

PHILIPS

Xitanium

LED Outdoor drivers



Design-in Guide

Reliable Xtreme and Outdoor technology for demanding LED applications

Single Current and 1-10V dimmable

May 2019

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Quality & reliability

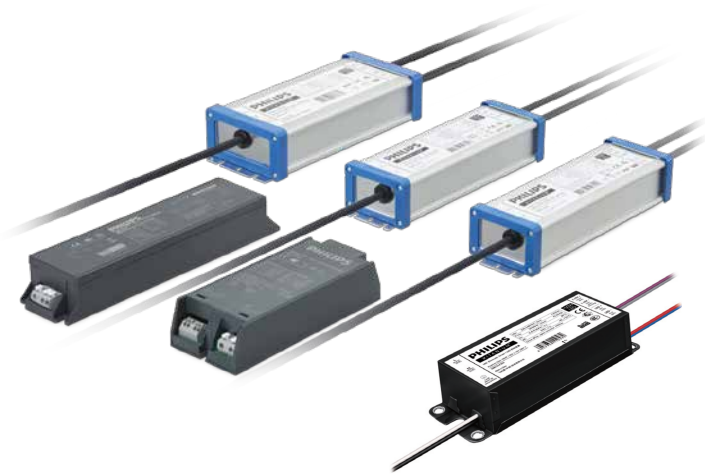
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Introduction to this guide



Examples of Xitanium LED Outdoor drivers

Thank you for choosing Philips Xitanium LED Outdoor drivers. In this guide you will find the information needed to integrate these drivers into a LED luminaire or a LED system.

This guide describes non-programmable 1-10V Dimmable and Single Current Xitanium Outdoor LED drivers (incl. Xtreme versions), optimized for outdoor and industrial applications. These drivers can be used for Built-in or Independent applications in humid and wet environments. We advise you to consult our website for the latest up-to-date information at www.philips.com/oem.

Applications

Xitanium LED Outdoor drivers are designed to operate LED solutions for outdoor and industrial lighting, like roads, streets, flood and highbay applications. If you use Philips LED drivers in combination with Philips LED modules, specific design-in guides are available at www.philips.com/oem.

Insulation classification

Depending on driver type, Xitanium outdoor drivers can be used in IEC Insulation Class I or Class I & II luminaires and lighting systems.

Information and support

Please consult your local Philips office or visit us at: www.philips.com/oem

Design-in support

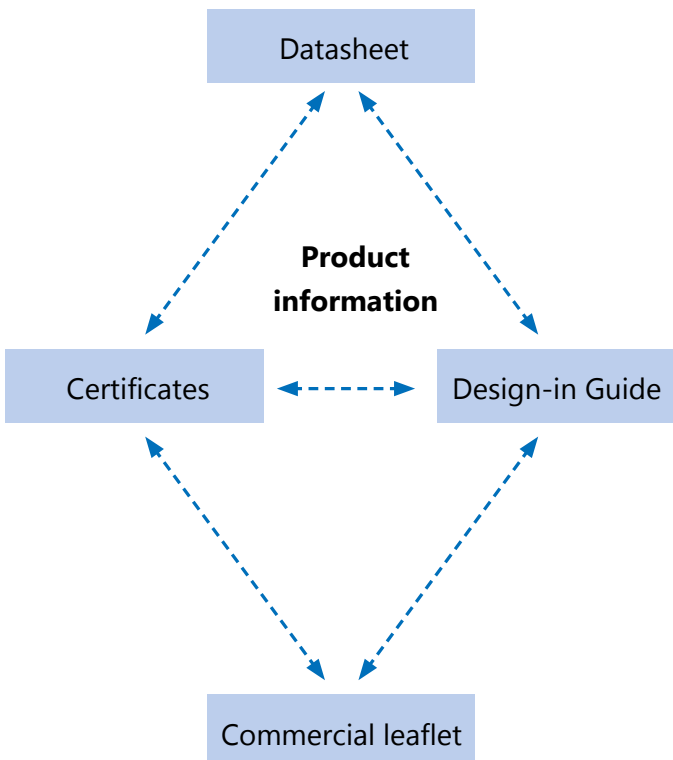
Dedicated design-in support from Philips is available on request. For this service please contact your Philips sales representative.

Document overview

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

- Commercial leaflet contains product family information & system combinations
- Datasheet contains the product-specific specifications
- Design-in guide describes how the product must be used
- Driver certificates list up-to-date compliance with relevant product standards

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



Warnings and instructions



Safety warnings:

- Avoid touching live parts!
- Do not use drivers with damaged housing, wiring and/or connectors!
- Driver housings/earth wires of drivers released only for Insulation Class I application must be connected to Protective Earth!
- Do not use Insulation Class-I only drivers in Insulation Class II systems/luminaires!
- Do not service the driver when the mains voltage is connected; this includes connecting or disconnecting the LED module!

Important installation instructions

- The luminaire manufacturer is responsible for its own luminaire design and has to comply with all relevant luminaire safety standards.
- The Xitanium LED Outdoor drivers for Built-in use must be protected against exposure to the elements such as snow, water and ice or to any other agent which can be expected to have an adverse effect on the driver (e.g. corrosive environments). It is the responsibility of both the luminaire manufacturer and installer to prevent exposure. Any suggestion from Philips with reference to minimum required luminaire IP rating serves only as non-binding guidance; a higher IP rating may be required under certain application conditions to protect the driver. Common sense needs to be used in order to define the proper luminaire IP rating for the intended application.
- The Xitanium LED Outdoor Independent drivers are suitable for exposure to the elements such as snow, water and ice. However, these drivers are not designed for permanent immersion and are also not designed for use in harsh chemically aggressive environments. Common sense needs to be used in order to define whether the IP rating of the Independent drivers matches the minimum IP rating required for the actual application.
- The suggested minimum IP rating of connectors used for Independent driver input/output/1-10V connections is IP65.
- Cap off all unused wires to prevent accidental contact with the luminaire or driver housing.
- For the drivers with IP-rated connectors, the installer shall check that the seal of the connector is present and not damaged before connecting the male/female connectors.
- If the IP-rated connector is cut off then the specified driver IP-rating cannot be guaranteed. Doing so is the responsibility of the luminaire manufacturer or installer.
- Drivers rated for Insulation Class I application: always connect the driver PE terminal/wire/housing to Protective Earth and to the luminaire chassis and LED module heatsink.
- Drivers rated for Insulation Class II application: always connect the driver EQUI terminal/wire/housing to Protective Earth and/or to the luminaire chassis and LED module heatsink.
- No components are allowed between the LED driver and the LED module other than connectors and wiring intended to connect the LED driver to the LED module. Do not connect or disconnect the LED module when the driver is powered up.

Xitanium LED Outdoor drivers



Single Current driver with cables for Independent use



1-10V dimmable Single Current driver with cables + IP-rated connectors for Independent use



1-10V dimmable Single Current driver with flying leads for Built-in use



1-10V dimmable Single Current driver with connectors for Built-in use

Xitanium LED Outdoor driver types

The Xitanium LED Outdoor drivers described in this design-in guide are of the following types:

- Xitanium 1-10V Dimmable Single Current for Independent use (with or without IP-rated cable connectors)
- Xitanium 1-10V Dimmable Single Current for Built-in use (with connectors or flying leads)
- Xitanium Single Current for Independent use (with or without IP-rated cable connectors, no control interface)
- Xitanium Single Current for Built-in use (with connectors or flying leads, no control interface)

These drivers are available in different power and output current ratings that enable the most popular light output levels for general outdoor and highbay applications and support Insulation Class II and/or Insulation Class I applications. We recommend to regularly check our Xitanium LED Outdoor driver leaflets for the most up-to-date overview of the driver range.

Detailed technical specifications can be found in the Xitanium driver datasheets at www.philips.com/oem.

Features

Controllability

Interfacing with Xitanium 1-10V dimmable LED Outdoor drivers can be done via the 1-10V dimming interface.

Amplitude Modulation (AM) output dimming

Philips Xitanium 1-10V Dimmable LED Outdoor drivers dim the output to the LEDs by means of continuous Amplitude Modulation (AM) dimming of the DC output current. No Pulse Width Modulation (PWM) is applied across any part of the entire output current range. AM dimming guarantees the most smooth and flicker-free operation over the entire dimming range.

DC operation

Select Xitanium Outdoor driver types are allowed to be connected to a DC power grid (e.g. in central emergency systems). More details about DC input voltage suitability can be found in the section DC Emergency operation and in the driver datasheet.

Naming of Xitanium LED drivers

Xitanium LED Outdoor drivers are part of a specific naming system. An example can be seen below.

Xitanium Dim 35W 0.7A 1-10V TWE I175 sXt

Protection suffix:

sXt = Xtreme technology; high robustness and lifetime
No suffix = basic robustness and long lifetime

Housing

S###, I###, I###C, Y, Q, F:

S=Stretched

I= Independent

IC = Independent + IP-rated Connectors ### = housing length in mm

Y, Q, F: legacy names for standard housing types

Regional version

None = not applicable

TWE = Taiwan

Dimming interface

S = SimpleSet

N = NTC interface

L = LineSwitch interface

1 = 1-10V interface (programmable)

1-10V = 1-10V interface (non-programmable)

D = DALI interface

A = AmpDim interface

E = DC Emergency (DCemDim, programmable)

M = Energy Metering

P = Auxiliary Power supply

AOC/AOCM = Manually Adjustable Output Current

Output current:

Rated output current or current range in A

Output power:

Rated output power in W

LED driver family:

None = Single Current, no controllability

Dim = 1-10V dimmable, non-programmable

FP = FULL Prog

LP = LITE Prog

BP = BASIC Prog

SR = Sensor Ready

Type of LED driver:

Xitanium

Xi = Xitanium

Mechanical Design-In

Introduction

This chapter describes the aspect of the mechanical design-in of Xitanium LED Outdoor drivers.

Dimensions

Xitanium LED Outdoor drivers are available in several different housing dimensions for both Independent and Built-in applications. The specific application area and dimensions can be found in the driver datasheet. 3D CAD files are available to verify fit and can be found at www.philips.com/oem.

IP rating

Guidelines below must be followed to ensure the right IP rated driver being selected according to OEM gearbox type. Please refer to the datasheet for the specified driver IP rating.

OEM gearbox	Protection against water ingress	Driver IP: 67	Driver IP: 66	Driver: IP65	Built-in
		IP6X: dust-tight	IP6X: dust-tight	IP6X: dust-tight	n.a.
		IPX7: 0.15-1m protected against the effects of immersion	IPX6: protected against power water jet	IPX5: protected against water jets	n.a.
No gearbox	Water immersion > 30 minutes	✗	✗	✗	✗
	Water immersion < 30 minutes	✓	✗	✗	✗
	Water jets	✓	✓ *	✗	✗
	Water splashing	✓	✓ *	✓ *	✗
Open gearbox (with holes)	Water immersion > 30 minutes	✗	✗	✗	✗
	Water immersion < 30 minutes	✓	✗	✗	✗
	Water jets	✓	✓	✓	✗
	Water splashing	✓	✓	✓	✗
Sealed gearbox (IP65+)	n.a.	✓	✓	✓	✓

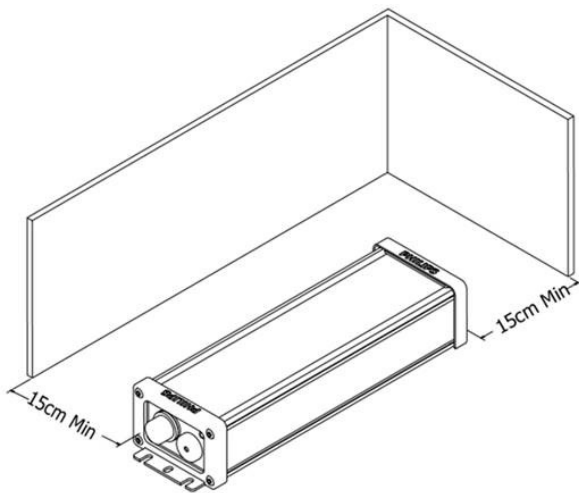
* For the applications without gearbox protection, the **IP66/65** rated driver has to be mounted in such a manner that it is not directly exposed to external environmental elements such as rain, hailstones, snow, sandstorms, etc.

Driver IP mapping for typical applications:

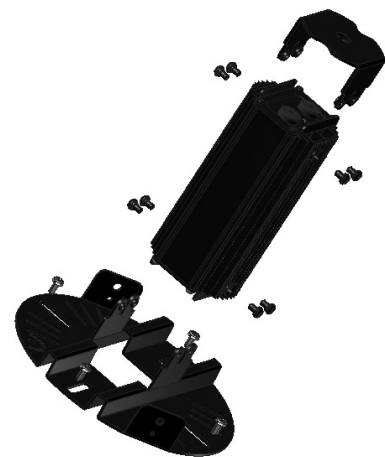
Application	Gearbox	Applicable driver IP rating
Road/Tunnel/Flood	No gearbox	IP67/IP66
Road/Tunnel/Flood	Open gearbox	IP67/IP66
Road/Tunnel/Flood	Sealed gearbox (IP65+)	IP67/IP66/IP65/Built-in



Minimum cable bending diameter



Driver thermal dissipation in a 3-walled enclosure



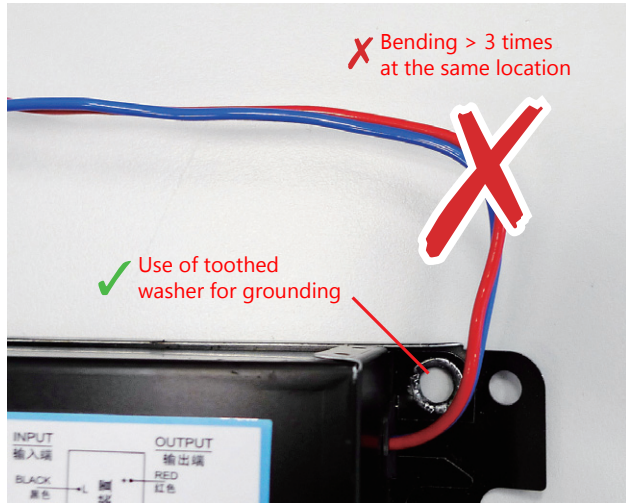
Driver highbay mounting

Installation of drivers

To secure the long-term reliability of the driver and application, below instructions have to be followed.

Independent drivers

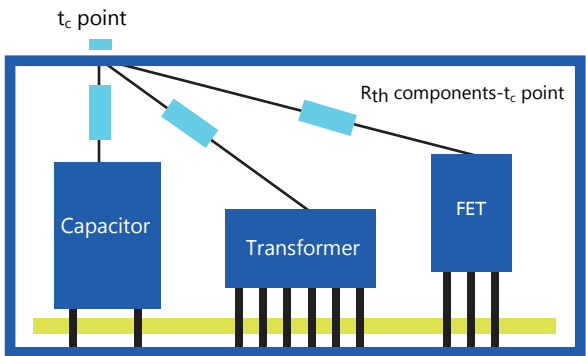
- Prevent too much mechanical stress on the cables or bending the cables at a too small angle to avoid water ingress. The recommended minimum bending diameter is 2.5cm. See the picture on the left.
- In case the driver is mounted in a three-wall enclosure, there must be at least 15cm distance between the driver housing and enclosure walls for sufficient thermal dissipation. See the illustration on the left.
- The water-proof connector has to be fully tightened to prevent moisture ingress.
- Moisture may be absorbed through cable ends. The ends must therefore be sealed inside an IP65+ chamber.
- Intense exposure to sunlight (UV) may make the seals brittle over time, causing ingress of moisture. It is recommended to cover the electrical connections to avoid this risk; also to avoid cables being damaged by wildlife.
- Xitanium Independent driver cannot be used in a marine environment without additional protection against salt.
- It is highly recommended to mount the driver by using all available mounting feet in order to achieve maximum mechanical robustness against shocks and vibration. The recommended mounting torque is 1.5Nm. These values should not be exceeded for drivers in plastic housing in order to prevent deformation of the mounting feet. The use of rivets is not recommended since mounting torque cannot be controlled; damage to the mounting feet or loose mounting may result.
- Mounting screw dimensions should be based on the specified fixing hole diameter in the driver datasheet. Oversized and undersized screws should not be used in order to prevent damage to the mounting feet or loose mounting.
- In order to maintain full mechanical integrity of the metal mounting feet in the long term, it is highly advised not to use stainless steel screws or screws plated with either copper, nickel or chrome for driver mounting. Otherwise, electrochemical corrosion of the driver mounting feet and mounting screws may compromise secure fastening.
- For highbay driver installation, use of screw type GB818-76 M5x8 is recommended for driver mounting with the top cover and bottom plate. Recommended screw torque is 1.5Nm.



Built-in drivers

- This driver type must be installed within a sealed enclosure with IP65+ rating.
- The wires should not be bent more than 3 times at the same position to prevent the wire core from breaking.
- In case extra weight is added to wires (e.g. addition of an axial ferrite bead) these wires must be fastened locally to prevent excess slack which adds stress due to shocks and vibration.
- Electrical grounding of the driver housing can be achieved via the screw hole. A toothed metal washer is suggested for reliable electrical connectivity.
- **Note:** the driver is certified to be used with controls co-located within the luminaire

Thermal Design-In



Schematic representation of internal thermal paths between driver components and driver t_c point

U _{in} : 220-240VAC	I _{out} : 1.05Adc	 	LED + BROWN (棕色)
Freq: 50/60Hz	U _{out} : 62-142Vdc		LED - BLUE (蓝色)
I _{in} : 0.6-0.83Aac	t _c : 80°C		----
PF: 0.98	t _a : -40...+55°C		I-10V + BROWN (棕色)
U _{out} (Max. open circuit)= 220Vdc			I-10V - BLUE (蓝色) Dimming

6 947939 1110407

t_c point position on the driver housing

Introduction

In order to facilitate correct design-in of LED drivers, the critical thermal management points of the LED 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 are of utmost importance. If these thermal points are taken into account this will ensure the optimum performance and lifetime of the system.

Driver case temperature point (t_c point)

In order to achieve optimal lifetime and reliability it is critical that the temperatures of the components in the driver remains within their ratings. The driver case point temperature (t_c) is a reference for the temperatures of the critical internal driver components. The location of the t_c point is identified on the driver type plate and is marked by a * or ° symbol. See the illustration on the left.

How to measure t_c point temperature

The t_c point temperature can be measured using a thermocouple that is firmly glued to the surface of the driver housing. For a representative measurement the temperature of the t_c point must be stable before any reliable data can be obtained (typically > 3 hours or when the temperature difference is less than 1°C within one hour).

Relation between t_c and ambient temperature

The t_c temperature increases, by approximation, linearly with the driver ambient temperature (t_a). The temperature offset between driver t_c and t_a depends on the thermal design of the luminaire and the actual delivered output power relative to the specified rated output power. A lower output power allows for a higher driver ambient temperature as long as the maximum specified driver $t_{c(max)}$ temperature is not exceeded.

There are two driver t_c values specified with corresponding lifetimes: $t_{c(life)}$ and $t_{c(max)}$. The rated driver lifetime can be achieved if the t_c value remains between $t_{a(min)}$ and $t_{c(life)}$. The driver is allowed to run hotter running up to $t_{c(max)}$. For the approved driver ambient temperature range and specified $t_{c(life)}$ and $t_{c(max)}$ values and corresponding driver lifetimes please refer to the driver datasheet.



Warning: The specified $t_{c(max)}$ and minimum t_a temperature limit values are not allowed to be exceeded in the application; otherwise driver warranty will be void.



Warning: In general, lowering the *overall* driver temperature will increase the driver lifetime since the temperature of critical components inside the driver will be lower. However, applying only local heatsinking of the driver -e.g. to lower the t_c point temperature or any other surface hotspot- will not lower the temperature of critical components. Do not apply local heatsinking to improve the intended thermal driver performance and/or to artificially lower the temperature of the t_c point.

ThermalGuard

In a thermally well-designed lighting system the specified $t_c(\text{max})$ value will not be exceeded. However, under extreme hot application conditions the driver may occasionally overheat. In that case the driver will automatically start to reduce the output current as an emergency measure to reduce overheating. The result of the output current reduction will be a mitigation of the excess decrease of driver lifetime as a result of thermal overstress. Once the t_c point temperature starts dropping the driver will automatically increase the output current up to the rated output current.

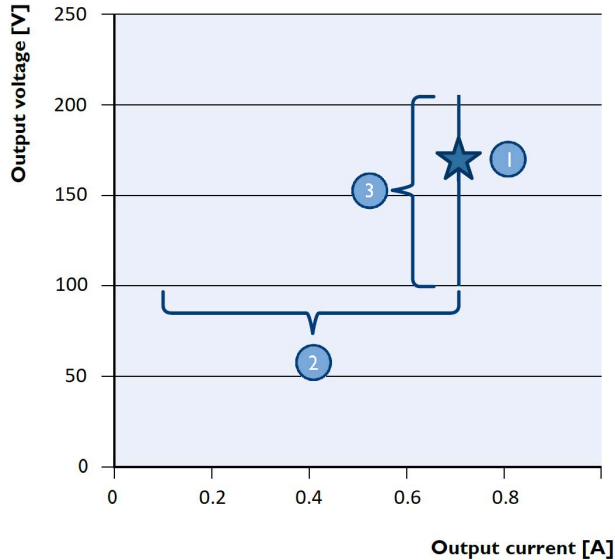
If the output current reduction is not sufficient to counteract the t_c point temperature increase then the output current will stabilize at a lower value .

This thermal driver protection feature is called ThermalGuard and its goal is to get the driver back in normal operating thermal conditions in which the specified driver lifetime can be met. Each driver type has its own specific factory default overheating behavior and it can be found as a ThermalGuard graph in the driver datasheet.



Warning: the ThermalGuard feature is designed as an emergency measure to protect the driver. It is **not** intended for structural activation to compensate for a poor thermal design of a lighting system.

Electrical Design-In



Example Operating window of a Xitanium Outdoor driver

1. Required set point for the LED solution
2. Current can be set within this range via a controller on 1-10V interface
3. Driver adapts to connected LED module forward voltage V_f , given it fits range

Xitanium driver operating window

LEDs can be driven at different output current levels based on the application requirement. Xitanium LED Outdoor drivers offer several common discrete output currents and power levels (e.g. 700/1050mA, 35/75/150/250W) to meet most common application requirements.

Xitanium LED Outdoor drivers can operate in a certain "operating window". This window is defined by the maximum and minimum voltage and current that the driver can deliver. Dimmable drivers offer the option to set the output current to a lower value by means of connecting a controller to the 1-10V interface. An example of an operating window is shown on the left. The ranges 2 and 3 indicate the possible current/voltage combinations covered by this example of a Xitanium 1-10V driver. The required current will depend on the type and manufacturer of the LEDs or the specific LED configuration of the PCB design. The voltage is the sum of the LEDs used (total string V_f). The operating window of the driver can be found in the driver datasheet.

See also section Control Features (p.19) on how set the driver at a lower permanent output current via the 1-10V interface



Warning: the forward voltage V_f of the connected LED module **must** remain within the specified driver operating window voltage boundaries under all application conditions. Otherwise, reliable operation cannot be guaranteed.

How to select the appropriate driver

Depending on application requirements, several drivers may fit a specific application. The following steps will help in selecting the appropriate driver(s). For a complete overview of the available drivers, please refer to www.philips.com/oem.

First step: check the Easy Design-In Tool to find released Philips – LED module combinations at www.easydesignintool.com

Step two: in case a non-Philips LED module is used:

1. Determine required driver current (I_{drive}) and voltage (V_f)
2. Calculate required power (P_{drive}) where $P_{drive} = V_f \times I_{drive}$ (W)
3. Select the datasheets from the website mentioned above based on the driver having a higher power than required.
4. Does the required LED current fit the driver output current?
The output current of the driver can be seen in the name itself. For example, driver Xitanium 150W 0.7A 230V I220 provides an output current of 0.7A.
5. Does the required LED voltage fit the voltage range of the driver? The exact values can be found in the driver datasheet.
6. Does the required power fit the power range of the driver?
In the naming of the driver, you can see the maximum possible output power. For example, for driver Xitanium 150W 0.7A 230 V I220, the maximum output power is 150W.

Connectors

Select Xitanium Outdoor drivers for Built-in use are equipped with push-in connectors. All push-in connectors accept stranded, solid core and crimped wires. More information about driver connectivity (wiring diagram, wire diameters, strip length, cable length) can be found in the driver datasheet.



Note: although the driver output connectors allow for quite small wire cross section areas (down to 0.2mm²) it is recommended for optimal connectivity to use LED output wires having at least 0.5mm² cross section area.

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

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

Mains operating conditions

Xitanium LED Outdoor drivers are designed for operation and performance by power sources or grids providing a clean and symmetric sinusoidal voltage wave form and do not support operation on power sources including but not limited to having e.g. a square-wave voltage or a "modified sine wave" form.

Xitanium LED Outdoor drivers are able to withstand high and low mains voltages for a limited period of time.

This includes under- and overvoltage due to malfunction such as a loose neutral wire in a 3-phase grid.

Voltage ranges for performance and operational safety

Xitanium LED Outdoor drivers are designed to be operated at mains under- and overvoltage per IEC requirements for performance and operational safety with respect to specified rated input voltage range.

The applicable lower limit for driver performance is lowest rated voltage - 8 % while -10 % applies to driver operational safety.

The applicable upper limit for driver performance is highest rated voltage +6 % while +10 % applies to driver operational safety.

The actual limit values may differ and can be found in the driver datasheet.

For optimal luminaire performance it is always recommended to operate drivers within the specified voltage performance range.

Excessive low mains voltage (MainsGuard)

In case of excessive low mains voltage an internal driver protection feature will protect the driver against electrical and thermal overstress conditions in the installation. Below a certain mains voltage the driver may start dimming the output to reduce the mains current or it may shut down. The specific driver behavior can be found in the driver datasheet.

Excessive high mains voltage

An excessive high mains voltage will stress the driver and have an adverse effect on the lifetime. Xitanium LED Outdoor drivers will survive an input overvoltage of 264 ... 320VAC for a period of max. 48 hours and 320 ... 350VAC for a period of max. 2 hours.

A loose neutral condition has to be avoided as this may reduce the lifetime dramatically. Immediate driver failure may occur if the driver is connected to 400VAC as a result of a connection error in a 3-phase 230/400VAC grid.

Power grids

Xitanium Outdoor LED drivers are suitable for direct connection to TN, TT and IT grids. An external luminaire-based fuse in the driver neutral connection is required in case both feeding phases are "hot".



Warning: certain restrictions apply for use in IT grids. Direct connection of Xitanium LED Outdoor drivers is only permitted in delta connection with a phase-to-phase voltage of 230 V. In case the drivers are connected in star connection in a 230/400 V IT grid, the use of a separate 1:1 insulation transformer with sufficient power rating is required to power the drivers. The secondary output of the transformer needs to be connected to earth.

Power Factor

Xitanium LED Outdoor drivers have a high power factor (PF) which is inherently capacitive. Its capacitive nature cannot be compensated for. The output power dependent PF graph can be found in the driver datasheet.

DC Emergency operation

Depending on driver type, the driver is released in compliance with lamp control gear standard IEC 61347-2-3 Part J. As a result, the driver is suitable for emergency luminaires in compliance with IEC 60598-2-22, *excluding high-risk task areas*.

These drivers support operation both a flat DC input voltage as well as operation on rectified sinewave "joker" input voltage. The allowed DC input voltage range supported by the driver is specified in the driver datasheet. Values outside that range will have an adverse effect on the driver performance and reliability.

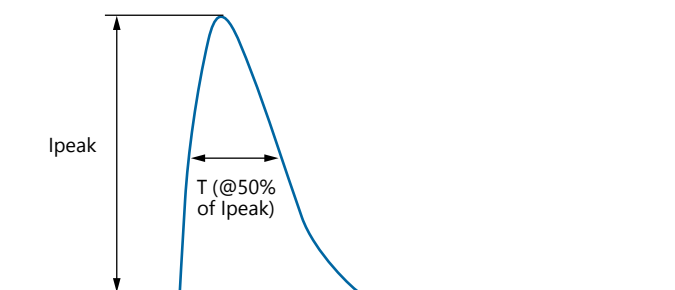
As soon as the driver detects a DC input voltage, the output current will drop to 60% compared to AC input voltage operation. The 1-10V dimming interface will remain active.

The mains input of DC-rated drivers is not polarity-sensitive for DC input voltage and the driver is fully CISPR15 EMC-compliant when operated on a DC grid.

The use of an external, luminaire-based DC rated fuse is not required for drivers supporting DC input voltage; these drivers have an internal fuse rated for DC application.

Hot wiring

It is **not** recommended to connect or disconnect LED modules from the Xitanium LED Outdoor drivers when the mains voltage is connected. Please turn off power beforehand and wait for at least 60s when doing so to prevent damage to the LED module.



Graphical representation of inrush current

Inrush current

The term '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. Typically, the amplitude is much greater than the steady-state input current. The aggregate inrush current of a given combined number of drivers may cause a Miniature Circuit Breaker (MCB) to trip or a fuse to melt. 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) if in accordance with electrical national standards.
 2. Distribute the group of drivers over multiple MCB groups or phases
 3. Power up drivers sequentially instead of simultaneously
 4. Install external inrush-current limiting devices
 5. Install a zero crossing relay to power up the drivers
- Inrush parameters are driver-specific and can be found in the driver datasheet.

How to determine the number of drivers on a MCB

The maximum recommended amount of drivers connected to a Miniature Circuit Breaker (MCB) can be calculated with the help of the conversion table shown on the left. In this table the stated amount for a 16A B type MCB is used as reference (100%). The maximum recommended amount of drivers for different types of MCB can be calculated by this formula:

Max. amount of drivers = reference x relative number in %

Example:

If the datasheet states a max. amount of 20 drivers on a 16A B type MCB then for a 13A C type the max. amount is $20 \times 135\% = 27$ drivers.

How to determine the number of drivers on a melting fuse

The maximum recommended amount of drivers on a melting fuse is defined by the aggregate inrush current. The amount of drivers can be calculated, using the specified values in the datasheet of the maximum input current and inrush current (I_{peak} and T_{width}) as well as the pre-arcing melting integral I^2t value of the applied fuse as specified by the fuse manufacturer.

The integral value I^2t of the aggregate inrush current must be 50% below the specified pre-arcing melting integral value I^2t of the fuse in order to prevent melting of the fuse when the drivers are powered up simultaneously. And the aggregate steady-state input current must remain below the generic 80% of the fuse rating to prevent overheating of the fuse.

MCB type	Rating (A)	Relative number of LED drivers (%)
B	4	25
B	6	40
B	10	63
B	13	81
B	16	100 (reference)
B	20	125
B	25	156
B	32	200
B	40	250
C	4	42
C	6	63
C	10	104
C	13	135
C	16	170
C	20	208
C	25	260
C	32	340
C	40	415
L, I	16	108
L, I	10	65
G, U, II	16	212
G, U, II	10	127
K, III	16	254
K, III	10	154

Note: The max. recommended amount of drivers in the table above only serves as guidance. The actual maximum amount in the application may differ; it is dependent on MCB brand/type and inherent MCB tolerances.

The following formula can be applied to calculate the I^2t value of the driver inrush current:

$$I^2t = (I_{\text{peak}})^2 \times (0.8 \times T_{\text{width}})$$

Example:

A group of drivers is connected to a 16A gG melting fuse with a pre-arcing melting integral value of 350A²s. Specified driver inrush current peak and width is 53A and 300μs. Steady-state input current is 0.9A per driver.

Question: what is the recommended maximum amount of drivers in this group connected to this fuse from inrush current and steady-state input current perspective?

Answer: the corresponding I^2t value of the inrush current is $(53)^2 \times (0.8 \times 300 \times 10^{-6}) = 0.68A^2s$ per driver. The aggregate value of the driver inrush current must remain below $0.5 \times 350A^2s = 175A^2s$. This translates in a maximum of $\sqrt{(175A^2s/0.68A^2s)} = 16$ drivers.

The corresponding steady-state input current is $16 \times 0.9 = 14.4A$. This is above the 80% rating of the 16A fuse. Therefore, the maximum recommended amount of drivers is $(16A \times 0.8) / 0.9 = 14$ drivers.

In this example, the maximum recommended number of drivers is defined by the steady-state input current.



Notes:

- Specified inrush current data is based on a average mains grid with an impedance of 400 mΩ + 800μH. Deviating mains impedance is of minor importance regarding the maximum amount of drivers per MCB.
- Specified maximum number of drivers is based on simultaneous switch-on, e.g. by a central switch or relay.
- For multiple MCBs in one cabinet the de-rating of the MCB manufacturer for steady-state load needs to be followed. If the actual de-rating is unknown then it is recommended to use a steady-state current de-rating of 0.8 by default. No de-rating is needed in respect to inrush current as this is not part of the thermal properties of the cabinet.
- The maximum number of drivers that can be connected to one 30mA Residential Current Device (RCD) is typically 30. However, the actual maximum amount depends on RCD brand and type so the actual number may vary and will have to be defined on-site.

Surge immunity

Xitanium LED Outdoor drivers have elevated differential-mode and common-mode surge immunity levels which surpass the limits as defined by IEC. By design, the high immunity levels do not only safeguard reliable driver operation in the field but also provide high immunity for the connected LED modules, thus enabling high surge immunity on system level. The driver immunity levels can be found in the driver datasheet.

In order to achieve these high immunity levels the driver EQUI or PE terminal/wire as well as driver housing must be connected to the metal parts of the luminaire and LED module heatsink in all cases (Insulation Class I: also to earth). Doing so will guarantee the specified surge immunity levels and will protect the driver and LED module against surge damage.

Depending on the local conditions, additional protection against excessive high surge voltages may be required by adding an external Surge Protection Device in the luminaire and/or at installation level (column/distribution cabinet). Please go to www.philips.com/oem to find more information about surge protection.

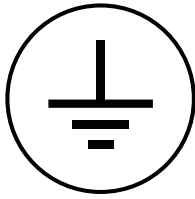
Touch current

Xitanium LED Outdoor drivers rated for Class I & II applications are designed to meet touch current requirements for insulation class II applications per lighting control gear standard IEC 61347-1 in order to enable an easy design-in in Insulation Class II luminaires per IEC60598-1. The specified peak values can be found in the driver datasheet and refer to single-driver only level. Please refer to the datasheet to verify Insulation Class II compatibility.



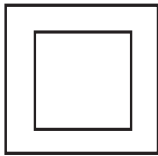
Warning:

- Drivers released for Insulation Class I-only application do **not** support application in an Insulation Class II luminaire/system!
- In a Class II luminaire/system, the cumulative touch current may be higher, since the LED module may introduce additional touch current. Precautions may be required on the luminaire level if multiple drivers are used in a single luminaire. Do not leave the driver EQUI terminal/wire or driver housing disconnected to lower the luminaire touch current; impaired EMC performance and reduced surge immunity will result.



Symbol for Protective Earth (PE):

This symbol indicates that the driver metal housing and PE wire **must** be connected to Protective Earth. Applies to drivers supporting Class I-only applications. Refer to driver datasheet for details.

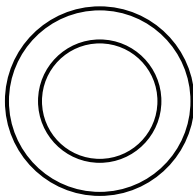


Double insulation symbol for drivers for Independent use.

This symbol indicates that the driver metal housing and EQUI wire may be connected to ungrounded accessible parts. This symbol applies to drivers supporting Class II-only applications. Refer to driver datasheet for details.

Double insulation is present between:

- mains input and LED output
- mains input and metal driver housing
- mains input and EQUI wire



Double insulation symbol for drivers for Built-in use.

This symbol indicates that the driver housing and EQUI connector/wire may be connected to ungrounded accessible parts. This symbol applies to drivers supporting both Class I & II applications. Refer to driver datasheet for details.

Double insulation is present between:

- mains input and LED output
- mains input and driver housing
- mains input and EQUI connector

Electromagnetic compatibility (EMC)

Electromagnetic compatibility (EMC) is the ability of a device or system to operate satisfactorily in its electromagnetic environment without causing unacceptable interference with other systems or being too susceptible for external emissions from other systems. Xitanium LED Outdoor drivers meet EMC requirements per CISPR15 for conducted and radiated emissions. This test is conducted with a reference setup that includes a driver and an LED module + heat sink combination mounted on a metal plate and is verified in Insulation Class I and II configurations.

Remote mounting and EMC

Remote mounting of Xitanium LED Outdoor Independent drivers is allowed as long as the additional summarized voltage drop as function of output current along the LED + and LED – wires is accounted for. Remote mounting of drivers for Built-in use is not recommended.

Philips has successfully performed CISPR15 EMC compliance tests on systems with a standard LED output cable length of 60cm as reference. For longer CISPR15-compliant cable lengths please check the driver datasheet for the maximum specified length.

If a longer distance beyond the maximum specified distance is required then the EMC performance needs to be verified separately. The use of shielded LED output wires is not recommended.



Warning: the driver EQUI connector/wire must be connected to accessible Class II luminaire parts for optimal EMC performance and surge immunity.

Doing so for Class II luminaires with drivers supporting Class II application is in safety compliance with IEC61347-1, IEC60598-1 and IEC61140 regarding the relation between the driver EQUI terminal and live parts with respect to:

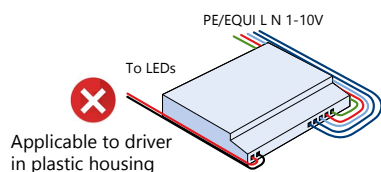
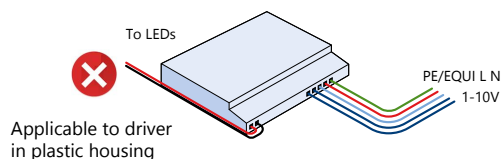
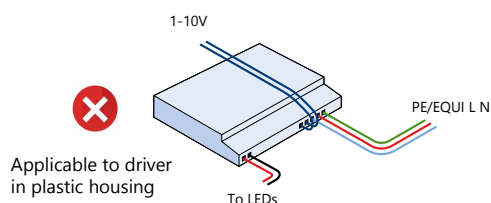
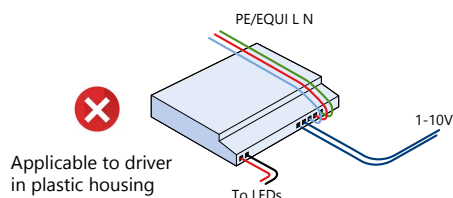
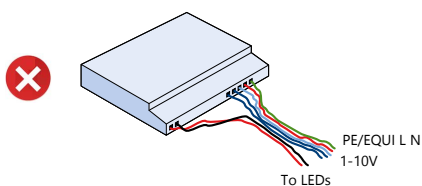
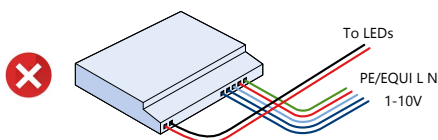
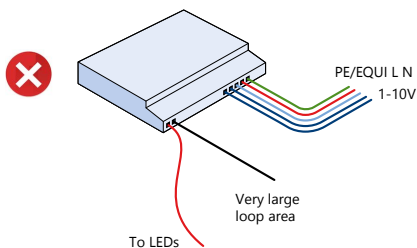
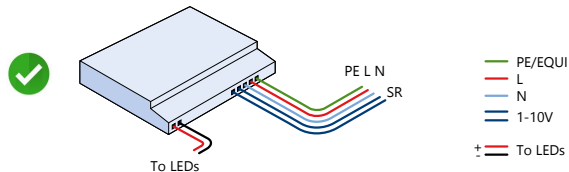
- Maximum allowable touch current
- Minimum required insulation resistance
- Minimum required creepage distances & clearances
- Minimum required dielectric strength

Electrical insulation

Driver insulation classifications between the several inputs, housing and output can be found in the driver datasheet and certificate. See the illustrations on the left for additional clarification.



Note: the purpose of the driver EQUI terminal/wire is purely for functional performance reasons by establishing equipotential bonding; the EQUI terminal/wire does **not** have a safety function.



EMC performance precautions

The following practical precautions need to be taken into account in a lighting system for optimal EMC performance:

- Minimize the loop area of the LED output wires going from the driver to the LED module by keeping the output wires close together (bundling).
- Minimize the parasitic capacitive coupling of the LED output wiring towards earth by keeping the wiring length as short as possible.
- Keep the length of the incoming mains wire inside the luminaire as short as possible.
- Keep mains and 1-10V control wires separated from the LED output wires. Do not bundle or cross the wires.
- Do not route any wiring over and/or along the built-in driver in a **plastic** housing to avoid any noise coupling/crosstalk with internal driver circuitry.



Insulation Class I application: ground the luminaire chassis and other large internal metal luminaire parts (driver mounting plate, reflector, canopy, heat sink etc. to protective earth (PE or driver housing. Always connect the driver EQUI or Protective Earth wire/connector/housing to protective earth.

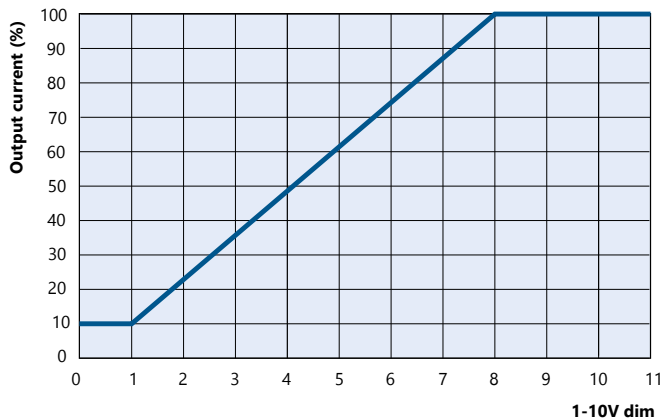


Insulation Class II application: use equipotential bonding wires between all large metal luminaire parts (driver mounting plate, canopy, heat sink etc.) Do not keep large metal parts electrically insulated. Always connect the driver equipotential connector/wire (EQUI) or driver housing for equipotential bonding.

Keep the equipotential wires as short as possible to maximize their effectiveness and use, as much as possible, large metal areas (chassis, mounting plates, brackets) for earthing purposes instead. Establish a reliable electrical connection by using a toothed washer and screw(s) fastened with adequate mounting torque.

Adhering to these rules will help to achieve EMC compliance. For further questions and/or **design-in support** please contact your local Philips representative.

Control features



Control Input 1-10V

1-10V dimming provides a traditional way to control the driver output current down to 10% by means of an analog current-controlled voltage source (see graph on the left). The interface is designed to comply with IEC60929 Annex E. The driver dimming interface sources a current of 150µA. The applied 1-10V controller must therefore be able to sink the cumulative current sourced by the dimming interfaces of a group of connected drivers.

In applications with long 1-10V cables there will be a voltage drop which depends on the cable length, number of connected drivers and the wire cross section in mm². The maximum recommended voltage drop on the 1-10V dimming wires is 100mV to prevent differences in light level.

The 1-10V control interface can be used not only for dimming but also to set the output current permanently at a lower value. This can be achieved by connecting a fixed resistor to the 1-10V interface. The relation between the resistance value and corresponding dimming voltage is as follows:

Required resistance value in kiloOhm = desired dimming voltage (in Volt) / 0.15.

Example:

The desired dimming voltage in the application needs to be lowered to 5V in order to permanently reduce the rated driver output current to 60%.

Q: Which resistance value is required to achieve this?

A: The required dimming resistor value is $5 / 0.15 = 33.3$ kilo-Ohm

This value can be realized by putting two standard-value resistors in series, one having a value of 33kilo-Ohm and another having a value of 330 Ohm.

A single resistor can also be used to dim multiple drivers simultaneously. Dimming can be realized by connecting the 1-10V interfaces of multiple drivers in parallel and connect them to a single resistor. Rule of thumb is that the calculated resistance value needs to be divided by the number of dimmed drivers. So in the example above, a resistance value of $33.3 / 3 = 11.1$ kilo-Ohm is required to dim three drivers simultaneously.

The applied resistor type needs to have a power rating of at least 0.125W. It must be well-protected against the external environment in case of Independent driver applications and must be protected against accidental contact to prevent electrical shock.

Quality & reliability

Switching & cycling lifetime of LED drivers

Impact of on and off switching on lifetime of electronic drivers in LED systems

This section describes the impact of mains voltage switching on the lifetime of electronic drivers in lighting systems. Because switching on and off the lighting has an impact on different failure modes, a distinction has to be made between switching on and off and thermal heating up and cooling down (thermal cycling).

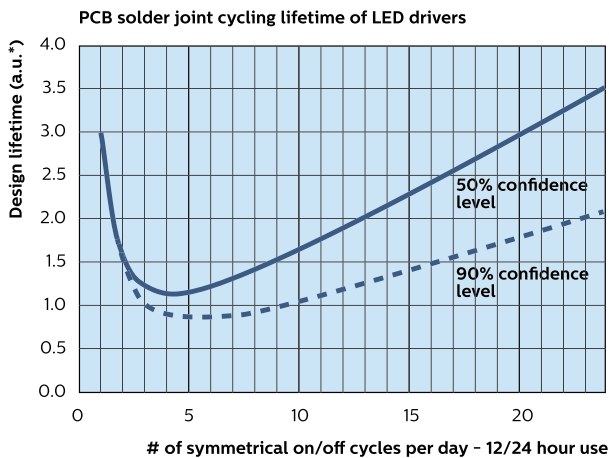
Electrical failures related to powering on and off

Prior to powering up a driver all capacitors in the driver are uncharged. By a simple toggle of the mains switch all capacitors will be charged instantaneously, causing peak currents in several driver circuits. Inductors in the driver react to this by creating peak voltages. The occurrence of peak currents and voltages during starting is inevitable. The circuit design and component selection should be of sufficient quality so that no components are overstressed during the starting conditions. If the quality is not sufficient, failures will occur over time at a certain rate. The failure rate will be influenced by usage conditions such as temperature and mains voltage. The failure rate will be further increased by irregular mains voltage events such as dips, surges or black outs. For a good quality driver design all conditions and components are carefully checked and selected by Philips. In general, Philips LED components and products are designed to withstand >100,000 switches under the specified temperature and voltage application 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 as a result of thermal cycling. Stresses in solder joints are caused by the differences of the thermal expansion coefficients (CTEs) of printed circuit board, solder and component materials. Due to heating up and cooling down, mechanical stresses are built up in the solder which eventually result in cracking and failure of the solder 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 wearout failure mechanism with a negligible failure rate for many years. Once the typical lifetime has passed, this failure occurs at an accelerated rate.

Philips Xitanium LED driver are typically designed to last for 50,000 operational hours. The reference for this lifetime is a typical user profile of 10-12hr daily usage and up to 3x switching on and off daily. Worst-case, this could imply 25,000 switches at a regular rate of 2hrs on and 2hrs off. For a 100,000hr specified product, the driver has to survive twice the number of switches. For the electrical stresses during switching there is no problem switching many more times, even up to >100,000 times. However for the solder joints there can be a risk for the lifetime of the product.



*) arbitrary unit value 1.0 means product design - lifetime will be reached (typical 50,000 h). Longer lifetimes can be limited by other failure modes.

Impact of thermal cycles per day on the driver lifetime

As the driver is typically designed to withstand 3 full thermal cycles every day, its lifetime will be reduced with increased cycling frequency. However this reduction will be limited by the heating time of the product in the application. As the heating time of a driver in real applications varies typically between 60 and 120 minutes, 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. This is expressed in the graph on the left.

Because of the large variation and differentiation between drivers and applications, it is an impossible task to specify this graph for every driver and application specifically. Therefore, only the critical conditions are listed for which there could be a risk to the cycling lifetime of the driver. Critical conditions for the driver lifetime due to thermal cycling are:

- Small driver / system (= short heating time) without appropriate heatsinking (= high maximum running temperature T_{max}).
- > 50 °C difference between T_{case_max} and ambient temperature in the off-state T_{min}
- Application at $T_{min} < -40$ °C.

Especially if the above parameters occur combined, cycling lifetime performance may be negatively affected. In case improvement of cycling lifetime is required, it is most relevant to decrease T_{max} by applying appropriate heat sinking of the driver. As a rule of thumb, a 10°C reduction of the temperature difference ΔT between T_{min} and T_{max} will yield typ. 30% increase of cycling lifetime performance.

Impact of product ambient temperature on cycling performance

In the first approximation the solder joint lifetime is independent of the ambient temperature. The driving parameter for the solder joint failure fatigue is the temperature difference ΔT between T_{max} during the on state and T_{min} during the off state. The way the driver is built into a luminaire is very important as this can decrease the temperature difference. Appropriate heatsinking of the driver is the most effective way to improve the driver cycling lifetime.

Compliance and approval

Driver compliances and approvals can be found in the published driver Declarations of Conformity (DoC) and ENEC/CB certificates as published on www.philips.com/oem. For further questions please contact your local Philips sales representative.

System Disposal

We recommend that the Xitanium LED Outdoor drivers and its components are disposed of in an appropriate way at the end of their (economic) lifetime. The drivers 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.

Disclaimer

Note that the information provided in this document is subject to change.

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