A new generation solution for downlight applications
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Introduction to this guide

Thank you for choosing the Philips Fortimo LED downlight modules. In this guide you will find all the information you require to design a luminaire based on these modules. As LED technology is continuously improving, we advise you to visit our website: www.Philips.com/Technology for latest details.

More information or support
If you require any further information or support please consult your local Philips office. The Philips Design-in Team is also available to support you and you can contact them via your local Philips representative.

Determine which documents contain what information

In order to provide information in the best possible way, Philips’ philosophy on product documentation is the following.

- **Commercial leaflet** contains product family information & system combinations (compatible Philips drivers and Rsets)
- **Datasheet** contains the module specification
- **Design-In Guide** describes how to design-in the products

All these documents can be found on the download page of the OEM website www.Philips.com/Technology. If you require any further information or support please consult your local Philips office.
Warnings and instructions

When using a driver, intended for these modules

⚠️ Warning:

- The Philips Fortimo LED DLM Flex Gen2 modules must be operated with double isolated (SELV) drivers!
- Avoid touching the light emitting surface!

Safety warnings and installation instructions
To be taken into account during design-in and manufacturing.

Design-in phase
- Do not apply mains power to the module (Philips Fortimo LED DLM Flex Gen2) directly.
- Connect the modules and drivers before switching on mains.
- Provide adequate environmental protection.

Manufacturing phase
- Do not use products in case the LEDs are dislodged or if the housing is broken.
- Do not drop the LED DLM Flex Gen2 or damage in any way.
- Connect the modules and drivers before switching on mains.

Installation and service for luminaires incorporating the Fortimo LED DLM Gen2 System
- Do not service the luminaire when the mains voltage is connected; this includes connecting or disconnecting the LED DLM Gen2 module from the driver.

Philips Design-in support
Is available; please contact your Philips sales representative.
Introduction to Philips Fortimo DLM Flex Gen2

Fortimo DLM Flex Gen2 is the next generation range of products for the Philips downlight family. As with the previous generation, you can receive a downlight module as a L2 solution (only LED board) and choose amongst 2 different housings as an accessory. Both housings have the same footprint as the previous generations of Fortimo DLM. The difference lies in the height. The shallow housing allows for a smaller luminaire design. The high housing allows the user to maintain the previous luminaire design as the dimensions are exactly the same as the DLM gen5. With DLM Flex Gen2, you get the freedom and flexibility to choose your module dimensions and to be able to tune the current to suit your requirements.

Applications
As the name suggests, the Philips Fortimo LED downlight module (DLM) Gen2 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, such as EN/IEC 62031.

Can the module be used in outdoor luminaires?
Neither the Fortimo LED module nor the driver has 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 us if you wish to deviate from the design rules described in this guide.

Fortimo LED DLM (downlight module) Flex Gen2
All DLM Flex Gen2 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.

Naming of Fortimo DLM Flex Gen2 modules
The names of the modules are defined as follows. The Fortimo LED DLM Flex 2000/840 Gen2 is used here as an example.

Fortimo: our brand name for efficient, clear and reliable lighting
LED: the light source used
DLM: downlight module
Flex: The new DLM modules offer flexibility in terms of design and usage
2000: 2000 lumens
/840: stands for a color rendering index of 80; 40 stands for a CCT of 4000 K
Gen2: indicates the 2nd generation

Xitanium LED drivers for Fortimo LED DLM Flex Gen2
These highly efficient LED drivers are designed for the Fortimo LED modules. These are available as a built-in or independent driver, dimmable or with a fixed output.

More information about the Xitanium drivers for Fortimo LED DLM Flex Gen2 modules can be found in the Xitanium indoor down and spotlight driver design in guide and the Xitanium commercial leaflet. These documents can be downloaded via www.Philips.com/Technology.

The Xitanium driver datasheets can also be downloaded on this website.
LED DLM cable
A Cable, 60 cm in length a wire diameter of AWG24 (0.5 mm), is available to connect the built-in or SELV drivers with a JST connector. The cable fits the poke-in connectors on the module at one end and has a JST connector to be attached to the driver on the other end.

Emergency Application
For emergency lighting application, Philips offers the Xitanium emergency kit (Xitanium EM 3W 50mA 50V 3H 230V) shown on the left as a de-centralized emergency solution. In case of the loss of AC power, the emergency kit will take over operation of the lamp source, Fortimo LED DLM Flex Gen2 for example. The emergency kit is designed to run the Fortimo system for >3 hours with a light output of ~150–260 lm depending on the module being used.

In case of a centralized solution, Xitanium LED drivers can be also directly powered by a DC voltage for emergency application. More details on the Xitanium emergency kit as well as Xitanium LED drivers, please refer to www.Philips.com/Technology.
Optical design-in

**Fortimo LED downlight modules address the issue of binning**

High-quality LED light is achieved by mixing the light of various LEDs. High quality white light is characterized by a good color consistency and a color rendering of >80, popular CCTs in general lighting applications of 3000 K and 4000 K. The mixing chamber ensures perfectly mixed light, resulting in uniform colors and good color consistency. The function of the diffuser is to shape the light distribution. With DLM Flex Gen2, it is possible to use the polycarbonate diffuser provided, or develop another to specifically fit an application. 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 1100 to 5000 lumens.

**Color consistency (SDCM)**

The current specification of the Fortimo modules for color consistency is 3 SDCM at 0 hours, xy deviation 0.005 (L2) and 0.01 (L2+). SDCM stands for Standard Deviation of Color Matching and the value 3 refers to the size of an ellipse around the black body locus. Staying within this ellipse results in a consistency of light whereby there is no perceivable difference from one luminaire to another.

**Starting characteristics**

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

**Lumen maintenance**

**L70B50 @ 60,000 hours**

The quality of the LED DLM Flex Gen2 portfolio is backed by the Philips’ claim of B50L70 @ 60,000 hours. This means that at 60,000 hours of operation at least 50% of the LEDs’ population will emit at least 70% of its original amount of lumens. This is contrary to conventional light sources, where some time after Service Life Hours the conventional light source emits no light at all.

In this section the example graphs show the estimated lumen depreciation curves for different percentage of the population and at nominal Tc temperatures. The actual data for the LED DLM modules can be found in the associated datasheet at www.Philips.com/Technology.

Average rated life is based on engineering data testing and probability analysis. The Fortimo LED DLM Flex Gen2 modules are specified to reach L70B50 for the nominal specifications.

**Lumen maintenance for B20 and B50**

The example graph is showing the lumen maintenance (% of initial lumen over time) for B50 (50% of the population) and B20 (80% of the population).

Please look up the actual lumen maintenance graph in the associated datasheet of the Fortimo LED DLM Flex Gen2 you are using at www.Philips.com/Technology.
Secondary optics
The Fortimo LED DLM Flex Gen2 module generates a lambertian beam shape, the polar intensity diagrams for each module are given in the datasheets. This 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 www.Philips.com/Technology.

Example Light distribution diagram

On the top of the Fortimo LED DLM Flex Gen2 there are mounting options (rim of diffuser and three mounting holes) for positioning secondary optics.

Companies supplying reflectors for secondary optics
Secondary optics is not part of the Fortimo LED DLM Flex Gen2 system offering. This can be an added value area for OEMs. We provide a list of complementary reflector partners that have developed reflectors around the Fortimo LED DLM Flex Gen2. The table below gives a list of complementary partners offering compatible reflectors for Fortimo LED DLM Flex Gen2 modules.

The following are examples of reflector suppliers that have products available to be used with the Fortimo LED DLM Flex Gen2 system. Reference to these products does not necessarily mean they are endorsed by Philips. Philips gives no warranties regarding these products and assumes no legal liability or responsibility for any loss or damage resulting from the use of the information given here.

<table>
<thead>
<tr>
<th>Complementary reflector partner</th>
<th>Website</th>
</tr>
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<tbody>
<tr>
<td>Jordan Luxar</td>
<td><a href="http://www.jordan-luxar.de">www.jordan-luxar.de</a></td>
</tr>
<tr>
<td>NATA</td>
<td><a href="http://www.nata.cn">www.nata.cn</a></td>
</tr>
<tr>
<td>ACL</td>
<td><a href="http://www.reflektor.de">www.reflektor.de</a></td>
</tr>
<tr>
<td>Almecco</td>
<td><a href="http://www.almecogroup.com">www.almecogroup.com</a></td>
</tr>
<tr>
<td>Widegerm</td>
<td><a href="http://www.widegerm.com.hk">www.widegerm.com.hk</a></td>
</tr>
</tbody>
</table>
Mechanical design-in

About the Fortimo LED DLM Flex Gen2 module
The LED module consists of the following main components:
1. LED board with LEDs
2. Option of 2 different housings as accessory
3. Cable to connect to drivers with a JST connector, also available as an accessory

Assembling the Module
The DLM Flex Gen2 module can be put together as described in the picture below. The LED board along with any of the 2 housings, have 3 screw holes. These need to be aligned and stacked together.

Mechanical fixation
Please note that due to the thickness of the LED board, mounting of the light engine from the back is not possible, only fixation through the module is applicable. The picture below shows the correct mounting procedure. There will be no difference to this irrespective to the housing used. The high housing has screw holes on the side that can be used to fix reflectors. The diameter of these holes is 3.4 mm and PT K40 self-tapping screws can be used. The Maximum load per screw is 5N with maximum weight of 500 gr and the total maximum load applied on the side fixation holes is 20N with maximum weight of 2000 gr. The recommended screw type is a self-tapping screw, like PT K40. 2D or 3D CAD drawings are available upon request or at www.Philips.com/Technology.

Fixing holes at the module to screw the heat sink

Recommended screw type
It is suggested to use a M4 metric socket cap screw from the top of the module to heat sink. The recommended torque on the M4 screws is 0.5 Nm.

Advice: Do not screw into the top of the module
Thermal design-in

The critical thermal management points for the LED module are set out in this chapter in order to facilitate the design-in of Fortimo LED DLM Flex Gen2 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 ensure optimum performance, the Fortimo LED DLM Flex Gen2 system must operate within specified temperature limits.

Test requirements
Measurements, e.g. 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 IEC 60598). Measurements must be performed using thermocouples that are firmly glued to the surface (and not, for example, secured with adhesive tape).

Critical measurement points
Because LEDs are temperature sensitive, LED modules require a different approach with respect to the maximum permissible component temperature. This is different to 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 on the left. 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.

Temperature test point Tc

Warning: Case temperature and thermal circuit
To ensure the performance of the Fortimo LED DLM system a maximum Tc is defined on the rear surface of the LED module. At this case temperature the proper junction temperature of the LEDs is assured and the performance indicated (lifetime, light output, lumen maintenance, etc.) can be guaranteed. Please note that DLM Flex Gen2 has no NTC feature on board.

How to measure the critical temperature point Tc
The Tc temperature can be measured by making a thin v-groove or a small drill hole in the heat sink to reach the bottom of the LED module. Be sure to measure the temperature of the bottom metal part of the module and not of the thermal interface material (TIM) or in the central hole.
For Fortimo LED DLM Flex Gen2, Tp as indicated in the figure on the bottom right, previous page, can also be used for easier access. The correlation between Tp and Tc is dependent on the heat sink design. The difference between Tp and Tc is around 1 to 2 °C using the standard heat sinks from our complementary partners.

**Thermal Interface Material (TIM)**

The function of a Thermal Interface Material (TIM) 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 on the left. Philips recommends to always use a Thermal Interface Material (TIM). The DLM Flex Gen2 is designed to be mounted with M4 screws. The advised applied torque is 0.5 Nm and should not exceed 1 Nm in order to avoid damage to the module.

<table>
<thead>
<tr>
<th>Advised TIM</th>
<th>Recommended Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paste</td>
<td>0.5 Nm</td>
</tr>
<tr>
<td>0.5 mm soft pad material (Shore A &lt; 40)</td>
<td>0.25 Nm</td>
</tr>
</tbody>
</table>

In order to avoid air gaps underneath the LED board, it is not recommended to use hard thermal interface materials (Shore A > 80), like graphite.

The following are suggestions for thermal interface material products that can be used with the Fortimo LED DLM system. Reference to these products does not necessarily mean they are endorsed by Philips. Philips gives no warranties regarding these products and assumes no legal liability or responsibility for any loss or damage resulting from the use of the information given here.

**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 the figure entitled ‘Electrical and thermal analogy’ on the left. 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.

**Advised TIM**

<table>
<thead>
<tr>
<th>Advised TIM</th>
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</thead>
<tbody>
<tr>
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<td>0.5 Nm</td>
</tr>
<tr>
<td>0.5 mm soft pad material (Shore A &lt; 40)</td>
<td>0.25 Nm</td>
</tr>
</tbody>
</table>

**In general:**

- Thermal paste performs better than thermal pads.
- The lower the thermal impedance the better.
- The thinner the TIM the better, restriction is the surface flatness.
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 the figure below.

A simplified model of the thermal path from LED module to ambient

Warning:
The maximum temperature difference between $T_c$ and $T_{ambient}$ should never exceed 50°C for DLM Flex Gen2, 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 upwards, thus creating 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.

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 flow follows 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 DLM system offering. This is an added-value area for OEMs, offering the possibility to differentiate. However, there are many thermal solution companies who 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 DLM Flex Gen2 modules. An up-to-date list can be found on our website: www.philips.com/Technology

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 necessarily mean they are endorsed by Philips. Philips makes no warranties regarding these products and assumes no legal liability or responsibility for any loss or damage resulting from the use of the information given here.

<table>
<thead>
<tr>
<th>Thermal interface partners</th>
<th>Website</th>
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<tbody>
<tr>
<td>Sunon</td>
<td><a href="http://www.sunon.com">www.sunon.com</a></td>
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<tr>
<td>AVC</td>
<td><a href="http://www.avc.com.tw">www.avc.com.tw</a></td>
<td>Released</td>
</tr>
<tr>
<td>Nuventix</td>
<td><a href="http://www.nuventix.com">www.nuventix.com</a></td>
<td>Released</td>
</tr>
<tr>
<td>Wisefull</td>
<td><a href="http://www.wisefull.com">www.wisefull.com</a></td>
<td>Released</td>
</tr>
<tr>
<td>MechaTronix</td>
<td><a href="http://www.mechatronix-asia.com">www.mechatronix-asia.com</a></td>
<td>Released</td>
</tr>
</tbody>
</table>
Electrical design-in

Connecting the module
There are two connectors available on the DLM Flex Gen2 LED board, these have been clearly marked for LED + and LED -. These can be used with simple push in wires in order to connect to the driver. The following are the specifications for the wires that can be used:

<table>
<thead>
<tr>
<th>Specification item</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire cross-section (Solid wire)</td>
<td>0.2 – 0.8</td>
<td>mm²</td>
</tr>
<tr>
<td></td>
<td>24 – 18</td>
<td>AWG</td>
</tr>
<tr>
<td>Wire cross-section (Stranded wire)</td>
<td>0.3 – 0.5</td>
<td>mm²</td>
</tr>
<tr>
<td></td>
<td>22 – 20</td>
<td>AWG</td>
</tr>
<tr>
<td>Wire strip length</td>
<td>7.5 – 8.5</td>
<td>mm²</td>
</tr>
</tbody>
</table>

The stranded wires should be pre-bonded or twisted and tinned before insertion.

If the DLM Flex Gen2 module is being used with a driver having a JST connector, the DLM Flex Gen2 cable can be used.

One end of the cable can be inserted into the JST connector of the driver. The other end has wires that can be pushed into the connectors on the module. Please note that 2 wires will be left unused. The following is the color scheme for connection:

Red : LED +
Black : LED -

The DLM Flex Gen2 module does not come with a Rset on board to provide the nominal current. The current can be set by means of a resistor or via programming. More information about such tuning can be found further in the following sections.

Tune the luminaire’s flux (lm) and efficacy (lm/W)
The LED DLM Flex Gen2 specifications are provided under nominal conditions, like nominal flux at nominal current. This setting changes depending on the housing chosen. For example, the LED board must be overdriven in order to get the same lumen output from the high housing, as is seen with the shallow housing. The nominal settings are adjusted accordingly. Each datasheet has the required information. These can be found at www.Philips.com/Technology. It is however possible to deviate from this nominal current. By altering the current, we can obtain different flux outputs. At the same time, the required forward voltage (Vf) also changes, leading to a change in the efficacy (lm/W). The following sections explain the impact and boundaries.

Example graph showing flux and efficacy as a function of current
**Effect of Choosing a different current value**

In case the customer chooses to set the current (either by programming or by applying an Rset resistor) other than nominal, the lifetime and reliability of the LED DLM must be taken into account. The following current regions can be distinguished:

1. **Current < nominal current** (mA)
   - Efficacy (lm/W) higher than nominal value
   - Lumen output (lm) lower than nominal value
   - Lifetime > 60,000 hours
2. **Current between nominal current and absolute maximum current** (mA).
   - Efficacy (lm/W) lower than nominal value
   - Lumen output (lm) higher than nominal value
   - Lifetime may be affected based on the current chosen. For up to 100% overdrive, 50,000 hours can be achieved.
3. **Current > absolute maximum current**: do not exceed the absolute maximum current as this can lead your LED DLM module to failure. No warranty applicable in this case.

The rated average life is based on engineering data testing and probability analysis. The hours are at the L70B50 point.

* Nominal current at which performance and lifetime is specified
** Maximum current tested for safety

**Set the output current via Rset**

By making use of a resistor component with a determined Ohmic value you can set the required current for your LED module. This component can be a leaded standard 1% tolerance resistor of e.g. 0.125 W or 0.25 W, 50 V. The Rset will not be part of the electrical chain driving the module.

An example of a resistor placed into the drivers’ input is shown on the left.

Three different Rset resistors are utilized in the Xitanium Indoor Spot and Downlight LED driver portfolio:

- Rset1 (older drivers)*; allows output current setting up to 700 mA
- Rset2; allows output current setting up to 2000 mA
- LEDset: Allows output current setting up to 8000 mA

In all documentation, Rset may refer to either Rset1, Rset2 or LEDset, depending on the driver type. Please check the driver datasheet for which Rset the driver you use reads. You can find this at [www.Philips.com/Technology](http://www.Philips.com/Technology).

**Note:**

The Rset must be inserted such that there is no mechanical pressure on it from the driver casing being closed.

Rset1 and Rset2 use different pins on the driver (and on the JST connector). The Rset1 and Rset2 values with the corresponding drive currents are shown in following tables. It is advised to select the nearest lower resistor value that is available to you, if the exact determined value is not at hand.

* All future drivers will support LEDset.
Note on E-series: in electronics, international standard IEC 60063 defines preferred number series for amongst others resistors. It subdivides the interval between subsequent values from 1 to 10 into 6, 12, 24, 48, 96 etc. steps. These subdivisions ensure that when some arbitrary value is replaced with the nearest preferred number, the maximum relative error will be on the order of 20%, 10%, 5%, 1% etc.

Datasheet LED driver; Look-up in section Features which Reset the driver reads

Read the next section, stating the Reset1 and Reset2 tables

Look-up in LEDset table the Ohm value that generates desired current

LEDset – E96 series: table with E96 resistor values

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>open</td>
<td>driver’s default current</td>
<td>23700</td>
<td>211</td>
<td>11000</td>
<td>455</td>
<td>5110</td>
<td>978</td>
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<td>23600</td>
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Note on E-series: in electronics, international standard IEC 60063 defines preferred number series for amongst others resistors. It subdivides the interval between subsequent values from 1 to 10 into 6, 12, 24, 48, 96 etc. steps. These subdivisions ensure that when some arbitrary value is replaced with the nearest preferred number, the maximum relative error will be on the order of 20%, 10%, 5%, 1% etc.

Datasheet LED driver; Look-up in section Features which Rset the driver reads
If both Rset1 and Rset2 are supported, Rset2 is advised for future compatibility

Look-up in Rset table the Ohm value that generates desired current
Look-up in Rset2 table the Ohm value that generates desired current

Note: next page shows extended Rset2 table: E96 values, stating smaller increments

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Rset1 priority behavior for drivers that read both Rset1 and Rset2

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Please refer to the datasheet of the driver you use to find which Rset or Rsets the driver actually reads.
### Rset2 – E96 series: table with E96 resistor values, stating smaller increments but covering same range as the E24 series on previous page

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August 2015 Design-in Guide - Philips Fortimo LED DLM Flex Gen2
Programming the output current
The Xitanium TD drivers offer a full range of controls, enabling customizable luminaire design and performance. It is possible to control light output levels, preset dimming protocols and set system specifications in the factory and even in the complete installations. This can be done with the Philips MultiOne configurator.

The MultiOne configurator is an intuitive tool that unlocks the full potential of all programmable drivers from Philips, ensuring that the driver performance matches the needs of the lighting solution. It offers unprecedented flexibility, before, during and after the product installation.

With the latest selected drivers, SimpleSet® functionality is also supported via MultiOne. Please check the datasheet of the driver on www.philips.com/technology to know if your driver supports SimpleSet® or not.

For more information on MultiOne visit: www.philips.com/multiOne
This site contains detailed information on how to install the software and how to program the driver.

Xitanium Indoor Spot and Downlight LED drivers
For the drivers, the same documentation philosophy holds as for the LED modules, meaning that also three documents make up the full information set of the drivers.

For detailed info, please refer to these documents for your driver on www.Philips.com/Technology.
LED technology is rapidly evolving. Using more efficient LEDs in a next generation means the same light output can be achieved with lower currents. At the same time, LEDs can be driven at different current levels based on the application requirement. Typically, LED drivers are available in discrete current levels e.g. 350 mA, 530 mA or 700 mA. It is often necessary to replace a driver when more efficient LEDs become available.

One of the key features of the Xitanium LED drivers is the adjustable output current (AOC), offering flexibility and future-proof luminaire design. The Xitanium drivers can operate in a certain “operating window”. This window is defined by the maximum and minimum voltage and current that the driver can handle. An example of an operating window is shown on the left. The area indicates the possible current/voltage combinations. The current you select will depend on the type and manufacturer of the LEDs or the specific LED configuration of the PCB design. The operating window of every driver can be found in the associated driver datasheets which can be downloaded on following website: www.Philips.com/Technology.

**Note:**
By means of dimming it is possible to go below the minimum value of the specified output current. The output current of these drivers can be set in three ways.

1. By connecting a specific resistor value to the driver’s Rset input.
2. Drivers with SimpleSet® functionality can be configured using the Philips MultiOne software and SimpleSet® interface.
3. TD driver versions can be programmed via the MultiOne interface in order to set the desired current. (www.Philips.com/multione).

How to determine what value the output current should be set at will be explained in the next sections.
To Select an Appropriate Driver
Depending on your requirements, several drivers can be a solution for you. The following steps can help you in selecting a driver. For a complete overview of the available drivers, please refer to the download section of www.Philips.com/Technology.

1. Determine your required driver current (I\text{drive}) and voltage (V\text{f}).
2. Calculate the required power (P\text{drive}) where \( P\text{drive}=V\text{f} \times I\text{drive} \) (W).
3. Select the datasheets from the website mentioned above based on the driver having a power greater than the required power. For Fortimo SLM Gen5, only SELV drivers can be selected.
4. Does the required current fit the current range of the driver? The current range of the driver can be seen in the name itself. For example, in the 17 W LH 0.3-1 A 24 V TD/Is 230 V, the minimum driver current is 0.3 A and maximum is 1 A.
   \[ I\text{driver min} \leq I\text{drive} \leq I\text{driver max} \]
5. Does the required voltage fit the voltage range of the driver? The voltage range of the driver can be seen in the name itself. For example, in the 17 W LH 0.3-1 A 24 V TD/Is 230 V, the maximum driver voltage is 24 V and the minimum is 50% of this value, which is 12 V in this case.
   \[ V\text{driver min} \leq V\text{f} \leq V\text{driver max} \]
6. Does the required power fit the power range of the driver?
   In the naming of the driver, you can see the maximum power possible. For example, in the 17 W LH 0.3-1 A 24 V TD/Is 230 V, the maximum power is 17 W. The minimum power is defined as \( I\text{driver min} \times V\text{driver min} \).
   \[ P\text{driver min} \leq P\text{drive} \leq P\text{driver max} \]
7. Choose your preferred dimming. Please refer to the section about naming of the drivers to know what the naming tells you about the possibilities.

Compatible drivers
A list of compatible drivers, specific to your choice of module and operating point can be obtained from the Easy Design-in Tool that can be found at easydesignintool.com.
Wiring
Connection of the driver to the mains supply/protective earth
The mains supply has to be connected to the power supply (Line and Neutral can be interchanged).

Class I and Class II
The main difference between a Class I and Class II product is the level of safety. A Class I product is safe due to the connection of the protective earth to the luminaire. All materials that can conduct electricity should be connected to the protective earth. In the event of a driver failure, it is possible that the mains may be connected to electrically conductive parts of the luminaire. As these parts are connected to the protective earth, the system fuse will blow.

In a Class II 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 Fortimo LED DLM is below 60 V, it complies with the rules governing Safety Extra Low Voltage (SELV) and is therefore safe to touch. This means that connection to a protective earth is not necessary. Whether you choose Class I or Class II depends on the choice of driver and the relevant legislation.

Connection to protective earth with Xitanium SELV drivers
The DLM Flex Gen2 modules are designed to be used with SELV drivers and with these drivers, protective earthing is not required. As a result, a luminaire can be rated as Class II.
Controllability

AM and PMW dimming protocol

Benefits of AM dimming
Xitanium LED TD, TDI, TDI/s TE drivers make use of an amplitude (AM) dimming protocol, whereas most LED systems work with pulse width modulation (PWM). With PWM the current is cut into parts and dimming levels are achieved by combining on/off settings (pulses) at high frequency. AM dimming reduces the current through the LEDs to achieve lower light levels. The great advantage of this is that LEDs operate more efficiently at lower currents (see graphs on left). In addition to this, other advantages of AM dimming include:

• No audible noise during dimming.
• No visual interference with other lighting or video sources.

DALI
DALI commands
The appendix gives an overview of the DALI commands implemented in the Fortimo and Xitanium dimmable drivers.

DALI connections
The Xitanium LED TD (or TD/I, TD/I/s) drivers include connectors for DALI-compatible user interfaces.

Recommended DALI controls
The following paragraphs contain basic information about the controls supplied by Philips for Fortimo LED modules. Visit our website for full specification details at www.Philips.com/Fortimo.

Below OEM control products can be considered:
1. ToBeTouched user interface (UID 8520)
2. Occuswitch DALI sensor/controller

For more details about Philips controls, please refer to the Philips control website.

Introduction
Dimming
To enable the Fortimo LED DLM modules to dim, dimmable Xitanium LED drivers are available. The dimming range is 10–100%. The Xitanium TD, TDI and TDI/s LED drivers have integrated Touch & DIM and DALI protocols. They include connectors for DALI-compatible user interfaces (controls). Thanks to the use of amplitude (AM) and not pulse width modulation (not PWM) protocol, the Fortimo system becomes up to 30% more efficient when dimmed. Next to DALI and Touch & Dim, also Xitanium LED drivers with Trailing Edge (TE) dimmability are available. Please refer to the Xitanium LED driver design-in guide for recommended dimmer types.
1. ToBeTouched user interface
This user interface has been designed to enable intuitive control of the lighting level in DALI lighting systems. It has the following features:
- On/off switch
- Backlit light ring for direct feedback / feed forward and an attractive appearance
- Audio feedback
- Wiring of back-end
- Integrated DALI power supply for 15 LED drivers
- Startup time after mains interrupt is about 20 seconds.

ToBeTouched user interface
2. Occuswitch DALI sensor/controller
The OccuSwitch DALI is a combined sensor and controller. It will dim and switch the lights in a room or area in response to occupancy and the available daylight, with options for local override, parallel operation and network links to Building Management Systems (BMS). Savings of up to 75% can be achieved with functions like daylight-dependent dimming, occupancy control and over-dimension correction. The OccuSwitch DALI is designed for an office area of 20 to 25 m², or a classroom of around 40 m² but the area can be doubled, or even tripled, with the extension sensor LRM8118.

Touch and Dim
Simple dimming via Touch and Dim protocol
For the Xitanium LED drivers with Touch and Dim function a switched mains is used to dim the light from the Fortimo module. The switching on and off is also done via this control input. This means that it is no longer necessary to use a power switch to interrupt the mains circuit. The 230 V supply voltage is always available at the LED driver (even when switched OFF), and light can be switched or dimmed by momentarily connecting the mains to the dim input. A short push will switch the lighting on or off, depending on the previous situation. If the switch is held pushed in, the light will dim up or down, depending on what is opposite from the last dimming direction. The driver will count the number of mains cycles and act on that.
Norms and Standards

Fortimo LED DLM together with Xitanium LED drivers comply with following norms and standards:

**Safety**
- IEC/EN 62031: LED modules for general lighting - safety specifications
- IEC 62471: Photo biological safety of lamps and lamp systems
- IEC 61347-1, IEC 61347-2-13: Control gear safety

**Performance**
- IEC 62384: Control gear performance

**Electromagnetic compatibility (tested with Fortimo LED DLM, cable and Xitanium LED driver)**
- EN 55015, EN55022
- CISPR 55015
- IEC/EN 61000-3-2: Limits for harmonic current emissions (equipment input current ≤16 A per phase)
- IEC/EN 61547: Equipment for general lighting purposes - EMC immunity requirements

**Environmental**

**Approval**
- ENEC, CE

**UV and other hazards**
- PET Value: >100 hrs /Klux (zero UV)
- Damage Factor: 0.08 @ 5000 K
- IR (infrared) radiation: As well as being free of UV radiation, the LED modules are also free of infrared radiation in the beam.

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<th>Hazard Category</th>
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*Exempt and Pass means 'no risk'*

**Emission List**

**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.

**Note:**
It is not recommended to use the Fortimo LED module without the housing. 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 ‘Photo biological safety of lamps and lamp systems’, which covers incoherent light sources, now applies. This international standard gives guidance on evaluating the photo biological 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 photo biological 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 photo biological safety standard, hazard categories are defined as follows:

**Radiance-based**
- Blue Light (LB) 300 - 700 nm
- Retinal Thermal (LR) 380 - 1400 nm

**Irradiance-based**
- Actinic UV Skin & Eye (ES) 200 - 400 nm
- Eye UVA (EUVA) 315 - 400 nm
- Thermal skin* (EH) 380 - 3000 nm
- Eye IR (EIR) 780 - 3000 nm

* Thermal skin is not defined in IEC 62471 and hence cannot be classified in risk groups. The Fortimo LED module passes as ‘no hazard during normal use’ if one would rate it according IEC 60825-1 ‘Safety for laser products’.

**Fortimo LED DLM Flex Gen2 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 3000 lumen version the permitted exposure time for Blue Light radiance (relevant when looking into the source) is limited to 1 hour, while for the 1100 lumen 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.
- 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.

**Chemical Compatibility**

The Fortimo LED DLM Flex Gen2 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 & cable entries, sealing’s or corrugated carton. Also do NOT use adhesives, cleaning agents, coatings containing suspect VOCs. Nor use the product in aggressive (corrosive) environments that may cause damage to the LED’s.

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 Philips representative for application support.
Chemical Name | Normally used as
--- | ---
Acetic acid | Acid
Hydrochloric acid | Acid
Nitric acid | Acid
Sulfuric acid | Acid
Ammonia | Alkali
Potassium hydroxide | Alkali
Sodium hydroxide | Alkali
Acetone | Solvent
Benzene | Solvent
Dichloromethane | Solvent
Gasoline | Solvent
MEK (Methyl Ethyl Ketone) | Solvent
MIBK (Methyl Isobutyl Ketone) | Solvent
Mineral spirits (turpentine) | Solvent
Tetrachlorometane | 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

**Electromagnetic compatibility**
Philips Fortimo LED DLM Flex Gen2 systems fulfill the requirements with regard to electromagnetic compatibility as laid down in European Norms EN 55015 and EN 55022, EN 61000-3-2 and EN 61547.

**Humidity**
Fortimo LED DLM Flex Gen2 modules and LED drivers can withstand a high humidity (60% rh) environment.

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

**IP codes, dust and moisture protection**
Fortimo LED DLM modules and LED drivers have no IP classification. The OEM is responsible for proper IP classification and approbation of the luminaire.

**Philips Fortimo LED DLM Flex Gen2**
**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 DLM Flex Gen2 modules and LED drivers from water ingress.

**Glow-wire test**
Philips Fortimo LED DLM Flex Gen2 systems conform to the 960-degree glow-wire test. Reference test: according to additional national deviations for clause 13.3 (Annex 2c of EN 60598-1). An exception is made for France, where local regulations are more strict.

**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 DLM modules are predicted to deliver an average of 70% of their initial intensity after 60,000 hours of operation. The life of the system is therefore more dependent on the other electronic system components and soldering methods.
The LEDs in the Fortimo LED DLM Flex Gen2 module are connected such that if one LED fails, the current is adjusted in order to give the same light output.

**Fortimo LED DLM Flex Gen2 system disposal**
We recommend that the Fortimo LED DLM Flex Gen2 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.
Contact details

Philips
Product information:  www.Philips.com/Technology

Or contact your local Philips sales representative.

Partners for cooling solutions

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Partners for reflector solutions

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Partners for thermal interface materials

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