**PHILIPS**

**Xitanium**

LED outdoor **drivers**

**LED**
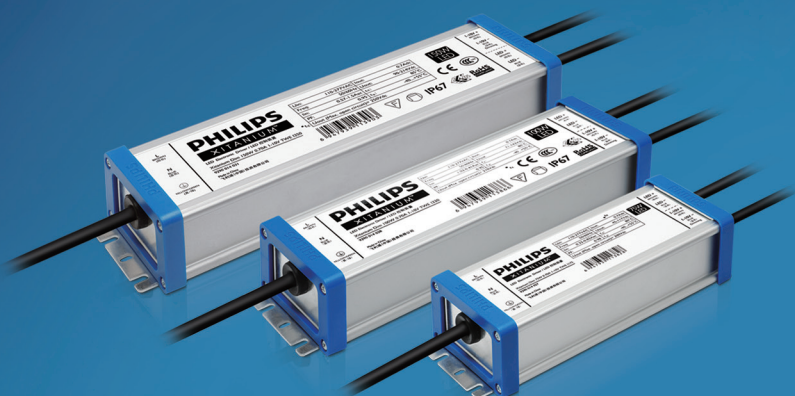
# Enabling **future-proof LED technology** for dynamic LED markets

August, 2021

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# Introduction to this guide

IP67 Independent version

IP65 Independent version

Built-in version

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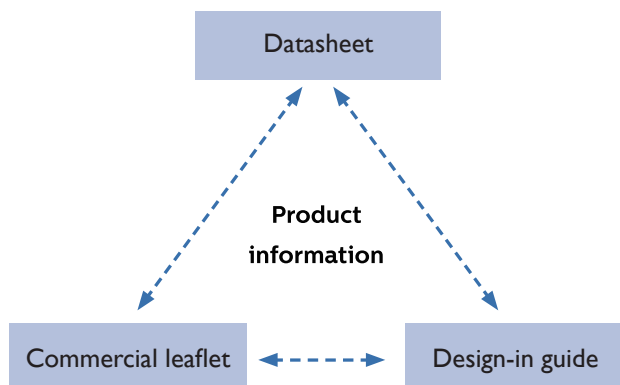
Thank you for choosing Philips Xitanium Outdoor LED drivers. In this guide you will find the information needed to integrate these drivers into a LED luminaire or LED system.

This edition describes the Xitanium Outdoor LED drivers optimized for outdoor application. We advise you to consult our websites for the latest up-to-date information.

## Applications
The Xitanium Outdoor LED drivers are designed to operate LED solutions for outdoor lighting, like industrial, street, road lighting and open area environments. If you use Philips LED drivers in combination with Philips LED modules, specific design-in guides are available from below mentioned technology websites.

## Classification
The Xitanium outdoor driver listed as below can be used in both Class I and Class II IEC isolation systems.

## Information or support
Please consult your local Philips office or visit:
www.philips.com/technology

## Determine which documents contain what information
In order to provide information in the best possible way, Philips' philosophy on product documentation is the following.
- **Commercial leaflet** contains product family information & system combinations
- **Datasheet** contains the product specific specifications
- **Design-in guide** describes how the product is to be designed-in

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

Datasheet

**Product information**

Commercial leaflet ◄ - - - ► Design-in guide

# Safety precautions

<div style="background:#5b8fc9; color:#fff;">

⚠️ **Warnings:**

- Avoid touching live parts!
- Do not use drivers with damaged housing and/or connectors!
- Do not use drivers with damaged wiring!
- Class I luminaires must be connected to protective earth!
- Do not service the driver when the mains voltage is connected; this includes connecting or disconnecting the LED load.
- Switchable function to make the open load on the driver output is abnormal condition, it is not an intended application that be allowed.
- For the driver claimed class II isolation, the EQUI must connected with luminaire grounding reference.

</div>

### Safety warnings and instructions

- Do not use damaged or defective contacts or housings.
- Do not use damaged products.
- Cap off all unused wires to prevent accidental contact with the luminaire or driver housing.
- For the drivers with IP-rated connectors, the installers shall check that the seal of the connector is present and not damaged before connecting the male/female connectors.
- For connector version drivers, when luminaire manufacturers choose to cut off the connector, the original IP-rating cannot be guaranteed and becomes the responsibility of the luminaire manufacturers.
- The luminaire manufacturer is responsible for its own luminaire design and has to comply with all relevant safety standards.
- Philips offers the LED outdoor drivers with two different housing designs, built-in and independent. The built-in type drivers should not be exposed to the elements such as snow, water and ice. Exposure will lead to corrosion and even failure of the driver what should be avoided. It is the luminaire manufacturer's responsibility to prevent exposure.
  The independent type drivers can be exposed to the outdoor elements and installed apart from fixture.

**Philips Design-in support** is available; please contact your Philips sales representative.

# Introduction to Xitanium Outdoor LED Drivers
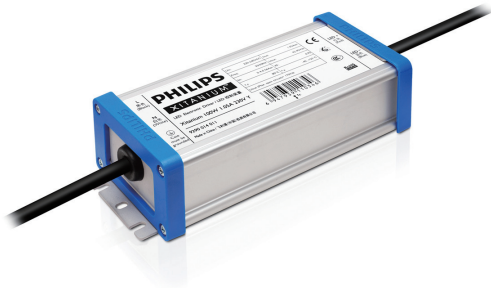
IP67 Independent version

Built-in version
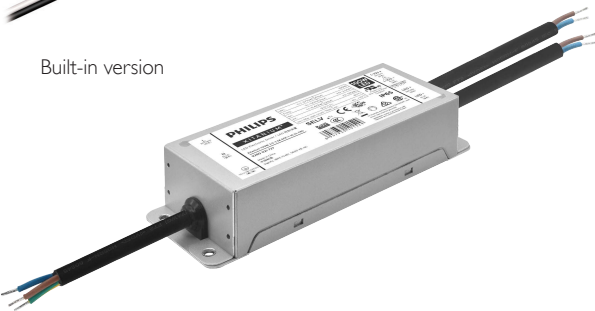
IP65 Independent version

IP65 round shape Highbay Independent version

## Introduction

Xitanium Outdoor LED drivers are designed to operate LED solutions for outdoor lighting applications such as flood, street, road lighting as well as open area environments.
The operating points are chosen specifically to match the most commonly used LEDs.

## Xitanium LED driver versions

The Xitanium LED drivers described in this guide are available in different versions, e.g. fixed-output and dimmable (1-10V; PWM; Line Switch; DALI), in a wide range of power ratings that enable the most popular light output levels for general lighting applications. We recommend you always check our Xitanium LED driver leaflet for the most up-to-date overview of our range. This leaflet can be found on the
 www.philips.com/technology website.

## Features

### Adjustable Output Current (AOC)

Flexibility in luminaire design is ensured by the adjustable output current (AOC).
The adjustable output current enables operation of various LED configurations from different LED manufacturers whilst also ensuring the solution remains "future proof" for new LED generations. The output current can be set with an external resistor (Rset). With our Programmable drivers, the output current setting can also be programmed using the Philips MultiOne programming hardware interface and the matching software "MultiOne driver configurator".
More information about AOC and how to set the output current can be found in de chapter "Electrical design"

## Controllability

The Xitanium Outdoor LED drivers are available in 3 different versions:
• Fixed Output
• 1-10V dimming
• DALI
• PWM
• Line Switch
• Amp Dim
• Communication (FELV) terminals marked "Risk of electric shock" are not safe to touch

Warning: Circuits connected to any FELV control terminal shall be insulated for the LV supply voltage of the controlgear and any terminals connected to the FELV circuit shall be protected against accidental contact.

The way of controlling is shown in the name of the driver. If no dimming protocol is given in the name, the Xitanium driver can only be used as a fixed output driver. The output current can be set as described in the Electrical design chapter. More information about the dimming protocols can be found in the Controllability chapter.

## Thermal de-rating

Thermal de-rating of your LED PCB is possible by integrating an NTC (Negative Thermal Coefficient) component on the LED PCB and connect this NTC to the driver's NTC input. More details about the NTC resistor can be found in the Chapter "Temperature design"

## Module Temperature Protection (MTP, adjustable on programmable drivers only)

This feature helps to protect the LEDs when operated in a hot ambient environment. The driver helps to regulate LED module temperature by regulating the output current. An NTC (Negative Temperature Coefficient resistor) must be present on the LED module and connected to respective pins on the driver in order to be able to make use this feature. Programmable drivers allow for changing the dimming behavior.

More information can be found under chapter Thermal Management.

## Constant Light Output (CLO, programmable drivers only)

Traditional light sources suffer from depreciation in light output over time. This applies to LED light sources as well. The CLO feature enables LED solutions to deliver constant lumen output through the life of the light engine. Based on the type of LEDs used, heat management and driver current, it is possible to estimate the depreciation of light output for specific LEDs and this information can be entered into the driver. The driver counts the number of light source working hours and will increase output current based on this input to enable CLO.
Since the CLO curve is not generic, the OEM needs to determine the appropriate CLO curve. This can be used to differentiate on e.g. lumen output or power consumption over lifetime.
The CLO feature can be programmed with the Philips MultiOne configurator tool. More information can be found on www.philips.com/multione

## DC operation

It is possible to connect the mains side of the Xitanium driver to a DC power net (e.g. central emergency system). Check for input requirements the drivers' datasheet which can be found on www.philips.com/technology
For the DC operation, the external DC fuse must be used in the luminaire.

## Naming of the LED outdoor drivers

Example:
1. Xitanium 150W 1.05A 230V I175C I67

| | |
|---|---|
| Xitanium: | Brand name for reliable, afforable LED drivers |
| 150W: | Maximum output power |
| 1.05A: | Output current |
| 230V: | Mains AC input voltage |
| I175 : | Housing length |
| | I (Independent housing design) |
| C : | Connector version |
| I67: | IP rating |

2. Xi FP 150W 0.2-0.7A SNLDAE prog
   + 230V S240 sXt

| | | |
|---|---|---|
| Xi: | Xitanium(Xi) | |
| Driver family: | SR | (sensor ready) |
| | FP | (full prog) |
| | LP | (lite prog) |
| 150W: | Maximum output power | |
| 0.2-0.7A: | Output current range | |
| SNLDAE: | S | (simpleset) |
| | N | (NTC input) |
| | L | (line switch) |
| | D | (DALI) |
| | A | (AmpDim) |
| | E | (DC Emergency) |
| | M | (Energy Meter) |
| | P | (Auxiliary Power supply) |
| 230V: | Mains AC input voltage | |
| S240: | Housing length | |
| | S | (stretch) |
| | C | (compact) |

# Electrical Design-in
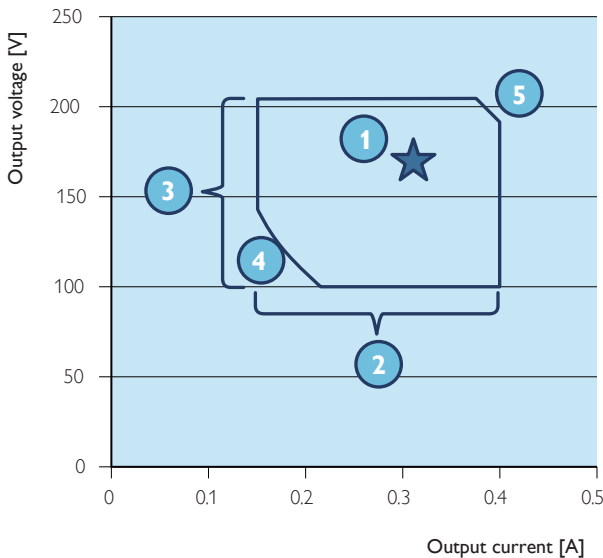


1. Required set point for the LED solution
2. Current can be set to needs within range
3. Driver adapts to required voltage, given it fits range
4. Driver minimum power limit
5. Driver maximum power limit

Example Operating window of a Xitanium driver

Note: by means of dimming it is possible to go below the minimum value of the specified output current.

## Operating window

LED technology is rapidly evolving. Using more efficient LEDs in a next generation means the same light output can be achieved with lower currents. At the same time, LEDs can be driven at different currents levels based on the application requirement. Typically, LED drivers are available in discrete current levels e.g. 350mA, 500mA or 700mA. It is often necessary to replace a driver when more efficient LEDs or different LED boards become available.

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

1. Drivers with SimpleSet® functionality can be configured using the Philips MultiOne software and SimpleSet® interface.
2. DALI driver versions can be programmed both via SimpleSet and DALI interface. More information can be obtained at www.philips.com/multiOne.
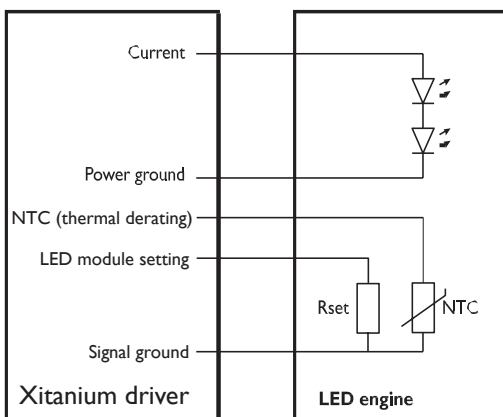
Note: by means of testing the accuracy of the output current, the condition is required as below:

- Iout tolerance <=5% @Ta=25°C is tested @0 hour (cold start)

- Warning: Iout may have ~20mA shift according to different Tc.

* Note: when connecting Philips LED Lines to the driver, the type of LED board (LV or HV) determines this requirement. Hybrid LED boards can be used on both type of drivers, indicated in commercial leaflet LED Lines, to be found in the download section of www.philips.com/technology

** Note: for Philips LED Lines standard system configurations, driven at nominal current, are stated in the commercial leaflet LED Lines, to be found in the download section of www.philips.com/technology

Note: for a HV scenario that allows a 2 chain parallel solution, you are likely to find with steps described a lower rated driver power (e.g. 75 W for 1 chain versus 36 W for 2 chain solution)

## How to… Select an appropriate driver

Depending on you requirements several drivers can be found as a solution for you. The following steps can help selecting the preferred driver.

For a full overview of available driver models, please refer to the commercial leaflet Xitanium Outdoor LED drivers, to be found in the download section of www.philips.com/technology, as are the datasheets associated with the drivers you intend to use.

1. Determine your required drive current (Idrive) and voltage (Vf)
2. Calculate required power via Pdrive = Vf × Idrive (W)
3. Determine which type* of driver do you need; Isolated or Non-isolated Collect the associated datasheets from the website.
4. Does required current fit current range of driver?
   - Idriver minimum ≤ Idrive ≤ Idriver maximum?
5. Does required voltage fit voltage range of driver?
   - Vdriver minimum ≤ Vf ≤ Vdriver maximum?
6. Does required power fit power range of driver?
   - Pdriver minimum ≤ Pdrive ≤ Pdriver maximum?
7. Choose your type** of dimming

## Driver wiring and pinning

Driver lead wires with corresponding functions can be seen in figures on the left. The function of each wire will be discussed further in detail in the following chapters.

Note: currently all the Xitanium Outdoor LED drivers are single channel drivers. This means that for drivers with a double "+" and "-" output (see figure on the left) that these outputs are simply in parallel.



Schematically representation of the drivers' output interfaces

## Adjustable Output Current (AOC) –set the driver output current

Output current can be set by placing an external resistor (LEDset and Rset) into the driver's Rset input. Next to that DALI driver versions allow also setting of the output current via software configuration.

Note: Rset is used as generic indication for Rset1, Rset2 or LEDset.

Note: LEDset and Rset-interface are not meant to be used as a control or dimming interface (for instance 1...10 V). If this is not observed, both performance and safety requirements of the installation may be affected.

## How to… Determine AOC priority with LED drivers

Since the DALI drivers allow two methods to set the output current (AOC), it is good to take note of the priority of each method with respect to the other.

Historically there are two groups of DALI drivers; those which can dim down to 1% (newer) and those which can dim down to 10% (older).

### Group 1: 10% minimum dim level (newer drivers)
AOC programming has priority over Rset. For the priority selection criteria see table on the left.

### Group 2: >1% minimum dim level (older drivers, 5% or 10% minimum dim level)
The value that sets the lowest current has priority over the other.
1. Iprogramming < IRset ? => priority for Iprogramming
2. IRset < Iprogramming ? => priority for IRset
E.g. programming 200 mA has priority over Rset which would generate 250 mA.
And Rset that generates 200 mA has priority over programming 250 mA.

Note: default current is stated in the driver's datasheet in the download section on www.philips.com/technology.

| Programming enabled | | | |
|---|---|---|---|
| **Yes** | **No** | | |
| | Rset connected | | |
| | **Yes** | **No** | |
| $I_{nom}$ = Programmed value | $I_{nom}$ = Rset Determined value | $I_{nom} = I_{default}$ | |
| Driver output current $I_{nom}$ should always be $I_{driver\,min} \leq I_{nom} \leq I_{driver\,max}$ | | | |

Priority selection citeria for Group 1 - 1% minimum dim level

Example of a Set'n'drive resistor featured by BJB, fitted with a leaded resistor inside and allowing both manual or robot placement





## How to… Set the output current via Rset

### Your lumen, your current

1 resistor value generates 1 current only at all window drivers as long as it fits within the driver window.
That is 1 philosophy for all window drivers.

### Why a resistor?

a)  Worldwide standardized building block
b)  Worldwide availability and well documented
c)  Freedom for OEM to choose the value and supplier

### Resistor placed into driver enables you to

1.  Connect different configurations, not just a unique solution
2.  Drive different type of LED boards, not restricted to one type
3.  Select and tune the current, hence flux or Tc

### Resistor characteristics

By making use of a resistor component with a determined Ohm value you can set the required current for your LED module. This component can be a leaded standard 1% tolerance resistor of e.g. 0.125 W or 0.25 W, 50 V. Rset will not be part of the electrical chain driving the LEDs, meaning it does not dissipate power. However, make sure it does not come into contact with the driver's housing. For safety reasons with non-isolated drivers the resistor must be insulated. Advice is to always insulate the resistor. Examples of a resistor placed into the drivers' input is shown on the left.

2 different Rset resistors are utilized in the Xitanium programmable LED driver portfolio;
• Rset1 (older drivers); allows output current setting up to 700 mA
• Rset2; allows output current setting up to 2000 mA
In all documentation, Rset may refer to either Rset1 or Rset2, depending on the driver type. Please check the driver datasheet for which Rset (1 and/or 2) the driver you use reads.

Note: While inserting the resistor, please refer to the image on the left. The resistor must be inserted such that there is no possibility of a short caused by the leads. Especially when using non-isolated drivers, make sure the leads of the resistor are insulated. This way they cannot generate a potential safety risk, nor can the trip the earth leakage circuit breaker.

**LED power supply**

LED+ ─── Idrive

LEDset ─── Iset

Rset

LED
(optional)

LED-
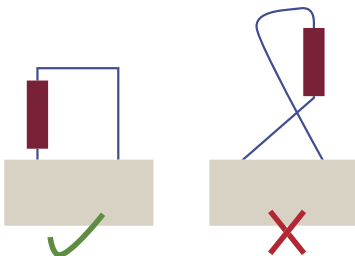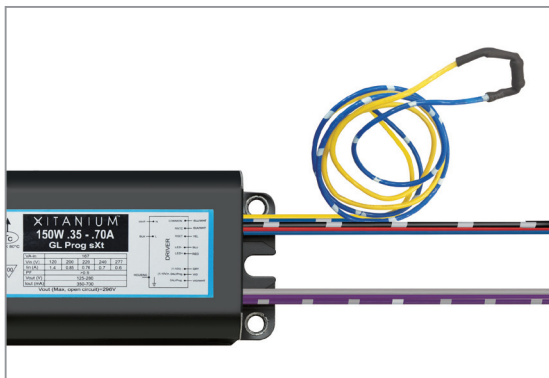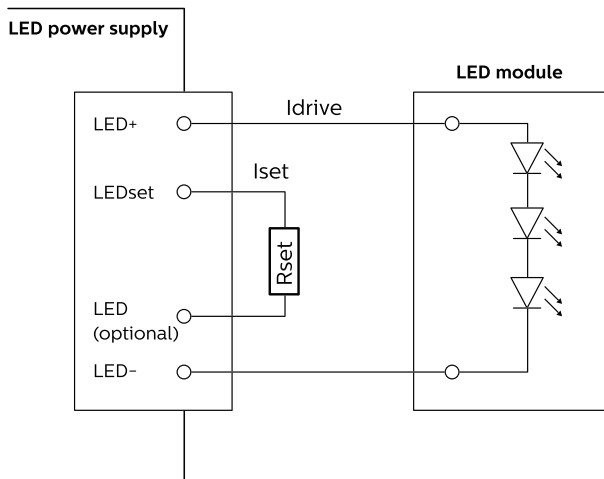
**LED module**

Rset resistor mounted directly onto the driver

**LED power supply**

LED+ ─── Idrive

LEDset ─── Iset

Rset

LED-
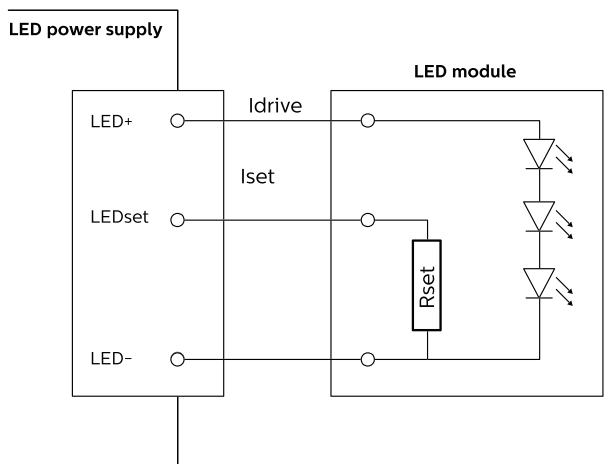
**LED module**

Rset resistor mounted onto the LED module

### Rset1 and Rset2 use different pins on the driver

The Rset1 and Rset2 values with the corresponding drive currents are shown in following tables. It is advised to select the nearest lower resistor value that is available to you, if the exact determined value is not at hand.

## How to… Set the output current via LEDset

Rset 1 and Rset 2 have been the traditional ways to set the current in the Xitanium window drivers. Next generation drivers will now be introduced with LEDset. LEDset is introduced by several vendors in the market to provide an industry standardized Rset interface. LEDset is, in essence, like Rset1 and Rset2, where one resistor value leads to one output current value only, differing only in the look-up table. Please find the table for E96 resistor values in the next section.

### What does LEDset offer

Like Rset1 and Rset2, LEDset is an analogue interface, allowing basic current setting. The interface supports the following functions:

- Output current setting of the constant current LED driver to LED modules
- Thermal protection of the LED module(s) via thermal dynamic resistors circuit

### How does LEDset work

LEDset is based on a 3 wire connection between LED driver and one or more LED modules as shown in the figure on the left. Only one additional wire, besides the two LED current supply wires, is used for transferring information from the LED module(s) to the LED driver, provided the Rset is mounted on the LED module.
Alternatively a standard resistor can be put directly into the driver's LEDset input connectors.

Iout vs. Rset
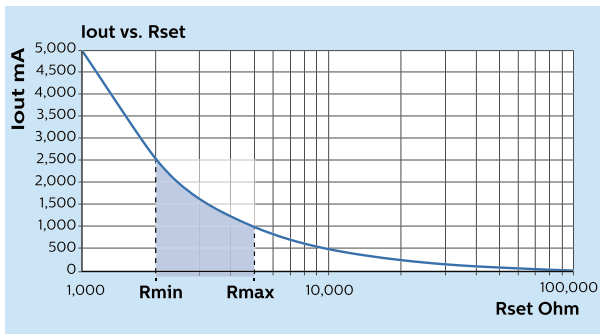
The LEDset interface measures the current Iset which flows from a 5V constant voltage source within the LED driver through the setting resistor(s) Rset which is/are located either on the LED modules or directly into the driver's Rset-input.

The current Iset flowing through one setting resistor Rset is determined by the equation:

$$Iset [A] = 5 [V] / Rset [\Omega]$$

A LED driver with LEDset interface is able to measure Iset and to set the LED driver output current Idrive dependent on the measured value of Iset according to the equation

$$Idrive = Iset \times 1000 [A]$$

Therefore the overall relationship between the setting resistor and the LED driver output current Idrive is then given by

$$Idrive [A] = (5 [V] / Rset [\Omega]) \times 1000$$

To calculate the required resistor value for a desired drive current Idrive use:

$$Rset [\Omega] = (5 [V] / Idrive [A]) \times 1000$$

The LEDset interface is intended to cover a LED driver output current range from 0.05 A to 8 A. The corresponding resistor Rset is therefore within the range 100 kOhm to 625 Ohm.

In addition, it is possible to add an over temperature protection circuit on the LED module which decreases the setting current in case of an over temperature event and thus limits or folds back the LED driver output current.
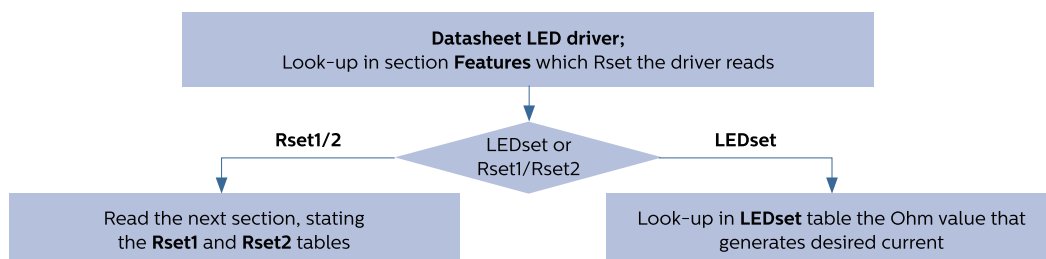
Datasheet LED driver;
Look-up in section **Features** which Rset the driver reads

**Rset1/2** | LEDset or Rset1/Rset2 | **LEDset**

Read the next section, stating the **Rset1** and **Rset2** tables

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

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

## LEDset − E96 series: table with E96 resistor values

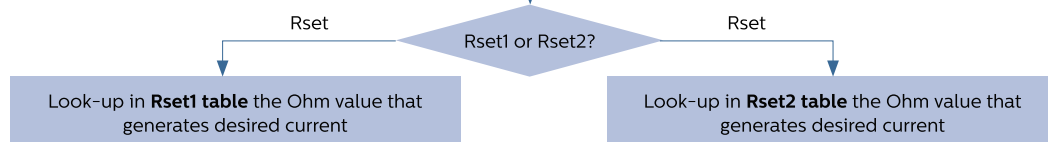| LEDset [Ω] | Idrive [mA] | LEDset [Ω] | Iset [mA] | LEDset [Ω] | Iset [mA] | LEDset [Ω] | Iset [mA] |
|---|---|---|---|---|---|---|---|
| open | driver's default current | 23700 | 211 | 11000 | 455 | 5110 | 978 |
| 49100 | 102 | 23600 | 212 | 10700 | 467 | 4910 | 1018 |
| 48700 | 103 | 23200 | 216 | 10500 | 476 | 4870 | 1027 |
| 47500 | 105 | 22100 | 226 | 10200 | 490 | 4750 | 1053 |
| 46400 | 108 | 21600 | 231 | 10000 | 500 | 4640 | 1078 |
| 45300 | 110 | 21000 | 238 | 9760 | 512 | 4530 | 1104 |
| 44200 | 113 | 20500 | 244 | 9530 | 525 | 4420 | 1131 |
| 43200 | 116 | 20000 | 250 | 9310 | 537 | 4320 | 1157 |
| 42200 | 118 | 19600 | 255 | 9090 | 550 | 4220 | 1185 |
| 41200 | 121 | 19100 | 262 | 8870 | 564 | 4120 | 1214 |
| 40200 | 124 | 18700 | 267 | 8660 | 577 | 4020 | 1244 |
| 39200 | 128 | 18200 | 275 | 8450 | 592 | 3920 | 1276 |
| 38300 | 131 | 17800 | 281 | 8250 | 606 | 3830 | 1305 |
| 37400 | 134 | 17400 | 287 | 8060 | 620 | 3740 | 1337 |
| 36500 | 137 | 16900 | 296 | 7870 | 635 | 3650 | 1370 |
| 35700 | 140 | 16500 | 303 | 7680 | 651 | 3570 | 1401 |
| 34800 | 144 | 16200 | 309 | 7500 | 667 | 3480 | 1437 |
| 34000 | 147 | 15800 | 316 | 7320 | 683 | 3400 | 1471 |
| 33200 | 151 | 15400 | 325 | 7150 | 699 | 3320 | 1506 |
| 32400 | 154 | 15000 | 333 | 6980 | 716 | 3240 | 1543 |
| 31600 | 158 | 14700 | 340 | 6810 | 734 | 3160 | 1582 |
| 30900 | 162 | 14300 | 350 | 6650 | 752 | 3090 | 1618 |
| 30100 | 166 | 14000 | 357 | 6490 | 770 | 3010 | 1661 |
| 29400 | 170 | 13700 | 365 | 6340 | 789 | 2940 | 1701 |
| 28700 | 174 | 13300 | 376 | 6190 | 808 | 2870 | 1742 |
| 28000 | 179 | 13000 | 385 | 6040 | 828 | 2800 | 1786 |
| 27400 | 182 | 12700 | 394 | 5900 | 847 | 2740 | 1825 |
| 26700 | 187 | 12400 | 403 | 5760 | 868 | 2670 | 1873 |
| 26100 | 192 | 12100 | 413 | 5620 | 890 | 2610 | 1916 |
| 25500 | 196 | 11800 | 424 | 5490 | 911 | 2550 | 1961 |
| 24900 | 201 | 11500 | 435 | 5360 | 933 | 2490 | 2008 |
| 24300 | 206 | 11300 | 442 | 5230 | 956 | short | driver's max. current |

| Datasheet LED driver; Look-up in section **Features** which Rset the driver reads |
|---|

| If both Rset1 and Rset2 are supported, Rset2 is advised for future compatibility |
|---|

Rset  ←  Rset1 or Rset2?  →  Rset

| Look-up in **Rset1 table** the Ohm value that generates desired current | | Look-up in **Rset2 table** the Ohm value that generates desired current |
|---|---|---|

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

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

## Rset1 − E24 series

| Ret1 [Ω] | Iset [mA] | Ret1 [Ω] | Iset [mA] | Ret1 [Ω] | Iset [mA] | Ret1 [Ω] | Iset [mA] |
|---|---|---|---|---|---|---|---|
| 39 | 200 | 510 | 292 | 6k8 | 583 | 91k | 690 |
| 43 | 201 | 560 | 300 | 7k5 | 591 | 100k | 691 |
| 47 | 202 | 620 | 309 | 8k2 | 599 | 110k | 692 |
| 51 | 203 | 680 | 318 | 9k1 | 60 | 120k | 693 |
| 56 | 204 | 750 | 327 | 10k | 614 | 130k | 693 |
| 62 | 206 | 820 | 336 | 11k | 621 | 150k | 695 |
| 68 | 208 | 910 | 347 | 12k | 627 | 160k | 695 |
| 75 | 209 | 1k | 358 | 13k | 632 | 180k | 696 |
| 82 | 210 | 1k1 | 369 | 15k | 640 | 200k | 696 |
| 91 | 212 | 1k2 | 379 | 16k | 643 | 220k | 697 |
| 100 | 215 | 1k3 | 388 | 18k | 649 | 240k | 697 |
| 110 | 217 | 1k5 | 406 | 20k | 654 | 270k | 698 |
| 120 | 219 | 1k6 | 414 | 22k | 658 | 300k | 698 |
| 130 | 221 | 1k8 | 429 | 24k | 661 | 330k | 698 |
| 150 | 226 | 2k | 442 | 27k | 665 | 360k | 699 |
| 160 | 228 | 2k2 | 455 | 30k | 669 | 390k | 699 |
| 180 | 232 | 2k4 | 466 | 33k | 671 | 430k | 699 |
| 200 | 236 | 2k7 | 481 | 36k | 674 | 470k | 699 |
| 220 | 240 | 3k | 494 | 39k | 676 | 510k | 699 |
| 240 | 244 | 3k3 | 505 | 43k | 678 | 560k | 700 |
| 270 | 250 | 3k6 | 517 | 47k | 680 | 620k | 700 |
| 300 | 256 | 3k9 | 525 | 51k | 682 | 680k | 700 |
| 330 | 261 | 4k3 | 536 | 56k | 683 | 750k | 700 |
| 360 | 267 | 4k7 | 546 | 62k | 685 | 820k | 700 |
| 390 | 272 | 5k1 | 555 | 68k | 686 | 910k | 700 |
| 430 | 279 | 5k6 | 564 | 75k | 688 | 1M | 700 |
| 470 | 286 | 6k2 | 574 | 82k | 689 | No Rset | default |

## Rset2 − E24 series

| Ret1 [Ω] | Iset [mA] | Ret1 [Ω] | Iset [mA] | Ret1 [Ω] | Iset [mA] | Ret1 [Ω] | Iset [mA] |
|---|---|---|---|---|---|---|---|
| short | 100 | 430 | 245 | 2k | 733 | 9k1 | 1558 |
| 100 | 100 | 470 | 261 | 2k2 | 780 | 10k | 1604 |
| 110 | 106 | 510 | 277 | 2k4 | 823 | 11k | 1653 |
| 120 | 111 | 560 | 297 | 2k7 | 884 | 12k | 1694 |
| 130 | 116 | 620 | 318 | 3k | 941 | 13k | 1730 |
| 150 | 121 | 680 | 340 | 3k3 | 993 | 15k | 1793 |
| 160 | 130 | 750 | 368 | 3k6 | 1042 | 16k | 1817 |
| 180 | 13 | 820 | 392 | 3k9 | 1086 | 18k | 1864 |
| 200 | 146 | 910 | 422 | 4k3 | 1143 | 20k | 1902 |
| 220 | 155 | 1k | 452 | 4k7 | 1192 | 22k | 1935 |
| 240 | 166 | 1k1 | 485 | 5k1 | 1238 | 24k | 1965 |
| 270 | 176 | 1k2 | 515 | 5k6 | 1293 | 27k | 2000 |
| 300 | 190 | 1k3 | 545 | 6k2 | 1350 | No Rset | default |
| 330 | 204 | 1k5 | 602 | 6k8 | 1402 | | |
| 360 | 215 | 1k6 | 632 | 7k5 | 1454 | | |
| 390 | 228 | 1k8 | 684 | 8k2 | 1503 | | |

## Rset priority behavior for drivers that read both Rset1 and Rset2

| Rset1 | Rset1 | Driver status |
|---|---|---|
| Open | Open | Driver's default current (see datasheet) |
| Rset | Open | Rset1 |
| Open | Rset | Rset2 |
| Rset | Rset | Rset2 |
| Short | Open | Rset1 (driver's minimum current, see datasheet) |
| Short | Short | Rset2 (driver's minimum current, see datasheet) |
| Open | Short | Rset2 (driver's minimum current, see datasheet) |

Please refer to the datasheet of the driver you use to find which Rset or Rsets the driver actually reads.

## Rset2 − E96 series: table with E96 resistor values, stating smaller increments but covering same range as the E24 series on previous page

| Rset2 [Ω] | Iset [mA] | Rset2 [Ω] | Iset [mA] | Rset2 [Ω] | Iset [mA] | Rset2 [Ω] | Iset [mA] | Rset2 [Ω] | Iset [mA] | Rset2 [Ω] | Iset [mA] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| short | min. | 255 | 171 | 665 | 335 | 1740 | 669 | 4530 | 1171 | 11800 | 1686 |
| 100 | 100 | 261 | 173 | 681 | 341 | 1780 | 679 | 4640 | 1185 | 12100 | 1698 |
| 102 | 101 | 267 | 175 | 698 | 347 | 1820 | 689 | 4750 | 1198 | 12400 | 1708 |
| 105 | 103 | 274 | 178 | 715 | 354 | 1870 | 701 | 4870 | 1212 | 12700 | 1719 |
| 107 | 104 | 280 | 181 | 732 | 361 | 1910 | 711 | 4910 | 1216 | 13000 | 1730 |
| 110 | 105 | 287 | 184 | 750 | 368 | 1960 | 724 | 5110 | 1239 | 13300 | 1739 |
| 113 | 107 | 294 | 187 | 768 | 374 | 2000 | 733 | 5230 | 1253 | 13700 | 1752 |
| 115 | 108 | 301 | 191 | 787 | 381 | 2050 | 745 | 5360 | 1267 | 14000 | 1761 |
| 118 | 110 | 309 | 194 | 806 | 387 | 2100 | 757 | 5490 | 1281 | 14300 | 1771 |
| 121 | 111 | 316 | 197 | 825 | 394 | 2160 | 770 | 5620 | 1295 | 14700 | 1783 |
| 124 | 113 | 324 | 201 | 845 | 400 | 2210 | 782 | 5760 | 1308 | 15000 | 1793 |
| 127 | 115 | 332 | 204 | 866 | 407 | 2320 | 806 | 5900 | 1322 | 15400 | 1802 |
| 130 | 116 | 340 | 207 | 887 | 414 | 2360 | 815 | 6040 | 1335 | 15800 | 1812 |
| 133 | 118 | 348 | 210 | 909 | 422 | 2370 | 817 | 6190 | 1349 | 16200 | 1822 |
| 137 | 119 | 357 | 214 | 931 | 429 | 2430 | 829 | 6340 | 1362 | 16500 | 1829 |
| 140 | 120 | 365 | 217 | 953 | 436 | 2490 | 841 | 6490 | 1375 | 16900 | 1838 |
| 143 | 122 | 374 | 221 | 976 | 444 | 2550 | 853 | 6650 | 1389 | 17400 | 1850 |
| 147 | 123 | 383 | 225 | 1000 | 452 | 2610 | 865 | 6810 | 1403 | 17800 | 1859 |
| 150 | 125 | 392 | 229 | 1020 | 459 | 2670 | 877 | 6980 | 1415 | 18200 | 1867 |
| 154 | 127 | 402 | 233 | 1050 | 469 | 2740 | 891 | 7150 | 1428 | 18700 | 1877 |
| 158 | 129 | 412 | 237 | 1070 | 475 | 2800 | 903 | 7320 | 1441 | 19100 | 1885 |
| 162 | 131 | 422 | 241 | 1100 | 485 | 2870 | 916 | 7500 | 1454 | 19600 | 1894 |
| 165 | 132 | 432 | 246 | 1130 | 494 | 2940 | 929 | 7680 | 1467 | 20000 | 1902 |
| 169 | 134 | 442 | 250 | 1150 | 500 | 3010 | 943 | 7870 | 1480 | 20500 | 1910 |
| 174 | 136 | 453 | 254 | 1180 | 509 | 3090 | 956 | 8060 | 1493 | 21000 | 1918 |
| 178 | 137 | 464 | 259 | 1210 | 518 | 3160 | 968 | 8250 | 1506 | 21600 | 1928 |
| 182 | 139 | 475 | 263 | 1240 | 527 | 3240 | 982 | 8450 | 1518 | 22100 | 1936 |
| 187 | 141 | 487 | 268 | 1270 | 536 | 3320 | 996 | 8660 | 1531 | 23200 | 1952 |
| 191 | 143 | 491 | 270 | 1300 | 545 | 3400 | 1009 | 8870 | 1544 | 23600 | 1959 |
| 196 | 145 | 511 | 278 | 1330 | 554 | 3480 | 1022 | 9090 | 1557 | 23700 | 1960 |
| 200 | 146 | 523 | 282 | 1370 | 565 | 3570 | 1037 | 9310 | 1569 | 24300 | 1968 |
| 205 | 148 | 536 | 287 | 1400 | 574 | 3650 | 1049 | 9530 | 1580 | 24900 | 1975 |
| 210 | 151 | 549 | 292 | 1430 | 582 | 3740 | 1062 | 9760 | 1592 | 25500 | 1982 |
| 216 | 153 | 562 | 297 | 1470 | 594 | 3830 | 1075 | 10000 | 1604 | 26100 | 1989 |
| 221 | 155 | 576 | 302 | 1500 | 602 | 3920 | 1088 | 10200 | 1614 | 26700 | 1996 |
| 232 | 161 | 590 | 307 | 1540 | 614 | 4020 | 1103 | 10500 | 1629 | 27000 | 2000 |
| 236 | 163 | 604 | 313 | 1580 | 626 | 4120 | 1117 | 10700 | 1639 | open | default |
| 237 | 164 | 619 | 318 | 1620 | 638 | 4220 | 1131 | 11000 | 1653 | | |
| 243 | 167 | 634 | 323 | 1650 | 645 | 4320 | 1145 | 11300 | 1666 | | |
| 249 | 169 | 649 | 329 | 1690 | 656 | 4420 | 1158 | 11500 | 1674 | | |

luminaire programming and testing

in-the-field commissioning

production preparation

status readout

complaint handling

in-the-field upgrade
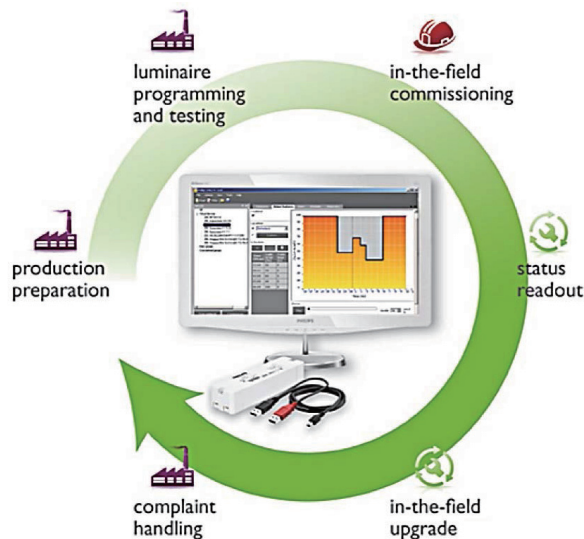
## How to… Program the output current

### 1 interface – connecting to indoor & outdoor, LED & conventional

The Xitanium Programmable drivers offer a full range of controls, enabling customizable luminaire design and performance.
It is possible to control light output levels, preset dimming protocols and set system specifications in the factory and even in the complete installations in the field. This can be done with the Philips MultiOne configurator software. The MultiOne configurator software is an intuitive tool that unlocks the full potential of all programmable drivers from Philips, ensuring that the driver performance matches the needs of the lighting solution. It offers unprecedented flexibility, before, during and after the product installation.

### Connecting to a programmable driver

Xitanium Programmable LED drivers are programmed via the Philips MultiOne configurator software. To do so, the driver must be connected to the computer via the MultiOne hardware interface.

For more information and latest version please visit www.philips.com/multione.
This site contains detailed information on how to install the software and how to program the driver.

### Mains voltage fluctuations

The driver is able to withstand high and low mains voltages for limited periods of time.

### Allowable voltage difference between mains input and control input (LED version)

The majority of our LED-drivers do comply with a voltage isolation difference up to 250V between mains and the Touch and Dim control input, as can be caused by a different phase of the power grid in an installation in the field.
Future drivers might have a value higher than 250 V by design.

### Use of LineSwitch in three-phase power 230/400V grids

The Xitanium Xtreme drivers allow for supplying power from another phase than the one controlling the LineSwitch interface

WL driver: Pout v.s Vin
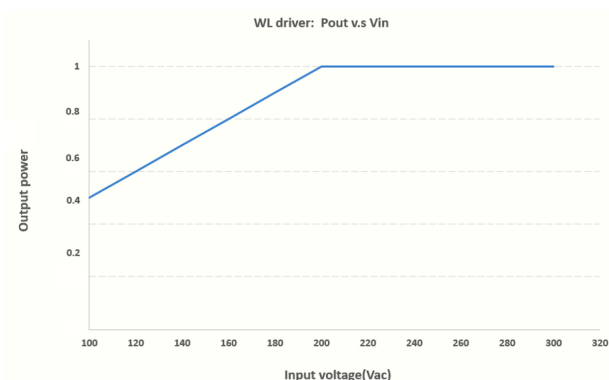
Derating curve of WL LP 100W driver
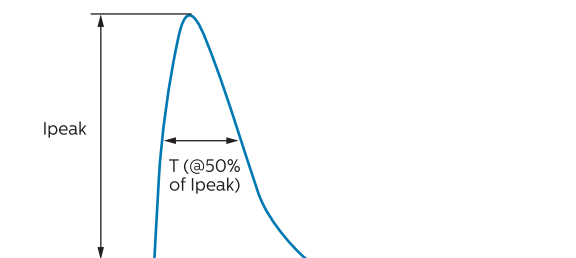


Graphical representation of inrush current

## Low mains voltage

A continuous low AC voltage (<202 V) can have an adverse effect on the driver's lifetime. The output power will be limited accordingly. A low voltage will not cause the driver to fail over a maximum period of 48 hours at minimum operating AC voltage and maximum ballast ambient temperature.

## High mains voltage

A high mains AC voltage will stress the driver and have an adverse effect on its lifetime (maximum of 264-305 V for a period of 48 hours).

## Mains guard function

The WL series drivers implement mains guard function. Mains guard function can protect driver under low mains voltage by dimming its output power. Please read driver datasheet to learn detail derating curve for each driver. However, a sudden spike in the mains will not be protected by Mains guard.

## Inrush current

'Inrush current' refers to the briefly occurring high input current which flows into the driver during the initial start-up to charge the capacitors on the input side. Typically, the amplitude is much greater than the operating or steady-state current, as illustrated.

The experimental setup for measuring the inrush current of the Xitanium LED Programmable driver is shown. For the test setup, a line impedance of 645 mΩ / 22 μH (nom values) is used (NEMA 410 standard requires a line impedance comprised of 450 mΩ / 100 μH for inrush current measurement). For the measurements, an input DC voltage equal to the peak of the corresponding line voltage is applied (via the capacitor bank).

On a system with an ABB S261 B16 miniature circuit breaker, up to a maximum certain number of Xitanium LED programmable drivers can be connected in parallel without the miniature circuit breaker tripping at driver turn-on. The exact maximum number can be found in the applicable driver datasheet. Please note that the inrush current does not increase proportionally with the number of drivers connected in parallel; i.e. for "N" drivers connected in parallel does not equal "N" times the inrush current for one driver.

| MCB type | Rating (A) | Relative number of LED drivers (%) |
|----------|-----------|------------------------------------|
| B | 16 | 100 (stated in datasheet) |
| B | 10 | 63 |
| B | 13 8 | 1 |
| B | 20 | 125 |
| B | 25 | 156 |
| C | 16 | 170 |
| C | 10 | 104 |
| C | 13 | 135 |
| C | 20 | 208 |
| C | 25 | 260 |
| L, I 1 | 6 | 108 |
| L, I 1 | 0 | 65 |
| G, U, II 1 | 6 | 212 |
| G, U, II 1 | 0 | 127 |
| K, III 1 | 6 | 254 |
| K, III 1 | 0 | 154 |

Conversion Table for maximum number of drivers on Different types of Miniature Circuit Breakers.

## How to… Determine the number of drivers on a MCB

The maximum amount of drivers on a 16A type B Miniature Circuit Breaker (MCB) is stated in the driver's datasheet on www.philips.com/technology.

In the conversion table on the left that stated amount is used as reference (100%).

The maximum quantity of drivers on different types of MCB can be calculated by the reference (see driver's datasheet) × Relative number (last column).

Example;
If datasheet states: max number on type B, 16 A = 20,
then for type C, 13 A the value will be 20 × 135% = 27.

Notes
1. Data is based on a mains supply with an impedance of 400 mΩ (equal to 15 m of 2.5 mm$^2$ cable and another 20 m to the middle of the power distribution) in the worst-case scenario. With an impedance of 800 m$^2$ the number of drivers can be increased by 10%.
2. Measurements will be verified in real installations; data is therefore subject to change.
3. In some cases the maximum number of drivers is not determined by the MCB but by the maximum electrical load of the installation.
4. Note that the maximum number of drivers is given when these are all switched on at the same time, e.g. by a wall switch.
5. Measurements were carried out on a single-pole MCB. For multiple MCBs it is advisable to reduce the number of drivers by 20%.
6. The maximum number of drivers that can be connected to one 30 mA Residential Current Detector is 30.

10 kV
Outdoor Power Surge Protection
LEDs + Supply Device

2,5 kV

+ + + + + + +
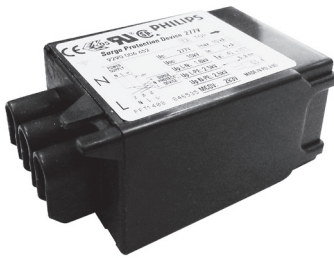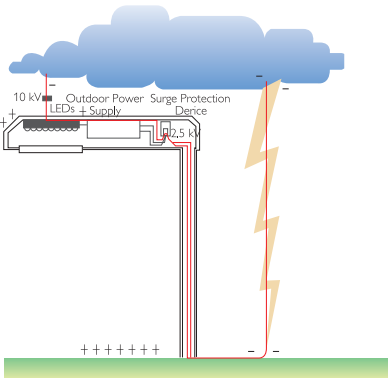


Example of SPD

## Surge protection

### The challenge for Outdoor lighting

Outdoor lighting systems are used in various types of applications, such as street and road lighting, parking areas and tunnels. In many of these installations there is a risk of extreme surges (e.g. lightning strikes). A direct hit will most likely destroy the components in a luminaire. Even an indirect hit near the lighting installation might cause severe damage.

### External SPD offers the maximum protection for Outdoor LED investments

Pole-mounted roadway lighting would typically fall into the more severe High Exposure location.
In C62.41.2 standard, for Location Category C (outside, service entrance and equipment), a protection level of 10 kV or more is required. There is almost no way to make the luminaire system surviving without any extra protection.
Installing an external SPD can offer the maximum protection for Outdoor LED luminaire.

| | Standard teste | | Optional teste |
| | 1.2/50 µs Voltage genarator | 8/20 µs Current genarator | 100 kHz Ring Wave for front-of-wave response evaluation |
| Exposure | Minimium open-circuit voltage to be applied to SPD | Current to be driven through the SPD[2] | |
|---|---|---|---|
| Low | 6 kV | 3 kA[3] | 3 kA[3] |
| High | 10 kV | 10 kA | 10 kA |

Surge Protection Devices (SPDs) intended for Location Category C

## Leakage current

The Xitanium Outdoor LED drivers are designed to meet touch current requirements per IEC 61347-1 standard. The specified maximum values are 0.7 mA peak for IEC and 0.75 mA RMS for UL norms. The test is done with the driver alone. In a luminaire, touch current may be higher, since the LED load may introduce additional touch current.
Precautions may be required on the luminaire level and if multiple drivers are used in a single luminaire.

## 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 in practical situations. Xitanium Outdoor LED drivers meet EMC requirements per CISPR15 ed 7.2. This test is conducted with a reference setup that includes a driver and an LED load/heat sink combination mounted on a metal plate.
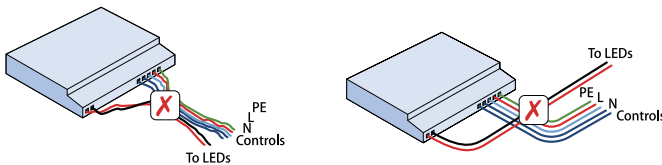
## Improvement in EMI Performance

The following practical precautions need to be taken into account in a lighting system to minimize EMI:

- Minimize the differential mode loop area of the lamp wires going from the driver to the light source by keeping the wires close together (bundling). This will minimize the magnetic field and reduce the radiated EMI. Long linear light sources are also part of that loop.
- Minimize the common mode parasitic capacitance of the output wiring + light source to earth by keeping the length of the wires between driver and light source as short as possible. Keep the length of the incoming mains wire inside the luminaire as short as possible.
- Keep mains separated from the output wires (do not bundle).
- Do not route any wiring over and/or along the driver enclosure to avoid any coupling/crosstalk with internal components of the driver.
- Do not route any wiring over and/or along the driver enclosure to avoid any coupling/crosstalk with internal components of the driver.
- Ground the lighting system chassis and other internal metal parts to protective earth (class I luminaires), do not let large metal parts electrically insulated from functional or protective earth. Always connect the protective/functional earth/equipotential connector or wire from   the driver and use equipotential bonding wires for all large metal parts like driver mounting plate, reflector, heatsink etc. Keep the protective/ functional earth/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 torque.
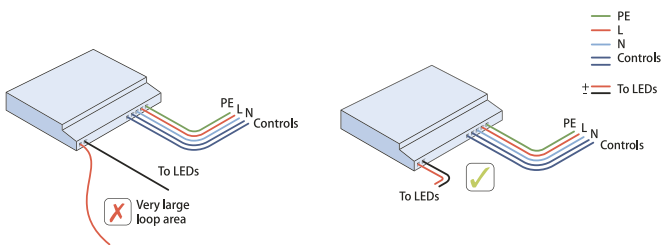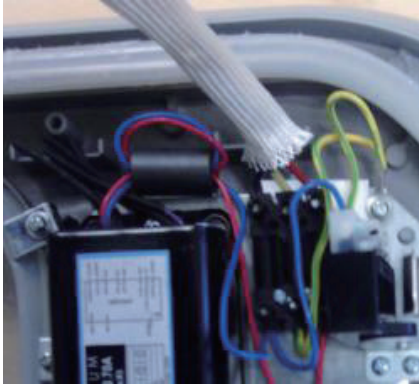


Keeping the wires close together



Keep mains separated from the output wires
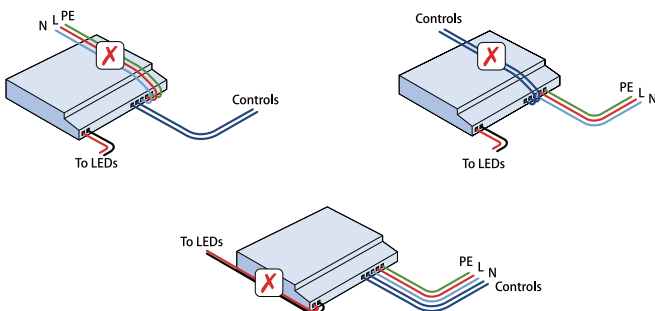


Do not route any wiring over and/or along the driver enclosure

Adding ferrite core to wires can improve EMI performance

- For Class II it is advised to establish a functional earth connection between all larger conductive, non-accessible luminaire parts and the driver to remedy potential EMC problems.
- Sometimes, radiated EMC compliance cannot be achieved, necessitating the use of a 100 … 300 Ωaxial ferrite bead(s) for either mains or lamp wiring (effective for interference between 30 MHz and 300 MHz), or coupling the wires through ferrite cores within the luminaire may improve the overall EMC performance. However, selection of the type and characteristics of the additional filter depends on what frequency components have to be damped and by how much.

Adhering to these rules will help in EMC compliance. For further questions, please contact your local Philips representative. Alternatively the Philips Lighting OEM Design-In team could be consulted for a possible solution.
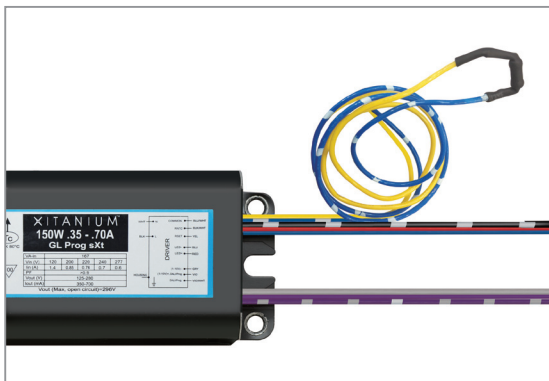
### How to… Improve EMI performance

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

- Minimize the Differential Mode loop area of the lamp wires going from the driver to the light source by keeping the wires close together (bundling). This will minimize the magnetic field and reduce the radiated EMI. Long linear light sources are also part of that loop.
- Minimize the Common Mode parasitic capacitance of the output wiring + light source to earth by keeping the length of the wires between driver and light source as short as possible. Also minimize the copper cooling area on the LED PCB and keep the length of the incoming mains wire inside the luminaire as short as possible.
- Keep mains and control wires (DALI, 0-10 V) separated from the output wires (do not bundle).

• Ground the lighting system chassis and other internal metal parts to earth (class I luminaires) and do not let large metal parts "float". Always use the safety or functional earth connector or wire from the lamp driver. Or use equipotential connecting wires for all internal floating metal parts which are inaccessable (class II luminaires). Keep safety and functional earth wires as short as possible to minimize their inductance, use as much as possible large metal areas (chassis, mounting plates, brackets) for earthing purposes instead.

• For Class II it is advised to establish a functional earth connection between all larger conductive, non-accessible luminaire parts and the driver to remedy potential EMC problems.

• Sometimes, radiated EMC compliance cannot be achieved, necessitating the use of a 100 … 300 Ω axial ferrite bead(s) for either mains or lamp wiring (effective for interference between 30 MHz and 300 MHz), or coupling the wires through ferrite cores within the luminaire may improve the overall EMC performance. However, selection of the type and characteristics of the additional filter depends on what frequency components have to be damped and by how much.

Adhering to these rules will help in EMC compliance. For further questions, please contact your local Philips representative. Alternatively the Philips Lighting OEM Design-In team could be consulted for a posible solution.

**Electrical isolation and protective earth**
One way to split the Xitanium Outdoor LED drivers is by Class I and Class II driver versions.
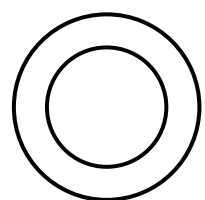
Class I drivers
These drivers have basic isolation (single isolation foil) between all the electronic circuits and the chassis, hence the presence of the Protective Earth (PE) symbol (see image on the left) on the driver housing.
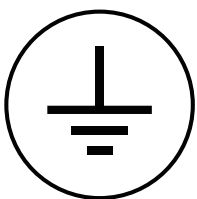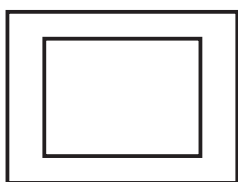


Symbol for Protective Earth (PE)

An adequate earth connection must to be made to all electrical conductive parts in the luminaire for Class I driver. The bottom part of the driver housing can be mounted to create earth contact to the luminaire housing, as the earth connector is internally connected to the driver housing. An intermitting earth contact should be prevented, as this is potentially unsafe and can cause a degraded performance. Most drivers in this group typically can generate output drive voltages higher than 60VDC. Always test the quality of your earth contacts between all relevant conductive parts.



Example of an insulated Rset

> ⚠ **Warnings for class I drivers:**
>
> - Do not touch any non-insulated live parts, even on the output (secondary) side!
> - Any live part on the output (secondary) side should not be touchable during normal operation. This includes the NTC component and Rset component.
> - Make sure to insulate the Rset to prevent it from touching the housing.



Built in version



Independent version

Symbol for Double Isolation between input and housing of a driver, in combination with built-in usage.

## Class II drivers

Design these drivers are intended for not only built in use, but also for independent use. According to the right symbol, you can find the related one for each application.

(Amendment 2 of safety standard IEC61347-1).

However, these isolated drivers can be used in both Class I and Class II luminaires under the following conditions:
- When used for Class I, the protective earth connection should be present (see previous section "Class I drivers").
- When used for Class II, the driver should be incorporated in the luminaire in such a way that

a) The driver housing is electrically insulated with respect to electrical conductive materials, such as the housing or reflector and as such not touchable during installation or operation.

b) All metal luminaire parts (chassis, heat sink, metallic reflector) connected to the driver housing are not allowed to be accessible by bare hand.

c) Any accessible conductive luminaire parts should have basic isolation towards the non-accessible luminaire parts and/or driver housing.

Note: for Class II, EMC requirements should be met without PE connection but need to connect to EQUI joint.

## Xitanium LED drivers meet the IEC 61347-1 safety standard

In accordance to this standard, the following safety requirements are met:
• Basic isolation between the Primary and Secondary side wires
• Driver output voltage < 1000 VDC
• *Insulation test voltage 1500 V (1000 V + 2 X 250 V)
• Double isolation between all wires and chassis:
  Insulation test voltage: 3750V for CCC
  3000V for IEC

*For Round shape high bay driver 1500V insulation test, please remove the screw indicated in left picture.*



**Removable Screw**

This screw should be tightened with 0.4NM torque in application.
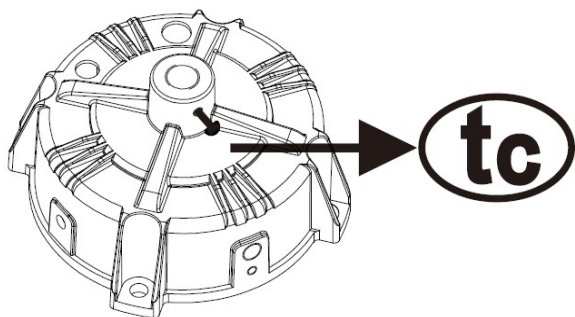But should be removed in HiPot test.

# Thermal Design-In
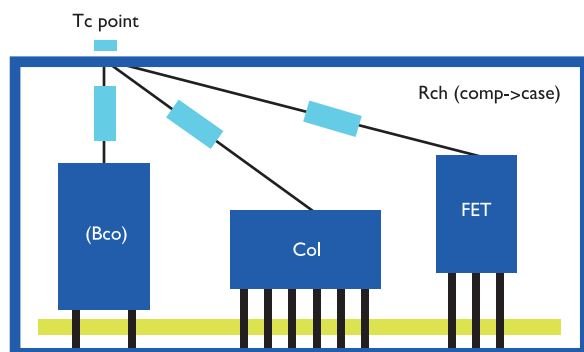


Schematically representation of internal thermal paths to the driver Tc point



Tc point position on driver housing



Tc point position on round shape Highbay driver housing

## Introduction

This chapter describes the relationship between the Xtanium Outdoor LED drivers in association with Tc point and lifetime.

## Definitions

- Case temperature: temperature measured at the Tc point of the driver
- Ambient temperature (Tamb): temperature outside the driver

When switched off >2 hours, temperature at Tc point is likely to equal Tamb

## Case Temperature Point (Tc point)

To achieve optimal lifetime and reliability, it is critical that the temperature of the components in the driver remains within its rating. In the LED driver design, all precautions are taken to ensure that the components within the driver are at the lowest possible temperatures.

All temperature measurements are related to a Tcase point (Tc) on the driver. Tc is a reference for the temperatures of the critical internal driver components. The location of the Tc point is identified on the product label. Tc point is marked by the-sign on the label of the driver.

Since there is a direct relation between the case temperature (Tc) and the driver components inside the driver, it is sufficient to measure the temperature at the Tc point of the LED driver. This Tc point must not exceed the maximum values stated in the associated datasheet in the download section on www.philips.com/technology

The temperatures as stated above are only valid for a situation where the driver is only cooled via the bottom surface.

## How to… Measure Tc at the Tc point

The location of the Tc point is identified on the product label. Tc point is inside the dot or on the side of the case at the location of the pointed arrow (See ellipse in figures on the left). The temperature can be measured using for example a thermocouple that is firmly glued to the driver housing. For a representative measurement the temperature must be stable before any reliable data can be obtained (typically > 0.5 hours).

## Relation between Tc and ambient temperature

The Tc increases by approximation linear with the ambient temperature (Tamb). The temperature offset between Tamb and Tc depends on the thermal design of the luminaire. The Xitanium Outdoor LED driver has been designed for outdoor use. For approved ambient temperature range please check the associated driver datasheet on www.philps.com/technology

## Driver lifetime

The lifetime of LED drivers depends on the temperature during operation. This means there is a relationship between the Tc point on the LED driver and its lifetime. Xitanium Outdoor LED drivers have a specified minimum lifetime of 50,000 hours with a minimum of 90% survivors at the specified Tc-max (see also respective datasheet).

## Module Temperature Protection (MTP)
### NTC and thermal design

This feature helps to protect the LEDs when operated in a hot ambient environment. The thermal design of an LED module/PCB should be designed in such a way that the temperature of the LED board (Tc-life) is not exceeded under normal application conditions. The utilization of a Negative Temperature Coefficient (NTC) component serves the purpose to help achieve the lifetime of the LED module or LED PCB if external thermal influences result in the temperature for lifetime (Tlife) being exceeded. When this occurs the light output will be regulated to remain below the critical temperature by the driver dimming down.

Two NTC part numbers which are supported, while the third option enables correct operation in combination with Philips LED modules.

1. 15 k NTC - Vishay 15 kOhm ± 2% NTC, B25/85=3700, 2381 615 54153

2. 15 k NTC - Murata 15 k, Part number NCP15XW153E03RC (with a Separate 390 ohms resistor in series with the NTC)

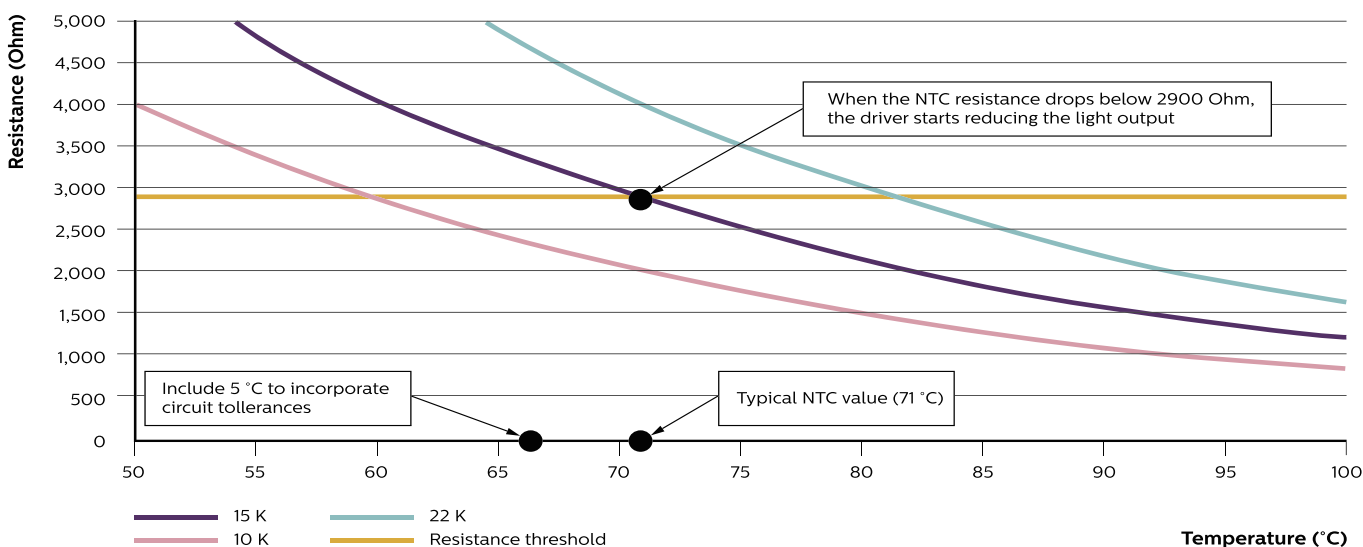3. On selected Philips LED light engines (currently no LED Lines)

## Setting the thermal de-rating point via NTC

The LED driver will start reducing the light output when the NTC reaches a value of 2966 Ω. The NTC should be selected such that 2966 Ω represents the desired critical temperature inside your LED module/PCB.

Take for example an LED board with a defined Tc-life of 65 °C. Taking the tolerances of the NTC into account results in ±5 °C. This gives a typical value for the NTC of 71 ±5 °C. By choosing this setting of 71 °C, we ensure that the driver will not dim the output, due to a too high temperature, before the module reaches 65 °C. The following graph shows a typical R vs. T curve of an NTC resistor. To match 2966 Ω at this temperature, the NTC of 15 kΩ ±2% has been selected.

**Setting MTP behavior (programmable drivers only)**

It is possible to set the temperature at which MTP feature is activated, defined by "MTP warn" and the slope, defined by "MTP max". Using the MultiOne Configurator software the settings can be changed.

When the NTC resistance drops below 2900 Ohm, the driver starts reducing the light output

Include 5 °C to incorporate circuit tollerances

Typical NTC value (71 °C)

| 15 K | 22 K |
| 10 K | Resistance threshold |

NTC resistance as function of temperature

# Mechanical Design-In

## IP rating

Below guide should be followed to ensure the right IP rated driver being selected according to OEMs' gearbox type

| OEMs' Gearbox | Protection from moisture | IP67 | IP66 | 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 the power water jet | IPX5: protected against water jets | N.A |
| No gearbox | Water immersion longer than 30 mins | ✗ | ✗ | ✗ | ✗ |
| | Water immersion less than 30 mins | ✓ | ✗ | ✗ | ✗ |
| | Water jets | ✓ | ✓ * | ✗ | ✗ |
| | Water splashing | ✓ | ✓ * | ✓ * | ✗ |
| Open gearbox (with holes) | Water immersion longer than 30 mins | ✗ | ✗ | ✗ | ✗ |
| | Water immersion less than 30 mins | ✓ | ✗ | ✗ | ✗ |
| | Water jets | ✓ | ✓ | ✓ | ✗ |
| | Water splashing | ✓ | ✓ | ✓ | ✗ |
| Sealed gearbox (IP65+) | N.A | ✓ | ✓ | ✓ | ✓ |

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

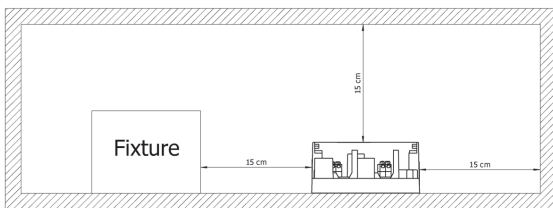Driver IP mapping for typical application

| Application | Gearbox | Applicable Driver IP rating |
|---|---|---|
| Road/Tunnel/Flood | w/o gearbox | IP67/IP66 |
| Road/Tunnel/Flood | w/ open gearbox | IP67/IP66 |
| Road/Tunnel/Flood | w/ sealed gearbox(IP65+) | IP67/IP66/IP65/Built-in |

IP67 fixed output connector version



IP67 1-10V dimmable output connecter version



>25mm



Fixture

15 cm

15 cm

15 cm

## Installation

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

### For independent drivers

1. It's recommended to mount the driver, including connectors on the cooler area of the luminaire. Verification of the Tc is always mandatory.
2. Putting too much stress on the cables or bending the cables with too much angle can cause seals to leak. The diameter of the bending circle should exceed 25mm.
3. In case driver being used in three-wall condition for the independent application, make sure to keep at least 150mm distance from the body to wall for the sufficient thermal dissipation.



15cm Min
15cm Min
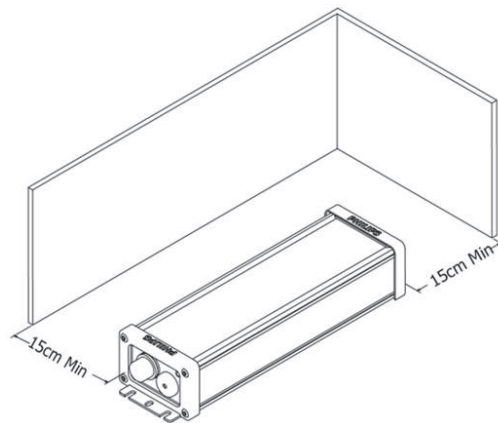
4. Make sure to keep the driver dry, acidfree, oilfree, fatfree and at least 15cm distance from the body which is not the mounting surface to wall for the sufficient thermal dissipation and do not exceed the maximum ambient temperature (ta) stated on the device.
5. The water proof connector has to be fully tightened to prevent the water leaking into the connection in the filed application.
6. Water could be absorbed through the end of cable. The end of cable shall be sealed inside an IP65+ chamber.
7. Intense exposure to sunlight (UV) will make the seals brittle over time causing water leaks. It's recommended to cover the electrical connections to avoid this risk, also to avoid cables being damaged by wildlife.
8. For the additional accessories used in the luminaire, please consider the relevant IP rating.
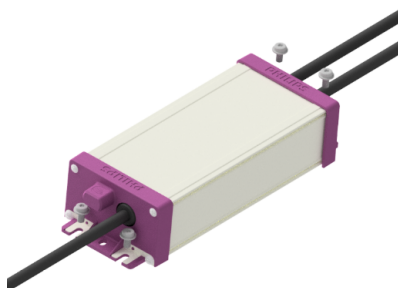
IP67 independent driver installation
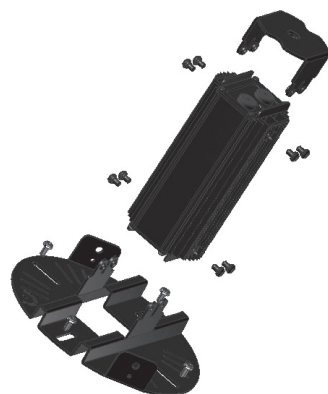


Highbay driver installation



GL RSHB driver and module installation



Design-in guide Philips Xitanium Outdoor
LED drivers

9. Cannot be used in a marine environment without additional protection against salt.

10. In a Class I system the driver has to be well connected to the protective earth of the installation for safety and reliability consideration.

11. For the independent driver installation, four M4 screws with washer are recommended to be used for driver mounting, recommended torque for screw is 0.9N.m.

12. For the Highbay driver installation, GB818-76 M5x8 Screw is recommended to be use for driver mounting with the top cover and bottom plate.

### Notes:

1. Driver is certified to be used with the controls co-located within the Luminaire.

2. In case of the EMI test failure for the independent use, a list of external EMI filter can be offered. Please contact with Philips key account manager or sales representative for support.

3. Driver is only suitable for Class I system.

4. For GL RSHB driver, if UL is required in luminaire, plastic bottom cover can't be exposed. Recommend Signify RSHB module. It can perfectly fit GL RSHB driver. Otherwise adding metal or 5VA flame retardant material to cover it by users.

### For built-in drivers

1. The drivers must be installed within a sealed enclosure with IP65+rating.

2. The wires should not be bended more than 3 times in same position, and the bending angle at outlet position should not exceed 60˚ to prevent wire breaking. A circle is suggested to be used to avoid too much bend angle when we have to make the wires go reverse direction.

3. In actual application, if it's necessary to add extra weight at the wires, eg. bead, the extra weight should be fixed properly so as not to bring extra stress to the wires to avoid the wire break in vibration.

4. The grounding can be achieved via the screw hole. A grooved metal washer is suggested to be used for better grounding reliability.

5. The driver is only suitable for Class I system, so it has to be well connected to the protective earth of the installation for safety and reliability consideration.

6. For the built-in driver installation, four M4 screws with washer are recommended to be used for driver mounting too, recommended torque for screw is 0.9N.m.

**Note:** Driver is certified to be used with the controls co-located within the Luminaire.

## For drivers with connecting lead cables

Where the luminaire is delivered with connecting leads (tails) and without a means of connection to the supply, the manufacturer of the lumianire shall specify which terminal block may be used which shall conform to IEC 60998-2-1 or IEC 60998-2-2; either the terminal block to be used shall be specified or the following shall be defined:

- To comply with the safety regulations, it is recommended to use the IP rated connectors which is same or higher than the driver.
- Rated voltage and current are recommended to follow the spec of the driver.

# Controllability

## Control characteristics
### Control input

| | |
|---|---|
| **Regulating level** | 100% down to 10% |
| **(module dimming)** | 100% down to 5% |
| | 100% down to 1% (H2-2013) |

The driver's dimming range is stated in the respective datasheet on www.philips.com/technology . The control input complies with EN 60929 (Annex E) and is compatible with Philips Lighting control equipment

| | |
|---|---|
| Standby power consumption | < 500 mW |
| Control input insulation, basic | ≥ 1500 V AC |

### Dynamic resistance
The Xitanium drivers are designed to driver and dim LED loads with a specified minimum dynamic resistance of the load, stated in the drivers' datasheet. This has been tested and released with the Philips Fortimo LED modules. LED loads which have a dynamic resistance outside the specification of the driver may cause instabilities and should not be used in combination with this driver.
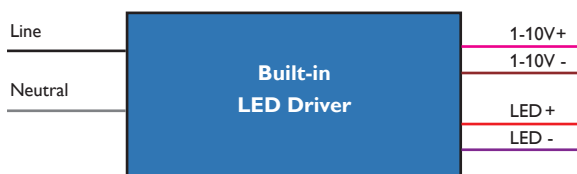When instabilities during deep dimming (e.g. to 1%) are observed, it is recommended to increase the minimum dim level by adjusting the DALI minimum dim level.

### Non-dimmable
The current of the non-dimmable Xitanium drivers can be set with Rset within the operating window. During normal operation, the set current cannot be changed.
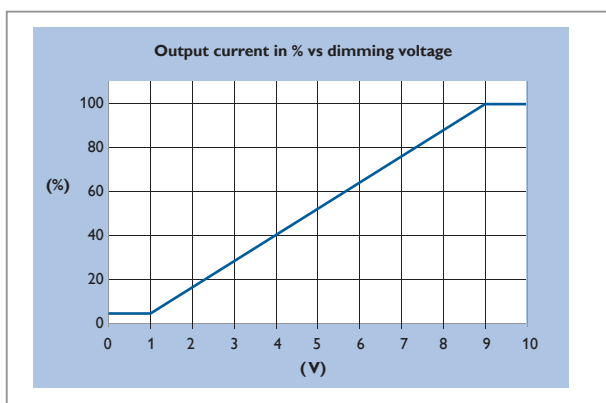
LED driver with 1-10V dimming interface



LED driver with 1-10V dimming interface



Output current in % vs dimming voltage



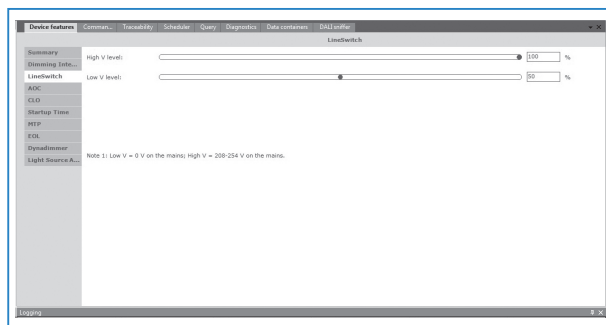Programming 1-10V dimming

## 1-10V Dimming

1-10V is a commonly used dimming interface for LED drivers. The interface requires 2 wires (1-10V + and -) to connect an LED driver to a 1-10V dimmer. The LED driver provides approximately 150μA sourcing current to the dimmer. A dimming curve is shown in Figure left.

Note that the output current at 100% level is determined by the driver. The minimum current that can be supplied by the driver is specified in the datasheet. The lowest dim level is defined by the higher of the two values: Minimum output current or 10% dim level for outdoor drivers.
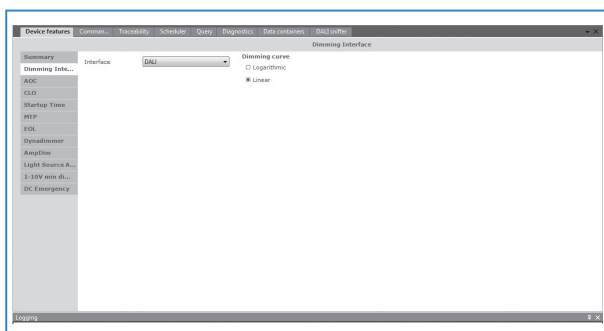
When long dimming wires are required in some applications, maximum length of the dimming wires can be estimated based on voltage drop on the dimming wires. The recommended max voltage drop on the two wires is 100mV.

Programming DALI



## DALI

Digital Addressable Lighting Interface, or DALI, is a digital communication protocol popular in the lighting industry. It is an IEC standard and there are many control devices from Philips and other manufacturers that communicate using DALI. The voltage across DALI wires is typically 16V (refer IEC specification for details) and it is polarity insensitive. The DALI wires can be run alongside input main wires and the maximum current on a DALI line is limited to 250mA.

Using DALI, it is possible to send dimming commands (1-254 levels), set fade rates and fade times, query driver or LED status, etc. Linear drivers also respond to LED-specific DALI commands e.g. query if the LED module is short circuit or open circuit; select between logarithmic or linear dimming curves, etc. Typically up to 64 DALI drivers can be on one DALI bus.

For more information on DALI, refer to the IEC specification for DALI protocol.
- **IEC 62386:**
  102 – General requirements – Control gear
- **IEC 62386:**
  207 – Particular requirements for control gear – LED modules.

## PWM

The PWM dimming protocol takes a 5V 250Hz (±25Hz) PWM as the input signal, and controls the LED current according to the duty cycle. It provides the best balanced to our customers in designing their dimmers and lighting systems, and can be expected to hold some sales volume in the marketplace.

- Simplicity (voltage levels compatible with microcontroller, low frequency PWM)
- Flexibility (auxiliary power supply given by LED driver, dimmer can be built up for more complex tasks like networking, GPRS, etc)

Integrated Dynadimmer settings



Dynadimmer virtual clock setting
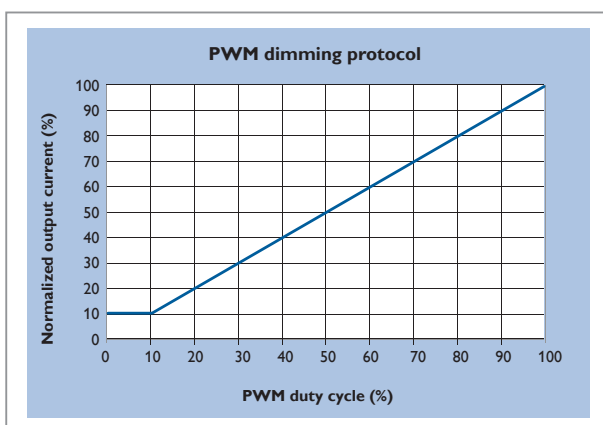
This document summarizes the design process of the PWM dimming interface and discusses some critical points in detail, attempts to make a standard building block out of it. However, every design has its special case that some part of the standard circuit may not apply. So the author also tries to point out reasons why such things came into being, as much as he can, aiming to help the readers to figure out solutions in their own work. But still the author cannot cover all aspects even for this very topic, limited by his knowledge and ability.

## Integrated programmable dimming protocols

### Integrated Dynadimmer

Dynadimmer is an external dimming control device developed by Philips that enables a simple, pre-programmed multistep dimming Programmable drivers offer an integrated version of this feature.

Integrated Dynadimmer allows dimming to predefined light levels based on the nightly operating time. With flexibility in setting time and light levels, the user can configure the driver for specific locations and application needs. Using Integrated Dynadimmer, it is possible to set up to 5 dim levels and time intervals. The driver does not have a real time clock. Instead it runs a virtual clock, determined by the length of nightly operating hours. After 3 ON-OFF cycles, the driver will calculate the virtual clock time. A valid ON-time is defined as a period during which the driver operates continuously for ≥4 hours to ≤24 hours. As shown in Figure 24, after repeating the driver ON-time for 3 consecutive days, the dim profile takes effect from the 4th day onwards. For more information on Dynadimmer scenarios please refer to Chapter 15.
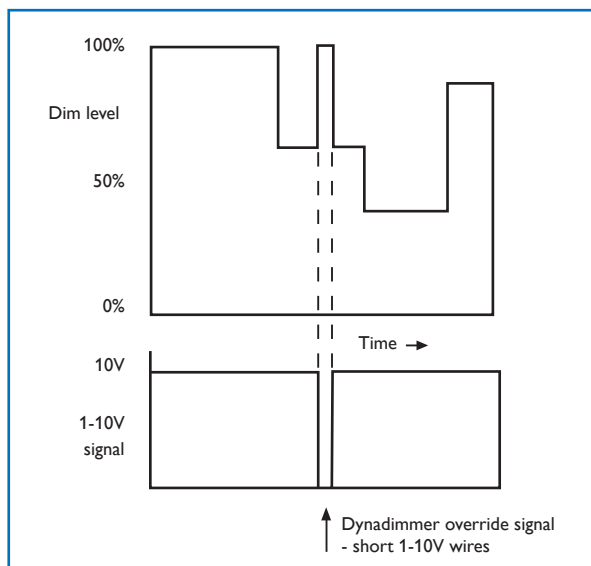
Newer driver types allow setting the predefined light level as low as 0% (OFF); in the near future all drivers will offer this option.
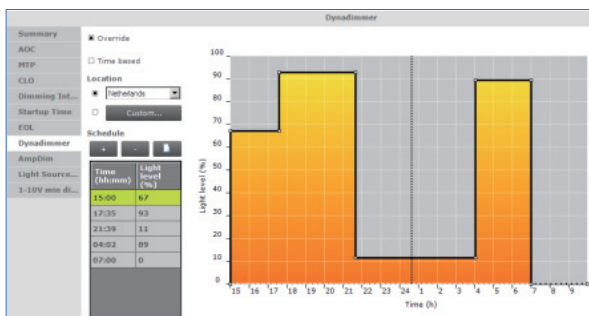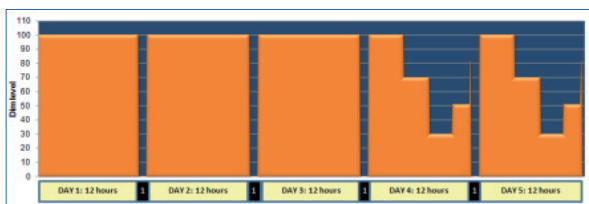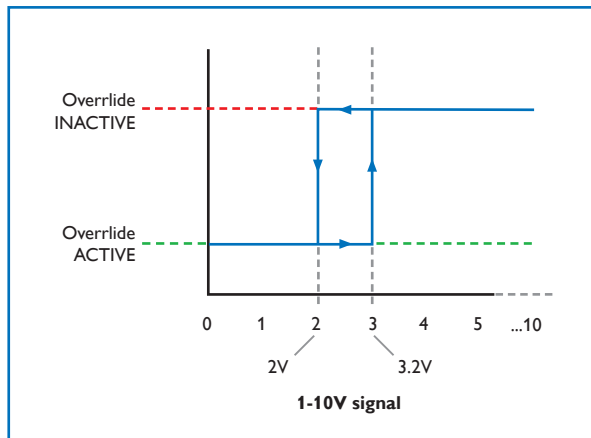
Dynadimmer override signal



Dynadimmer voltage threshold

## Dynadimmer Override

In some instances, there is a need to override the Dynadimmer dim cycle either manually or automatically. For example, luminaires in a parking garage may be configured to utilize the integrated Dynadimmer feature with a defined dim cycle. A motion sensor can be associated with one or more luminaires which, when activated by passing cars, can signal the driver to override the dim cycle and go to full light output. When the Dynadimmer Override function is enabled and the 1-10 V wires are shorted, the driver will override the active dim cycle and go to full light output. The driver will return to normal Dynadimmer dim cycle when the 1-10 V wires are open. As shown in Figure 25, the 1-10 V wires function as a switch in the Dynadimmer override mode. Figure 26 depicts the voltage threshold necessary to activate the override functionality and the hysteresis margin.
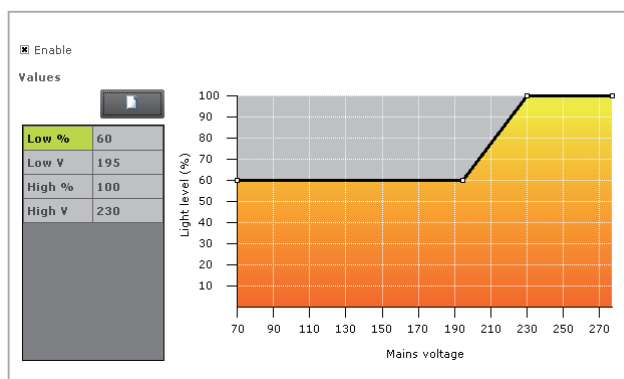
Programming AmpDim functionality

## AmpDim

Historically mains dimming was used on magnetic ballasts to dim conventional lamps. By lowering the mains voltage, a proportionate reduction in light output was achieved. Until now electronic ballasts were not able to replicate this function. AmpDim enables cabinet based dimming without the need for additional control wires or infrastructure changes.

A cabinet controller signals to the driver to lower the light output via a reduction in the amplitude of the mains voltage. The intelligence embedded in the LED driver allows for a pre-programming of multiple dimming levels based on the amplitude of the mains voltage.

The default range of AmpDim is 170 V – 250 V. The range can be customized via the programming interface. It is possible to set the Start Voltage, Start Percent, Stop Voltage, and Stop Percent. Shows an example of the AmpDim programming interface.

### Programming note

- There needs to be a minimum of 20 V difference between Start and Stop Voltage settings when programming the driver.
- There must be a minimum delta of 5 V in the mains voltage before the driver starts dimming. This prevents accidental dimming due to small fluctuations in the mains voltage.

| Parameter | Min | Max | Increments |
|---|---|---|---|
| Start Voltage | 170 V | 250 V | 1 V |
| Stop Voltage | 150 V | 230 V | 1 V |
| Start Percent | 30% | 100% | 1% |
| Stop Percent | 30% | 100% | 1% |
| Start Voltage - Stop Voltage | 20 V | 100 V | |

AmpDim programming parameters
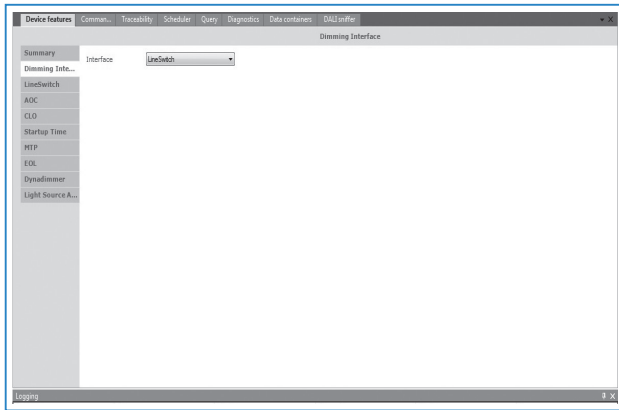
## LineSwitch

The LineSwitch feature operates by using the extra mains pilot line. This is a one-step dimming solution which enables dimming of groups of light points to a predefined level with only a simple switch controlled by a timer, presence detector etc.
Dimming to the desired level can be achieved by applying mains voltage to the LineSwitch driver input.
The pilot line wiring must be rated for the applied mains voltage. Copper diameter is not critical because this is a signal line with negligible current draw.
The driver mains input wiring is line- and neutral-polarized and its polarity should be observed.
The total pilot line cable length should not exceed 56m per driver based on a common parasitic cable capacitance of 100 pF/m.

The change-over from full light level output to a predefined dimming level can be achieved by either disconnecting the pilot line mains from or applying mains voltage in the range of 220 … 240V on the pilot line.

This feature can be enabled via the MultiOne Programming software in combination with the USB DALI programmer.

Configurable parameters are:
• Light Output in % when mains voltage (High V level) is present at the LineSwitch input:
• Light Output in % when no mains voltage is present (Low V level) at the LineSwitch input

Philips MultiOne hardware interface



Example of a shorted DALI interface

## How to... Connect to and program driver

### Connecting to a programmable driver

Xitanium Outdoor drivers are programmed via the Philips MultiOne configurator software. To do so, the driver must be connected to the computer via the MultiOne hardware interface.

This can be done with Programmable drivers only. Check the datasheet for the driver's ability on www.philips.com/technology.

For the latest version of the MultiOne configurator software please check www.philips.com/multione.

## How to... See the programming taking effect

### Programming time

Depending on the selected features to program, the programming time varies between 2 up to about 15 seconds. It is possible to program up to 64 drivers at the same time. In case of group programming there is no individual confirmation (verification) from each driver.

In order to have the programmed values take effect for Xitanium programmable LED drivers, the mains power needs to be cycled. For newer drivers (1% minimum dim level) On/Off via standby is also sufficient.

# Configurability

## Introduction

This chapter describes the way you can configure the drivers with the MultiOne Configurator.
Please check the datasheet of the driver on www.philips.com/technology to know if your driver supports configurability.

The characteristics of the MultiOne configurator are:
- One tool for all Philips configurable drivers: Xitanium LED Indoor and Outdoor drivers; HF-R Indoor fluorescent gear; DynaVision Xtreme HID electronic gear…
- Future proof by design: modular approach, very scalable and backwards compatible
- Provides access to all features built in the driver
- Tool combines configuration with debugging
- Settings of the drivers can be changed any point in the product lifecycle.

This configurator consists of:
1. Philips MultiOne Interface tool
2. USB cable (connection to PC or laptop)
3. Philips MultiOne Software

## Philips MultiOne Interface tool

There are 2 versions of MultiOne interface tooling depending on the type of communication:

### 1. LCN8600/00 MultiOne Interface USB2DALI

The interface that can be used with the MultiOne PC software to commission, configure, diagnose drivers via the DALI interface

### 2. LCN9600 MultiOne SimpleSet® interface

The interface that can be used with the MultiOne PC software to configure drivers wirelessly using SimpleSet® technology.

Note: The programming of the drivers with SimpleSet must be done while disconnected from mains.

When ordering the MultiOne Interface, the correct USB cable will be supplied with the interface tool. The tool can be ordered via your Philips sales representative or via the Philips OEM webshop, http://oemwebshop.philips.com.


MultiOne Interface USB2DALI


MultiOne SimpleSet® interface

## Philips MultiOne Software

There are 2 versions of MultiOne Software  depending on functionality and location:

### 1. MultiOne Engineering

Especially developed to access all functionality of the driver; to configure,  diagnose and prepare the configuration file for the production environment. Includes also:

- DALI commands, scheduler.
- SimpleSet®.

### 2. MultiOne Workflow

Developed to configure  all devices or subassemblies  in the production environment or field  in a simple and quick way.

Get your software (free downloadable) or check if you have the latest version via the website,
http://www.philips.com/multione.

## System requirements

The MultiOne configurator must be connected to a system with minimum system requirements:

- Windows PC or Laptop
- Microsoft Windows XP + SP3 or Windows 7, Windows 8.0, Windows 8.1
- USB 2.0 ports (preferable two free ports)
- Min 35 MB of free disk space
- Microsoft.NET Framework 3.5 SP1 (!)

## Getting Started

Connect the USB cable of the MultiOne Configurator between the PC and the configuration tool.
To install the software, launch the installation file for the latest version and follow the instructions on your screen. The installation wizard will guides through  the process of installing the software and will asks where the software needs to be installed, if a shortcut  is needed  on the desktop and a new program is also created in the Start Menu.

More information on how to program a driver, can be found in getting started and the instruction manual on the website,
http://www.philips.com/multione.

## MultiOne System





### Settings

The Xitanium  configurable LED drivers have a fixed set of features and factory settings when supplied. The set of features is defined in the datasheet  of the driver.
The default settings of the driver can be found  in the driver datasheet  in the download section on www.philips.com/technology

# Quality and Reliability

### Switching & cycling lifetime of LED drivers

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

In this section a description is presented of 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 cycling.

### 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.

Electronic Drivers for LED lighting are typically designed to last 50,000 operational hours. The reference for this lifetime is a typical user profile of 10-12 hrs usage and 1 switching on and off every day. 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.

## Impact of thermal cycles per day on the driver lifetime

As the drivers are typically designed to withstand 1 full thermal cycles every day, lifetime will reduce with an increasing 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 above graph.

**PCB solder joint cycling lifetime of LED drivers**
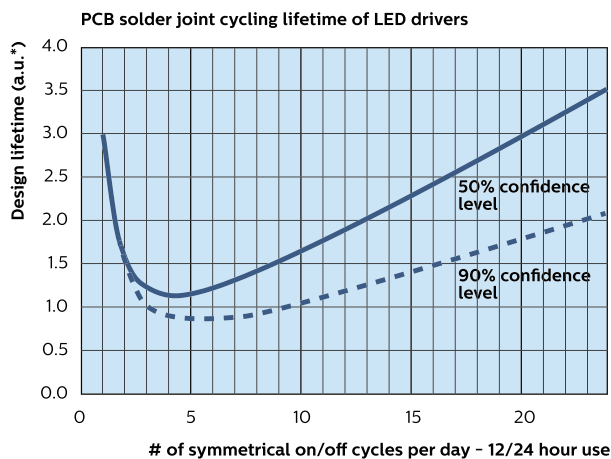


*) arbitrary unit value 1.0 means product design - lifetime will be reached (typical 50,000 h). Longer lifetimes can be limited by other failure modes.

Because of the large variation and differentiation between drivers and applications, it is an impossible task to specify the above 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 heat sinking (high T_max).
- Large difference between T_max and temperature in off state T_min (e.g. > 50 °C). See also next paragraph.
- Application @ temperatures < -40 °C T_ambient.

Especially if the above parameters occur in combination with each other there can be a risk for thermal cycling lifetime. To improve cycling lifetime when required, it is most relevant to decrease the T_max by appropriate heat sinking of the driver. As a rule of thumb 10 °C diminished ΔT between Tcase on/off, will add 30% to cycling 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 between T_max during the 'on' state and T_min during the 'off' state. The way the driver is built in to a luminaire is very important as this can decrease the temperature difference. Appropriate heat sinking of the driver is the most effective way to improve the driver cycling lifetime. As a rule of thumb 10 °C diminished ΔT between Tcase on/off, will add 30% to cycling performance.

## 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

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.

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**Design-in guide – Philips Xitanium Outdoor LED drivers**