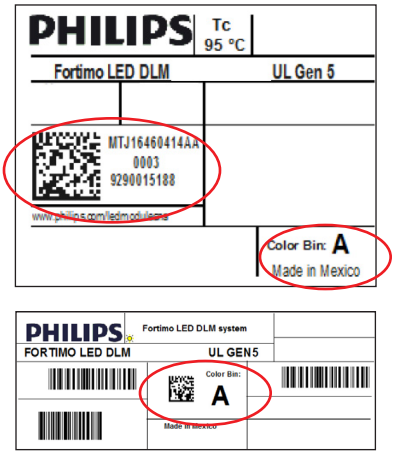


Figure 8. Labels.

Philips Fortimo LED downlight modules light quality

High-quality LED light is achieved by mixing the light of various LEDs and applying a special phosphor technology remotely from the LEDs. High-quality white light is characterized by a good color consistency and a color rendering of >90, popular CCTs in general lighting applications of 3000K and 4000K. The mixing chamber ensures perfectly mixed light, resulting in uniform colors and good color consistency. In addition to facilitating high efficiencies, the remote phosphor technology makes it relatively easy to develop virtually any fluorescent color. The function of the diffuser is to shape the light distribution, resulting in a lambertian beam. You have the freedom to design your own secondary optics. The LED module integrates easy mounting options for secondary optics. The overall dimensions of the LED module are optimized for lumen packages varying from 1100lm to 3000lm.

Note that the optical parameters included in this guide, such as colorpoints x and y, CRI, luminous flux, etc., are measured in an integrating sphere.

Color consistency standard deviation color matching (SDCM)

The current specification of the Fortimo modules for color consistency is 2 SDCM @ 0-hours and 3 SDCM @ 6,000 hours, based on LM80 testing. Refer to your Philips representative for updated values as the tests continue. The value 2 refers to the size of an ellipse around the color target point. Staying within this ellipse results in a consistency of light whereby there is no perceivable difference from one luminaire to another. This really demonstrates the unique quality of the remote phosphor concept.

Starting characteristics

The Fortimo modules can be switched on in milliseconds, which is a general characteristic of LEDs. Thanks to the dimmable driver, the light can be switched on at a dimming level between 1% to 100% in milliseconds.

Secondary optics

The Fortimo LED downlight module generates a lambertian beam shape, which is a pragmatic starting point for secondary optic design. The secondary optic design should not cover the exit aperture. Ray-set files are available via the website https://www.na.my-technologyportal.lighting.philips.com/public-dashboard/download-center-public.html.

The luminaire manufacturer must ensure that the temperature of the yellow diffuser does not exceed 160°C. The temperature of this light exit window can be measured using infrared temperature sensing technology.[3] In order to achieve this we recommend that a lens or diffuser is not placed within 70mm of the Fortimo LED module light exit window.

On the top of the Fortimo LED downlight module there are mounting options (rim of diffuser and three mounting holes) for positioning secondary optics.

Companies supplying reflectors for secondary optics

Secondary optics are not part of the Philips Fortimo LED downlight module system offering. This is an added value area for OEMs. Meanwhile, a complementary reflector business has developed around the Fortimo LED downlight module. The table below gives a list of complementary partners offering compatible reflectors for Fortimo LED downlight modules.

The following are examples of reflector suppliers that have products available to be used with the Fortimo LED downlight module system. Reference to these products does not mean they are endorsed by Philips for use with the Fortimo LED downlight module system. Philips gives no warranties regarding the use of these products in connection with the Fortimo LED downlight module system products and assumes no legal liability or responsibility for any loss or damage resulting from the use of this information, which is given on an “as-is” basis.

Complementary Reflector Partners		**Status**
Jordan	www.jordan-reflektoren.de	Released
NATA	www.nata.cn	Released
Widegerm	www.widegerm.com.hk	Released

Table 2. Complementary reflector partners.

See footnotes on page 31.

Mechanical design

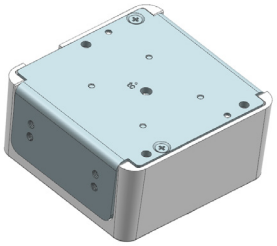


Figure 9. Philips Fortimo LED downlight module.

About the Fortimo LED downlight module

The module consists of the following main components:

- PCB with LEDs
- Heat spreader
- Mixing chamber
- Diffuser with remote phosphor technology
- Metal housing

Mechanical fixation

The screw holes (M4 threaded) on the side can be used to fix reflectors. The maximum load per screw is 5N with maximum weight of 500gr, and the total maximum load applied on the side fixation holes is 20N with maximum weight of 2000gr.

Recommended screw type

From the top of the module to heat sink: M4 socket head cap screw. The recommended torque on M4 screws is 4Nm. Do not secure from housing top.

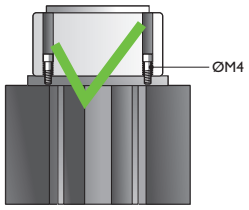


Figure 10. Conforming attachment.

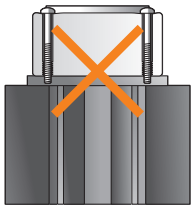


Figure 11. Nonconforming attachment.

Below you will find an example of a possible way to fix the heat sink to the module. Note that when fixing the module to the heat sink from the top, M4 thread is used.

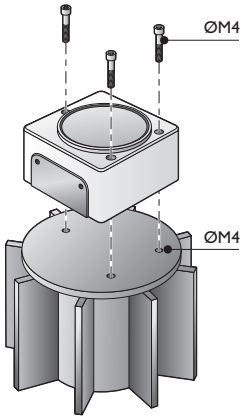


Figure 12. Heat sink, fixation through the module housing and not on the top surface of the housing.

Thermal management

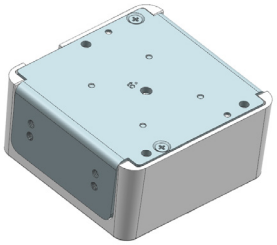


Figure 13. Temperature test point Tc. (Do not measure inside the central hole, but around it).

The critical thermal management points for the LED module are set out in this chapter in order to facilitate the design-in of Philips Fortimo LED downlight modules. If these thermal points are taken into account, this will help to ensure optimum performance and lifetime of the LED system.

Optimum performance

To help ensure optimum performance, the Fortimo LED DLM gen 5 modules must operate within specified performance temperature limit of 85°C. Note that the maximum performance Tc value for the Fortimo LED DLM gen 5 is 5°C higher than for the Fortimo LED DLM gen 4, allowing much more compact and cost-effective heat sinks to be used or to be operated at a high fixture ambient temperature.

Test requirements

Measurements, for example, of temperature, luminous flux and power, are reliable once the luminaire is thermally stable, which may take between 0.5 and 2 hours. The time depends on the thermal capacity of the luminaire (see also the relevant clauses in UL1598). Measurements must be performed using thermocouples that are firmly glued to the surface (and not, for example, secured with adhesive tape).

Critical measurement points

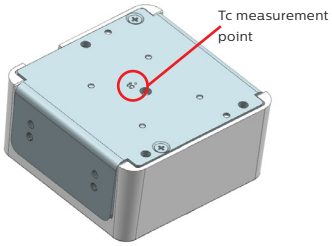


Figure 14. Tc temperature measurement point.

Because LEDs are temperature sensitive, LED modules require a different approach with respect to the maximum permissible component temperature. This is different from most other types of light sources. For LEDs the junction temperature is the critical factor for operation. Since there is a direct relation between the case temperature and the LED junction temperature, it is sufficient to measure the aluminum casing of the LED module at its critical point. The critical point is on the rear surface of the LED module, as shown in the Figure 14. If the case temperature (Tc) at the critical measurement point exceeds the recommended maximum temperature, the performance of the LEDs will be adversely affected, for example, in terms of light output, lifetime or lumen maintenance.

Warning: Case temperature and thermal circuit

The maximum Tc on the rear surface of the LED module has been defined to ensure the performance of the Philips Fortimo LED downlight module system. At this case temperature the proper junction temperature of the LEDs is assured and the performance specified (lifetime, light output, lumen maintenance, etc.) will be met over life of the product. Above Tc = 80°C, a thermal circuit in the LED driver will be activated that will dim the LED module to limit the temperature raise. The thermal circuit is intended to protect the module under abnormal condition but NOT the lifetime of the module.

Self-cooling feature

The Philips Fortimo LED DLM gen 5 brings a new and revolutionary thermal feature available for all module at all color temperatures up to 2000lm, which helps to simplify the overall thermal design of the fixtures, eventually contributing to more cost-effective solutions by enabling the removal or significant reduction of external heat sinks.

As a reference, a 2000lm 2700K module can be maintained below its maximum life/ warranty case temperature (85°C), in a free airflow ambient below 35°C, without the addition of any heat sink or interface materials such as brackets or holders that influence positively on the thermal performance of the fixture. The setup is provided to scale in Figure 15.

Please notice that the self-cooling feature is only enabled for modules up to 2000lm. For the Fortimo LED DLM gen 5 3000lm and above, an additional heat sink will always be required in order to keep the module within its life and warranty conditions. Please refer to the complementary thermal solution partners section in this guide.

Regardless of the available self-cooling feature, it remains to the OEMs, the responsibility to verify always the modules' thermal condition according to the final luminaire design and application conditions.

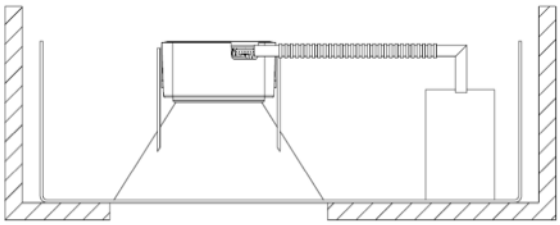


Figure 15. Self-cooling validation set-up. Image drawn to scale.

For more information regarding the test procedure for the self-cooling proposition, respective annex is available through your local Philips sales representative.

Fixture design using safety related electronic circuit

The system of Philips Fortimo DLM gen 5 with approved Philips Advance Xitanium drivers qualifies for the UL safety related electronic circuit program as prescribed by UL 991 and CSA 22.2.

This program allows the Fortimo DLM gen 5 system to be installed as a replacement for the thermal protector as described in UL 1598 section 11.5 titled Thermal Protectors.

The OEM can use the thermal protection circuit when testing the luminaire for compliance to UL 1598 for temperature tests. The Fortimo DLM gen 5 system will ensure that the luminaire will stay below 90°C surface temperature.

Thermal interface material

The function of a thermal interface material is to reduce thermal impedance between the LED module and the heat sink. The thermal interface material replaces air, which is a thermal insulator, by filling the gaps with material that has better thermal conductivity. This is shown schematically in the Figure 16. Philips recommends to always use a thermal interface material.

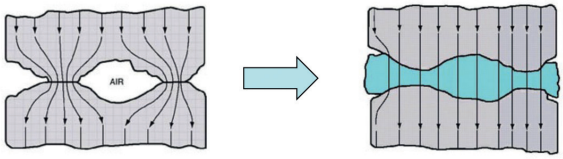


Figure 16. The working principle of thermal interface material.

It is the OEM responsibility to maintain temperature within specifications.

The thermal interface partners listed in Table 3 can provide interface material products that can be used with the Philips Fortimo LED DLM system.

Reference to these partners does not mean they are endorsed by Philips for use with the Fortimo LED downlight module system. Philips gives no warranties regarding the use of these products in connection with the Fortimo LED downlight module system products and assumes no legal liability or responsibility for any loss or damage resulting from the use of this information, which is given on an “as-is” basis.

Thermal Interface Partners	
Laird Technologies	www.lairdtech.com
The Bergquist Company	www.bergquistcompany.com

Table 3. Thermal Interface partners.

Electrical and thermal analogy

Standard static thermal situations can be modeled using "thermal resistances." These resistances behave like electrical resistances. The analogy between electrical and thermal resistances is explained in Figure 17, Electrical and thermal analogy. The electrical units are shown on the left, while the thermal equivalents are given on the right. With a known voltage difference at a certain current it is possible to calculate the electrical resistance using Ohm's law. The same applies for a thermal resistance. If the temperature difference and the thermal power are known, the thermal resistance can be calculated using the thermal Ohm's law.

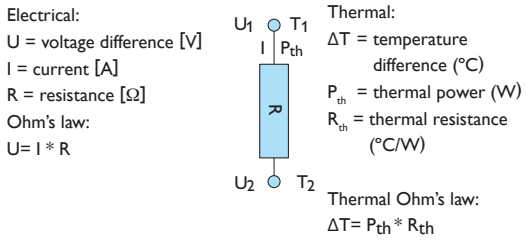


Figure 17. Electrical and thermal analogy.

Thermal model

A thermal model that can be used to determine the required thermal performance of the cooling solution for the LED module is shown in Figure 18.

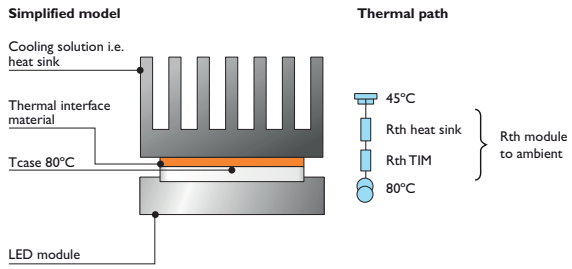


Figure 18. Thermal model.

Warning

The maximum temperature difference between Tc and Tambient should never exceed 55°C for Fortimo DLM gen 5, otherwise it could lead to a reduction in the lifetime of the system.

Passive cooling

Passive cooling systems are based on the fact that hot air moves upward, thus creating an airflow along the surfaces. This is called natural convection. There are many standard heat sinks available, but it is also possible to design your own heat sink. In general, a passive cooling solution requires a larger heat sink than an active cooling solution.

Design guidelines for passive cooling

Before starting to perform any calculations, an important point to consider is the airflow. In general hot air moves upward at a relatively low speed. The shape and position of the heat sink will affect the airflow. Ideally, the fins should be parallel to the direction of airflow. Closure of the top of the profile will reduce the cooling capacity of the heat sink and should, therefore, be avoided during design and installation.

Some additional design guidelines for passive cooling include:

- Limit the number of thermal interfaces in the thermal path from module to ambient.
- Thick fins conduct heat better than thin fins.
- Large spacing between fins is better than small spacing between fins, air flowing the path with least resistance.
- Make cooling surfaces more effective by using proper conductive materials, appropriate thickness and correct fin orientation.
- Thermal radiation plays a significant role/anodized or powder-coated surfaces are preferable to blank surfaces.

Complementary thermal solution partners

Thermal solutions do not form part of the Fortimo LED downlight module system offering. This is an added-value area for OEMs, offering the possibility to differentiate. However, there are many thermal solution companies that have a standard portfolio of compatible heat sinks available, enabling quick and easy luminaire creation. The table below gives a list of complementary partners offering compatible cooling systems for Fortimo LED downlight modules.

The following are examples of providers of cooling solutions that can be used with the Fortimo LED DLM system.

Reference to these products does not mean they are endorsed by Philips for use with the Fortimo LED downlight module system. Philips gives no warranties regarding the use of these products in connection with the Fortimo LED downlight module system products and assumes no legal liability or responsibility for any loss or damage resulting from the use of this information, which is given on an “as-is” basis.

Complementary Heat Sink Partners		**Status**
AVC	www.avc.com.tw	Released
Wisefull	www.wisefull.com	Released
Mechatronix	www.mechatronix-asia.com	Released
Sunon	www.sunon.com	Released

Table 4. Complementary heat sink partners.

Electrical design

Wiring

Connect the alternating current mains and protective earth grounding. The mains supply has to be connected to the power supply.

Class 2

In a Class 2 product the driver design is such that in the event of single fault conditions the mains cannot come into electrical contact with the electrically conductive parts of the luminaire. As the maximum voltage of the Philips Fortimo LED downlight module is below 60V, it complies with the rules governing UL 1310 driver and is, therefore, safe to touch.

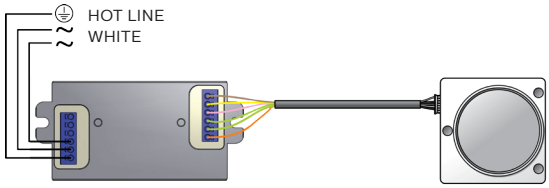


Figure 19. Schematic wiring diagram with protective earth of 25W/36W/50W driver.

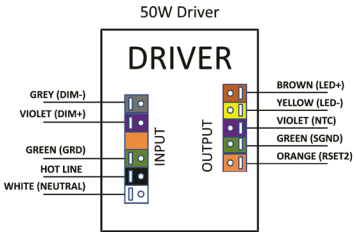


Figure 20. Driver schematic wiring diagram.

Substitution of gen 4 system with gen 5 system

Mechanical difference between Fortimo downlight modules gen 4 systems and gen 5 systems

Housing change

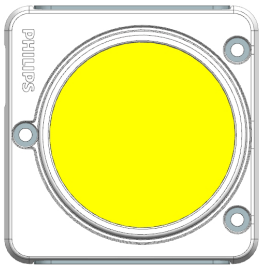
Top view

gen 4

- Tapered holes Ø8 mm
- Fit for M4 (socket head cap screw)

Top view

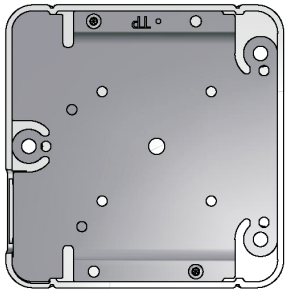
gen 5



- Tapered holes Ø8 mm
- Fit for M4 (socket head cap screw)

Bottom view

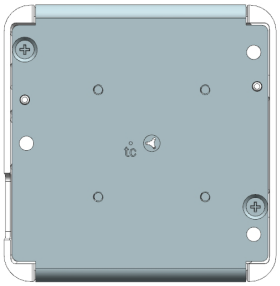
gen 4



- 3 x M5 bottom-up mounting

Bottom view

gen 5



- The 3 x M5 bottom-up mounting threads included in gen 4 have been removed in gen 5.

Mounting holes

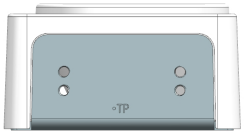
Side mounting holes view

gen 4

- Full metal housing
- Side mounting holes 2 x M4

Side mounting holes view

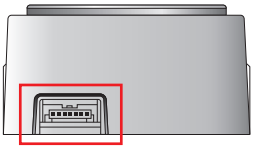
gen 5



- Full metal housing
- Side mounting holes 4 x M4

Side connector view

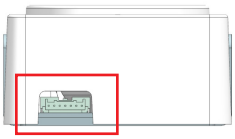
gen 4



- Connector depth = 2.7 mm
- Connector height = 10.5 mm

Side connector view

gen 5



- Connector depth = 2.7 mm
- Connector height = 10.5 mm

Approbation

Compliance and approval

CSA/UL/UL SREC

Application information

IP Rating	No IP Rating
Overheating protection	UL SREC

Cat. No. downlight modules gen 4 series may represent Cat. No. downlight modules series LED module series DLMxxxx yyW/zccUL (gen 3, volume 1, section 1), report dated 2010-03-11, without additional end-product normal temperature testing provided that:

a. The wattage for the DLM gen 4 is the same or lower than the wattage of the originally end-product tested DLM gen 3,

b. only the bottom heat spreader is used for cooling and

c. end product thermal management construction is not reduced.

Cat. No. DLM gen 5 series may represent Cat. No. DLM gen 4 series without additional end-product normal temperature testing provided that:

a. The wattage for the DLM gen 5 is the same or lower than the wattage of the originally end-product tested DLM gen 4,

b. only the bottom heat spreader is used for cooling and

c. end product thermal management construction is not reduced.

Norms and standards

Philips Fortimo LED downlight modules together with Philips Advance Xitanium LED drivers comply with following norms and standards:

Safety

CAN/CSA C22.2 No. 250.13-14	Light emitting diode (LED) equipment for lighting applications
NA	Photobiological safety of lamps and lamp systems
UL1310/UL8750/CSA c22.2 no. 223	Control gear safety

Safety related electronic circuit

UL991/CSA C22.2 No. 0.8-09	Tests for Safety Related Controls Employing Solid State Safety functions incorporating electronic technology. To comply to this standard, both modules and drivers need to carry the additional UL mark for UL SREC.

c US
Safety Related
Electronic Circuit

Performance

UL8750/SSL 7	Control gear performance

Electromagnetic compatibility (tested with Philips Fortimo LED DLM, cable and Philips Advance Xitanium LED driver)

FCC47 subpart 15 Class A	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
FCC47 subpart 15 Class A	Equipment for general lighting purposes – EMC immunity requirements
ANSI C82.77	Limits for harmonic current emissions (equipment input current <16 A per phase)

Environmental

The product is compliant with European Directive 2011/65/EC Restriction of Hazardous Substances on Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).[4]

Approval

CSA/cURus

Chemical compatibility

The Fortimo DLM makes use of LEDs containing a silver-finished (Ag) lead frame. The lead frame finish is sensitive to pollution and/or corrosion when exposed to oxygen and certain volatile organic components [VOCs]. Examples of VOCs are substances containing sulfur or chlorine. In that case parts of the lead frame may blacken, which will impair the lumen output or the color point of the LED light. Materials that are known to have a higher risk to be a source of sulfur and chlorine are, for example, rubbers used for cables and cable entries, sealings or corrugated cartons. Also do NOT use adhesives, cleaning agents or coatings containing suspect VOCs. Do not use the product in aggressive (corrosive) environments that may cause damage to the LEDs.

We recommend ensuring that the direct environment of these LEDs in the luminaire does not contain materials that can be a source of sulfur or chlorine for optimal reliability of the LED, LED module and/or LED luminaire. Furthermore, make sure that the products with these LEDs are not stored or used in vicinity of sources of sulfur or chlorine and the production environment is also free of these materials. Also avoid cleaning of the LED products with these types of LEDs with abrasive substances, brushes or organic solvents like acetone and TCE.

Applications of the product in industry and heavy traffic environment should be avoided in case of risk of ingress of sulfur and chlorine from the environment.

A list of chemicals often found in electronics and construction materials for luminaires that should be avoided is provided in the table below. Note that Philips does not warrant that this list is exhaustive since it is impossible to determine all chemicals that may affect LED performance. These chemicals may not be directly used in the final products, but some of them may be used in intermediate manufacturing steps (e.g., cleaning agents). Consequently, trace amounts of these chemicals may remain on (sub) components, such as heat sinks. It is recommended to take precautions when designing your application.

In case of questions on compatibility of materials or applications of the product, please contact your local Philips representative for application support.

Chemical Name	**Type**
Acetic Acid	Acid
Hydrochloric Acid	Acid
Nitric Acid	Acid
Sulfuric Acid	Acid
Ammonia	Alkali
Sodium Hydroxide	Alkali
Potassium Hydroxide	Alkali
Acetone	Solvent
Benzene	Solvent
Dichloromethane	Solvent
Gasoline	Solvent
MEK (Methyl Ethyl Ketone)	Solvent
MIBK (Methyl Isobutyl Ketone)	Solvent
Mineral Spirits (Turpentine)	Solvent
Tetracholorometane	Solvent
Toluene	Solvent
Xylene	Solvent
Castor Oil	Oil
Lard	Oil
Linseed Oil	Oil
Petroleum	Oil
Silicone Oil	Oil
Halogenated Hydrocarbons (containing F, Cl, Br elements)	Misc
Rosin Flux	Solder flux
Acrylic Tape	Adhesive
Cyanoacrylate	Adhesive

Table 5. Chemical list.

UV and other hazards

PET value	>100 hrs /Klux (zero UV)
Damage factor	0.08 @ 4100 K
IR (infrared) radiation	As well as being free of UV radiation, the LED modules are also free of infrared radiation in the beam.

Hazard Category	Emission Limit
LB	Low (Risk Group 1)
LR	Exempt[5]
LIR	Exempt
ES	Exempt
EUVA	Exempt
EB	Exempt
EIR	Exempt

Table 6. Emission limit.

IEC recommendations

The general recommendations for luminaire design given by the IEC (IEC 60598) and the national safety regulations are also applicable to LED-based luminaires.

Warning

Photobiological safety is not assured if the Fortimo LED downlight module is lit up without the cover. Direct exposure to the blue LED light is dangerous for the eyes.

Photobiological safety aspects

As of March 2007, LEDs and LED-based products for general lighting are no longer included in the scope of the eye safety standard for lasers, IEC 60825-1 “Safety of laser products.” The new lamp standard, IEC 62471 “Photobiological safety of lamps and lamp systems,” which covers incoherent light sources, now applies. This international standard gives guidance on evaluating the photobiological safety of lamps and lamp systems, including luminaires. It specifically defines the exposure limits, reference measurement technique and classification scheme for the evaluation and control of photobiological hazards from all electrically powered incoherent broadband sources of optical radiation, including LEDs but excluding lasers, in the wavelength range from 200 nm to 3000 nm.

In the photobiological safety standard, hazard categories are defined as follows:

Radiance-based

• Blue Light	LB	300 – 700 nm
• Retinal Thermal	LR	380 – 1400 nm
• Retinal Thermal Weak Stimulus	LIR	780 – 1400 nm

Irradiance-based

• Actinic UV Skin & Eye	ES	200 – 400 nm
• Eye UVA	EUVA	315 – 400 nm
• Blue Light Small Sources	EB	300 – 700 nm
• Eye IR	EIR	780 – 3000 nm

Philips Fortimo LED DLM gave the following results

The following should be taken into account:

- The effective radiance measurement for blue light (LB) modules is “low,” meaning that the LED modules are categorized in Risk Group 1. For the 2000lm version the permitted exposure time for blue light radiance (relevant when looking into the source) is limited to 1.5 hours, while for the 1100lm version it is 3 hours. Because of the Law of Conservation of Radiance, integration of the LED module into a luminaire results in either the same radiance or a reduced radiance. Final assessment of the luminaire is recommended.
- The measured irradiance-based values (E) for the categorized hazards are all within the exempt group (both 1100lm and 2000lm versions).
- In general the permitted exposure time for irradiance is limited when in the “low,” “moderate” or “high” risk group. Limiting the exposure time and/or the distance to the source can reduce the hazard level. However, for the measured LED modules no special precautions are necessary because they are ranked in the exempt group. Final assessment of the luminaire (including, e.g., secondary optics) is recommended.

Humidity,

The LED driver is suitable for use in “dry” and “damp” locations.

Exposure to direct sunlight

Exposure to direct sunlight during operation may have severe temperature or UV effects. Where this situation is likely, extensive temperature testing is recommended.

Vibration and shocks

Shock resistance: 50g @ 6ms semi-sinusoidal. Vibration resistance: sweep 50-150 Hz, one hour at resonance frequency (all 3 axes) without failure.

Philips Fortimo LED downlight module systems are to be used for indoor applications

When used in a non-weather protected environment, additional measures shall be taken to protect the Fortimo LED modules and LED drivers from water ingress.

End-of-life behavior

Unlike typical conventional light sources, LEDs are not subject to sudden failure or burnout.

There is no time at which the light source will cease to function. Instead, the performance of LEDs shows gradual degradation over time. When used according to specification, Fortimo LED downlight modules are predicted to deliver an average of 70% of their initial intensity after 50,000 hours of operation.[2]

The LEDs in the Fortimo LED downlight modules are connected in series. If one LED fails, this may be due to an internal short-circuit. In this case, it will still conduct current so that the other LEDs will continue to operate.

Philips Fortimo DLM system disposal

We recommend that the Fortimo LED DLM or its components are disposed of in an appropriate manner at the end of their (economic) lifetime. The modules are essentially normal pieces of electronic equipment containing components that at present are not considered to be harmful to the environment and can be disposed of with normal care. We, therefore, recommend that these parts are disposed of as normal electronic waste, in accordance with local regulations.

See footnotes on page 31.

Contact details

Philips

Product information www.philips.com/ledmodulesna

Or contact your local Philips sales representative

Partners for cooling solutions

Complementary Heat Sink Partners
AVC (www.avc.com.tw)
Wisefull (www.wisefull.com)
MechaTronix (www.mechatronix-asia.com)
Sunon (www.sunon.com)

Table 7. Partners for cooling solutions.

Partners for reflector solutions

Complementary Reflector Partners	
Jordan	www.jordan-reflektoren.de
NATA	www.nata.cn
Widegerm	www.widegerm.com.hk

Table 8. Partners for reflector solutions.

Partners for thermal interface materials

Complementary Thermal Interface Partners	
Laird Technologies	www.lairdtech.com
The Bergquist Company	www.bergquistcompany.com

Table 9. Partners for thermal interface materials.

Abbreviations

AM	Amplitude
AWG	American Wire Gauge
CISPR	Comité International Spécial des Perturbations Radioélectriques (Special International Committee on Radio Interference)
CRS	Customer Requirements Specification
CSA	Canadian Standards Association
EC	European Community
EMC	Electromagnetic Compatibility
EP	European Parliament
FCC	Federal Communications Commission
FR	Flame Retardant
IEC	International Electrotechnical Commission
IP	Ingress Protection
ISO	Organisation Internationale de Normalisation (International Organization for Standardization)
LED	Light Emitting Diode
NTC	Negative Temperature Coefficient
PCB	Printed Circuit Board
PCE	Power Conversion Efficiency
PWM	Pulse Width Modulation
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RTI	Relative Temperature Index
SDCM	Standard Deviation of Color Matching
SLM	Spot Lighting Module
SREC	Safety Related Electronic Circuit
Tcase	Temperature; at center of back of module
TIM	Thermal Interface Material
UL	Underwriters Laboratory
NA	Not Applicable

Footnotes

1. Fortimo DLM gen 4 has a CRI >80 whereas Fortimo DLM gen 5 has a CRI>90.
2. Average rated life is based on engineering data testing and probability analysis. The hours are at the B50, L70 point – 50,000 hours life with 70% lumen maintenance at Tc point of 85°C. Temperature rise from maximum fixture ambient to Tc point should be no higher than 55°C.
3. Typical settings for infrared temperature sensing are a minimum resolution of 1 mm^2 per pixel, using an emissivity of 0.9 for the yellow diffuser.
4. Restrictions on Hazardous Substances (RoHS) is a European directive (2002/95/EC) designed to limit the content of 6 substances [lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE)] in electrical and electronic products. For products used in North America compliance to RoHS is voluntary and self-certified.
5. Exempt means "no-risk."

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