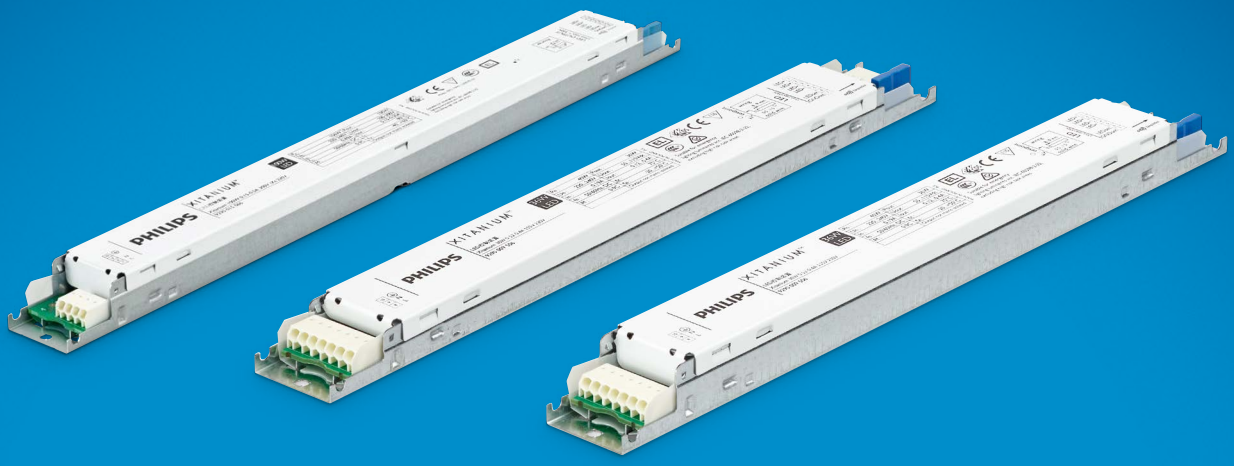
PHILIPS

Xitanium

LED indoor drivers

Linear



Design-in Guide

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

July 2023

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Introduction to this guide

Xitanium LED Indoor Linear drivers

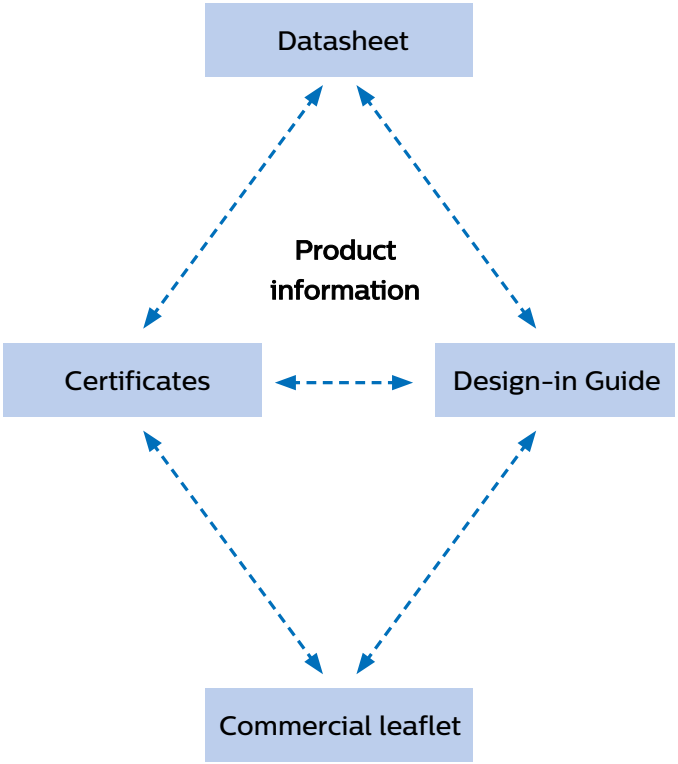
Thank you for choosing Philips Xitanium LED Indoor Linear constant-current drivers. In this guide you will find the information needed to integrate these linear-shaped drivers into a LED luminaire or LED system.

This edition describes the following driver types:

- Xitanium Dimmable DALI/Touch and Dim
- Xitanium Dimmable 1-10V
- Xitanium Non-dimmable
- Xitanium Single Current
- Xitanium Wireless MasterConnect (MC)

Applications

Xitanium LED Indoor Linear drivers are designed to be used built-in and to operate LED solutions for indoor lighting like offices, public buildings, industrial applications and retail environments. Specific design-in guides are available to enable easy integration of Philips LED drivers and Philips LED modules and can be found at www.philips.com/oem.



Information and support

Downloads and information

Please consult your local Signify office or visit: www.philips.com/oem.

Design-in support

On request Design-in support from Signify is available. For this service please contact your Signify sales representative.

Information overview

In order to provide information in the best possible way, Signify's 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
- Driver certificates list up-to-date compliance with relevant product standards

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

Warnings and instructions

Safety warnings:

- Avoid touching live parts!
- Do not use drivers with damaged housing and/ or connectors!
- Do not service the driver when the mains voltage is connected; this includes connecting or disconnecting the LED module!

Safety warnings and installation instructions, to be taken into account during design-in, manufacturing and installation

- Do not use damaged products
- Do not use Xitanium LED Indoor drivers in extra-luminaire-applications. All wiring must remain within the luminaire. Independent use is not supported.
- The luminaire manufacturer is responsible for its own luminaire design and compliance with all relevant safety standards including minimum required IP rating to protect the driver.
- The Xitanium LED drivers are suitable for built-in use only and must be protected against ingress of and exposure to including but not limited to water, dust, insects or any other chemical agent - be it in the gaseous, vapor, liquid or solid form- which can be expected to have an adverse effect on the driver (e.g. use in wet/corrosive/dusty environments). It is the responsibility of both luminaire manufacturer and installer to prevent ingress and exposure. Any suggestion from Signify with reference to minimum required luminaire IP rating serves only as a non-binding guidance; a different 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 application.
- Do not service the driver when mains voltage is connected; this includes connecting or disconnecting the LED module. The driver generates an output voltage of the driver that may be lethal. Connecting a LED module to an energized driver may damage both the LED module and driver.
- No components are allowed between the LED driver and the LED module(s) other than connectors and wiring intended to permanently connect the Xitanium driver to the LED module.
- The iSet interface of all driver types as well as the Rset and LEDset interfaces of drivers with no galvanic insulation between mains input and LED output are galvanically connected to mains and thus "live". Therefore, the setting resistor has to be made inaccessible to prevent the chance of electric shock.
- Adequate earth connections needs to be provided wherever possible.

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

Disposal

Please, inform yourself about the local waste disposal, separation and collection system for electrical and electronic products and packaging. Please act according to your local rules and do not dispose of your packaging and old product with your normal household waste. The correct disposal of your product will help prevent potential negative consequences for the environment and human health.

Introduction to Xitanium LED Indoor Linear drivers

Xitanium LED Indoor Linear drivers

Introduction

Xitanium LED Indoor Linear drivers are designed to operate LED solutions for general lighting applications such as linear lighting in offices and in industry applications. Reliability is underpinned with 5-year warranty, enhanced by specific features that protect the connected LED module, e.g. reduced ripple current and thermal derating. All Xitanium Linear LED drivers support central DC operation.

With Xitanium LED drivers, flexibility in luminaire design is assured thanks to an adjustable (selectable) output current. Application-oriented operating windows offer the flexibility required to provide the stable lumen output and light quality levels that lighting specifiers and architects demand. And the adjustable output current also enables operation of various LED module solutions from different manufacturers.

The remarkable energy savings and CO_2 reductions achieved with LED lighting can be further extended with dimming. Xitanium Indoor Linear LED drivers offer a range of dimming options. The 1-10 V interface allows for simplified one-way management, while the DALI interface makes any installation with the Xitanium Linear driver ready for a fully networked control system. Alternatively these DALI drivers also are suitable to interface with Touch and Dim dimming controllers. Wireless MC drivers offer the possibility for wireless control by external controllers and by our Philips field app MC.

Xitanium LED Indoor Linear driver versions

The Xitanium LED drivers described in this guide are available in different versions, e.g. both isolated (SELV) and non-isolated versions, non-dimmable and dimmable (1-10V, wireless and Touch and Dim & DALI) and come in a wide range of power and current ratings that enable the most popular light output levels for general lighting applications. We recommend you always check our Xitanium LED driver commercial leaflet for the most up-to-date overview of our range. This leaflet can be found in the download section at www.philips.com/oem.

Features

SimpleSet

Philips SimpleSet wireless programming technology allows luminaire manufacturers to quickly and easily program Xitanium LED drivers at any stage during the manufacturing process, without a connection to mains power, offering great flexibility. As a result orders can be met faster, while reducing costs and inventory.

For more information, please visit www.philips.com/multione or contact your local Signify representative.

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 newer LED generations.

Depending on driver type the output current can simply be set with an external setting resistor (referred to as Rset1, Rset2, LEDset or iSet) or be set manually by means of one or two dip switches.

DALI/TD drivers also enable setting the output current by using MultiOne configuration software and the appropriate programming interface.

More information about AOC and how to set the output current can be found in the section Electrical design. Information about configuring drivers with SimpleSet can be found in the section Configurability.

More information on Philips MultiOne configurator software and hardware interfaces can be found at www.philips.com/multione.

Controllability

Depending on driver type, the following controllability is offered:

- None (fixed output current)
- Analogue dimming (1-10V)
- Digital addressability (DALI) & Touch and Dim (TD)
- Touch and Dim (TD) only
- Wireless (MC)

Amplitude Modulation (AM) output dimming

Philips Xitanium indoor Linear LED drivers dim the output to the LEDs by means of Amplitude Modulation dimming (AM). This means at no stage of the dimming range Pulse Width Modulation dimming (PWM) at the output to the LEDs is involved. AM dimming guarantees the most smooth and flicker-free operation over the entire dimming range.

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 non-dimmable driver. The output current can be set as described in the section Electrical Design. More information about the dimming protocols can be found in the section Controllability.

Temporal Light Artifacts (flicker & stroboscopic effects)

A small inherent ripple is superimposed on the DC output current of Xitanium Indoor Linear LED drivers. This ripple consists of a low-frequency LF component (double the mains grid frequency) and a high-frequency HF component. This ripple current has such a low amplitude that Temporal Light Artifacts (flicker & stroboscopic effects) with camera systems other than possibly those for high-speed slow-motion HD recording are not be expected. The ripple values of both LF and HF components as well as the TLA values for short-term flicker (P_{st}^{LM}) and Stroboscopic Visibility Measure (SVM) can be found in the driver datasheet..

LED Module Temperature Protection (MTP)

MTP / NTC on LEDset; applicable to DALI/TD drivers only

The Module Temperature Protection (MTP) and NTC on LEDset are features that help to protect the LED module against overheating when operated in a hot ambient environment. The driver helps to regulate the LED module temperature by dimming the output current above a predefined temperature threshold. A prescribed NTC resistor must then be present on the LED module and be connected to the NTC or LEDset interface of the driver in order to enable this feature. Programmable drivers allow these LED module overheating features to be customized.

More important information on this feature can be found in the section Thermal Design-In at p.35 and 36 of this document.

Use in hazardous areas

Warning: the use of lighting control gear in hazardous areas is bound to very strict safety regulations. Xitanium indoor Linear LED drivers are **not** certified per standard IEC/EN 60079 and latest EU directive ATEX for use in hazardous areas in which there is risk of explosion. Therefore, these drivers do not directly support application in luminaires and lighting systems in such environments.

Constant Light Output (CLO) – TD 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 software and requires as input a table which specifies a percentage and a time variables.

CLO LITE – simplified

CLO LITE offers a simplified, straight forward approach for CLO. A schedule can be created that gradually increases the lamp's power level over time. By configuring the Maximum working hours and the Initial power level a linear schedule is defined which consists of up to 16 scenes (data points). The first scene starts at 0h and at the specified initial power level, which should be lower than the final power level, referred to as 100%. The last scene starts at the specified working hours and at 100% power level.

Note: The reliable use of Constant Light Output requires extensive LED specification assessment of life time behavior of LEDs. The CLO feature can be programmed with the Philips MultiOne configurator software and requires as input a table which specifies a percentage and a time variable.

More information can be found in the section Controllability and at www.philips.com/multione.

DC mains emergency operation (DCemDim)

Philips Xitanium indoor Linear LED drivers support operation on a DC power grid (e.g. central emergency system). On select drivers, the driver behavior once switched to DC input voltage can be configured via MultiOne software by means of the DC Emergency feature (DCemDim). By default, the output current of those drivers is reduced to 15% of its programmed output current at DC (emergency) operation. More details about DC input voltage suitability can be found in the driver datasheet.

All Xitanium LED Indoor Linear drivers supporting DC operation have a built-in fuse rated for AC and DC operation. Use of an external DC-rated fuse is therefore not required in case th driver is operated on a DC grid. The internal fuse characteristics are specified in the driver datasheet or available upon request.

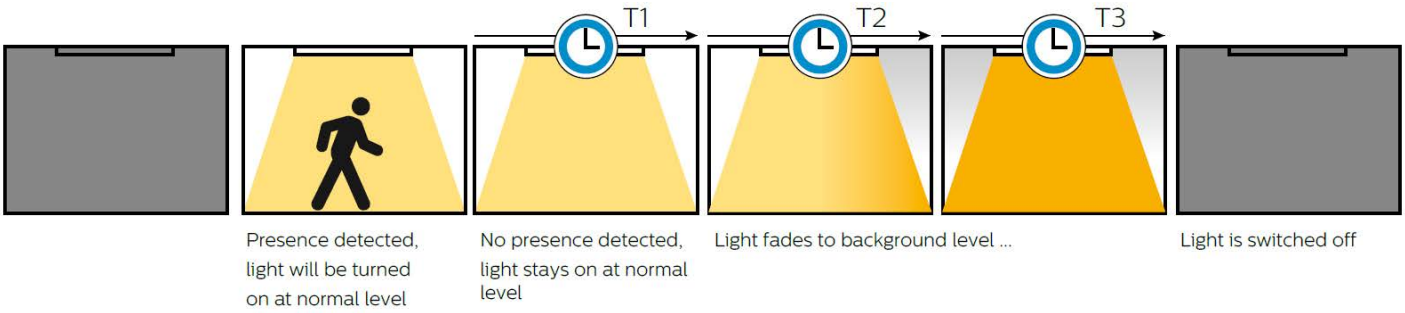
Driver behavior on LED module fault conditions
Open-load protection – If there is no LED module connected to the driver then the output current will drop to zero and the driver output voltage will rise to its maximum specified open-load voltage. When the driver detects this condition then it will shut down its output.

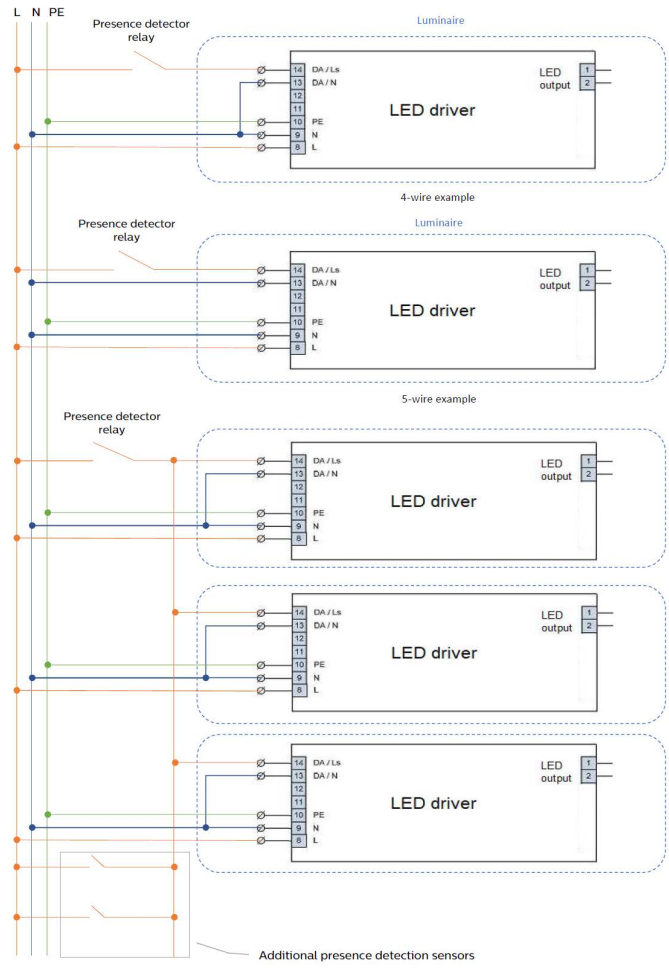
Output overvoltage detection – select driver types are equipped with intelligent LED module voltage sensing circuitry. If the driver detects abnormal dynamic behavior of the connected LED module (reflected by rapid and/or irregular changes in forward voltage) then the driver will shut down its output and resume operation automatically after 10 seconds. If the abnormal behavior is persistent then the overvoltage detection will act repetetively until power is turned off (hiccup mode).

Short-circuit protection – If the output of the LED-driver is short-circuit, the output current will momentarily rise while the forward voltage will drop to zero. When the driver detects this then it will shut down its output.

Overpower protection – If the specified maximum output power is exceeded (e.g. by a wrong LED module) then the output current will be reduced until the maximum allowable power is met again. This way the driver protects itself against overloading conditions.

Automatic recovery – If the fault condition is resolved and mains power is applied again, the LED driver will start automatically its normal way of operation at its designated operating point.





Connection examples for Corridor Mode

Corridor Mode

Applicable to DALI/TD drivers only

Corridor Mode is typically used in corridors, stairwells, entrance halls, storage rooms, underground carparks, pedestrian underpasses, underground railway stations and lifts. It is a simple, energy-saving function that controls the light level when presence is detected by means of a simple on/off presence sensor with a built-in mains relay contact. This feature is easy to use and can be activated using default parameters, so no driver programming via software is required.
When the sensor detects presence, the light is switched on. When it no longer detects any presence, instead of the light switching off immediately, the driver takes over control of the light level and dims it down to a lower background level before turning off the lights. The settings can be customized using the Philips MultiOne configurator software.

How does it work?

A simple mains presence sensor (based on e.g. PIR or RF) provides mains voltage to the driver Touch & Dim DA/Ls control input via an internal relay contact. When this control input detects mains voltage, it switches on the light to the normal level. When mains voltage is present on the control input for more than 55 s (default activation time), the driver changes over from DALI mode to Corridor Mode.

See the illustration on the left for several connection examples.

When the presence sensor no longer detects any movement, it will go into its own delay time while still providing mains voltage to the driver control input. After the delay time of the sensor has expired, the driver control input will no longer receive mains voltage and the driver will take over control of the light level by going into its preconfigured Corridor Mode sequence:

1. During the delay time the driver maintains the light at the normal level
2. During the fade time the driver dims the light to the background level
3. During the prolong time the driver maintains the light at the background level, after which the light is switched off.

If the presence sensor detects movement at any moment during the Corridor Mode sequence, the light will revert to the normal level.

Xitanium indoor Linear DALI/TD drivers incorporate the Corridor Mode feature. The datasheet will specify whether for the driver you have chosen this feature is present. For the default settings please check the associated datasheet of the driver you use, to be found in the download section at www.philips.com/oem.

The settings can be customized to suit your application using the Philips MultiOne configurator software. Please refer to the MultiOne user guide at www.philips.com/multione as well as to page 44 for more details.

Driver diagnostics and maintenance (actual measurements and logging) – DALI/TD drivers only

On select DALI/TD drivers the diagnostics functionality is available. The purpose of Diagnostics is to gather information and help diagnose the history of the driver and connected LED module. The diagnostics consist mainly of counters which keep track of specific variables like for example the number of startups of the driver, temperature of driver and LED modules, current and voltages etc. When the driver is shut down the diagnostics data is stored automatically in non-volatile memory. Depending on driver type, this diagnostics and maintenance feature is compliant per DALI part 253. Please refer to the MultiOne user guide at www.philips.com/multione more details.

Energy reporting

This feature provides on select drivers an indication of the (total) energy consumption of the device. Several values can be read; the actual power currently drawn, the total power consumption over life (from 0h) and the power consumption since last reset. The energy reporting feature has a metering accuracy is 10% and is not intended for billing purposes. Depending on driver type, the energy reporting is compliant per DALI part 252.

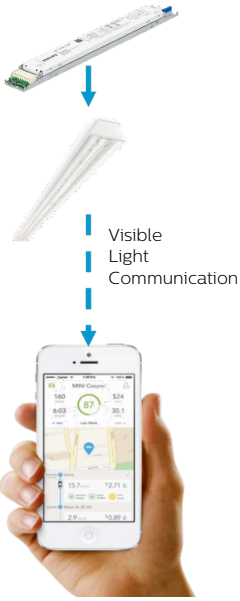
Traceability

The Traceability tab summarizes how many times the configuration of the device was changed, when the last configuration change happened using unknown software and a pane showing details of the first, second and last configuration change (if present). Every entry in the list shows the date of the configuration change, which software version was used and which type of interface was used at the time of the configuration change.

OEM Write Protection (OWP)

OEM Write Protection defines a password that will be set in the driver so the data of OEM Write-protected features can only be written to the driver by providing the configured password. Reading the properties is possible without the need of the password. Once a password is configured into the device, it is necessary to provide the current password when writing other features that are OEM Write-protected. These features are indicated by a padlock icon in the Write screen in MultiOne software. When the OWP feature is activated it is not possible to retrieve the currently configured password!

YellowDot



YellowDot ready LED driver enables LED board in YellowDot certified luminaire to send a unique code that can be detected by the front camera of a smartphone.

YellowDot software determines the real-time position and heading of the phone. Available as Software Development Kit (SDK) for integration into retailer mobile app.

Philips Lighting indoor positioning technology – YellowDot program

YellowDot program enables luminaires to be certified for interoperability with Philips LED indoor positioning technology.

Philips Lighting YellowDot program opens up indoor positioning technology to other lighting companies. The YellowDot program allows manufacturers to test and certify their LED luminaires to work with Philips' indoor positioning technology, and is supported by the launch of YellowDot Ready LED drivers in Europe. It addresses the growing demand from LED luminaire and retail customers for lighting based indoor positioning technology.

Philips Lighting's indoor positioning technology works by individual light points transmitting a unique identifier through a modulation of light that is imperceptible to the human eye but detected by the shopper's smart phone camera. The modulation of light is generated by YellowDot enabled LED drivers. Once shoppers download the retailer's app they can choose to access location-based services, such as locate items on their shopping list to a high accuracy. The data stream is one-way and no personal data is collected by the lighting system.

For information on how to design a YellowDot approved luminaire please contact your Signify contact. A Design-In Guide for YellowDot is available on request.

Dimensions

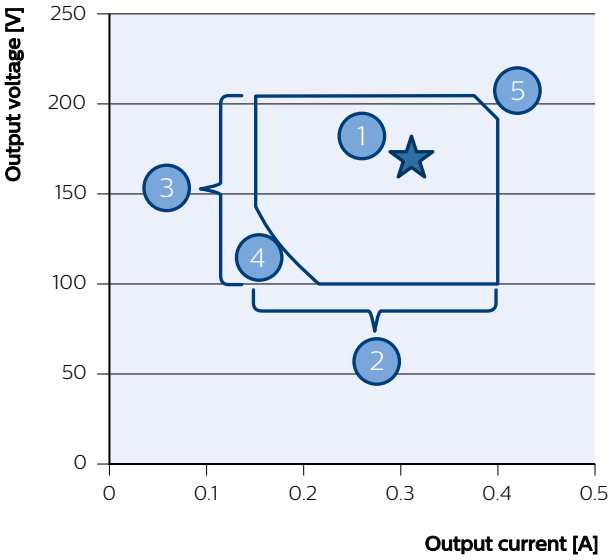
The housing of the Xitanium Indoor Linear LED drivers has a linear form factor compatible with typical fluorescent driver housing design. Exact dimensions can be found in the driver datasheet.

Explanation of the driver naming

The driver naming system is shown in the example below.

Example	: Xitanium 60W 0.08-0.35A 300V TD16CL 230V
Xitanium	: brand name for highly efficient and extremely reliable LED drivers
60W	: maximum output power
0.08-0.35A	: AOC output current range in A
300V	: maximum output voltage
TD	: dimming protocol (Touch and Dim & DALI)
16	: 16 mm driver height
CL	: Coded Light functionality
230V	: Rated mains AC input voltage 220-240V

Electrical design-in



Example of a Driver Operating Window

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

1. Required set point for the LED solution
2. Current can be set to needs within range
3. Driver adapts to required LED module voltage V_f, given it fits range
4. Driver minimum power limit
5. Driver maximum power limit
   Note: by means of dimming it is possible to go below the minimum value of the specified output current.

Xitanium driver operating window

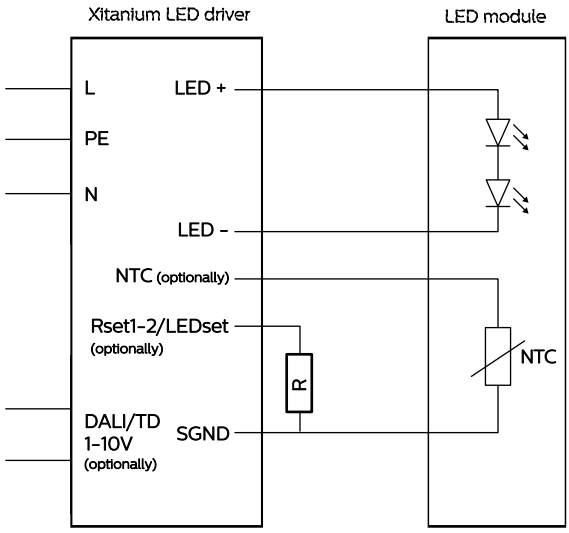
LED technology is rapidly evolving. Using more efficient LEDs in a next generation means the same light output can be achieved with less power, hence lower drive currents. At the same time, LEDs can be driven at different currents levels based on the application requirement. Typically, LED drivers are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

One of the key features of the Xitanium LED drivers is the adjustable output current (AOC), offering flexibility, differentiation for the OEM and future-proof luminaire design. The Xitanium drivers can operate in a so called “operating window”. This window is defined by the maximum and minimum ouput voltage (V), output current (A) and output power (W) 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, the specific LED module configuration and the desired light output per LED. The voltage is the sum of the LEDs used (total string forward voltage V_f). Both the operating window and default output current setting of every driver can be found in the driver datasheet.

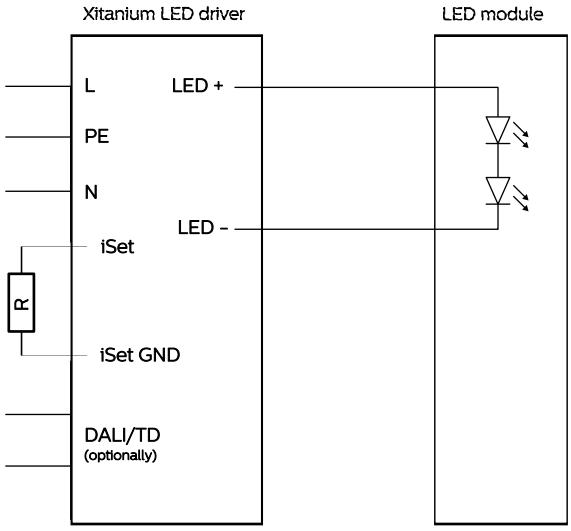
The output current of these drivers can be set in the following ways, depending on driver type:

1. By connecting a specific resistor value to the driver resistor interface (e.g. Rset, LEDset, iSet).
2. By using the AOC feature via the SimpleSet interface.
3. By using the AOC feature via the DALI/TD interface.

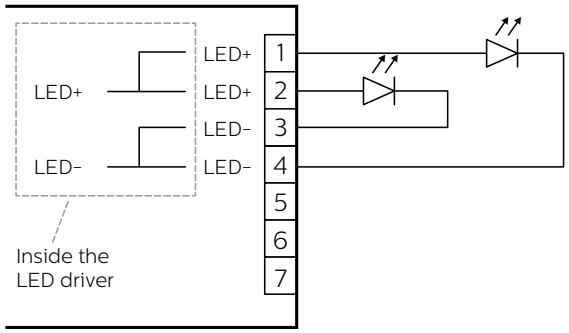
Warning: the forward voltage V_f of the connected LED module **must** remain within the specified driver operating window voltage boundaries under all application conditions! Otherwise, reliable driver operation cannot be guaranteed.



Schematic representation of Rset/LEDset driver connections



Schematic representation of iSet driver connections



Inside the driver the single output is split in two parallel-connected LED+ and LED- output connector poles to enable easy output wiring of multiple LED modules in the luminaire

How to... Select an appropriate driver

For a complete overview of suitable driver(s) for your application, please use the Easy Design-in Tool (EDIT) at www.easydesignintool.philips.com as starting point.

As an alternative, the following steps below will help in selecting suitable driver(s).

1. Determine your required output current I_{output} and voltage V_f.
2. Calculate required output power via $P_{output} = V_f \times I_{output}$ (W)
3. Select the datasheets from the website mentioned above based on the driver having a higher power than required.
4. Does required current fit current range of driver? - $I_{output_minimum} \leq I_{output} \leq I_{output_maximum}$?
5. Does required voltage V_f fit driver voltage range? - $V_{driver_minimum} \leq V_f \leq V_{driver_maximum}$?
6. Does required power fit power range of driver? - $P_{driver_minimum} \leq P_{output} \leq P_{driver_maximum}$?
7. Choose your type of control (TD/DALI, 1-10V, wireless or non-dimmable)

Driver connections

Examples of driver connections with corresponding functions can be seen in the figure on the left. More specific connection details can be found in the driver datasheet. The function of each wire will be discussed further in detail in the following chapters.

Single-channel driver

Currently all the Xitanium Indoor Linear LED drivers are single-channel drivers. This means for drivers with a double "+" and "-" output that the output connectors are connected in parallel inside the driver (see image on the left). This internal parallel connection enables simpler and less cluttered luminaire wiring without the need for wire splices between the driver and multiple LED modules. Note that only one output current can thus be set.

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

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

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)

Output open-load and short-circuit conditions

Xitanium Linear Indoor drivers can withstand output open-load and short-circuit conditions. These are to be considered abnormal driver conditions. Consequently, it is not recommended to use drivers as such. Neither is it recommended to switch the driver output by means of e.g. relays ("hot switching") to connect or disconnect LED modules.

How to... Use wires and cables

In the driver datasheet the following is specified:

- Supported wire cross section range in mm^2
- Recommended strip length of the wires
- Maximum LED output cable length (for EMC reasons)

Direct wiring between driver and LED modules

Be informed that no components are allowed between the LED driver and LED modules other than connectors and wiring intended to connect the LED driver to the LED module. E.g. it is not allowed to install a switch or a Surge Protection Device (SPD) between the driver and LED module(s).

Note: although the driver connectors sometimes allow for quite small wire cross section areas (down to $0.2mm^2$) it is recommended for optimal connectivity to use mains and LED output wires having at least $0.5mm^2$ cross section area.

For currents between 1.0 and 2A (rms/DC) per connector, a minimum cross section of $0.75mm^2$ is advised.

Two wires into one connector hole

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

Ferrules

The compatibity of twin-wire ferrules (or wire end stops), accepting the wires intended for use, should be checked with the supplier of these ferrules.

Adjustable Output Current (AOC)

–set driver output current via a resistor

The required output current can be set by connecting an external resistor (LEDset, iSet or Rset) into the corresponding driver interface. It may also be set manually by means of one or two dip switches. Next to that, DALI/TD drivers also support setting of the output current via software configuration instead without the need for a physical current setting resistor.

Warning: the LEDset, iSet and Rset interface do not support use as a general control or dimming interface. Please use the 1-10V/DALI/TD interface instead for that purpose. The max. advised wiring distance between the driver resistor interface and the current setting resistor (Rset, LEDset, iSet) is 0.6m. This wiring must remain within the luminaire. Do not (temporarily) interrupt connection between resistor interface and resistor by means of e.g. jumpers and switches when the driver is operational.

Warning: The iSet interface of all driver types as well as the Rset and LEDset interfaces of drivers with no galvanic insulation between mains input and LED output are galvanically connected to mains and are live. Therefore, the setting resistor itself has to be made inaccessible.

Default driver output current

The default output current is specified in the driver datasheet.

Drivers based on Rset1/Rset2 technology will go to the default output current if the Rset interface is left open (no setting resistor connected), while shorting the Rset results in the output current going to the minimum value.

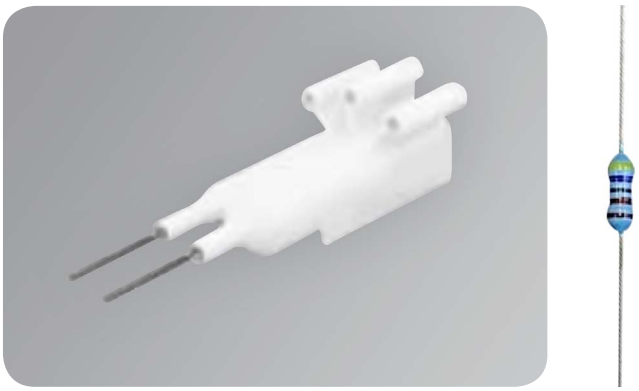
On the other hand, drivers based on LEDset/iSet technology have an undefined output current when the LEDset/iSet interface is either left open or shorted. Both open and shorted situations must therefore be avoided in the application. It is imperative to connect a resistor to the LEDset/iSet interface prior to powering up the driver.

In case the LEDset/iSet interface is shorted, the output of the driver will go to its maximum specified output power ($P_{out,max}$). However, the forward voltage V_f of the connected LED module defines if at $P_{out,max}$ the maximum output current (I_{output_max}) is also reached (refer to the power window graph point 5, in the section Electrical design-in section on p.15). The output current accuracy in this situation is lower compared to the one in which a resistor is used to set the output current. Exceptions are: the non-isolated Xitanium 36W and 75W Fixed Output drivers with the output current potentially reaching up to 133% of the specified I_{output_max} (530mA).

Drivers with a dip switch will deliver an output current depending on the position of the dip switch(es). E.g it can be either 200mA or 250mA or e.g. 300 or 350mA.

<table>
<tr><td colspan="3">Programming enabled
Yes / No</td></tr>
<tr><td rowspan="2">I_{output} = Programmed value</td><td>Rset connected
Yes</td><td>No</td></tr>
<tr><td>I_{output} = Rset Determined value</td><td>I_{output} = $I_{default}$</td></tr>
<tr><td colspan="3">Driver output current I_{output} should always be
$I_{driver\ min} \leq I_{output} \leq I_{driver\ max}$</td></tr>
</table>

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... Determine AOC priority with TD drivers

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

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

Group 1: 1% minimum dim level (newer drivers)

AOC programming (including SimpleSet) 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. $I_{programming} < I_{Rset}$? => priority for $I_{programming}$
2. $I_{Rset} < I_{programming}$? => priority for I_{Rset}

E.g. programming 200 mA has priority over an Rset value which would generate 250 mA.
And an Rset value that generates 200 mA has priority over programming 250 mA.

Note: the default output current is specified in the driver datasheet.

How to... Set the output current via Rset

Your lumen, your current

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

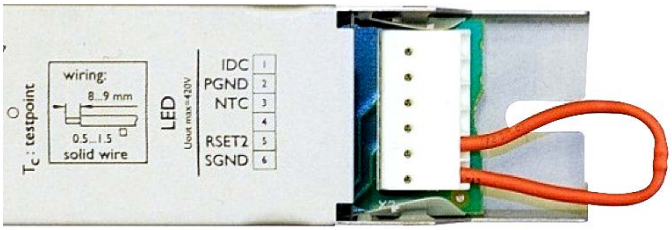
Why a resistor?

a) Worldwide standardized building block
b) Worldwide available and well-documented
c) Freedom to choose the supplier and value

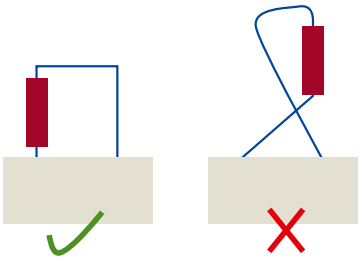
Resistor placed into driver enables you to

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

Example of improper use of a non-isolated Rset2 resistor; the bottom lead wire is positioned too close to the driver housing. Contact with the metal driver housing may result in driver malfuncioning or failure.



Example of proper use of a fully insulated Rset2 resistor



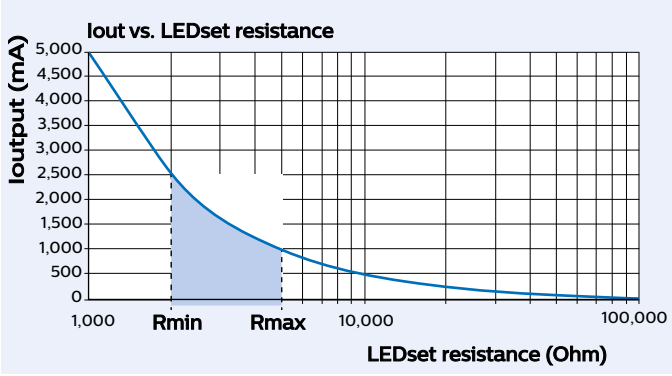
Resistor characteristics

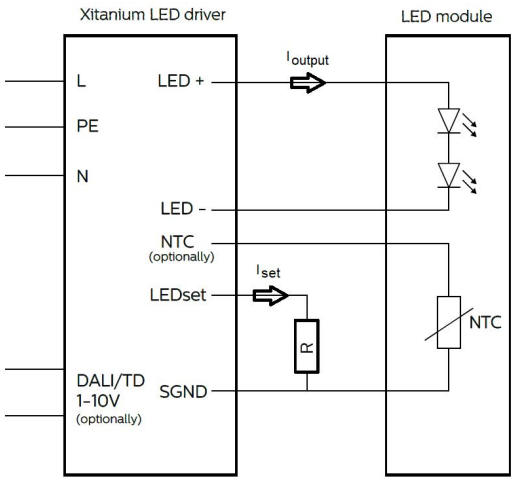
The use of a resistor allows for setting the required output current for a given LED module. This resistor can be a general-purpose leaded standard 1% tolerance resistor of e.g. 0.125W or 0.25W power rating and min. 50V voltage rating. This resistor will not be part of the electrical chain driving the LEDs, meaning it does not dissipate significant power.

Note: please ensure that the resistor body or its leads do not come into (close) contact with the driver housing or other conductive parts to prevent driver malfunctioning or driver failure. It is highly recommended to fully insulate the resistor; see the pictures on the left as an example.

Different ways of current settings are utilized in the Indoor Linear LED driver portfolio;

- Rset1: (older driver types); allows output current setting up to 700 mA
- Rset2: allows output current setting up to 2000 mA
- LEDset and iSet; (new industry standard); allows for higher output current settings. Please refer to the driver datasheet to look up which current setting method is supported.





LEDset resistor R used to set the driver output current

Rset1 and Rset2 use different pins on the driver The Rset1 and Rset2 resistance values with the corresponding output currents are shown in following tables at p.24-25. It is advised to select the nearest commercially available lower resistance value for the required output current.

How to... Set the output current via LEDset/iSet

The LEDset/iSet resistance values with the corresponding output currents can be calculated as shown below. It is advised to select the nearest commercially available lower resistance value for the required output current.

What does LEDset/iSet offer

Like Rset1 and Rset2, LEDset/iSet is an analogue interface, allowing basic output current setting. In addition, LEDset offers the additional functionality:

- Thermal protection of the LED module(s) via an NTC interface (NTC on LEDset)

Please refer to the driver datasheet for more Rset/LEDset/iSet connectivity details.

How does LEDset/iSet work

LEDset/iSet is based on a 2-wire connection between LED driver and one or more LED modules as shown in the figure on the left. A standard resistor R can be put directly into the driver LEDset/iSet interface or on the LED module.

The LEDset interface measures the current i_{set} which flows from a reference voltage source within the LED driver through the setting resistor R.

The current i_{set} flowing through LEDset/iSet setting resistor R is determined by the following equation:

$$i_{set}\ [A] = 5 / R\ [\Omega]$$

A driver with LEDset/iSet interface is able to measure i_{set} and to set the driver output current I_{output} dependent on the measured value of i_{set} according to this equation:

$$I_{output} = i_{set} \times 1000\ [A]$$

Therefore the overall relationship between the setting resistor R and I_{output} is then given by:

$$I_{output}\ [A] = (5 / R\ [\Omega]) \times 1000$$

To calculate the required setting resistor value R for a desired output current I_{output} :

$$R\ [\Omega] = (5 / I_{output}\ [A]) \times 1000$$

The LEDset/iSet interface is intended to cover a output current range from 50mA to 8A. The corresponding value for the LEDset/iSet resistor R is therefore within the range from 100,000 Ohm to 625 Ohm. The actual supported minimum and maximum output current values are dependent on driver type and can be found in the driver datasheet.

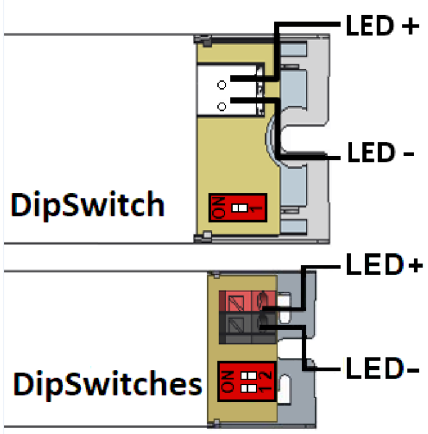
LEDset + NTC on LEDset (does not apply to iSet)

Once the NTC on LEDset feature is enabled, the LEDset AOC functionality is no longer enabled. The required output current must then be configured by means of MultiOne software instead.

How to... Set the output current via a dip switch

Select driver types (suffix: DS) support setting the output current manually via one or two dip switches with the choice of several different discrete values (e.g. 200/250mA or 300/350mA). See the illustration on the left. Please refer to the driver type plate to find out which switch position(s) correspond to the required output current.

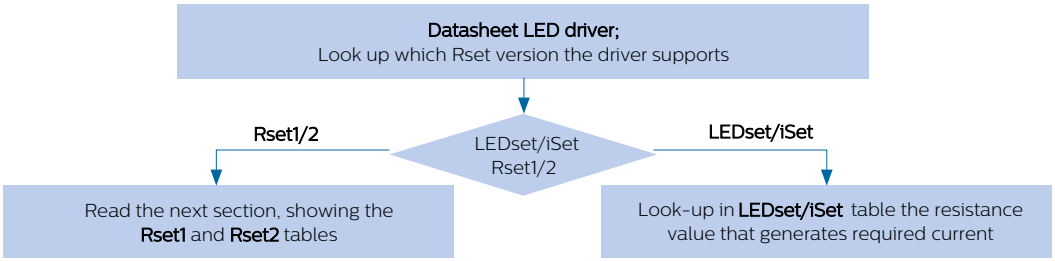
Warning: do not activate the dip switches when the driver is powered up. Disconnect the driver from mains voltage first before activating the switch to set the driver to a different output current.



Example of dip switch (DS) drivers

Top driver: single dip switch, enabling two discrete output current values

Bottom driver: two dip switches, enabling four discrete output current values

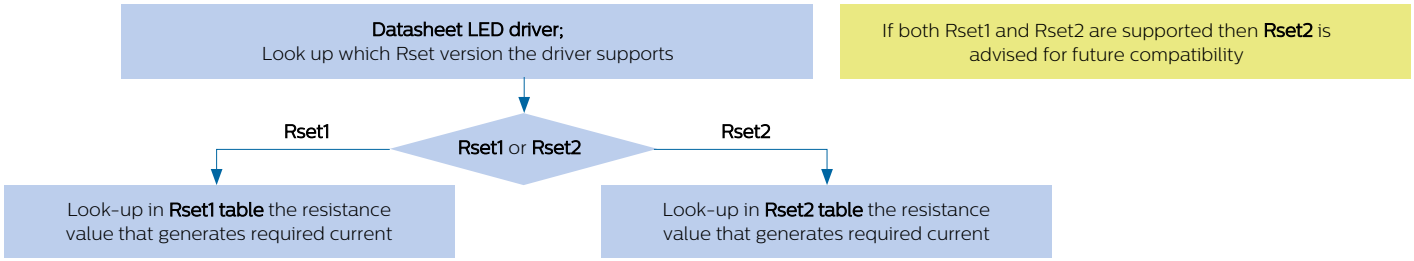


Note on E-series: in electronics, international standard IEC 60063 defines preferred number series for amongst others resistors. It subdivides the interval between subsequent values from 1 to 10 into 6, 12, 24, 48, 96 etc. steps. These subdivisions ensure that when some arbitrary value is replaced with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

LEDset/iSet – Resistor table (E96 series)

R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]
open	avoid*	23700	211	11000	455	5110	978
100000	50	23200	216	10700	467	4990	1002
83333	60	22600	221	10500	476	4870	1027
71428	70	22100	226	10200	490	4750	1053
62500	80	21500	233	10000	500	4640	1078
55555	90	21000	238	9760	512	4530	1104
49900	100	20500	244	9530	525	4420	1131
47500	105	20000	250	9310	537	4320	1157
45300	110	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	avoid*

*: Avoid leaving the LEDset/iSet interface as open-circuit or shorted to avoid instable driver operation. Always connect a LEDset /iSet resistor in the range of 2490 ... 100,000 Ohm. Leaving the LEDset/iSet interface open-circuit is only supported in case the driver supports disabling the AOC External Rset feature by MultiOne software.



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, showing smaller increments

Rset1 – Resistor table (E24 series)

R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [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	**Open**	default

Rset2 – Resistor table (E24 series)

R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]
shorted	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	**open**	default
330	204	1k5	602	6k8	1402		
360	215	1k6	632	7k5	1454		
390	228	1k8	684	8k2	1503		

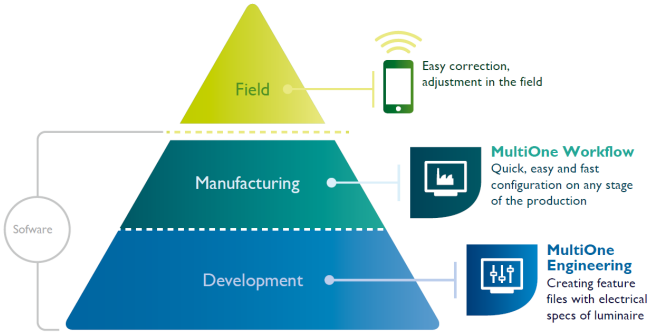
Rset priority for drivers supporting Rset1 and Rset2

Rset1	Rset1	Driver status
Open	Open	Driver default output current (see datasheet)
Rset	Open	Rset1
Open	Rset	Rset2
Rset	Rset	Rset2
Shorted	Open	Rset1 (driver minimum current, see datasheet)
Shorted	Shorted	Rset2 (driver minimum current, see datasheet)
Open	Shorted	Rset2 (driver minimum current, see datasheet)

Please refer to the datasheet to look up which Rset type(s) the driver supports.

Rset2 – Resistor table for finetuning (E96 series)

R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]	R [Ω]	Iout [mA]
shorted	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	4990	1226	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	2150	768	5620	1295	14700	1783
124	113	324	201	845	400	2210	782	5760	1308	15000	1793
127	115	332	204	866	407	2260	793	5900	1322	15400	1802
130	116	340	207	887	414	2320	806	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	21500	1926
182	139	475	263	1240	527	3240	982	8450	1518	22100	1936
187	141	487	268	1270	536	3320	996	8660	1531	22600	1943
191	143	499	273	1300	545	3400	1009	8870	1544	23200	1952
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
215	153	562	297	1470	594	3830	1075	10000	1604	26100	1989
221	155	576	302	1500	602	3920	1088	10200	1614	26700	1996
226	158	590	307	1540	614	4020	1103	10500	1629	27000	2000
232	161	604	313	1580	626	4120	1117	10700	1639	open-circuit	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		



How to... Program the output current

Xitanium LED drivers offer a tailored range of controls, enabling customizable luminaire design and performance. It is possible to control light output levels, preset dimming protocols and set system specifications in the factory and even in the complete installations. This can be done with the Philips MultiOne configurator. The MultiOne configurator is an intuitive tool that unlocks the full potential of all configurable drivers from Signify, ensuring that the driver performance matches the needs of the lighting solution. It offers unprecedented flexibility, before, during and after the product installation. Programming of new Xitanium LED drivers can be done either by SimpleSet and/or by the DALI/TD interface.

Please check refer to the driver datasheet to find out which configuration option(s) are supported.

For more information on MultiOne installation – software and programming: go to www.philips.com/multione.

Mains voltage fluctuations and behavior

Xitanium LED Indoor Linear drivers support operation on power sources or grids providing a clean and symmetrical sinusoidal AC voltage wave form as well as on a clean DC voltage or rectified sinewave input voltage ("joker voltage"). Operation on power sources including but not limited to having e.g. a square-wave voltage form or a "modified sinewave" is not supported.

Xitanium LED Linear Indoor 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 for 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 can be found in the driver datasheet.

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

Mains fluctuations

The use of Xitanium LED drivers inside luminaires ensures that mains voltage fluctuations up to a certain level are not visibly transferred to the LEDs. Thanks to the driver-internal Active Power Factor Controller (PFC) the Xitanium LED drivers draws a sinusoidal input current, in phase with the input voltage. Mains voltage variations are compensated for by the PFC; therefore this kind of disturbance has no effect on the light output.

Allowable voltage difference between mains input and Touch and Dim interface

The Touch and Dim interface is rated for use in a 3-phase 230/400V grid, therefore supporting the use of Touch and Dim control from one phase while power to the driver is supplied by one of the other two phases.

Low mains voltage

A continuous low AC voltage (<202Vac) may have an adverse effect on the driver 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 driver ambient temperature.

Excessive high mains voltage

An excessive high mains voltage will stress the driver and have an adverse effect on the lifetime. Xitanium LED Indoor Linear drivers will survive an input overvoltage of 265 ... 320Vac for a period of max. 48 hours and 320 ... 350Vac for a period of max. 2 hours.

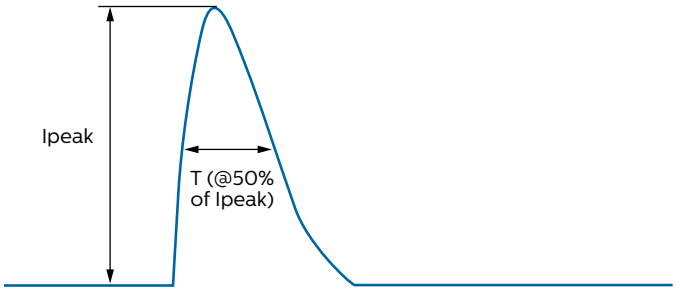
A loose neutral condition has to be avoided as this may reduce the lifetime dramatically. Immediate driver failure may occur if the driver is connected to 400Vac as a result of a connection error in a 3-phase 230/400Vac grid.

DC emergency operation

The Xitanium Indoor Linear LED drivers are able to operate on DC voltage on the mains input, e.g. when connected to a central DC emergency grid. These drivers support operation both a flat DC input voltage as well as operation on a rectified sinewave "joker" input voltage. Depending on driver type, the driver is released in compliance with lamp control gear standards as stated under “Emergency standards” in section “Quality” at the end of this document. As a result these drivers are suitable for emergency luminaires in compliance with IEC 60598-2-22, *excluding high-risk task areas*.

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 supported DC input voltage range is specified in the driver datasheet. Values outside the performance range will have an adverse effect of driver performance and reliability.



Graphical representation of inrush current

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
D	4	80
D	6	130
D	10	210
D	13	280
D	16	350
D	20	470
D	25	550
D	32	700
D	40	940
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

The max. recommended amount of drivers in the table above is based on inrush current and only serves as guidance. The actual maximum amount in the application may differ; it is dependent steady-state current, MCB brand/type and inherent MCB tolerances.

DC emergency dimming (DCemDim)

On select Xitanium LED drivers, the DC Emergency Dimming feature DCemDim is available. This configurable feature allows a pre-defined dimming level of the driver output to which the driver will switch over automatically once connected to a DC (emergency) power grid. The factory default DCemDim level is 15% of the defined output current. The level can be set at a different level by means of our MultiOne software and configuration tools; depending on driver type it can be set down to 1% and up to 100%.

Depending on driver type, EL marking may apply. For those drivers the corresponding Emergency Output Factor EOFx range can be found in the driver datasheet.

Drivers which are not equipped with the DCemDim feature will maintain the same output current when switched over from an AC to a DC grid.

Inrush current

'Inrush current' refers to the briefly occurring high input current which flows into the driver during the moment of connection to mains; see the illustration on the top left. Typically, the amplitude is much greater than the steady-state input current. The cumulative inrush current of a, given, combined number of drivers may cause Mains Circuit Breakers (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)
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

Inrush parameters are driver-specific an can be found in the driver datasheet.

Max. recommended number of drivers per MCB

The maximum recommended amount of drivers on a 16A type B Miniature Circuit Breaker (MCB) is stated in the driver datasheet. In the conversion table on the left that stated amount is used as reference (100%). The maximum quantity of drivers on different MCB types and current ratings can be calculated by the reference (see driver datasheet) x 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 x 135% = 27.

Note: Keep in mind that in case a D type MCB is used that the steady-state current may be the limiting factor instead!

Notes:

1. Specified maximum number of drivers is based on simultaneous switch-on, e.g. by a central switch or relay.
2. 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.
3. The maximum number of drivers that can be connected to one 30 mA 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 drivers have elevated surge immunity. Depending on the grid conditions, additional protection against excessive high surge voltages may be required by adding a Surge Protection Device. The actual driver immunity level can be found in the driver datasheet.

Note for industrial Xtreme indoor drivers (iXt)

Xtreme Indoor Linear LED drivers (iXt) allow a higher maximum surge on the mains input (2 kV DM/4 kV CM) than on the control input (1 kV DM/2 kV CM). Therefore, Touch and Dim operation in environments with surges higher than 1 kV DM/2 kV CM are not recommended.

Protective conductor current

The Xitanium Indoor Linear LED drivers are designed to meet safety requirements per IEC 61347-1 standard. The specified value of the protective conductor current can be found in the driver datasheet. The test is done on driver level only. In a luminaire, this current may be higher, since the LED load may introduce additional current due to its inherent parasitic capacitance. Therefore, precautions may be required on luminaire level.

Tips on Total Harmonic Distortion (THD)

- THD is related to distortion of the supply current which a product (e.g. driver) is drawing from the mains.
- This distortion is caused by harmonic currents which are superimposed on the fundamental supply current (multiples of the fundamental mains frequency).
- The THD together with the phase shift (cos ϕ) is decreasing the Power Factor (PF) of a product.
- These harmonic current can affect electrical installation in terms of neutral conductor overloading in a 3-phase grid, caused by odd multiples of 3 times the fundamental mains grid frequency.
- All harmonic currents are leading to extra reactive power being drawn from the grid, increasing grid transmission losses.
- For all products complying to the standard IEC/EN 61000-2-3, the above stated effects are of minor importance since the harmonic distortion of the supply current is reduced sufficiently.
- In case of dimming, the relative content of harmonics may increase. However, the overall load on the electrical installation and the losses are decreasing in absolute terms.

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 while having sufficient immunity. Xitanium LED Indoor Linear drivers meet EMC requirements per CISPR15 for conducted and radiated emissions in Insulation Class I application. 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 configuration.

Cable length and EMC

Signify has successfully performed EMC tests for a total output cable length of 0.6m (cable length between driver and Philips Fortimo LED Line modules). Select drivers may allow for a longer length; please refer to the driver datasheet to look up the applicable maximum value. Since EMC performance of the luminaire is heavily dependent on the wiring itself, we advise for lengths exceeding the maximum specified length to repeat EMC testing to ensure compliance.

Remote mounting

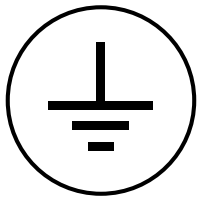
Xitanium LED Indoor Linear drivers are primarily intended for built-in use only inside/on a luminaire. Remote mounting or independent use will require additional measures like strain reliefs and may require additional measures for EMC compliance.

How to... Improve EMC performance

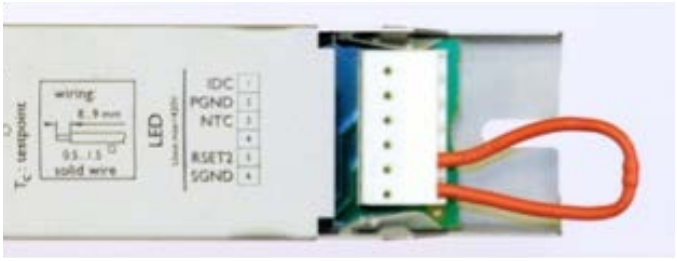
As mentioned before, the total amount of parasitic current needs to be minimized. For that reason, the following practical precautions need to be taken into account in a lighting system to minimize EMI:

- 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, TD, 1-10 V) separated from the output wires (do not bundle).
- Ground the lighting system chassis, driver housing and other internal metal parts to Protective Earth and do not let large metal parts “float”. Keep the protective earth wires as short as possible to minimize their inductance, use as much as possible large metal areas (chassis, mounting plates, brackets) for earthing purposes instead.
- Sometimes, radiated EMC compliance cannot be achieved, necessitating the use of a 100 ... 300 Ohm axial ferrite bead(s) for either mains or lamp wiring (effec-tive 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 Signify representative for additional design-in support.



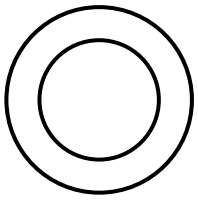
Symbol for Protective Earth (PE)



Example of a properly insulated Rset resistor

Warning

- Do not touch any non-insulated live parts, even on the output (secondary) side! Make all live parts inaccessible.
- This includes the NTC as well as iSet/Rset/LEdset resistor.
- Insulate the iSet/Rset/LEDset resistor to prevent accidental contact with the metal driver housing.



Symbol for Double Isolation between primary and secondary side of a driver. This symbol applies to drivers intended for built-in use only.

Electrical insulation and protective earth

One way to split the Xitanium LED Indoor Linear drivers is by isolated and non-isolated output driver versions.

Non-isolated drivers

These drivers have no insulation between the mains input and the LED output. Basic insulation is present between all internal (live) driver parts and the metal driver housing.

Therefore, the driver housing must be connected to Protective Earth (PE) as indicated by the PE symbol as shown on the left to ensure electrical safety. The bottom part of the driver housing (unpainted) may be used to create a protective earth contact to the luminaire housing, as the earth connector is internally connected to the driver housing. An intermittent earth contact should be prevented, as this is potentially unsafe and can cause negatively luminaire performance.

Note that all output connections of non-isolated drivers (incl. Rset/LEDset/iSet interface) are live and thus not safe to touch; therefore all these live parts must be made inaccessible.

Isolated drivers (SELV output)

These drivers have double insulation between the mains input and the LED output. Since basic insulation is present between all internal live driver parts parts and the metal driver housing, it is also required that the housing of this driver type be connected to PE.

Supported lumnaire Insulation Classes

All Xitanium LED Indoor Linear drivers fully support integration in Insulation Class I luminaires.

Although not recommended, the integration in Insulation Class II luminaires *may* be supported under the following conditions:

- Additional measures are taken on luminaire level to meet IEC60598-1 safety requirements.
- Level of conducted and radiated emissions on mains and DALI/1-10V control lines are in compliance with EMC standard CISPR15.
- DALI communication between driver(s) and controller(s) is not negatively affected.

Exposed live parts

Please note that certain driver types have exposed live parts in the form of PCB copper traces and pads next to the driver output connector. These live parts can be touched by bare hand and their location is indicated in the driver datasheet. Measures on luminaire level must be taken to make these parts inaccessible to eliminate the risk of electric shock.

Power grids

Xitanium LED Indoor Linear drivers are suitable for direct connection to TN and TT grids. Depending on driver type, a luminaire-based fuse in the driver neutral connection may be required in case both feeding phases are “hot”.

Warning: certain restrictions apply for use in IT grids. Direct connection of Xitanium LED Indoor Linear drivers is only permitted in delta connection with a phase to-phase voltage of 230Vac. In case the drivers are connected in star connection in a 230V/400Vac 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 must be connected to earth.

Output open-load and short-circuit conditions

Xitanium LED Indoor Linear drivers can withstand output open-load and short-circuit conditions. These are to be considered abnormal driver conditions. Consequently, it is not recommended to use drivers as such. Neither is it recommended to switch the driver output by means of e.g. relays ("hot switching") to connect or disconnect LED modules.

Thermal design-in

Introduction

This chapter describes two thermal aspects of the Xitanium Indoor Linear LED drivers:

1. The LED driver itself and relationship between case temperature point (tc) and lifetime of the LED driver
2. Module Temperature Protection (MTP) can be used to help achieve lifetime of the LED module

In order to facilitate thermal design-in of a LED driver, the critical thermal management points of the LED driver are set out in this section. Please familiarize youself with the following key aspects to achieve optimal thermal design-in of the driver.

1: Driver case temperature point (t_c point)

The driver case point temperature (t_c) is the only 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. Please use ***only*** the t_c point as reference to define thermal suitability of a driver in the application. Its temperature can be measured using a thermocouple that is firmly glued to the t_c point surface on 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).

2: Driver t_{c_life} value

The specified full driver lifetime and corresponding failure rate will apply as long as the t_c point temperature remains between the lower t_{a_min} and upper t_{c_life} limits.

3: Driver t_{c_max} value

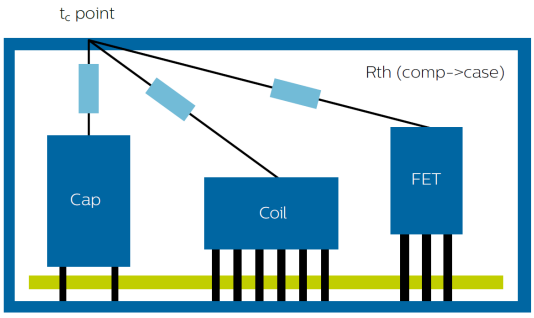
Select driver types support running at a higher temperature than the specified t_{c_life} temperature, up to the t_{c_max} temperature. Keep in mind that doing so will be at the expense of the driver lifetime and failure rate. A graphical representation thereof can be found in the driver datasheet. Running the driver above the specified t_{c_max} temperature is ***not*** supported and will negatively affect driver lifetime and void driver warranty. The ***only*** way to verify whether either t_{c_life} or t_{c_max} is exceeded in the application is by using a thermocouple. Please refer to the driver datasheet for the specified t_{c_life} and t_{c_max} values.

4: Driver minimum ambient temperature (t_{a_min})

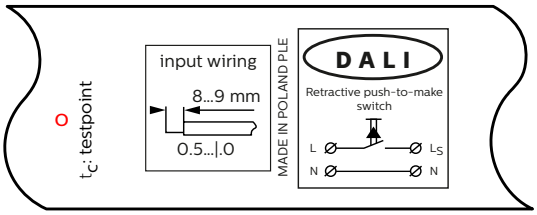
This lower limit value as specified in the driver datasheet stipulates the minimum ***luminaire*** ambient temperature at which the driver can be used, e.g. in frozen storage warehouses or (sub)arctic areas. Using the driver below its specified minimum t_{a_min} value is not supported and will negatively affect driver performance and lifetime. Driver warranty will then be void.

5: Driver maximum ambient temperature (t_{a_max})

Typically, the driver t_c point will reach its specified t_{c_max} value at the specified driver ambient t_{a_max} temperature ***inside*** the luminaire. However, if the driver is not running at full output power then the actual t_c point temperature may be lower than the t_{c_max} value. In that case a higher driver t_a is supported up to the point when the specified t_{c_max} value is reached.

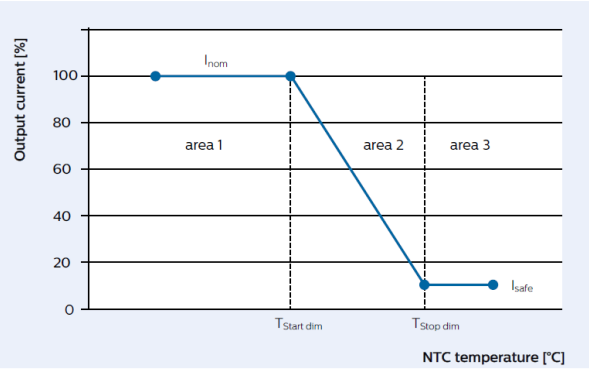


Schematically representation of internal thermal paths to the driver t_c point



Example of t_c point position (red dot) on driver housing

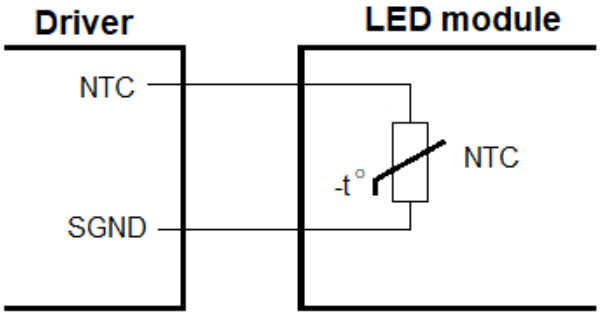
Driver output current vs. NTC temperature



Area 1: temperature of NTC < $T_{Start\ dim}$
The driver is operating at nominal output current, no temperature derating is active.

Area 2: $T_{Start\ dim}$ < temperature of NTC < $T_{Stop\ dim}$
Temperature derating is active, the LED driver dims down the output current linearly between I_{nom} and I_{safe}. The temperature of the LED module is monitored to adjust the current. Once the temperature becomes lower than $T_{Start\ dim}$, the output current will be back to its normal level I_{nom}.

Area 3: temperature of NTC > $T_{Stop\ dim}$
The LED driver limits the output current to a specified minimum value, I_{safe}. The temperature of the LED module NTC is monitored to adjust the current and will go back to Area 2 once the temperature decreases below $T_{Stop\ dim}$.



NTC connection diagram for Rset1 and Rset2 drivers

Note for LEDset drivers: once the MTP feature is enabled the Rset1/ Rset2 functionality is disabled for setting the output current. The output current can then only be set via the AOC feature, either via DALI or SimpleSet programming, depending on driver type.

6: Driver temperture readout in MultiOne Diagnostics

The "Driver temperature" readout via the Diagnostics function in MultiOne software (supported by select drivers) represents the temperature of a driver-internal thermal sensor.
Please do ***not*** use this readout to define thermal suitability of a driver for a given luminaire; this temperature readout does not represent the t_C point temperature and does not correspond 1:1 with the t_C point temperature. It is therefore not suitable as a reference for thermal design-in.

The thermal design-in of the driver inside the luminaire also influences the relation between the driver t_a temperature and t_C temperature. E.g. mounting the driver on an effective heatsink or placing it further away from LED modules will lower the t_C value at a given ta. The t_C point temperature is always leading with respect to t_{C_life} or t_{C_max}.

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 necessarily lower the temperature of critical components. Do not apply local heatsinking to improve intended thermal driver performance and/or to artificially lower the temperature of the t_c point.

LED Module Temperature Protection

Two different kinds of thermal protections for LED modules are offered, depending on driver type:

1:***MTP*** (applicable to select Rset1 and Rset2 drivers)
2:***NTC on LEDset*** (applicable to LEDset drivers)

For more information on configuration of MTP and NTC on LEDset features please refer to the MultiOne user guide at www.philips.com/multione.

Module Temperature Protection (MTP)

-Applicable to Rset1 and Rset2 drivers

The MTP feature helps to protect the LED module(s) when operated in a hot ambient environment. The thermal design of a luminaire should be designed in such a way that the maximum allowable temperature of the LED module (Tc-life or Tc-max) is not exceeded under normal application conditions. The utilization of a Negative Temperature Coefficient resistor (NTC) on the module serves the purpose to help achieve the lifetime of the LED module if external thermal influences result in the temperature for module lifetime (Tlife) being exceeded. If this happens then the driver output current will be reduced by default down to 10% to lower the running temperature of the LED module. See the graph on the left for details.

Three NTC types support the MTP feature:

1: 10 kilo Ohm NTC - Murata p/n NCP18XH103J03R

2: 15 kilo Ohm NTC - Vishay p/n NTCS0805E3153GMT

3: 15 kilo Ohm NTC - Murata p/n NCP15XW153E03RC
+ separate 390 ohms resistor in series with this NTC

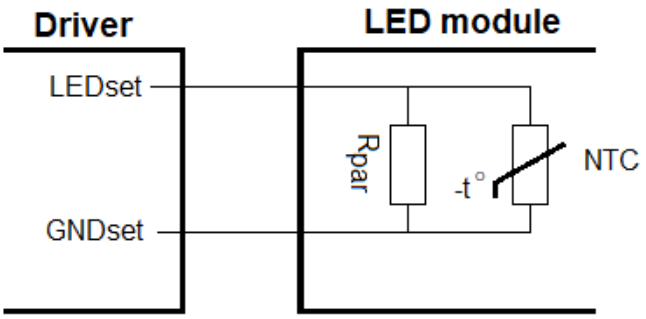
Other NTC types are supported. The applicable values for R(25°C) and β however need to be specified separately during MTP configuration in MultiOne for proper MTP behavior.

Cluster I	Value	Temperature with recommended circuit	Remarks
$R_{Start\ dim}$	27kΩ	70 °C	NTC= NCP18WM474J03RB R_{par} = 47kΩ
$R_{Stop\ dim}$	22.5kΩ	80 °C	
Derating Dimlevel	10%	-	Independent of driver minimum dim level

Cluster II	Value	Temperature with recommended circuit	Remarks
$R_{Start\ dim}$	10kΩ	70 °C	NTC= NCP18WM224J03RB R_{par} = 15kΩ
$R_{Stop\ dim}$	8.7kΩ	80 °C	
Derating Dimlevel	10%	-	Independent of driver minimum dim level

Cluster III	Value	Temperature with recommended circuit	Remarks
$R_{Start\ dim}$	4.7kΩ	70 °C	NTC= NCP18WF104J03RB R_{par} = 6.8kΩ
$R_{Stop\ dim}$	4.1 kΩ	80 °C	
Derating Dimlevel	10%	-	Independent of driver minimum dim level

Note: $R_{start\ dim}$ and $R_{Stop\ dim}$ values represent the equivalent resistance value of the parallel-connected R_{par} and the actual NTC resistance value.



NTC + R_{par} connection diagram for LEDset drivers

NTC on LEDset

-Applicable to LEDset drivers only

The NTC on LEDset feature is based on the same principle as MTP with two key differences:

1: The NTC type is dependent on the specified driver AOC range and corresponding cluster

2: An additional parallel-connected resistor R_{par} must be connected in parallel to the prescribed NTC

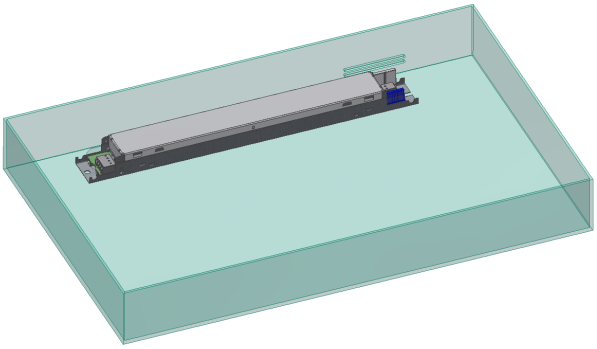
Three AOC-dependent clusters have been defined for Xitanium LEDset drivers as listed below in order to support the required thermal NTC on LEDset protection: see more details below and on the left to find out which NTC type and R_{par} value apply.

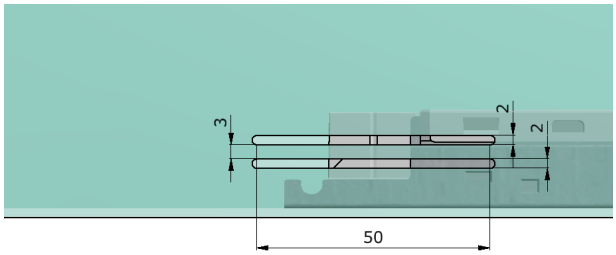
Cluster I	100mA – 500mA
Cluster II	300mA – 1000mA
Cluster III	700mA – 2000mA

Notes:

- Once the NTC on LEDset feature is enabled the LEDset functionality is disabled for setting the output current. The output current can then only be set via the AOC feature, either via DALI or SimpleSet programming, depending on driver type.
- Do *not* leave the LEDset interface open in case the feature NTC on LEDset is enabled. Otherwise, the output current will be reduced to the minimum value as supported by the driver.
- The iSet interface does *not* support the NTC on LEDset feature; it can only be used to set the output current.

Mechanical design-in: wireless MC drivers





Recommended dimensions of the two antenna slots:

- 2.0mm (±0.2mm) x 50mm (±5mm).
- two slots parallel with 3.0mm (±0.2mm) inbetween distance

General guidelines for proper integration of Philips Xitanium Linear Indoor MasterConnect drivers

- Follow general EMC guidelines as stipulated at p.30 and 31.
- Avoid placing metal parts close to the radio antenna as indicated by the white plastic cover.
- Keep at least 5mm clearance between the radio antenna and any metal part or wire.

The radio performance of the driver is depending on luminaire properties. In general, luminaires can be distinguished into three distinct types from radio performance perspective:

1: Fully or partly plastic luminaires ➔ no particular measures are required for radio performance.

2: Folded sheet metal luminaire ➔ in general no particular measures are required for radio performance. Keep at least 10mm clearance between the radio antenna and metal parts.

3: Extruded metal or cast metal luminaires. ➔ special attention needed for optimal radio performance. See below for details.

Folded metal sheet and extruded/cast luminaires

These types of luminaires generally attenuate the radio signals significantly and may result in bad radio performance. When releasing a radio-equipped driver in these luminaires a Total Radiated Power (TRP) measurement is recommended. Release limit should be > -7dBm.

General measures which may improve the radio performance for these luminaires are:

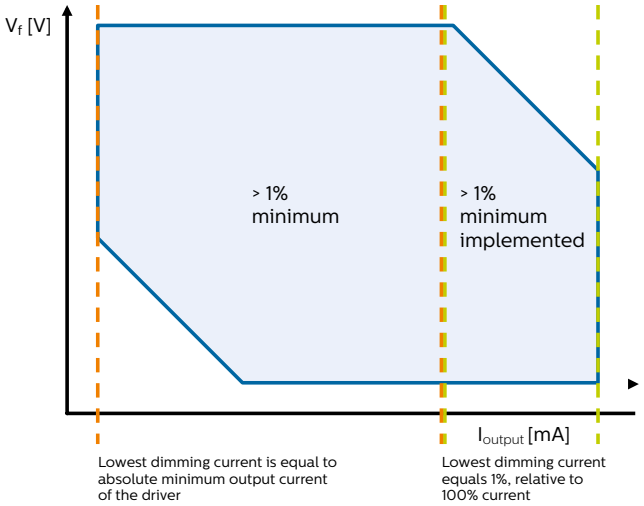
- Apply a set of two slots in the luminaire and place the radio-equipped driver in such a position that the radio antenna is facing these slots. The slots do not need the be covered from electrical safety point of view. The radio antenna for the radio equipped driver is indicated by the white plastic cover. The antenna is in the upper part of this cover. See the drawing on the left for more details.

- Apply a round or rectangular hole covered with plastic and place the radio-equipped driver in such a position that the radio antenna is close to this (covered) hole. For the hole to be effective the largest dimension should be at least 20mm.

MC driver/sensor distance limitations

- Max. guaranteed luminaire-to-luminaire distance: **5m** line-of sight (metal housing luminaires)
- Typical (but to be verified) luminaire-to-luminaire distance: **10m** line-of sight (plastic housing luminaires)
- Max distance switch-to-first-luminaire: **7.5**m line-of sight
- Max. BLE range for user to luminaire/sensor: **7.5m** line-of-sight (depending on smartphone brand and model)
- Field configuration: via BLE. Parametric setting set via the Philips MC field app

Controllability



Minimum dimming output current

Maximum selectable output current [mA]	Minimum absolute output current [mA]	Current range allowing for 1% dimming [mA]	Drivers examples
400	3	300...400	Xitanium 75W 0.12-0.4A 215V TD 230V
700	4	400...700	Xitanium 150W 0.2-0.7A 300V TD 230V iXt
2000	14	1400...2000	Xitanium 75W 0.7-2A 54V TD 230V

MC driver grouping attention points

- Maximum number of wireless drivers in a group: **40** (with no ZGP sensors or ZGP switches being part of the group)
- Maximum number of wireless drivers in a group with ZGP device(s): **25**
- Maximum number of switches in a group: **5**
- Maximum number of ZGP sensors in a group: **15** (minus the number of switches)

Control characteristics

Amplitude Modulation dimming

Philips Xitanium indoor Linear LED drivers dim by means of Amplitude Modulation dimming (AM). This means at no stage of the dimming range Pulse Width Modulation dimming (PWM) is involved. AM dimming guarantees the most smooth and flicker-free operation over the entire dimming range.

Dimming ranges

In the current driver portfolio there are several different dimming ranges applicable: e.g. 10-100%, 5-100% and 1-100%. Please refer to the driver datasheet to find out which range applies.

Note: for Xtreme Indoor Linear LED drivers (iXt) the allowed dimming range is dependent on ambient temperature (t_a). The influence of the ambient temperature on the minimum allowed dimming levels are stated in the table below. The applicable minimum dimming value should be set via the MultiOne configurator software, The default value is stated in the driver datasheet.

T_a -40..-25 °C	T_a -25..+50 °C	T_a +50..+60 °C
Minimum dimming 10%	Minimum dimming 1%	Minimum dimming 10%

Minimum dimmed output current

The driver min-max current range is by approximation a factor of 140. This means that a 1% minimum dimming current is not feasible for the full operating window. For the lower current part of the operating window the dimming level is limited by an absolute minimum output current of the driver (see illustration on the left). This value differs by design per LED driver. Some examples are provided in the table on the left.

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.

Wireless MC drivers

Select Philips Xitanium Indoor Linear LED drivers support wireless control based on Philips MasterConnect protocol. These drivers can be recognized by the suffix MC in the driver name. Wireless MC drivers are equipped with a radio antenna and can be controlled wirelessly via an external controller (sensor or switch) or via the Philips MasterConnect field app. Please refer to the MC brochure and user manuals at www.philips.com/oem and to the listing on the left for more details about how to commission and control a system with wireless MC drivers. For more information about how to design-in a wireless MC driver in a luminaire, please refer to the section Mechanical design-in: wireless MC drivers at p.37 of this document.

Warning: DALI and 1-10V control interface terminals are rated as FELV and are marked with the symbol “Risk of electric shock” as shown below. These terminals are not safe to touch!

Dynamic resistance of the LED module

Xitanium LED Linear Indoor drivers are in general able to drive and dim LED modules regardless of their dynamic resistance. This has been tested and released with the Philips Fortimo LED modules. LED modules 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 light instabilities and/or uniformity issues are observed during deep dimming (e.g. down to 1%) it is recommended to increase the minimum dim level by adjusting the DALI minimum dim level to the point when effects are no longer perceived.

1-10V Dimming

1-10V dimming is the traditional way of dimming a driver between 100% and 10% with 1% increment, based on dimming voltage per IEC60929 Annex E. Note that the 100% level is determined by the output current level, set via external Rset (or AOC feature). The minimum current that can be supplied by the driver is specified in the datasheet. The lowest possible dim level is defined by the higher of the two values: Minimum output current or 10% dim level. Sourcing current of the 1-10 V control interface is 150µA typically.

Dimming: Touch and Dim (TD) & DALI

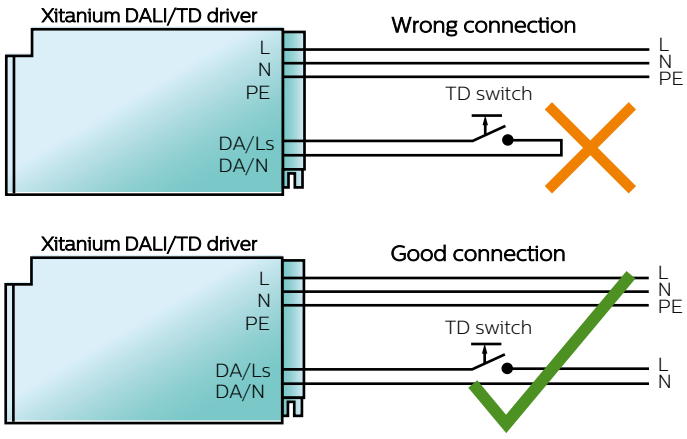
DALI

Digital Addressable Lighting Interface, or DALI, is a bi-directional 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 16V typically (refer IEC specification for details) and it is not polarity-sensitive. The DALI wires can be run alongside input main wires and the maximum current on a DALI line is limited to 250mA.

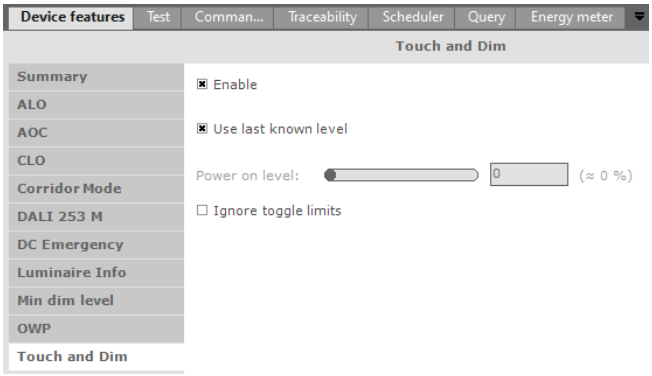
Using DALI, it is possible to send dimming commands (1-254 levels), set fade rates and fade times, query driver or LED status, etc. Linear drivers also respond to LED-specific DALI commands e.g. query if the LED module is short circuit or open circuit; select between logarithmic or linear dimming curves, etc. Typically up to 64 DALI drivers can be connected to one DALI bus. Note that after a power cycle (not standby) the driver by default will come back to its last known light level.

This behavior however can be programmed differently into “off” or any dim level between 1 ... 254 DALI level.

For more information on driver compliance per DALI, refer to www.digitalilluminationinterface.org/products for latest DALI certification status.

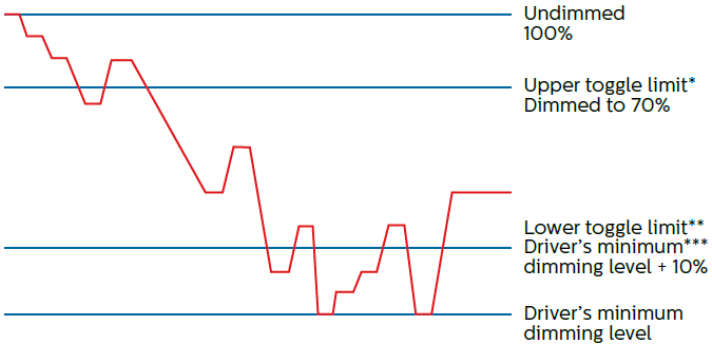


Appropriate connection to the dimmable driver using the Touch and Dim protocol



Screenshot from MultiOne - Touch and Dim tab

It is advised to de-activate the TouchDim function with MultiOne if that feature is not used. This to prevent unwanted / accidental triggering of the Touch and Dim function by external influences.



* Always decrease lightlevel above the upper toggle limit

** Always increase light level under the lower toggle limit

*** Example: a driver with dimming minimum of 10% leads to lower toggle level of 10% + 10% = 20%.
1% leads to lower toggle level of 10% + 1% = 11%"

Touch and Dim action	Contact duration	Driver response
Ignore	< 40ms	Ignore
Short push	40ms to 0.5s	Toggle on/off
Long push	0.5 to 10s	Regulate light up or down
Reset push	> 10s	Driver synchronization

Touch and Dim timing table

Touch and Dim (TD)

For Xitanium drivers equipped with the Touch and Dim function mains voltage can serve as a control signal to dim and turn on/off the light by applying mains voltage to the DA/Ls and DA/N control interface (= TD interface). This means that it is no longer necessary to use a power switch to interrupt power to the driver mains input. Mains voltage is permanently present at the LED driver mains input (even when the light is switched off) and light can be switched on or regulated by momentarily applying mains voltage to the TD interface via the TD switch. A short push will switch the lighting on or off, depending on the previous situation. See the electric connection diagram on the left.

Touch and Dim behavior

When the light is turned off via the TD switch (short push), the driver will store the current light level. As soon as the driver is turned back on again (short push) the driver will recall this stored light level. If it was dimmed to e.g. 60% at turn-off then it will come back on at 60%.

If the TD switch is pushed for a longer period of time, the light will dim up or down, depending on what is opposite from the last dimming direction. See the graph and timing table on the bottom left for details.

The initial light level after mains power-on or after a blackout can be configured via MultiOne (see screenshot on the left). When the "Use last known level" tick box is checked, the light level at the last mains power-off is restored. When left unchecked, a "Power on level" value can be entered. The value range of this level is between 0 (light = off) and 254 (100%). Note that this range is according to the arc power levels specified in IEC 62386:102.

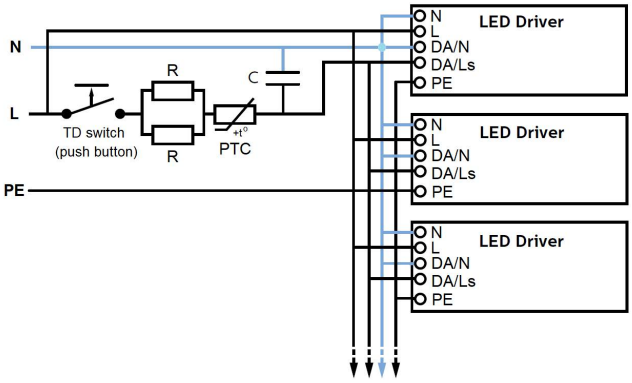
If the installation has to be extended by one or more light points/drivers, the dimming direction of the newly connected modules may be opposite from that of those already connected. In order to solve this, a synchronization feature is built into the drivers and can be invoked at any time by pressing the TD switch for at least 10 seconds: all drivers will then go to 37% light level and the dimming direction of all drivers will be set to downwards.

Please refer to the MultiOne user guide at www.philips.com/multione for more details how to configure the Touch & Dim feature.

Touch and Dim wiring

Special wiring, such as twisted pairs or special cables, is not required to install a Touch and Dim system. All wiring is standard mains wiring and the switch is a standard push-to-make switch. There is no limit to the length of the dim cable or the number of switches connected. The only limitation is the maximum amount of drivers, which is 30 per dimming unit.

The Touch and Dim interface is rated for use in a 3-phase 230/400V grid, therefore supporting the use of Touch and Dim control from one phase while power to the driver is supplied by one of the other two phases.



Recommended RC filter and driver grounding when using Touch and Dim in noisy power grids.

Use of Touch and DIm in noisy power grids

The Touch and Dim interface allows for long control cable lenghts (tens of meters) between the driver Touch and Dim interfaces and the TD control switch without any adverse effects on the Touch and DIm functionality. However, in case such long control cable lengths are used in power grids with increased noise levels due to high-frequency load currents (generated by e.g. electronic motor controls, induction ovens) then the increased noise levels ending up on the control cable may have a negative effect on the performance of the Touch and Dim function *during* operation of the TD switch.

In order to minimize the chance of any negative effects in such application conditions, it is strongy recommended to:

- Properly ground every driver housing by connecting it to Protective Earth (PE).
- Add a customized R-PTC-C filter between the TD switch and the group of Touch and Dim interfaces controlled by that switch.

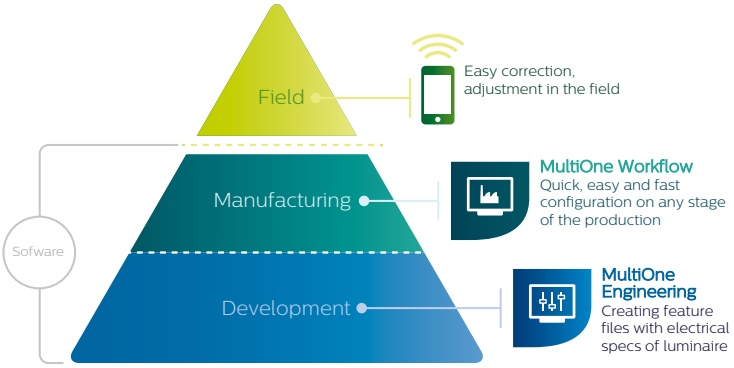
This R-PTC-C filter comprises a fixed resistor, a Positive Temperature Coefficient resistor (PTC) and a film capacitor. This filter can be placed either near or at the TD switch or at the luminaire closest to the TD switch. See the connection diagram on the left for more details.

Fixed resistor R characteristics:
2x leaded metal film power resistor
Resistance = 10 kilo-Ohm, power rating at least 3W
Voltage rating: at least 250VAC.
E.g. Vishay p/n PR03000201002JAC00

PTC characteristics:
Leaded PTC resistor
$R_{(25C)}$ = 1.5 kilo-Ohm, voltage rating at least 250V
E.g. Epcos-TDK p/n B59886C0120A070

Capacitor characteristics:
Leaded metal film safety capacitor
C = 330nF, voltage rating: at least 275Vac
Type: X1 or X2
E.g. Vishay p/n BFC233820334

Configurability



Philips MultiOne software

Xitanium LED drivers offer a extensive range of controls, enabling customizable luminaire design and performance. It is possible to control light output levels, preset dimming protocols and set system specifications in the factory and even in the complete installations. This can be done with the Philips MultiOne configurator. The MultiOne configurator is an intuitive tool that unlocks the full potential of all programmable drivers from Philips, ensuring that the driver performance matches the needs of the lighting solution. It offers unprecedented flexibility, before, during and after the product installation. Programming of new Xitanium LED Xtreme drivers can be done by both the DALI interface (when present) or via the SimpleSet. In the name of the driver you can see which interface is supported.

For more information on MultiOne installation – software and programming: www.philips.com/multione.

Module Temperature Protection (MTP) and NTC on LEDset

The points at which MTP/NTC on LEDset can be set to start (Start dim) and stop dimming (Stop dim) can be configured. The required dimming level in % can be set as well.

Note: enabling the MTP or NTC on LEDset feature requires the AOC function to be enabled. Otherwise, these features cannot be enabled.

Constant Light Output setting (CLO)

Traditional light sources like fluorescent and HID 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 sinking 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.

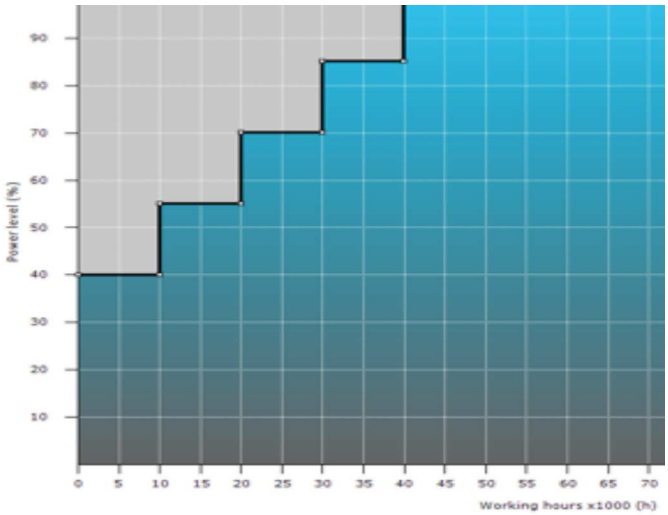
Example with CLO

When the CLO feature is enabled, the driver nominal output current will be defined by the CLO percentage as shown by the equation below:

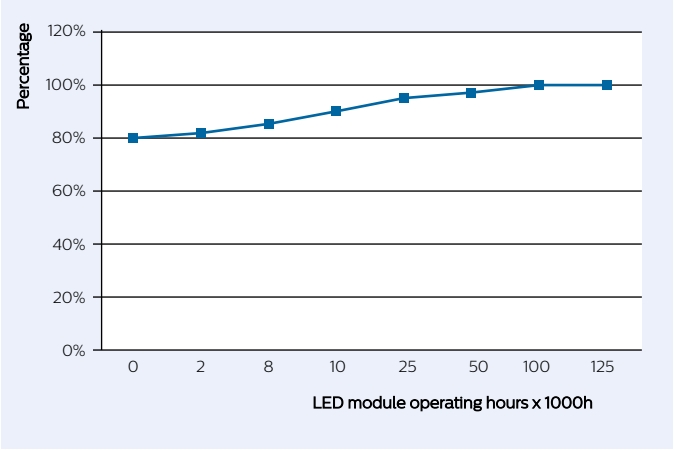
Driver target nominal output current =
CLO [%] x AOC [mA]

Assume a driver with a current range of 300-1000 mA. For example, in the CLO profile shown in the ilustration on the left, between 20-30 working kh, the CLO percentage is set at 70%. Assuming the nominal AOC is set to 800 mA, the driver output current with CLO enabled will be 0.7 x 800 = 560 mA from 20 to 30kh.

Please take into account what the AOC (driver current) needs to be when CLO reaches 100%. This value might be higher than the nominal current stated in the datasheet of the LED module. Since the CLO curve is not generic, the OEM needs to determine the appropriate CLO curve for a given luminaire. This can be used to differentiate on e.g. lumen output or power consumption over lifetime.



Example of a CLO profile



Example with CLO

The time variable is the time at which the driver switches to the current timeslot linear interpolation curve. The first timeslot should always be 0. The actual output limitation is calculated between two neighboring percentage set points on the current timeslot and next timeslot. See the example graph on the left. So for example the first slot is [Percentage = 80, Time = 0], the second slot is [Percentage = 82, Time = 2] etc. This means that driver will start from 80% operation, and during first 2000 hours, the output limitation will be calculated as a linear curve from 80% to 82% based on the burning time. After 2000 hours are passed, it will then be operation at 82% and switch to the next linear curve calculated based on the percentage in 2nd slot and 3rd slot. .

DCemDim setting

During emergency situations it is in general not required to provide 100% egress light level. The DC emergency dimming function (DCemDim) is intended to automatically dim the light to a predefined light level as soon as DC mains is applied to the driver mains input. The MultiOne configurator software can be used to configure the required DC emergency dimming feature of the driver.

DCemDim Example

Driver AOC is set to 200 mA, DCemDim is set to 15%. The result when mains switched to DC is that the driver output current goes down to 200mA x 15% = 30mA. For the driver default settings please refer to the driver dataheet.

Adjustable Start-up Time (AST)

The AST feature enables a time-adjustable gradual increase of the light level after powering up the driver, ensuring a smooth and comfortable transition from a low light level to the full light level. This ramp-up time is configurable via MultiOne software.

The initial low light level is fixed and will be either 1% of the configured AOC value or the absolute minimum output current of the driver, depending on which lower limit is reached first.

Please refer to the driver datasheet to verify whether this feature is supported and which default value and options apply.

Note: the AST feature does not in any way influence the driver inrush current at mains turn-on.

Corridor Mode setting

The Corridor Mode adjusts the light to a defined level when a presence sensor detects a person. Corridor Mode can only be activated when the device is in Touch and Dim mode. The settings can be customized to suit your application using the Philips MultiOne configurator software, after which it automatically set at DALI mode.

How to activate Corridor Mode

a) Via hardware: by applying mains voltage permanently to the TD input for at least the "Activation time" duration (default time = 55s). Examples are a TD switch or selected occupancy sensors, capable of generating the required pulse.
b) Via software: reconfigure with MultiOne configurator software, cycle mains and activate

If the TD switch in the application cannot make a pulse that long then the activation time in the tab Corridor Mode can be reconfigured (e.g. to 10s). This value is then stored and will be available after a power cycle.

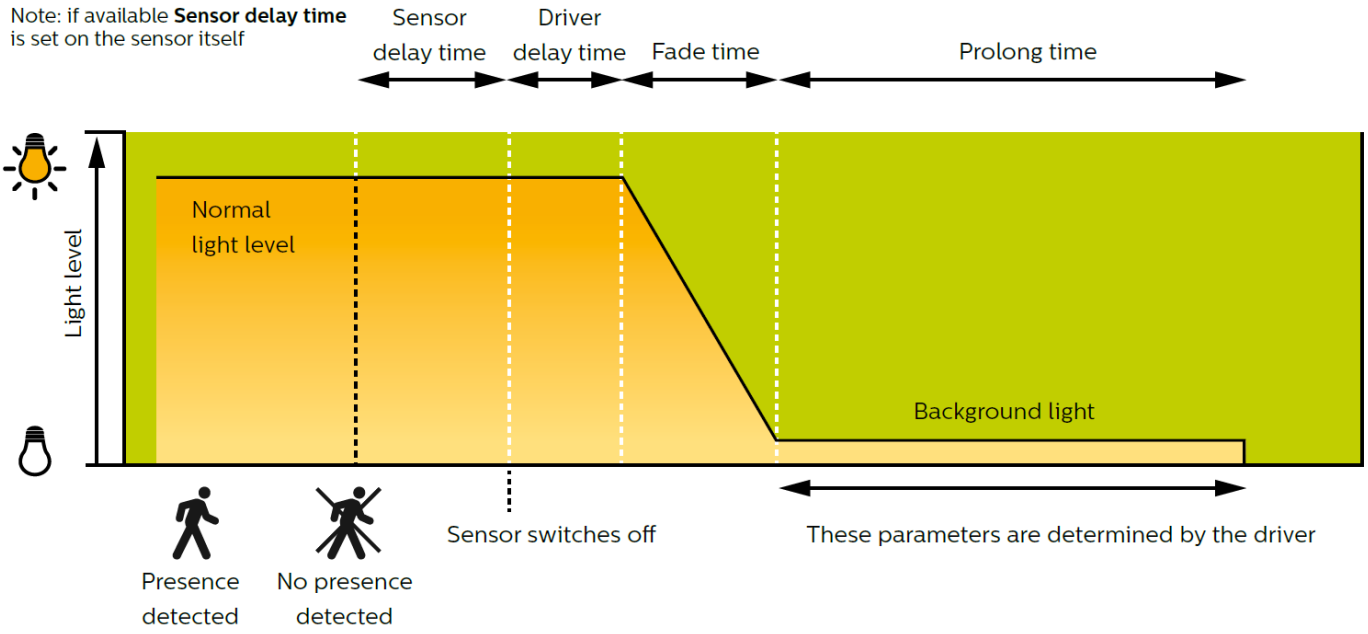
Reactivate Corridor Mode after a mains power cycle

Please keep in mind that when the mains voltage to the driver is cycled, e.g. after installation of the luminaire or during a blackout, the Corridor Mode will be default be disabled and Touch and Dim will be enabled instead. This behavior is similar to the conventional Philips fluorescent ballasts. Once powered again the Corridor Mode needs to be reactivated (see previous section). Examples are a TD switch or selected occupancy sensors, capable of generating the required pulse.

How to deactivate Corridor Mode

a) Cycling the mains on both control input and mains input of driver.
b) Deselect via MultiOne configurator software and cycle mains power afterwards. Activation via hardware (TD) is no longer possible, only via MultiOne software.

The driver enters this mode with default settings.



How to... Set DALI minimum dimming level

A practical example when to use this feature: having a 1% dimming driver next to an older 10% dimming driver controlled in the same installation. This will enable setting the output currents of a group of drivers at the same level in order to achieve even light levels during dimming.

OEM Write Protection (OWP)

By enabling the OWP feature the OEM can prevent unauthorized changes of crucal driver settings. The OWP feature is based on password protection that will be set in the driver so the preconfigured data of OEM write-protected driver features can only be modified by providing the correct password. Depending on the type of driver the OEM can protect the following:

- a set of features (fixed)
- a selection of individual features (free selection) To know which features are locked you see a small lock symbol on each feature while trying to write the driver.

How to program this feature is described in the user manual of MultiOne Engineering at www.philips.com/multione. The password is needed to change the protected features of this driver. Without the password these features cannot be modified.

Encrypted in the feature file, the password can be easy programmed in production via the MultiOne workflow software. New drivers or replacement drivers can be programmed on this way. Already programmed drivers with password are protected and will give an error. They can only be changed using the correct password.

It is important for the OEM to set up a password management system, keeping feature file and password together in the BoM of the luminaire. The password management is under the responsibility of the OEM who sets it. In case of a lost password, the OEM is advised to contact the local Signify representative.

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 mains voltage switching

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 instantaneously, 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) of printed circuit board, solder and component materials.

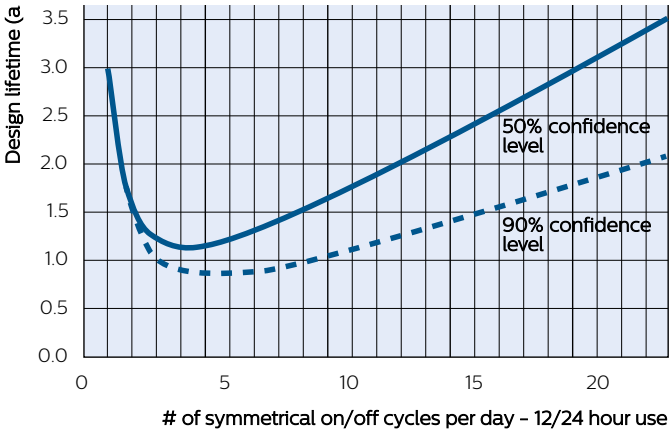
Due to heating up and cooling down mechanical stresses build up in the solder, which eventually result in cracking and finally failure of the joint. In most cases failure of one solder joint means the end of the product. The solder joint failure mechanism is also referred to as solder joint fatigue. 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 ... 100kh of operational hours. The reference for this lifetime is a typical user profile of 10-12h usage and up to 3x switching on and off

every day. In the worst case this could mean 25,000 switches at a regular rate 2h on/2h off. For a 100kh 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.

Impact of thermal cycles per day on the driver lifetime

As the drivers are typically designed to withstand 3 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 120minutes, 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.



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

Because of the large variation and differentiation between drivers and applications, it is virtually impossible 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 < -20 °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.

For potted products additional failure mechanisms can occur at temperatures <-20 °C, which can increase the impact of thermal cycling on the product lifetime.

Applicable driver standards

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

System Disposal

We recommend that the Xitanium LED 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.

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

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

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

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

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

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

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