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LED Linear ES family

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Design-in Guide

The first linear LED system with **matching light engines and drivers in one**

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Contents

Introduction to this guide

Thank you for choosing the Philips LED Linear ES family. In this guide you will find the information you need to design this system into a luminaire.
This edition covers the Philips LED Linear driver on board (DoB) family released for Europe. Extensions to the range will be included in future updates of this guide. We advise you to consult our website for the latest up-to-date information. For a full portfolio overview please consult the **Commercial Leaflets**, to be found in the download section on www.philips.com/technology.

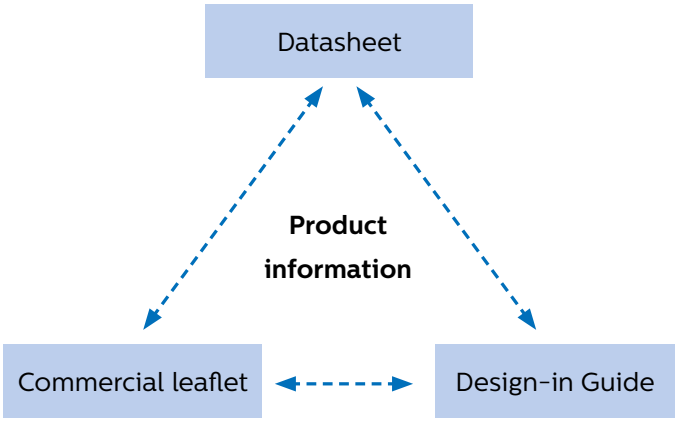
Note: LED technology is continuously improving.
For the latest updated information, please check www.philips.com/technology.

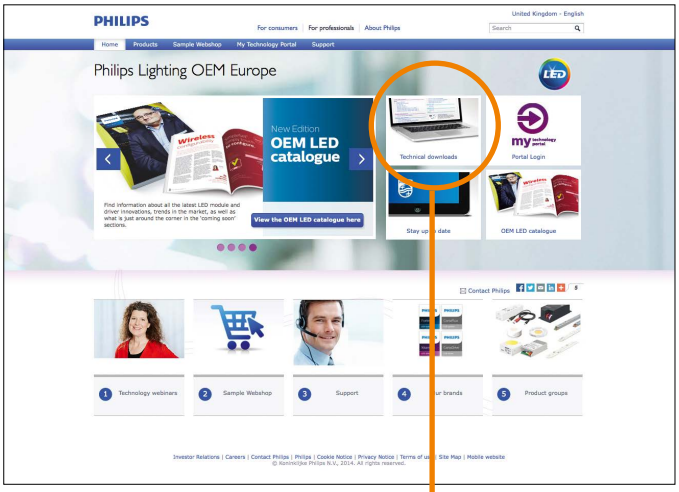
How to... Determine which documents contain what information

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

- Commercial leaflet: product family overview.
- Datasheet: product specific specification.
- Design-In Guide: describes how to design-in the products into a system.

These documents can be found in the download section on the OEM website www.philips.com/technology.
If you require any further information or support please consult your local Philips office.





Download section of the OEM web.

Warnings and instructions for HV products

When using these products, comprising a non-isolated driver.

Warning:

- Avoid touching live parts!
- Avoid touching any bare components on the PCB, e.g. LEDs or driver components!
- Do not use damaged LED modules!
- Class I luminaires must be connected to protective earth!

Safety warnings and installation instructions

To be taken into account during design-in and manufacturing.

Philips Design-in support

Is available; please contact your Philips sales representative.

Design-in phase

- The LED modules covered in this design-in guide are Built-in Self-ballasted LED Modules.
- Do not use as a single module system.Use the set of modules (married couple) as indicated in the respective datasheet.
- The general IEC recommendations for luminaire design and legal safety regulations (ENEC, CE, ANSI, etc.) are also applicable to Philips LED Linear ES systems. Luminaire manufacturers are advised to conform to the international standards for luminaire design (IEC 60598-Luminaires).
- Suitable for Class I and II luminaires.
- The luminaire must be constructed in such a way that the LED module cannot be touched by an end-user, both in off state and when live.
- It is mandatory to design the luminaire in such a way that it can only be opened with special tools (by a qualified person) in order to prevent touching of live parts.
- For Class I luminaires, do not install a reflector near the LED module without a proper earth connection.
- Do take into account the minimum required creepage and clearance distances.
- Do not apply mains power to the LEDs directly.
- Connect all electrical components first before switching on mains.
- Avoid possibilities of water or dirt ingress: use appropriate IP-rating of luminaire with regard to specific conditions of application.
- The LED products covered by this design-in guide are intended for indoor use and should not be exposed to the elements such as snow, water and ice. It is the luminaire manufacturer's responsibility to prevent exposure.

Manufacturing phase

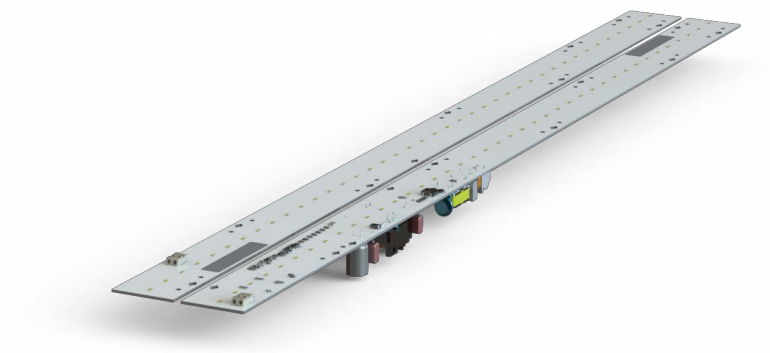
- Do not use damaged or defective LED modules, including damaged connectors or PCB.
- Do not drop the LED module or let any object fall onto the LED module because this may damage the PCB, LEDs and or components. If the LED module has been dropped or an object has fallen onto the LED module, do not use it, even if there are no visible defects or signs of damage.
- Connect all electrical components first before switching on mains.

Installation and service for luminaires incorporating the Philips LED Linear ES system

- This LED system is not suited for DC input operation!
- Do not service the luminaire when the mains voltage is connected; this includes connecting or disconnecting the LED module cables.
- Do not use damaged products.

For optimal reliability of the LED module we advise not to apply an AC electric strength test to the luminaire as this might damage the LEDs. It is recommended instead to apply an insulation resistance measurement at 500 VDC (noted as alternative test in IEC/EN 60598-1 annex Q).

Introduction the Philips LED Linear ES systems



Applications and luminaire classification

The Philips LED Linear ES family is the ideal replacement for linear fluorescent lamps in general lighting. The system features a high level of energy efficiency, which surpasses T5 systems, enabling the lowest total cost of ownership (TCO). It offers high-quality white light with excellent color rendering and color consistency. Comes with a multiple year Philips system warranty.

This Philips LED Linear ES system contains high-voltage solutions that comply with European requirements for indoor lighting applications. Other applications or luminaires can be explored by OEMs as long as this does not create a design conflict. European luminaire standards, like IEC/EN 60598, must be complied with.

In this guide you will find the specific information required to develop a luminaire based on the Philips LED Linear ES system.

How to... Use LED Linear ES systems in outdoor luminaires

The LED modules covered in this design-in guide are Built-in Self-ballasted LED Modules. Neither the LED modules nor the on-board LED driver have an IP classification >IP20. Please also familiarize yourself with the section on Chemical compatibility. Furthermore for outdoor luminaires, compliance to a higher mains surge standard is required than the indoor standard LED module is tested against. Not complying with the outdoor standard will lead to damaged LEDs. If deciding 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 Philips if you wish to deviate from the design rules described in this guide (see last page for contact details).

Cautions during storage and transportation

When storing this product for a long time (more than one week)

- Store in a dark place. Do not expose to direct sunlight.
- For Philips LED Linear modules: do maintain temperature and relative humidity between specified range as stated in the respective datasheets.

During transportation and storage for a short time

Maintain temperature below 100 °C at normal, non-condensing relative humidity.

Electrical design-in

System configuration of Driver on Board LED Linear ES Modules

A double module system only
Intended released combinations are depicted in the respective datasheet, to be downloaded from the website www.philips.com/technology.

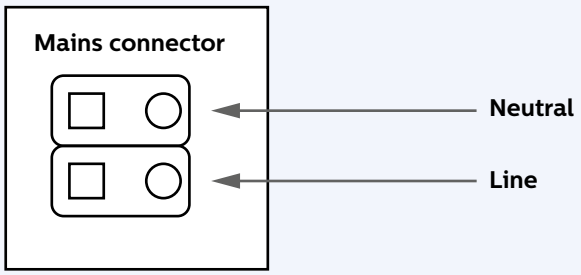
Warning

Note that the master modules cannot be used for a single-module system.
Note that modules of the same type only should be connected (married couple).

Wiring the system

Both the LED modules and driver are equipped with push-in connectors. No specific cabling other than standard installation wire is required. To find details of each connector, see the respective datasheet of the product you use.
Note: the LED modules are polarity-sensitive.

Connecting the driver to the mains supply
The mains supply has to be connected to the mains connector on the master LED module carrying the driver, not the LED-only slave module.

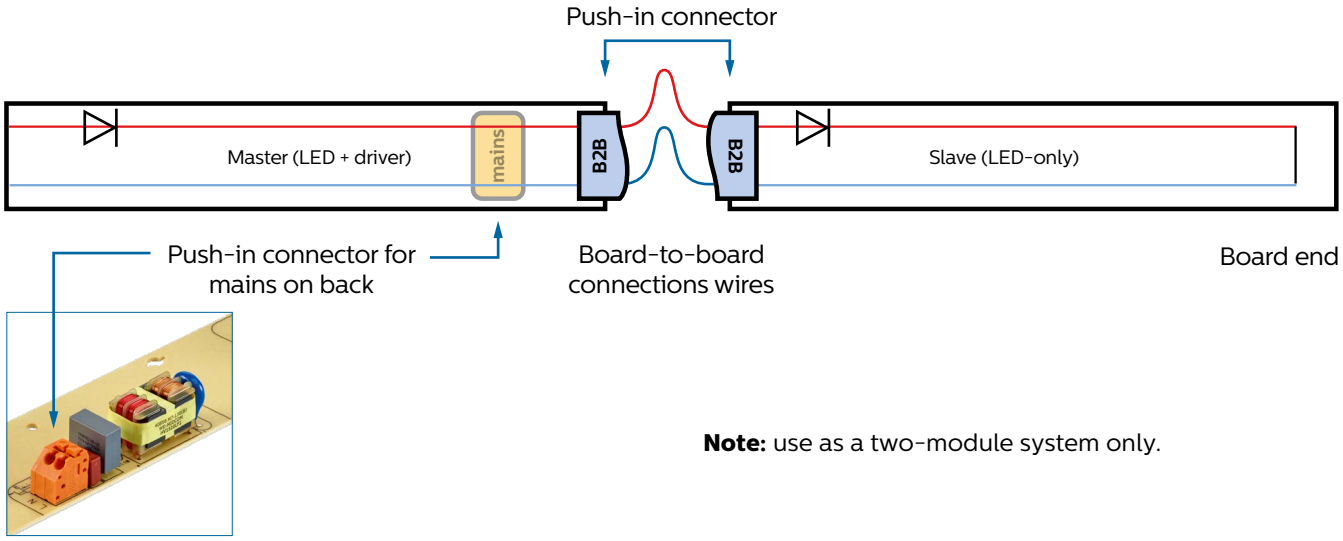


Attention

- First compose, wire and fixate the system components before connecting to, or switching ON the mains.
- IEC protection classification of the module and IP rating needs to be handled by the OEM.
- The modules have no protective-earth connection.

Interconnecting LED modules

By default the cables are connected from the 'OUT' connector of the master LED module to the 'IN' connector of the slave LED module, keeping the polarity ('+' and '–') consistent. LED Linear modules are polarity sensitive. Please assure a correct wiring before switching on the LED Linear ES system.



Note: use as a two-module system only.

Please find for the LED Linear product that you are using the wiring schematic at the end of each datasheet. Datasheets can be downloaded in the product download section from www.philips.com/technology.

Insulation safety indicated by working voltage

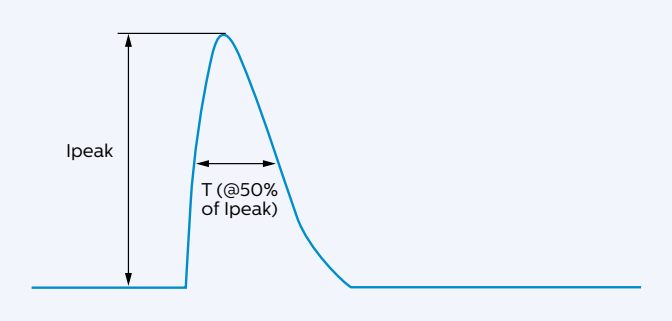
The working voltage is the highest voltage that may occur across any insulation of the module without compromising the safety of the module. The actual values are stated in the associated datasheet of the product you are using.

Cables and wires

With the current Philips LED Linear modules both stranded and standard solid core installation wire can be used. This approach allows the OEM to choose the preferred supplier, as well as preferred cable properties like color, thickness, lengths, although mains-rated wiring is advised. Please check the datasheet for details like wire thickness and strip length on www.philips.com/technology.

Mains voltage fluctuations and behavior

The driver (part of the master LED module) is able to withstand high and low mains voltages for limited periods of time. Operating outside this range will stress the driver and LEDs, which in turn will have an adverse effect on their lifetime. See the associated datasheets for specific values.



Graphical representation of inrush current

Inrush current

'Inrush current' refers to the briefly occurring high input current which flows into the driver during the moment of connection to mains; see the illustration on the left.

The cumulative inrush current of a, given, combined number of driver on board ES systems may cause Mains Circuit Breakers (MCB) to trip. In such a case, either one or a combination of the following measures need to be taken to prevent nuisance tripping:

1: Replace existing MCB for a less sensitive type (e.g. exchange B type for C type)
2: Distribute the group of driver on board ES systems over multiple MCB groups or phases
3: Power up driver on board ES systems sequentially instead of simultaneously
4: Install external inrush-current limiting devices

Inrush parameters are product-specific and can be found in the datasheet at www.philips.com/technology.

Surge protection

The driver part of the master LED boards has built-in surge protection up to a certain limit. Depending on the mains connected, additional protection against excessive high surge voltages may be required by adding a Surge Protection Device. The actual limit can be found in the datasheet in the download section on www.philips.com/technology.

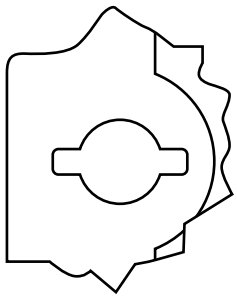
Touch current

The driver part of the master LED boards is designed to meet touch current requirements per IEC 61347-1 standard. The specified maximum values are 0.7 mA peak down to 0.4 mA peak for IEC and 0.75 mA RMS for UL norms. In a luminaire, touch current may be higher, since the LED load may introduce additional touch current. As such, precautions may be required on the luminaire level and if multiple driver on board LED Linear ES systems are used in a single luminaire.

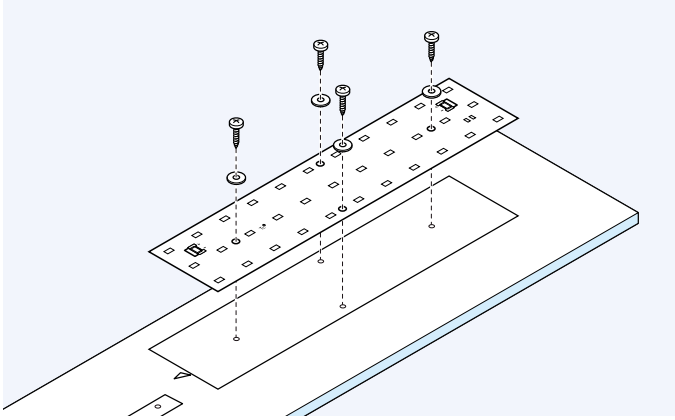
Electromagnetic compatibility (EMC)

The driver part of the master LED boards meets EMC requirements per CISPR 15 ed 7.2. The test is conducted with a reference setup. In Class II luminaires, functional earth is not needed to meet EMC.

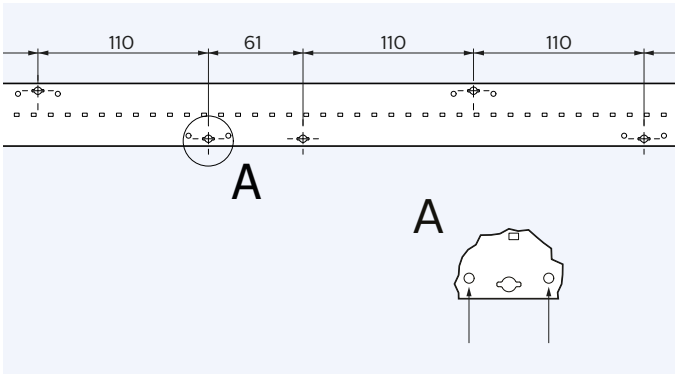
Mechanical design-in



Example of a fixation slit-hole.



Example of using washers.



Optics alignment hole

Mechanical fixation and creepage for LED Linear modules
To allow performance achieving the specification, it is advised to use all mounting holes. Optionally you can omit some fixation points and evaluate the modules performance on mechanical flatness and thermal contact. Make sure the modules are thermally in good contact with the mounting surface. This can be verified by measuring the Tc temperature. When in good thermal contact, it is likely no additional thermal paste or cooling bodies are required. The fixation holes are indicated in each product's datasheet in the download section of www.philips.com/technology.

Screws, washers and fixation holes

Each LED module fixation hole accepts M3 screws. OEMs may choose different size screws, as long as the **creepage** and **clearance** (explained in the next chapter "Optical design-in) is guarded. When using washers we recommend using insulating washers and not metal washers, as with metal washers the creepage distance of earthed screw connection with respect to PCB tracks is more difficult to be guaranteed.

To ensure the electrical insulation when using for example M3 metal screws, the diameter of the screw head (and optional metal washer) must **not exceed 5.6 mm**, as this can lead to an electrical shock. When using electrically non-conductive materials the size could be allowed larger than that.

Warning

Some holes are 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 module, as this can lead to an electrical shock.

Damage of insulation layer

In general the surface of the PCB must not be damaged by mounting materials as this may compromise the electrical insulating layer. However scratching of the PCB's white top layer in the region that is intended for fixation by screw will not lead to loss of function or reliability. The area around fixation holes does not carry any copper tracks. This can be seen when looking carefully at the LED module. The mounting materials must still comply with the relevant creepage and clearance.

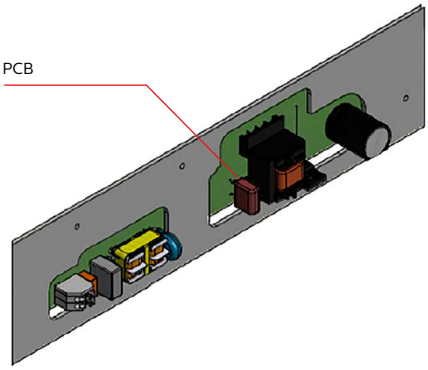
Screw torque

The maximum torque that should be applied depends on the screw type and luminaire material. The fasteners used to secure the LED module 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	0.6 Nm	1.0 Nm

Alternative fixation methods

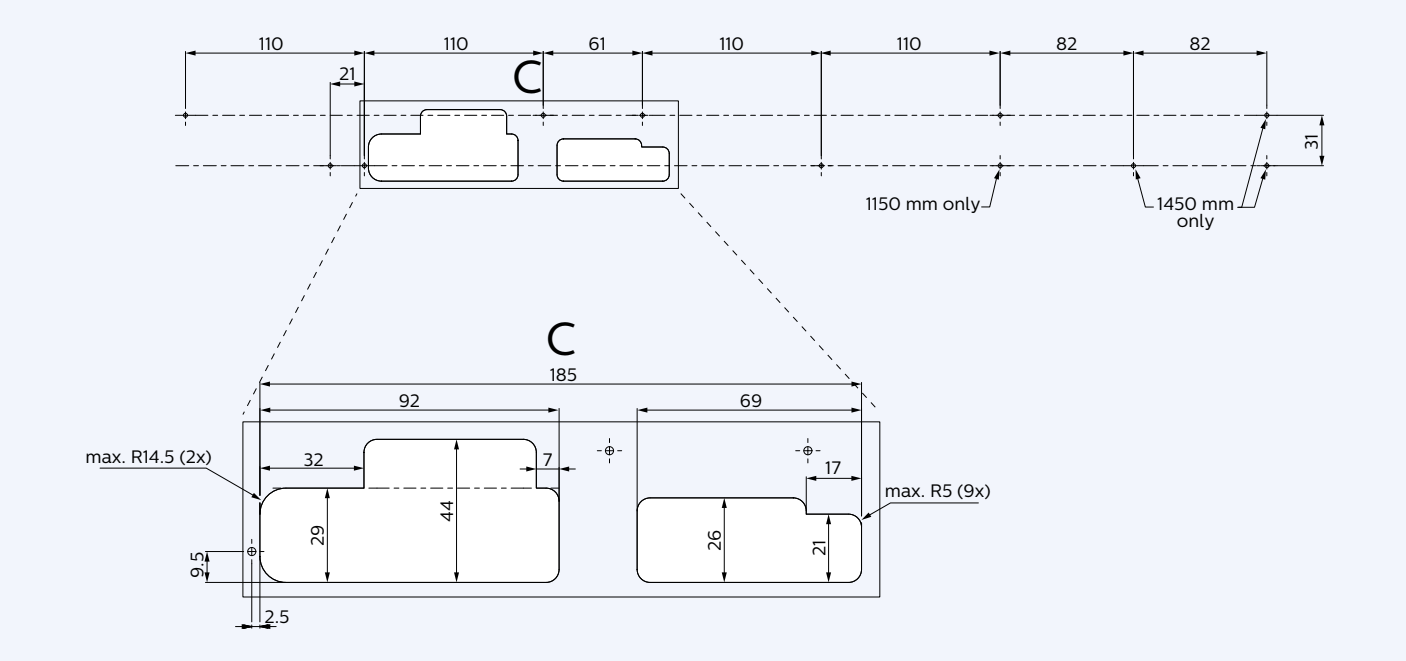
With Philips LED Linear ES modules fixation methods other than screws can be explored, potentially leading to fewer screws and faster mounting times. In order to achieve this, larger copper-free isles have been designed around the mounting holes. This freedom applies to the whole LED Line portfolio. Be careful that the clamping pressure on the PCB still enables flat assembly of the LED Linear module, so if the clamp somehow prevents the product from taking a flat position to make good thermal contact with the luminaire, it is undesired. Suggestions are made in this section.



3D impression of how the driver components go through the gear tray cut-out.

Requirement on the mounting plate (gear tray)

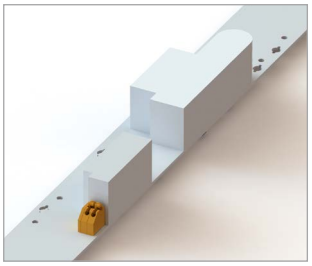
When mounting the modules onto a board or plate (gear tray) be sure the cut-out in that plate or gear tray is made prior to mounting the LED module, carrying the driver, as indicated in drawing below. Reference is to start measuring from the middle, where the two modules meet.



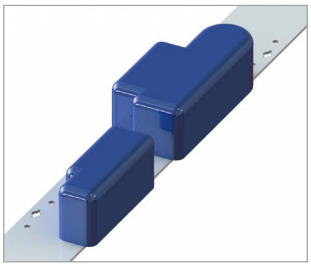
Drawing shows an example of a cut-out in the gear tray for the driver components including the pcb mounting holes.

Warning

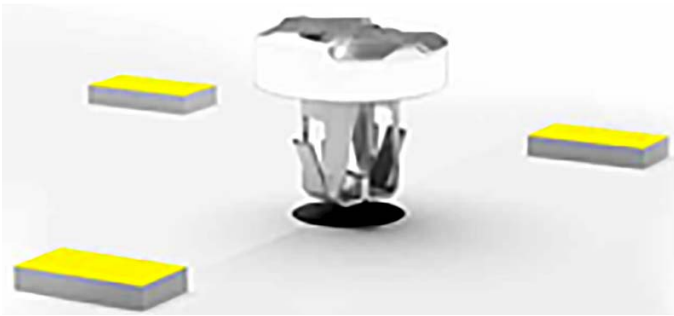
If a luminaire requires protective earth, all conductive parts – like the reflector – must be electrically connected to protective earth in order to prevent hazardous conditions!



The volume that is occupied by the driver components is represented by the two white volumes, provided in a 3D CAD file.



The air volume (clearance) that is required around the driver components with respect to conductive surroundings (like a metal housing) is represented by the two blue volumes, also provided in a 3D CAD file.



Example of a Push to Fix component by BJB.

Example of a Florence Press Fit Screw Replacement component by LEDiL.

Required minimum clearance distance

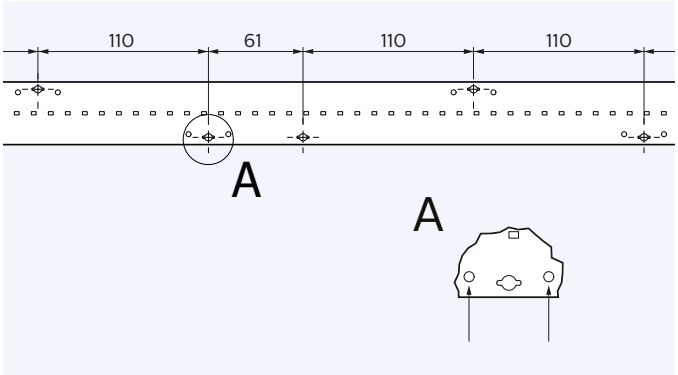
Depending the maximum driver output voltages that can occur under normal working conditions, IEC 60598 prescribes minimum clearance distances. The permissible maximum working voltages are stated in the datasheet of the product you use in the download section on www.philips.com/technology

Complementary partners for fixation alternatives

Fixation materials, such as screws, are not part of the Philips LED Linear ES system offering. This is an added-value area for OEMs, offering the possibility to differentiate. However, there are several suppliers offering push-and-fix-like components or adhesive tapes, enabling quick and easy luminaire creation. Some of these are listed in the complementary partner section in our LED Catalogue (both available printed and digital) or in the Support section on www.philips.com/technology.

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. We advise not to use bare plastic push pin fasteners (without any metal parts) as these are likely to wear out before the lifetime of the LED product is reached, reducing the mechanical and thermal contact between the LED module and the luminaire.

Optical design-in



Optics alignment hole

Optics on top of, or near the LED Linear modules

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 Linear ES modules in order to align electrical non-conductive optics onto the LED 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 LED module.

Complementary partners for optics

Secondary optics is not part of the Philips LED Linear ES system offering. This is an added-value area for OEMs, offering the possibility to differentiate. However, there are many companies offering for example reflectors, lenses or bulk diffusers who have a standard portfolio of compatible optics available, enabling quick and easy luminaire creation. Some of these are listed in the complementary partner section in our LED Catalogue (both available printed and digital) or in the Support section on www.philips.com/technology.

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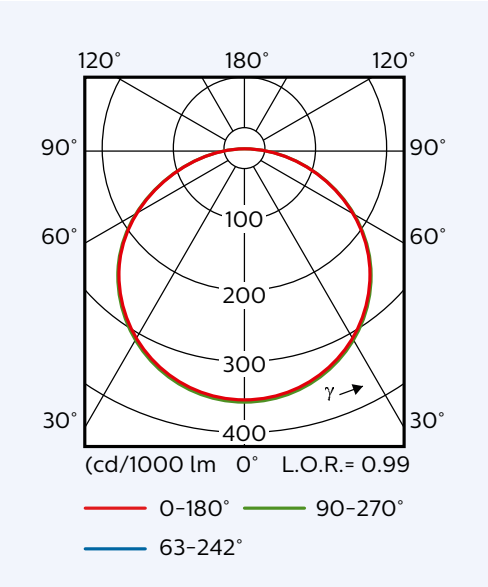


Light distribution

Philips LED Linear modules generate a Lambertian beam shape (see light distribution diagram).
The IES (or .ldt) files are available via the website www.philips.com/technology.

Ray sets

Ray set files are available for customer use, and can be downloaded from the download section on www.philips.com/technology. All ray set files are available containing 100,000, 500,000 and 5,000,000 rays, although due to their size the last two types are not in the download section. Please contact your Philips representative to obtain these separately if required.

Ray-set ZIP file contains typically

Software	File extension
ASAP	.dis
Light Tools (ASCII)	.ray
TracePro/Oslo (ASCII)	.dat
Zemax	.dat
Explanation & definitions	.ppt
Solid 3D model	.stp

The origin of the ray sets is shown in the accompanying slide deck presentation file per module type, as are the 3D Step files.

Color Consistency (SDCM)

Color consistency refers to the spread in color points between modules. It is specified in SDCM (Standard Deviation of Color Matching) or MacAdam ellipses, which are identical. The value refers to the size of an ellipse around a point close to 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 module and another with the naked eye in most applications.

SDCM value in the datasheet represents an integrated measurement over the complete LED module.

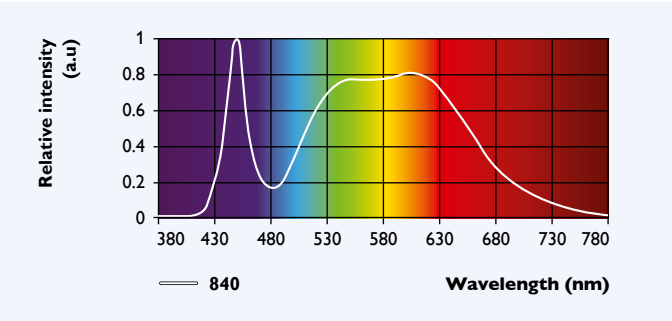
Please be aware that in applications that are more sensitive for color differences (color consistency of <3 SDCM) such as wall washers (<2 SDCM), we advise you to contact your local Philips representative or the Philips design-in team for expertise and support in luminaire design and evaluation.

Color targets (CCT)

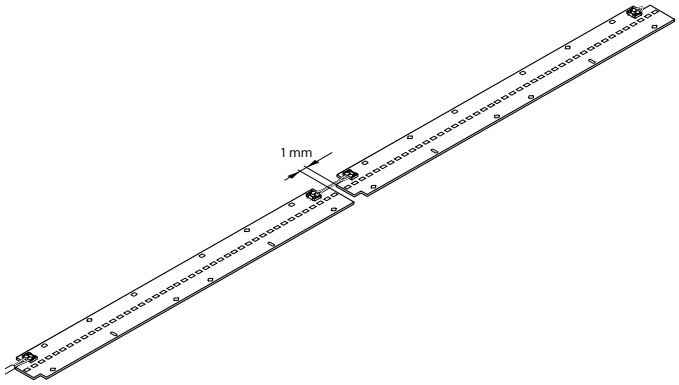
The color target points of both Correlated Color Temperature (CCT) and Color coordinates (CIEx, CIEy) of the Philips LED modules are found in the respective datasheets on www.philips.com/technology.

Spectral light distribution

The typical spectral light distributions of the Philips LED modules are shown in the respective datasheets on www.philips.com/technology.



Example of an LED light spectrum, CCT 4000K and CRI 80 (840).



Continuous LED pitch

To achieve optimal lighting uniformity, it is advised to keep the LED pitch between the modules the same as on the module itself. For the 2-module systems, the continuous LED pitch is ensured if the correct pitch between the mounting holes is applied. This distance can be derived from the measures in the drawings provided in the datasheet of the LED module you use, in the download section on www.philips.com/technology.

Reflector design

If a reflector is designed around the LED module, it is essential to allow a proper clearance distance between the LED module and reflector around the LED module surface, LEDs, electrical components and the connectors. This clearance distance is necessary to ensure safe insulation of the system and is in line with IEC regulations 60598 to prevent short circuiting, damage and an open circuit to the LED module.

Thermal design-in

Introduction

To facilitate design-in of Philips LED Linear ES systems, the critical thermal management points of the LED modules and driver are set out in this section. In Philips' product design phase all possible precautions have been taken to keep the component temperature as low as possible. However, the design of the luminaire and the ability to guide the heat out of the luminaire is important. If these thermal points are taken into account this will ensure the optimum performance and lifetime of the system.

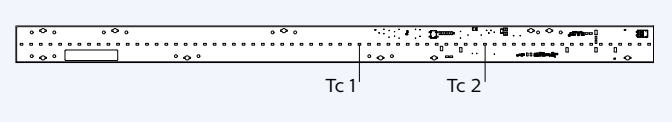
Definitions

- LED module temperature: temperature measured at the Tc point of the LED module.
- Ambient temperature (Tamb): temperature outside the luminaire of the air volume that absorbs the luminaire's heat.

As a reference, when switched off >2 hours, temperature at Tc point is likely to equal Tamb.

Tc point

The Tc test point indicates a reference point for measuring the LED modules 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.



How to... Measure temperature at the Tc point

The Tc test points for each ES LED system are is indicated both on the master LED module (pcb) and in the associated datasheet on www.philips.com/technology. The temperature can be measured using for example a thermocouple that is firmly glued or taped to the upper surface of the LED module. Do make sure the thermocouple does not make contact with other electrical components or open soldered connections. For a representative measurement the temperature must be stable before any reliable data can be obtained (typically minimum 1 hour stabilizing time).

Tc points on the master LED module

Please make sure in the design-in phase both the temperature at Tc points and Tamb is measured, in order to enable determination of the specifications of the luminaire in its intended application.
Note: Two Tc points are indicated on the module carrying the driver, for all different types at the same center position. Given Tc position and value are only for reference to determine up to what Tamb this ES LED system is feasible in your luminaire and application conditions.
Tc1 is linked to performance and lumen depreciation.
Tc2 is linked to driver performance and lifetime.

Relation between Tc and flux

The flux of the LED 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 LED module. Tc1 is leading for this parameter.

Relation between Tc and ambient temperature

The Tc increases by approximation linearly with the ambient temperature (Tamb). The temperature offset between Tamb and Tc depends on the thermal design of the luminaire. The Philips LED Linear ES system has been designed for indoor use. For approved ambient temperature range please check the associated LED module datasheet on www.philps.com/technology.

How to... Tune for anticipated ambient temperature (°C)

The LED module specifications are provided under nominal conditions, like nominal flux at nominal Tc. In previous sections it has been explained how to determine the temperature at Tc point. It is however possible to deviate from the LED modules nominal Tc. As the ambient temperature (Tamb) and Tc are related, thermally designing for a different Tc could allow for e.g. a higher Tamb or using different housing materials. Deviating Tc1 from nominal will lead to relative small changes in flux (lm) and efficacy (lm/W).

Temperature at Tc2 has some impact on performance but a distinct impact on lifetime. Advice is to not exceed Tc2-life. The rated average life is based on engineering data testing and probability analysis.

Cooling via the gear tray

Ensure a good thermal contact and to avoid local stress and strain on the LED module. By ensuring good thermal contact between the bottom surface and the luminaire surface the use of thermal paste is almost certainly unnecessary. Preventing an air gap is ensuring the best thermal contact.

Contact Philips at any time if you need advice on your luminaire design (see section entitled 'Contact details').

Reliability

Impact of thermal cycling on product failure

Not only the drive current (I [mA]) and steady state case temperature (Tc [°C]) have an impact on the lifetime of LEDs. Also the number of full thermal cycles has a significant impact on product failure. A full thermal product cycle means the complete warm up to stabilized Tc2 of the product in use and full cool down to ambient temperature (Tamb) of the product being switched off. For your convenience the amount of warranted full thermal product cycles of the LED product at a given Tc2 is stated in the datasheet of the LED module you use in the download section on www.philips.com/technology. Electrically faster switching, thereby not reaching the thermal limits of a full thermal cycle, will allow for higher numbers. Note: always take the Tc temperature limits into account as stated in the datasheet of the ES Linear LED system you use.

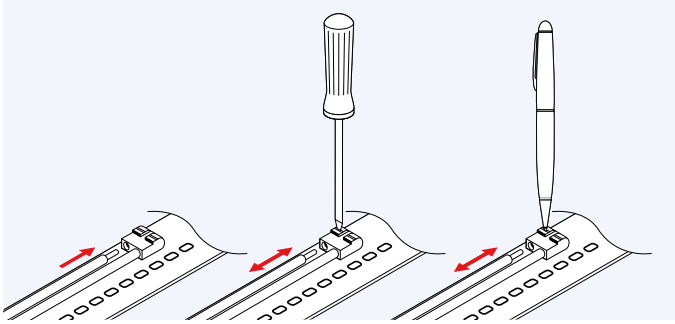
Lumen maintenance of the Philips LED Linear modules

The quality of the Led Linear portfolio is underpinned with Philips' lumen maintenance table for several LxBy and operating hour values. This means that for L70B50 for example, at provided hours of operation at least 50% of the LEDs' population will emit at least 70% of its original amount of lumens. The decreased lumen level can be a result of less light out of an LED, discrete LEDs failing - leading to a reduced lumen output of the luminaire - or a combination of the two. This 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 for different Tc temperatures. The actual data for the LED Linear modules can be found in the associated datasheet.

These estimations are based on thousands of hours of LM80 testing and calculated according to the TM-21 guideline.

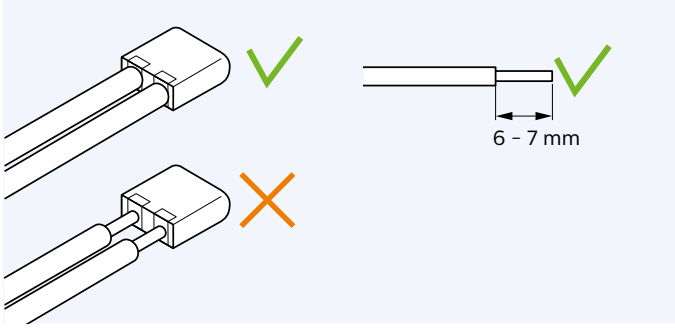
Please refer to the associated LED module datasheet for the specific graphs on www.philips.com/technology.

Tips for assembly and installation

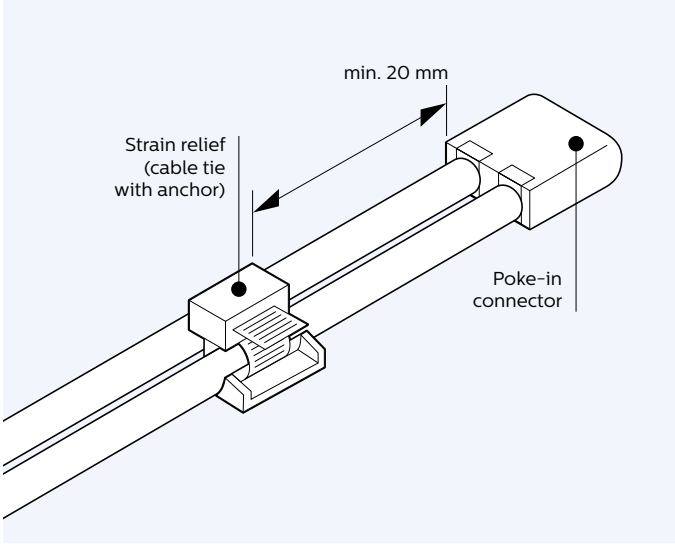


Inserting solid conductor via push-in termination.

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



Example of wire insertion and strip length.



Strain relief.

Warning

Do not service the system when the mains voltage is connected. This includes connecting or disconnecting the cables between the LED modules.

Inserting and removing the cables

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.

Wire insulation

The wires must be fully inserted such 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 LED module connector is achieved when the wire, with stripped insulation (by hand or machine) to the indicated length stated in the **datasheet**, ensures a solid connection. For the driver connector the required wire termination depth is stated in the **datasheet**. Check datasheets for information on www.philips.com/technology.

Strain relief

It is important to add a strain relief to the wiring of the connector from driver to mains 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 input or output connector!
- Do not touch, attach or detach LED modules in a live system.

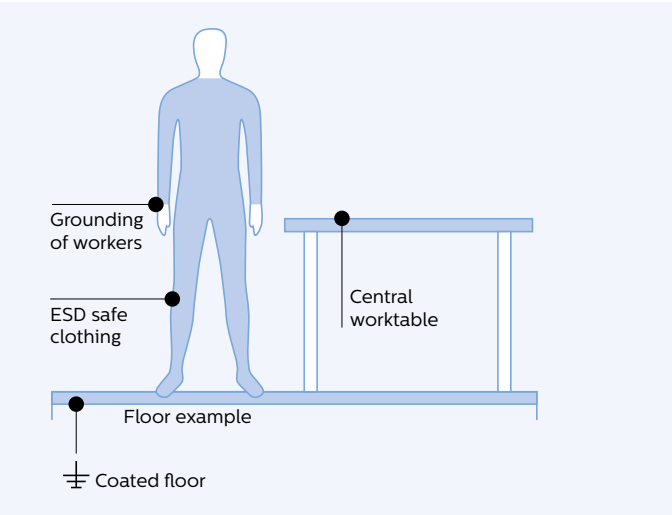
ElectroStatic Discharge (ESD)

Introduction to ESD

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 implementation of extensive and disciplined measures to avoid ESD damage in their finished end products. Now, with the introduction of LED electronic components for lighting a new breed of users, such as OEMs and installers, are exposed to handling and manufacturing with LED electronic components.

ESD requirement links to product specification

Philips designed their Philips LED Linear products rather robustly against ESD. Specifications of the LED Linear modules maximum contact discharge level and air discharge level, according to IEC 61000-4-2 (HBM 150 pF + 330 Ω), are stated in the associated datasheets of the LED module you use, on www.philips.com/technology.



Example of ESD measures, which could contain wrist bands, ESD-safe shoes and floor, ESD friendly materials and ESD-control plan general awareness.

ESD in your production environment

The purpose of an effective ESD-control strategy is the reduction of assembly line failures, final inspection failures and field failures. Depending on the immunity level of the LED module (product specification) a minimum set of measures has to be taken when handling LED modules. ESD measures are required in a production environment where handling can exceed the ESD immunity level (product specification). Furthermore ESD vulnerable products should be packed and shipped in ESD safe packaging. Note that air humidity has an important influence on electrostatic charge build-up.

How to... Meet the ESD requirement

Advice is to make use of ESD consultancy to determine how the ESD requirement can be met. One should think of an ESD control plan and ESD adequate equipment. Independent ESD consultancy companies can advise and supply adequate tools and protection guidance. For example Philips Innovation Services can provide that consultancy. More information can be found in the section entitled 'Contact details'.

Servicing and installing luminaires

It is highly recommended that Installers are informed that they should not touch the LED components and should use earthed arm-straps to avoid ESD damage during installation and maintenance.

Quality, compliance and approval for the LEDs

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 Ethly Ketone)	Solvent
MIBK (Methyl Isobutyl Ketone)	Solvent
Mineral spirits (turpentine)	Solvent
Tetracholorometane	Solvent
Toluene	Solvent
Xylene	Solvent
Castor oil	Oil
Lard	Oil
Linseed oil	Oil
Petroleum	Oil
Silicone oil	Oil
Halogenated hydrocarbons	
(containing F,Cl,Br elements)	Misc
Rosin flux	Solder flux
Acrylic tape	Adhesive
Cyanoacrylate	Adhesive

Energy efficiency labelling

The European Regulation 1194/2012, Directive 2009/125/EC, is one of the strategic priorities of the IEC association. The first step is the self-declaration of performance data for LED modules and LED luminaires through specific data put on internet to provide the market comparable information between them, which allow the raising of the level of quality of the products placed.

The Philips LED Linear product family is in accordance with European Regulation 1194/2012. The individual labeling of each product on which this statement is applicable can be found in the Performance Characteristics for Philips LED Linear ES systems in the download section on www.philips.com/technology.

Chemical compatibility

In the current market medium power LEDs exist, 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 **natural rubbers** used for **cables, cable entries** or **sealing**, or **corrugated fiberboard (also called cardboard)**. Also be careful using **adhesives, cleaning agents**, coatings and applications in **aggressive (corrosive) environments**.

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.

The Philips LED Linear family makes use of LEDs with above explained type of lead frame. Therefore above recommendations apply for the Philips LED Linear modules. Philips LED Linear ES systems comply with the standards shown in below paragraphs.

A list of chemicals, often found in electronics and construction materials for luminaires that should be avoided, is provided in the table on the left. 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.

Compliance and approval marks

The Philips LED Linear family is ENEC approved and comply with CE regulations. The relevant standards are summarized at the end of this chapter. 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).

Ingress Protection – IP rating, humidity and condensation

The Philips LED Linear ES 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 Philips LED Linear modules have been developed and released for use in damp locations and **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. Example measurement results for LED Linear products are given below. Based on these measurements, conclusion is no safety measures are required. This conclusion (verdict) is added to each datasheet.

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

Please refer to the datasheet of the module you use.

Blue Light Hazard

From the nature of most LEDs applying blue light, emphasis has been put on the hazard in terms of Photo Biological Safety (PBS). Evaluation by the European lighting industry (ELC, Celma) has concluded LED light sources are safe for customers when used as intended. Nevertheless luminaire makers have to comply with Luminaire standards including PBS. To avoid extensive retesting, the market prefers to build on the test conclusions of the LED (module) suppliers. The testing conclusion then will be expressed in Risk Groups (RG), where **RG0 and RG1 do not require** marking and/or specific action for the OEM (as compared to RG2 and 3). The Certificates with the verdict of the LED products can be found in the download section of www.philips.com/technology.

Some facts on blue light

- All light – visible, IR, UV – causes fading.
- It has long been known that blue light causes fading in yellow pigments.
- LEDs do not produce more blue light than other sources by its nature.
- Blue light content is relative to color temperature, not to light source.

"Often, investigations into the effect of short-wavelength radiation—be it on humans or artwork—suggest that LEDs are dangerous because they emit more blue light than other sources like incandescent bulbs or CFLs. While it is true that most LED products that emit white light include a blue LED pump, the proportion of blue light in the spectrum is not significantly higher for LEDs than it is for any other light source at the same correlated color temperature (CCT)."

For more details follow the link of the U.S. Department of Energy.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/opticalsafety_fact-sheet.pdf

System disposal

We recommend that the Philips LED Linear modules 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. We therefore recommend that these parts are disposed of as normal electronic waste, in accordance with local regulations.

Relevant Standards

CE and ENEC

The Philips LED Linear modules carry ENEC, recognized by the ENEC marking on each LED module. Next to that we publish relevant certificates, partly in the download section on www.philips.com/technology.

Safety

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

Philips indoor Linear LED driver

IEC/EN 61347-1	Lamp control gear.

Electromagnetic compatibility

(tested with LED Linear modules, cables and Philips indoor L inear LED 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.

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).

Quality and Reliability for the driver

Electrical failures due to switching Vmains on and off

Before the lighting is switched on in the electronic circuit all capacitors are uncharged. By a simple toggle of the mains voltage all capacitors will be charged, causing peak currents in the circuit. Inductors react to this by creating peak voltages. Occurrence of peak currents & voltages during starting is inevitable. The circuit design and component selection should be of sufficient quality that no components are overstressed during the starting conditions. If the quality is not sufficient, failures will occur at a certain rate over time. The failure rate will be influenced by usage conditions such as temperature and mains voltage. The failure rate will be further enhanced by irregular mains voltage events such as dips, surges or black outs. For a good quality design all conditions and components are carefully checked. In general LED systems and products are designed to withstand >100,000 switches under the specified use conditions.

Mechanical failures due to thermal cycling

A completely different failure mode which is also due to switching on and off the light is the failure of solder joints, due to thermal cycling. Stresses in solder joints are caused by the differences of the thermal expansion coefficients (CTE's) of printed circuit board, solder and component materials.

Due to heating up and cooling down mechanical stresses build up in the solder, which eventually result in cracking and finally failure of the joint. In most cases failure of one solder joint means the end of the product. The solder joint failure mechanism is also referred to as solder joint fatigue. This is a typical wear out failure mechanism with a negligible failure rate for many years, but for which after the typical lifetime has passed, failures come at an accelerated speed.

Maximum and minimum driver temperature will not be reached when the cycling frequency is faster than 60 minutes. Because the solder-joint damage relates to a higher power of the temperature difference between hot and cold condition, the negative effect on lifetime reduces for the higher cycling frequencies.

Standards the LED Linear ES master modules are tested against

The tables below state the standards the drivers are tested against. Consequently the drivers do carry CE and ENEC, as stated in the driver's datasheet.

Compliance and approval	Generated disturbances, EMI and EMC
EN 55015 A2/CISPR15	Conducted EMI 9 kHz-30 MHz
EN 55015 A2/CISPR15	Radiated EMI 30 MHz-300 MHz
IEC 61000-3-2 A1 + A2	Limits for harmonic current emissions
IEC 61000-3-3	EMC – Limitation of voltage fluctuation and flicker in low voltage supply systems for equipment rated up to 16 A

Immunity	Generated disturbances, EMI and EMC
IEC / EN 61547, A12000	Equipment for general lighting purposes – EMC immunity requirements
IEC / EN 61000-4-2	Electrostatic Discharge
IEC / EN 61000-4-3 A1	Radiated radio frequency, electromagnetic field immunity
IEC / EN 61000-4-4	Electrical fast transient/burst immunity
IEC / EN 61000-4-5	Surge immunity
IEC / EN 61000-4-6	Conducted disturbances induced by RF fields
IEC / EN 61000-4-11	Voltage dips, short interrupts, voltage variations

Performance	Generated disturbances, EMI and EMC
IEC 62384	DC or AC supplied electronic control gear for LED modules - Performance requirements
IEC 62386	Digital Addressable Lighting Interface (DALI)

Safety standards	Generated disturbances, EMI and EMC
IEC 61347-1	General and safety requirements
IEC 61347-2-13	LED Particular requirements for DC or AC supplied electronic control gears for LED modules

Emergency standards	Generated disturbances, EMI and EMC
IEC 61347-2-3	Particular additional safety requirement for AC/DC supplied electronic ballasts for emergency lighting
IEC 61347-2-7	Particular requirements for DC supplied electronic ballasts for emergency lighting

Contact details and suggested suppliers

Philips LED Linear systems

www.philips.com/technology
Or contact your local Philips sales representative.

Philips PInS ESD support

The Philips corporate EMC competence centre is a leading provider of approbation and consultancy services.

www.innovationservices.philips.com
Phone: +31 (0) 40 27 46214

The following are suggestions of products that can be used with the Philips LED Linear system. Reference to these products does not constitute their endorsement by Philips. Philips makes no warranties regarding these products and assumes no legal liability or responsibility for loss or damage resulting from the use of the information herein.

ESD-related material and tool suppliers

Amcatron Technology Co Ltd	www.amcatron.com
Botron Company Inc.	www.botron.com
Desco	www.desco.com
Static Solutions Inc.	www.staticsolutions.com

Disclaimer

Philips will perform the testing of the LED systems to high standards of workmanship. The tests are carried out with reference to the EN/IEC standards, if any, which are regarded by Philips as being of major importance for the application of the lamp gear and the lamp within the fixture for horticultural applications.

The design-in guide, regarding the testing and design in of the LED system provided by Philips, is not an official testing certificate, and cannot be regarded as a document for official release of the fixture. The OEM is liable for the official testing by a certified test body and all markings, such as CE and ENEC marks, on the fixture assembly.

The design-in guide is for information purposes only and may contain recommendations for detecting weak points in the design of the system (lamp – lamp gear – fixture), if any.

Specifically mentioned materials and/or tools from third parties are only indicative: other equivalent equipment may be used but it is recommended that you contact Philips for verification.

Philips will not be liable for unforeseen interactions of the proposed solutions when applied in the fixtures or applications using these fixtures. Philips has not investigated whether the recommendations are or will in the future be in conflict with existing patents or any other intellectual property right. Philips does not warrant that its recommendations are technically or commercially the best options.

Since the tests are only performed on one particular fixture provided by the customer, it will be treated as a prototype. This means that there is no statistical evidence regarding later production quality and performance of the lamp – lamp gear – fixture system.

As Philips does not have control over manufacturing of the fixtures, Philips cannot be held liable for the fixture assembly.

Philips will not accept claims for any damage caused by implementing the recommendations.

No warranty whatsoever may be claimed by the OEM with regard to the content and/or quality of the design-in guide or any other advice, or the conclusions and/or recommendations in the design-in guide or any other document, either express or implied, and Philips expressly disclaims any implied warranties of any kind, including without limitation any warranties of satisfactory quality, fitness for a particular purpose or non-infringement and any warranties regarding the design-in guide or any other advice or the use of the results of any activity performed while testing the fixture with respect to its correctness, quality, accuracy, completeness, reliability, performance or otherwise.

The OEM expressly agrees that test design-in guides are provided by Philips on an ‘as is’ basis and an ‘as available’ basis at customer’s sole risk and expense. Philips shall not be liable for any lost profits or lost savings, indirect, incidental, punitive, special, or consequential damages whether or not such damages are based on tort, warranty, contract, or any other legal theory – even if Philips has been advised, or is aware, of the possibility of such damages.

The OEM must bring any claim for damages within ninety (90) days of the day of the event giving rise to any such claim, and all lawsuits relative to any such claim.

12/2015