Design-in guide

Philips Fortimo LED Line Systems Gen 2 -LV

PHILIPS

Contents

Introduction to this guide

Thank you for choosing the Philips Fortimo LED Line Gen 2 System. In this guide you will find the information you need to design this system into a luminaire.

This guide describes the whole Philips Fortimo LED Line Gen 2 family, including the new ranges: Fortimo LED Line High Flux LV. Extensions to the range will be included in future updates of this guide. We advise you to consult your local Philips Sales Representative for the latest up-to-date information.

Note: LED technology is continuously improving. For the latest updated information, please check www.philips.com/ledmodulesna.

Warnings and instructions for LV products

When using an isolated driver, intended for LV products

Warnings

- Avoid touching live parts!
- Avoid touching any bare components on the PCB, e.g. LEDs!
- Do not use damaged LED Lines!

Safety warnings and instructions to be taken into account when the Fortimo LED Line System is designed into luminaires and during assembly.

Design-in phase

- It is mandatory to use an UL class 2 / IEC compliant SELV driver in combination with the LED Line LV products.
- The general IEC and UL recommendations for luminaire design and legal safety regulations (ENEC, CE, ANSI, etc.) are also applicable to Philips Fortimo LED Line Systems. Luminaire manufacturers are advised to conform to the international standards for luminaire design (e.g. UL1598, IEC 60598-Luminaires).
- It is advised to construct the luminaire in such a way that the LED Line cannot be touched by an end-user.
- Do not apply mains power to the LED Line directly.
- Connect all electrical components first before switching on mains.
- Avoid possibilities of water and dust ingress: use appropriate IP-rating of luminaire with regard to specific conditions of application

Warnings and instructions for LV products

Manufacturing phase

- Do not use damaged or defective LED Lines, including damaged connectors or PCB.
- Do not drop the LED Line or let any object fall onto the LED Line because this may damage the PCB or LEDs and affect proper functioning of the product.
- Connect all electrical components first before switching on mains

Installation and service for luminaires incorporating the Fortimo LED Line System

- Do not service the luminaire when the mains voltage is connected; this includes connecting or disconnecting the LED Line cable.
- Do not use damaged products.

For optimal reliability of the LED Line we advise against applying an AC electric strength test to the luminaire as this might damage the LEDs. Recommend instead is applying an insulation resistance measurement at 500 V DC (noted as alternative test in IEC/EN 60598-1 annex Q).

Introducing the Fortimo LED Line Gen 2 System

Philips Fortimo LED Line 3R

Philips Fortimo LED Line 1R

Applications and luminaire classification

The Philips Fortimo LED Line Gen 2 System is the replacement for linear fluorescent lamps in general lighting.

The Fortimo LED Line System consists of a range of modules and Xitanium drivers. In this guide you will find the specific information required to develop a luminaire based on Philips Fortimo LED Line system. Product specific data can be found under Literature and Tools section on www.philips.com/lighting.

In this guide you will find the specific information required to develop a luminaire based on the Philips Fortimo LED Line System for LV products.

Can the LED Line be used in outdoor luminaires?

Neither the Fortimo LED Line nor the driver have an IP classification > IP20. Furthermore, products used outdoors need to meet higher surge standards than required for indoor products. Failure to comply with the higher outdoor standard will lead to damaged LEDs. If you decide to use these products in a luminaire for outdoor applications the OEM will be responsible for ensuring proper IP protection, adequate mains surge protection and approbation of the luminaire. Please consult you Philips representative if you wish to deviate from the design rules described in this guide (see last page for contact details).

Commercial naming of the Fortimo LED Line modules

The names of the Fortimo LED Lines are defined as shown in underneath example:

Fortimo LED Line 1ft 650lm 840 3R LV2

Fortimo:	our concept name for efficient, clear and reliable lighting
LED:	the light source used
Line:	linear board
1ft:	length of LED Line
650 lm:	650 lumen output
840:	8denotes a color rendering index of 80 (CRI divided by 10)
	40 stands for a CCT of 4000 K (CCT divided by 100)
3R:	indicates the number of LED rows on a LED Line, in this case 3
LV:	Low Voltage
2	Generation 2

Introducing the Fortimo LED Line Gen 2 System

In this design-in guide

In this design-in guide you will find all necessary guidelines to configure the Fortimo LED Line system to exactly your needs. The Fortimo LED Line range is designed to enable all types of luminaires in general lighting that traditionally were equipped with fluorescent tubes.

The range exits of

- Fortimo LED Line Gen 2 → focus on mainstream fluorescent replacement
- Fortimo LED Line High Flux → focus on higher lumen packages

On top of this broad range in standard settings and building blocks, the Fortimo LED Line portfolio provides the luminaire manufacturer with a high level of flexibility to differentiate its luminaire, to design a specific luminaire performance and change settings of luminaire in the factory while using the same components.

Zhaga

Zhaga¥

Almost every LED Line module is Zhaga certified. Please check the associated datasheet of the LED Line you are using for details.

General remark on wiring

With respect to LED Lines Gen 1, LED Lines Gen 2 have the same wiring approach except that there are no longer pre-defined cables with polarity-defined connectors.

Electrical design-in

In this section you will find all of the product information needed to design a configuration based on the Fortimo LED Line Gen 2 System. These systems typically consist of the following products:

- Fortimo LED Line modules
- Philips Advance Xitanium Indoor Linear LED Drivers
- Standard installation wire (solid core, not provided by Philips)
- Optionally a resistor to set the output current (not provided by Philips)

Xitanium Indoor Linear LED Drivers

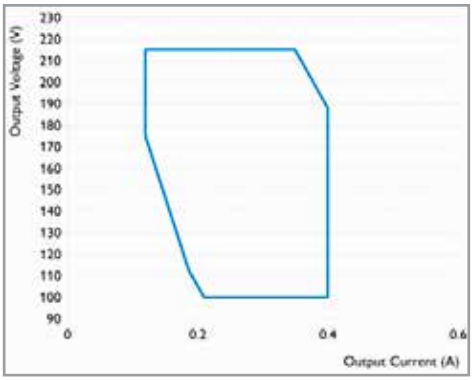
For detailed info, please refer to the associated drivers datasheets.

Xitanium driver operating window

The Xitanium LED drivers have a voltage and a current range, known as the 'operating window'. This means that multiple combinations of modules and drivers are possible. The graph shows an example operating window of a Xitanium driver.

¥ Philips Fortimo LED Line Module is a Zhaga certified light engine. For more information visit www.zhagastandard.org

Electrical design-in



Example of a Driver Operating Window

The driver supplies a constant current to drive the module. If no resistance value is connected, this automatically results in the default output current of the Xitanium driver. This value is stated in the associated datasheet on www.philips.com/technology.

The output current can be set in two ways.

1. By connecting a specific resistor value to the driver's Rset input.
2. TD driver versions can be programmed via MultiOne interface in order to set the desired current. (www.philips.com/multione)

How to determine what value the output current should be will be explained in the next section.

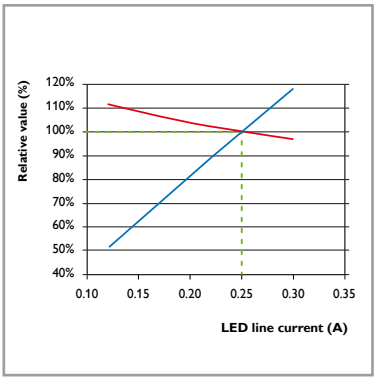
What connections to the driver can be made?

Typically Xitanium indoor linear LED drivers have the following connections

- LED output, to power the LED modules
- Rset input(s), to set the output current
- NTC input, to allow a temperature dependent resistive component (e.g. NTC) to be connected to the driver. This component can be used to have the driver dim above a certain temperature threshold. More information is to be found in the associated driver's datasheet.
- Control input, for dimming and or programming (1-10V, TD, Dali)

Please check the specification of your chosen driver. To determine the resistor value for Rset, please check the driver's datasheet which Rset (1 or 2) it accepts. Next in the Xitanium Indoor Linear LED driver datasheet Rset1 and Rset2 tables can be found. In that table, via the determined current, the required resistor value can be found.

Electrical design-in



Example of tuning flux and efficacy by altering the drive current. For specific details please check the appropriate datasheet of the LED Line you are using.

Choose the LED current

The LED Lines specifications are provided for nominal conditions, like nominal flux at nominal current. It is however possible to deviate from the nominal LED Line module current. Next table explains the impact and boundaries.

Important

In cases where the OEM chooses to set the current (either by programming or by applying an Rset resistor), the lifetime and reliability of the LED Line must be taken into account. The following current regions can be distinguished:

1. Current < nominal current
   a. Lifetime > 50,000 hours
   b. Efficiency higher than nominal value, lumen output lower than nominal value
2. Current between nominal current and lifetime current
   a. Lifetime > 50,000 hours
   b. Efficiency lower than nominal value, lumen output higher than nominal value
3. Current between lifetime current and absolute maximum current. No warranty applicable in this case.
   a. Lifetime < 50,000 hours
   b. Efficiency lower than nominal value, lumen output higher than nominal value
4. Current > absolute maximum current: do not exceed the absolute maximum current as this can lead to LED line failure. No warranty applicable in this case.

Lifetime is based on engineering data testing and probability analysis. The hours are at the B50, L70 point.

An example is given below on how these values are stated in the associated LED Line datasheet.

Fortimo LED Line	I nominal* mA	I life** mA	I max*** mA
LED Line example	150	250	300

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

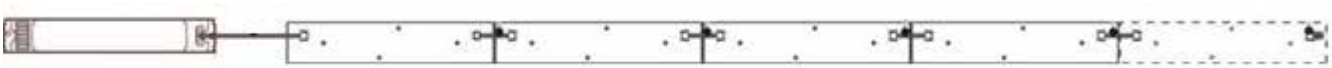
Electrical design-in

When configuring the system with the Philips Advance driver and Fortimo LED Line Module, the final driver operating point needs to be within the driver operating window. The following guidelines may help in determining the optimum driver operating point. In case of questions, contact your local Philips Sales Representative or the Philips Design-In Team.

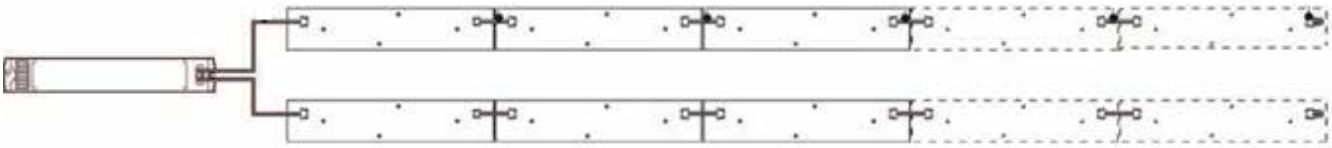
Configuration examples LED Line 1 chain and 2 chain

The drawings below show both a 1-chain (1C) configuration and a 2-chain (2C) configuration. All the required wire connections are included (driver-to-board, board-to-board).

One-chain configuration



Two-chain configuration



2 wires into one connector hole

In some scenarios two wires need to be connected to one connector hole. In this case the pairing has to be done outside the driver, resulting in only one wire going into the driver. Two wires into one connector hole is not supported.

Examples of what solutions could look like for pairing wires

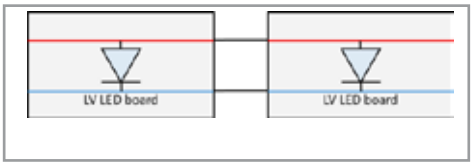
Ferrules

The reliability of twin-wire ferrules (or "wire end stop"), accepting the wire intended to use, should be checked with the supplier of these ferrules.

Configuration algoritm for LV product (using isolated drivers)

LV product is a parallel system; adding a LED Line board requires a higher current.

1. Determine the operating current for the desired flux of per LED Line, using the datasheet. Make sure the operating current does not exceed the specified value for lifetime.
2. Multiply the operating current by the amount of LED Lines to calculate the total driver current needed
3. Check whether the resulting total current is within driver's current range. If the current is too low, you can decide to select a driver with a lower output power. If the current is too high for the selected driver, a driver with a higher output power may provide a solution.
4. Connecting too many LV LED Lines in a single chain may lead to flux imbalance. Check the advised maximum number of LED Lines per chain in the associated LED Line datasheet. If the number of LED Lines in your system exceeds the specified maximum value it is advised to create a second chain.



Schematic representation of the wiring of 2 connected LV LED boards, not needing a Return-End cable

Electrical design-in

Most isolated drivers enable the connection of two chains of LED Lines. Note that the number of LED Lines per chain does not have to be the same for all chains, since all LED Lines are electrically connected in parallel.

Note: LV product does not make use of a Return-End connection

Mixing different Fortimo LED Line Modules

Please note that although different types of Fortimo LED Line Modules can be connected to one another, only combinations indicated in the datasheets are allowed. Another reason being that the voltage and current requirements differ per type and by mixing this can lead to undesired performance differences. If you wish to deviate by mixing other types, please consult your local Philips Representative.

Cables

With the Fortimo LED Lines Gen 2 standard solid core installation wire can be used. This approach allows the OEM to choose the preferred cable properties like color, thickness and lengths, although mains-rated wiring is advised. Please check the LED module and driver datasheet for details like thickness and strip length.

Automatic wiring with robot

Equipped with a new connector, Fortimo LED Line Gen 2 Module is now allows for automatic robot wiring. As do the latest Philips Advance Xitanium Indoor Linear LED drivers. For implementation details please check with your robot manufacturer.

General remark on wiring

With respect to LED Lines Gen 1 modules, LED Lines Gen 2 modules have the same wiring approach, being different only in that there are no longer pre-defined cables or polarity-defined connectors.

Connecting the modules to the driver

On the module each connector is marked 'IN' or 'OUT' and has both a '+' and '-'. They are polarity sensitive. Please assure a correct wiring before switching on the LED driver. In a '2-chain' configuration, 2 plusses and 2 minuses have to be connected to the driver.

Interconnecting LED Lines

Default the cables are connected from the 'OUT' connector of a module to the 'IN' connector of the neighboring module, keeping the polarity ('+' and '-') consistent. LED Lines are polarity sensitive. Please assure a correct wiring before switching on the LED driver.

Electrical design-in

Connecting the driver to the mains supply

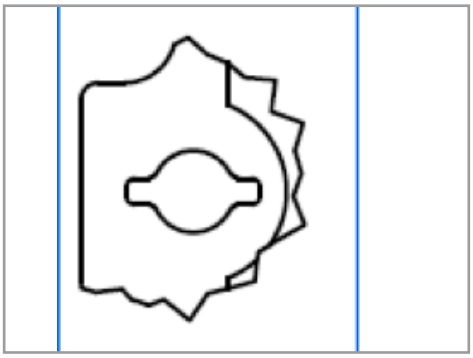
The mains supply has to be connected to the LED driver, not the LED board.

Warning

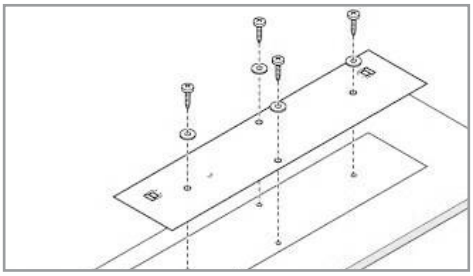
Connecting the luminaire to protective earth

If the driver requires being connected to protective earth, like non-isolated Philips Advance Xitanium LED drivers, the luminaire needs to be connected to protective earth in order to comply with safety regulations and EMI.

Mechanical design-in



Example of a fixation slit-hole



Insulating washers

Mechanical fixation for LED Line

To ensure optimum thermal contact with the luminaire (and therefore optimum lifetime) we recommend all fixation holes are used. These can be recognized by its slit-hole shape.

Screws

Each module fixation hole accepts M4 (or size 8) screws. OEMs may choose different size screws, as long as the creepage and clearance is guarded. To ensure the electrical isolation when using metal screws, the diameter of the screw head (and optional washer) must not exceed 8 mm.

Some module types have holes available for mounting electrically non-conductive optics. The electrical isolation distance around these holes is not suitable for metal screws. Do not use these holes for mounting and fixating the LED board.

Insulated washers

The surface of the PCB must not be damaged by mounting materials as this may compromise the electrical isolating layer. The mounting materials must comply with the relevant creepage clearances as defined in the section entitled 'Lighting Characteristics'. We recommend using insulating washers and do not use metal washers, as with metal washers creepage distance of earthed screw connection with respect to PCB tracks is more difficult to be guaranteed.

Screw torque

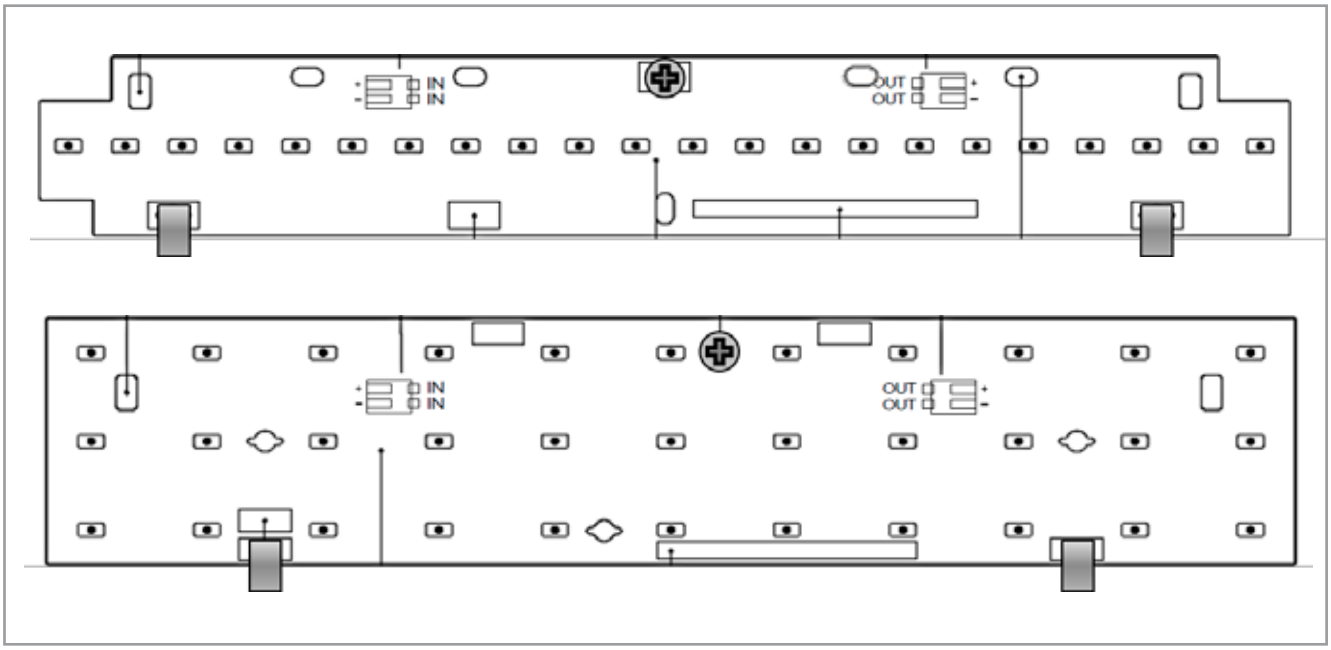
The maximum torque that should be applied depends on the screw type and luminaire material. The fasteners used to secure the LED Line to a heat sink must be tightened with a torque in accordance with the table below.

Screw torque	min	max
Steel or aluminum, threaded/tektite M4	0.6 nm	1.0 nm

Mechanical design-in

Alternative fixation methodes

With Fortimo LED Line Gen 2 module fixation methods can be explored, leading to fewer screws and faster mounting times. In order to achieve this, larger copper-free isles around the mounting holes are designed. This freedom applies to the whole Fortimo LED Line Gen 2 portfolio.

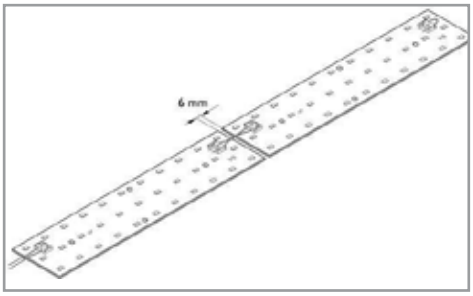


Examples of a one-screw fixation with clamps for LED Lines

Screw or alike

Clamp or alike

Optical design-in



Example of a continuous LED pitch

Optics ontop or near the LED Line module

Luminaire manufacturers have the freedom to design their own optics in order to maximize the lm/W efficiency and beam shape of the system.

Additional fixation holes are provided in the module in order to align electrical non-conductive optics onto the module. These are holes without a slit.

To allow possible future changes it is advised to take into account some additional room around the connector when designing optic directly onto the module board.

SDCM

SDCM stands for Standard Deviation of Color Matching and the value 3.5 refers to the size of an ellipse around the black body locus. Staying within this ellipse results in a consistency of light which ensures that no color difference is perceivable between one LED Line and another with the naked eye in most applications.

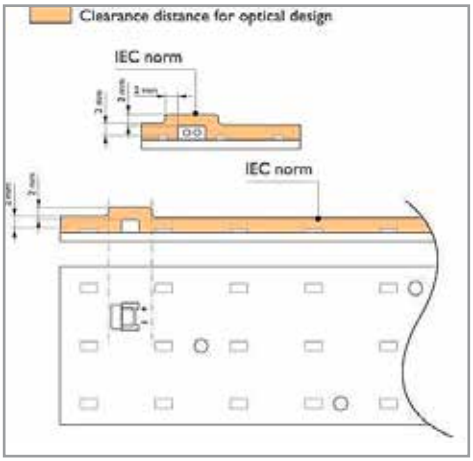
The SDCM color consistency specification of the LED Lines may not be sufficient for applications that are sensitive to color differences like wall washers, which typically require 2 SDCM.

LED pitch

To achieve optimal lighting uniformity, we recommend a continuous optical pitch with 6mm distance between the LED Lines 1ft 3R and for LED Lines 1ft 1R a distance of 1.3mm.

Reflector design

If a reflector is designed around the module, it is essential to allow a clearance distance between the module and reflector around the module surface, LEDs and the connectors (see drawing left). This clearance distance is necessary to ensure safe isolation of the system and is in line with IEC regulations 60598 to prevent short circuiting, damage and an open circuit to the module.



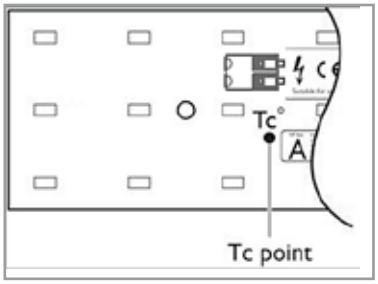
Required minimum clearance distance

LV product requires 1 mm

Warning

If luminaire requires protective earth, all conductive parts – like the reflector – must be electrically connected to protective earth in order to prevent hazardous conditions!

Thermal design-in



Examples of Tc point position

Introduction

To facilitate design-in of Fortimo LED Line Systems, the critical thermal management points of the module and driver are set out in this section. The design of the product is intended to keep the component temperature as low as possible, but the design of the luminaire and the ability to guide the heat out of the luminaire are of utmost importance. If these thermal points are taken into account this will help ensure the optimum performance and lifetime of the system.

Definitions

- Module temperature: temperature measured at the Tc point of the LED Line module
- Ambient temperature: temperature outside the luminaire

When switched off >2 hours, temperature at Tc point should equal to the ambient temperature.

Xitanium drivers

Besides the LED Lines another important component is the driver. For specific design-in guidelines please consult the associated design-in guide for the Xitanium indoor linear LED drivers and the associated driver datasheet.

Tc point

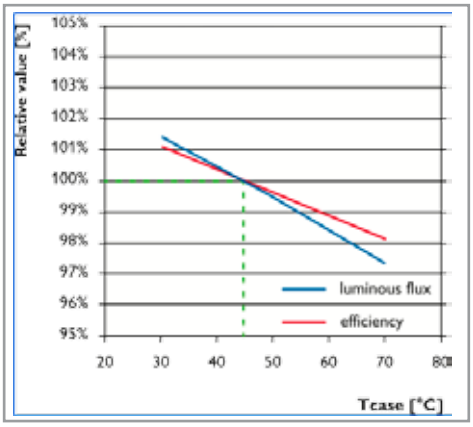
The Tc test point indicates a reference point for measuring the LED Line temperature. This can be used during the luminaire design to verify that the temperature remains below the maximum specified temperature for the Tc test point.

For LEDs it is the junction temperature that is the critical factor for operation and lifetime. Since there is a direct relation between the case temperature and the LED junction temperature, it is sufficient to measure the temperature at the Tc point of the module. This Tc point must not exceed the maximum values shown in the associated datasheet.

How to measure Tc of the LED Line

The Tc test point for each LED Line is indicated in the associated datasheet. The temperature can be measured using for example a thermocouple that is firmly glued to the upper surface of the module. For a measurement the temperature must be stable before any reliable data can be obtained (0.5 - 3 hours).

Thermal design-in



Example of altering flux and efficiency by allowing a different Tc. For specific details please check the associated datasheet of the LED Line you are using.

Relation between flux and Tc

The flux of the module is specified at a nominal Tc, which is a lower value than the maximum Tc corresponding to the lifetime specification. Increasing the Tc temperature has an adverse effect on the flux and lifetime of the module.

Relation between T (ambient) and flux

Tc approximately increases in a linear fashion with the ambient temperature. The temperature offset between T (ambient) and Tc depends on the thermal design of the luminaire. The Fortimo LED Line System has been designed for indoor use. For approved ambient temperature range please check the associated LED Line datasheet.

Choose the maximum Tc

In previous sections it has been explained how to determine the Tc. It is however possible to deviate from the nominal LED Line module Tc. Next section explains the impact and boundaries.

Important

In cases where the OEM chooses to allow the temperature at the Tc point to exceed the temperature to assure lifetime (Tc-life) the lifetime and reliability of the LED Line must be taken into account. Given a constant current, following temperature regions can be distinguished:

1. Temperature at Tc < nominal value
    a. Lifetime > 50,000 hours
    b. Efficiency higher than nominal value, lumen output slightly higher than nominal value
2. Temperature at Tc between nominal value and lifetime value
    a. Lifetime > 50,000 hours
    b. Efficiency lower than nominal value, lumen output slightly lower than nominal value
3. Temperature at Tc between lifetime value and absolute maximum value. No warranty applicable in this case.
    a. Lifetime < 50,000 hours
    b. Efficiency lower than nominal value, lumen output lower than nominal value
4. Temperature at Tc > absolute maximum value: do not exceed the absolute maximum value as this can lead to LED line failure. No warranty applicable in this case.

Thermal design-in

Lifetime is based on engineering data testing and probability analysis. The hours are at the B50, L70 point.

An example is given below on how these values are stated in the associated LED Line datasheet. Please make sure to look up the corresponding Tc values for the Fortimo LED Line product you are using.

Fortimo LED Line	Tc min[2] °C	Tc life[3] °C	Tc max[4] °C
LED Line example	45	55	65

2 Minimum Tc at which performance is specified
3 Maximum Tc at which lifetime is specified
4 Maximum Tc for safety

Influence of thermal resitance of the luminaire

Retrofitting Fortimo LED Line Gen 2 Systems into existing fluorescent fixtures is possible in many cases. However, in case of a high flux LED Line - with a high power density – the luminaire design has to enable sufficient heat transfer from the LED Line to ambient. In other words, the higher the flux density (lm/ft) the lower the total thermal resistance (Rth) from the module to the ambient has to be in order to keep the module temperature at the specified level. The total Rth is determined by both the module and the luminaire design. The lower the Rth, the better the thermal performance of the system.

In case the measured Tc value of the module inside the luminaire is higher than specified and the luminaire design cannot be modified, reducing the module current can provide a solution.

The total Rth can be calculated from the measured difference between Tc and Tambient and the module current and voltage by the following formula:

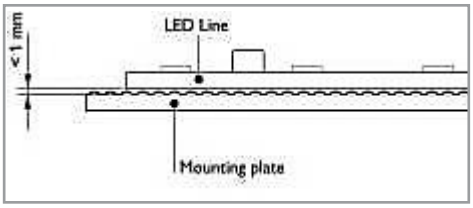
$$R_{th} = \frac{(T_c - T_{ambient})}{V \bullet I}$$

Cooling via the luminaire housing or cooling plate

Thermal contact

The unflatness (air gap) of the area where the LED Line is mounted should not exceed 1 mm along the LED Line length to ensure good thermal contact and to avoid local stress and strain on the LED Line. By ensuring good thermal contact between the bottom surface and the luminaire surface thermal paste almost certain is needless. Preventing an air gap is ensuring the best thermal contact.

Thermal design-in



The unflatness of the area where the module is mounted should not exceed 1 mm along the module.

Material	k (W/mK)
Copper	400
Aluminum	200
Brass	100
Steel	50
Corrosion-resistant steel	15

Thermal conductivity of different materials

Cooling via the luminaire housing

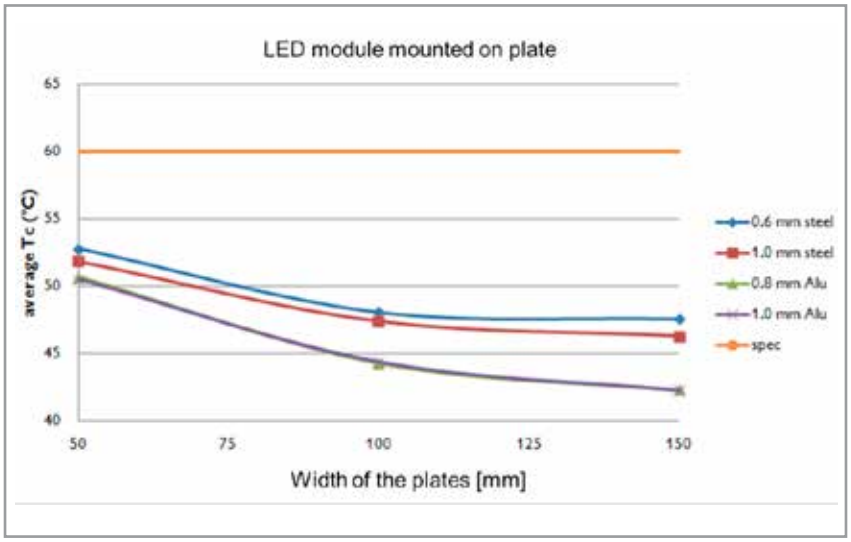
The Fortimo LED Line itself has been optimized to spread the generated heat. However, extra cooling can be achieved via the luminaire housing or, if this is not sufficient, via an extra cooling plate. For this to work well, good thermal contact must be achieved. Obviously the plate must release its heat via the luminaire to the surroundings as well.

Cooling surface area and material

The amount of heat that needs to be transferred away from the LED Line to the ambient air is about two thirds of the electrical power. This heat needs to be dissipated and transferred to ambient air via the luminaire housing.

If the luminaire housing has a good thermal conductivity the effective cooling area is increased. It is therefore recommended to use a material that has high thermal conductivity and is of sufficient thickness. This will lower the Tc temperature and enable the system to perform better (lifetime and flux).

The required size of the luminaire housing area per LED Line depends on the design and volume of the luminaire, the thermal properties of the material used and the expected ambient temperature.

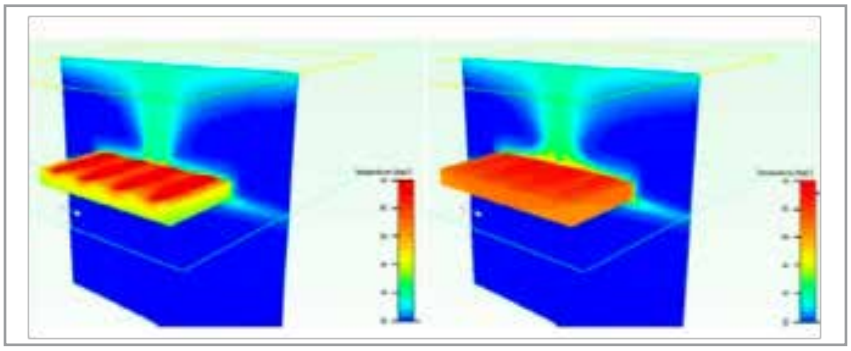


Effect on Tc of the mounting plate material, thickness and width

Aluminum is preferred over steel because of its higher thermal conductivity, although for most applications steel is likely to be adequate for ambient temperatures of up to about 40 °C. If Tc is exceeding the target value, consider the use of aluminum.

Thermal design-in

The following examples show that the heat is transferred in a correct way

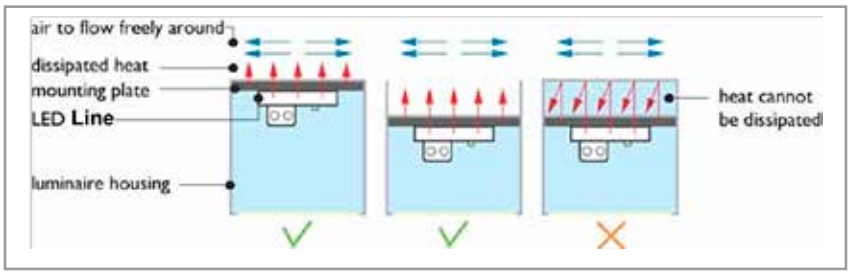


1 mm steel 1 mm aluminium

Temperature distribution using different mounting plate materials

Tips for small volume and double chamber conditions

The heat produced by the module and driver in the luminaire (or similar housing) must be dissipated to the surroundings. If a luminaire is thermally insulated by a ceiling, wall or insulation blanket, the heat produced cannot be easily dissipated. This will result in a higher temperature of the driver and module, which will have an adverse effect on system performance and lifetime. For optimum performance and lifetime it is advised that air be allowed to flow freely around the luminaire and that the mounting plate is in direct thermal contact with free air. Designing the luminaire in such a way that air can also flow through it will provide extra cooling, which may be beneficial in certain cases.



Operation under built-in conditions, applicable for both LED module and driver

General thermal recommendations

General thermal design guidelines to improve the thermal management and performance of a luminaire:

- Simplify the heat path from Tc to cold ambient air; less interfaces is better
- Use good thermally conductive materials in the primary heat path
- Ensure proper heat spreading by using materials with good conductivity and/or sufficient

Thermal design-in

thickness to increase the effective cooling surfaces

- Anodized, painted surfaces are preferable to blank surfaces in order to increase heat transfer via thermal radiation
- Use of thermal interface materials (TIM) can be considered to improve thermal contact, i.e. between the module and luminaire housing

Contact Philips Sales Representative at any time if you need advice on your luminaire design.

Reliability

Lumen maintenance of the Fortimo LED Line

B50L70 @ 50000 hours

The quality of the Led Line portfolio is underpinned with Philips' claim of B50L70 @ 50000 hours. This means that at 50000 hours of operation at least 50% of the LEDs' population will emit at least 70% of its original amount of lumens.

In this section the example graphs show the estimated lumen depreciation curves for different percentage of the population and for different Tc temperatures. The actual data for the LED Line modules can be found in the associated datasheet.

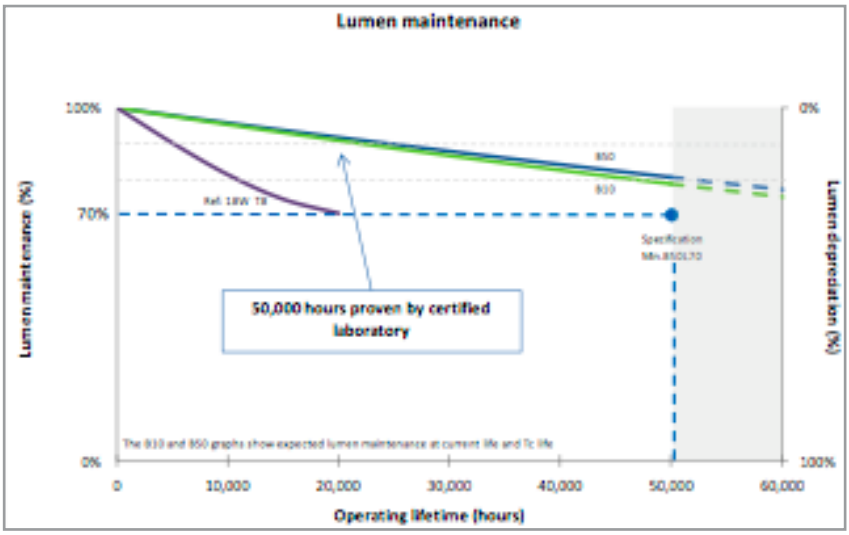
These estimations are based on 9000 hours of LM80 testing and calculated according to the TM-21 guideline. After 50,000 hours the lines are dotted, because lumen maintenance beyond 50,000 hours cannot be predicted according to the TM-21 guideline. Lowering the drive current and or temperature can increase the lumen maintenance time.

Please refer to the associated LED Line datasheet for the specific graphs.

Reliability

Lumen maintenance for B10 and B50

Below example graph is showing the lumen maintenance (% of initial lumen over time) for B50 (50% of the population) and B10 (90% of the population).

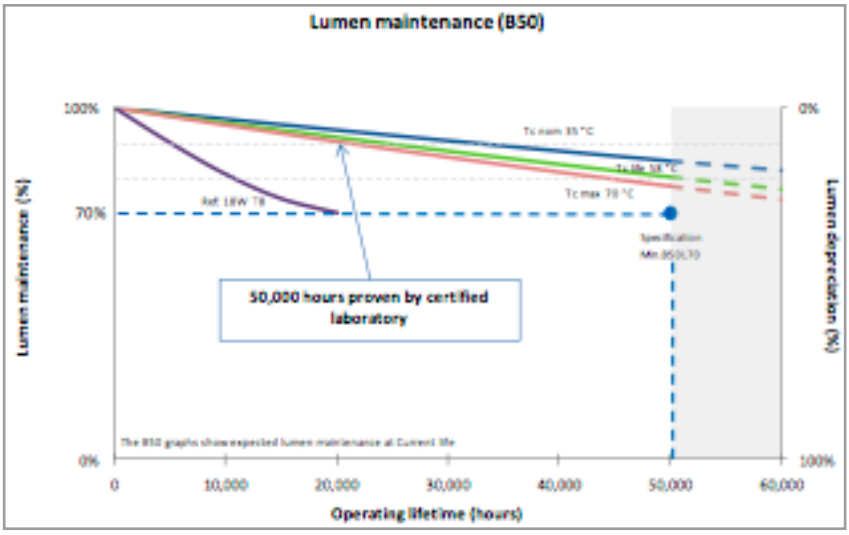


Example lumen maintenance as a function of operating hours for B10 and B50

Please look up the actual lumen maintenance graph in the associated datasheet of the Fortimo LED Line you are using.

Lumen maintenance for for different Tc temperatures

Lumen maintenance is also affected by temperature. Lowering the Tc will increase the lumen maintenance time. Below example graph is showing the lumen maintenance (% of initial lumen over time) for B50 (50% of the population) at l life and three different Tc temperatures (Tc nominal, life and maximum).



Example lumen maintenance as a function of operating hours at different Tc values

Reliability

Note: above graphs are lifetime predictions based on LM80 data; no guarantee outside specified lifetime specifications.

Tips and instructions for assembly and installation

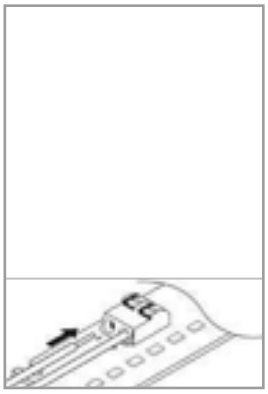
Warning

Do not service the system when the mains voltage is connected.
This includes connecting or disconnecting the cable.

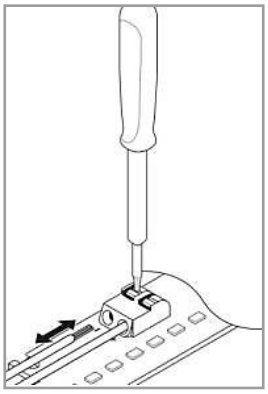
Inserting and removing the cable connectors

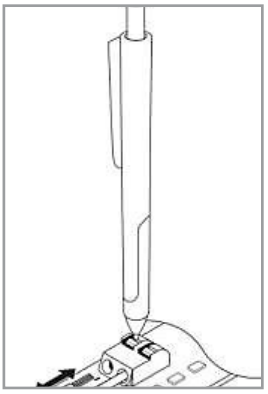
Conductor insertion and release

All wires must be pushed firmly into the contact wire opening. The wire can be released by pushing the release button.



Inserting solid conductor via push-in termination





Insert/Remove stranded conductor by lightly pushing on push button, e.g. using a tool or e.g. a ball point (pen)

Tips and instructions for assembly and installation

Wire insulation

The wires must be fully inserted so that the wire insulation is inserted into and surrounded by the end of the housing (no bare wire should be visible).

Wire termination depth

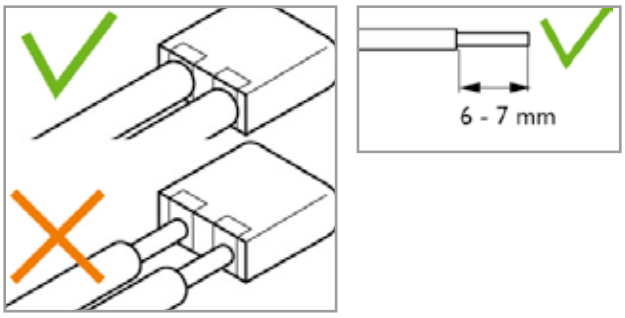
The required wire termination depth on the module connector is achieved when the wire, with insulation stripped (by hand or machine) to indicated length, stated in the datasheet, to ensure a solid connection. For the driver connector the required wire termination depth is stated in the driver datasheet. Check for the latest information both the LED Line and driver datasheets.

Strain relief

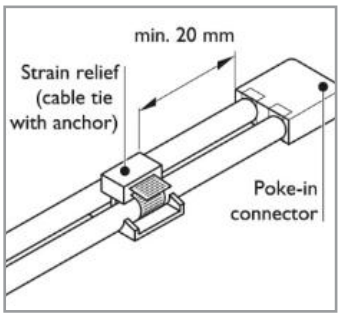
It is important to add a strain relief to the wiring of the connector from driver to line and from line to line when the length of the cable is more than 15 cm.

Warning

- The contacts and housings are not repairable.
- DO NOT use damaged or defective contacts or housings.
- Do not apply mains power directly to a LED Line!
- Do not touch, attach or detach LED Lines in a live system.



Wire insertion and strip length



Strain relief

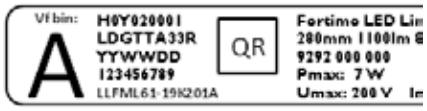
Tips and instructions for assembly and installation

Binning

Philips has created high-quality LED light by ensuring correct mixing of the LED bins within each module. There is a limited need for binning of LED Lines in two bins only for the Linear boards.

Fortimo LED Line modules are labeled and packaged in maximum two voltage bins. LED Line linear is divided into bins, indicated with two letters, for example 'A' and 'C'. In order to ensure optimum flux and color uniformity, we advise against mixing two different bins in the same luminaire.

The Vf bin is clearly indicated on the label, as shown in the example below. All modules packaged in one box will be from the same bin.



Example label on LED Line indication bin A

Why address the issue of LED binning?

It is important to understand binning because it is very important in LED system design. As in other semiconductor manufacturing processes, in the production of LEDs the number of parameters of the epitaxy process is very large and the process window is small (for example, the temperature must be controlled to within 0.5 °C across the wafer at temperatures of ~800 °C). The fact that it is difficult to achieve such a high degree of control means that the properties of the LEDs may vary significantly within single production runs and even on the same wafer. To obtain consistency for a given application, binning (= selection in bins) is mandatory. Binning involves characterizing the LEDs on the basis of measurement and subsequently categorizing them into several specific bins. To keep the cost per LED down, LED manufacturers need to sell the full production distribution. At the same time they cannot guarantee the availability of all bins at all times. There is a trade-off between logistics and cost price on the one hand, and the application requirements on the other. The advantage of this is that there will only be a limited need for LED Line module pairing by the OEM.

EMC

EMC and cable length

Philips has successfully performed EMC tests for a total length 4m (sum of wire length and length of Core LED Lines). For longer lengths it is advised to repeat these tests.

EMC precautions

As mentioned before, the total amount of parasitic current needs to be minimized. For that reason, the following practical precautions need to be taken in a lighting system to minimize EMI:

- Minimize the DM loop area of the lamp wires going from the driver to the light source by keeping the wires close together (bundling). This will minimize the magnetic field and reduce the radiated EMI. Long linear light sources are also part of that loop like LED strips and linear fluorescent lamps.

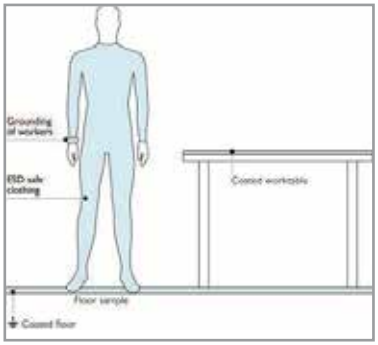
Tips and instructions for assembly and installation

- Minimize the CM parasitic capacitance of the output wiring + light source to earth by keeping the length of the wires between driver and light source as short as possible. Also minimize the copper cooling area on the LED PCB and keep the length of the incoming mains wire inside the luminaire as short as possible.
- Keep mains and control wires(DALI, 0-10V) separated from the output wires (do not bundle).
- Ground the lighting system chassis and other internal metal parts to earth (class I luminaires) and do not let large metal parts "float". Always use the safety or functional earth connector or wire from the lamp driver. Or use equipotential connecting wires for all internal floating metal parts which are inaccessable (class II luminaires). Keep safety and functional earth wires as short as possible to minimize their inductance, use as much as possible large metal areas (chassis, mounting plates, brackets) for earthing purposes instead.
- Sometimes, radiated EMC compliance cannot be achieved, necessitating the use of a 100 … 300 axial ferrite bead(s) for either mains or lamp wiring (effective for interference between 30MHz and 300MHz).

Adhering to these rules will in general result in EMC compliance. If not, the Philips Lighting Design-In team can be consulted for a posible solution.

Electrostatic discharge (ESD)

Introduction to ESD



Example of ESD measures

It is generally recognized that ElectroStatic Discharge (ESD) can damage electronic components, like LED chips, resulting in early failures. Professional users of electronic components are used to implement extensive and disciplined measures to avoid ESD damage in their finished end products. Now, with the introduction of LED components for lighting, a new breed of users, such as OEM's and installers, are exposed to handling and manufacturing with LED electronic components.

ESD in production environment

Depending on the immunity level of the LED board a minimum set of measures has to be taken when handling LED boards. ESD measures are required in a production environment where handling can exceed the ESD immunity level. Furthermore ESD vulnerable products should be packed and delivered in ESD safe packaging.

The purpose of an effective ESD-control strategy is the reduction of line failures, final inspection failures and field failures.

ESD specifications

Philips designed their Fortimo LED Line products rather robustly against ESD. Specifications of the LED Line maximum contact discharge level and air discharge level, according to IEC 61000-4-2 (HBM 150pF + 330), are stated in the associated datasheets of the LED Line you use.

Tips and instructions for assembly and installation

Servicing and installing luminaires

It is highly recommend informing installers not to touch the LED components and use earthed arm-straps to avoid ESD damage during installation and maintenance.

ESD consultancy

Independent ESD consultancy companies can advise and supply adequate tools and protection guidance.

Controllability

OccuSwitch

ActiLume DALI

ActiLume 1-10V

Dimming

The Philips Fortimo LED Line Systems are complemented with a range of Philips Advance Xitanium drivers:

- isolated 54W and 75 W drivers for UL Class 2 / Class II / SELV luminaires

These drivers are available in various dimming protocols:

- Touch & DALI protocol
- 1-10V dim protocol (0-10V for USA)

Stand-alone Philips systems

For DALI systems we recommend:

- OccuSwitch
- ActiLume DALI
- ActiLume 1-10V

For 1-10V systems or fixed-output switching we recommend:

- OccuSwitch (switch on/off using fixed-output drivers)
- ActiLume 1-10V (for movement-detection and daylight-sensing systems)

Visit www.philips.com/lightingcontrolsna to find out more about our entire portfolio of control products.

Compliance and approval

Chemical compatibility

In the market medium power LEDs exist containing a silver (Ag)-finished Lead frame. The lead frame finish is sensitive to corrosion when exposed to substances containing Sulfur or Chlorine. In that case parts of the lead frame may blacken, which will impair the Lumen Output or the color of the LED. Materials that are known to have a higher risk to be a source of Sulfur and Chlorine are for example natural rubber or corrugated paper.

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.

The Fortimo LED Line uses LEDs with above explained type of lead frame.

Therefore above recommendations apply for the Fortimo LED Line modules.

Philips Fortimo LED Line Systems comply with the standards shown below.

Compliance and approval marks

The Fortimo LED Line family is ENEC approved and comply with CE regulations. The relevant standards are summarized in the table below. To ensure luminaire approval, the conditions of acceptance need to be fulfilled. Details can be requested from your local sales representative. All luminaire manufacturers are advised to conform to the international standards of luminaire design (IEC 60598-Luminaires).

IP rating, humidity and condensation

The Fortimo LED Line systems are build-in systems and therefore have no IP classification. They are not designed for operation in the open air. The OEM is responsible for proper IP classification and approbation of the luminaire.

The Fortimo LED Line has been developed and released for use in damp locations but not for locations where condensation is present. If there is a possibility that condensation could come into contact with the modules, the system/luminaire builder must take precautions to prevent this.

Photobiological safety

The lamp standard, IEC 62471 'Photobiological safety of lamps and lamp systems' 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, in the wavelength range from 200 nm to 3000 nm. Measurement results for LED Line products are given below. Based on these measurements, no additional safety measures have been included.

Tips and instructions for assembly and installation

Item	Result: Risk group
Actinic UV	Exempt
Near-UV	Exempt
Retinal Blue Light	Exempt
Retinal Blue SmallScr	Exempt
Retinal thermal	Exempt
Infrared Eye	Exempt

Electromagnetic compatibility

Electromagnetic compatibility, EMC, is the ability of a device or system to operate satisfactorily in its electromagnetic environment without causing unacceptable interference in practical situations. In general, LED modules have no effect on the EMC of a luminaire. The Fortimo LED Line family modules are evaluated in combination with a Xitanium driver in a reference luminaire, according to the standards mentioned below. No unacceptable interference levels were observed.

System disposal

We recommend that the Fortimo LED Line and its components are disposed of in an appropriate way at the end of their (economic) lifetime. The modules are in effect normal pieces of electronic equipment containing components that are currently not considered to be harmful to the environment. Consult your federal, state and local government laws and regulations and industry standards for disposal of electronic devices.

Examples of applicable regulatory standards

IEC/EN 62031	LED modules for general lighting – safety specifications
IEC 62471	Photobiological safety of lamps and lamp systems

Philips Xitanium driver

IEC/EN 61347-1	Lamp control gear

Electromagnetic compatibility

(tested with LED Lines, cables and Philips Xitanium driver)

EN 55015, CISPR 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
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

Compliance and approval

Environmental

The product is compliant with European Directive 2002/95/EC of January 2003 on Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)*.

Cautions during storage and transportation

When storing this product for for more than one week

- Store in a dark place. Do not expose to sunlight.
- For Fortimo LED Line: maintain
  - temperature between -40..+85 °C
  - RH 5..85 %.
- For LED Line Cover 2ft soft-diffuse: maintain
  - temperature between -40..+75 °C
  - RH 5..85 %.

During transportation and storage for a short time

- Maintain temperature below 100 °C at normal humidity.

Philips Fortimo LED Line Systems Gen 2 must be operated within the specifications found in the product sheets and Design In Guide. Please consult your local Philips Representative for additional information.

* 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.

Form no. LE-6550-B

Philips Lighting Company
A Division of Philips North America
10275 W. Higgins Road
Rosemont, IL 60018
Tel: 800-322-2086
Fax: 888-423-1882
Cuxstomer Support/Customer Care: 800-372-3331
www.philips.com/ledmodulesna