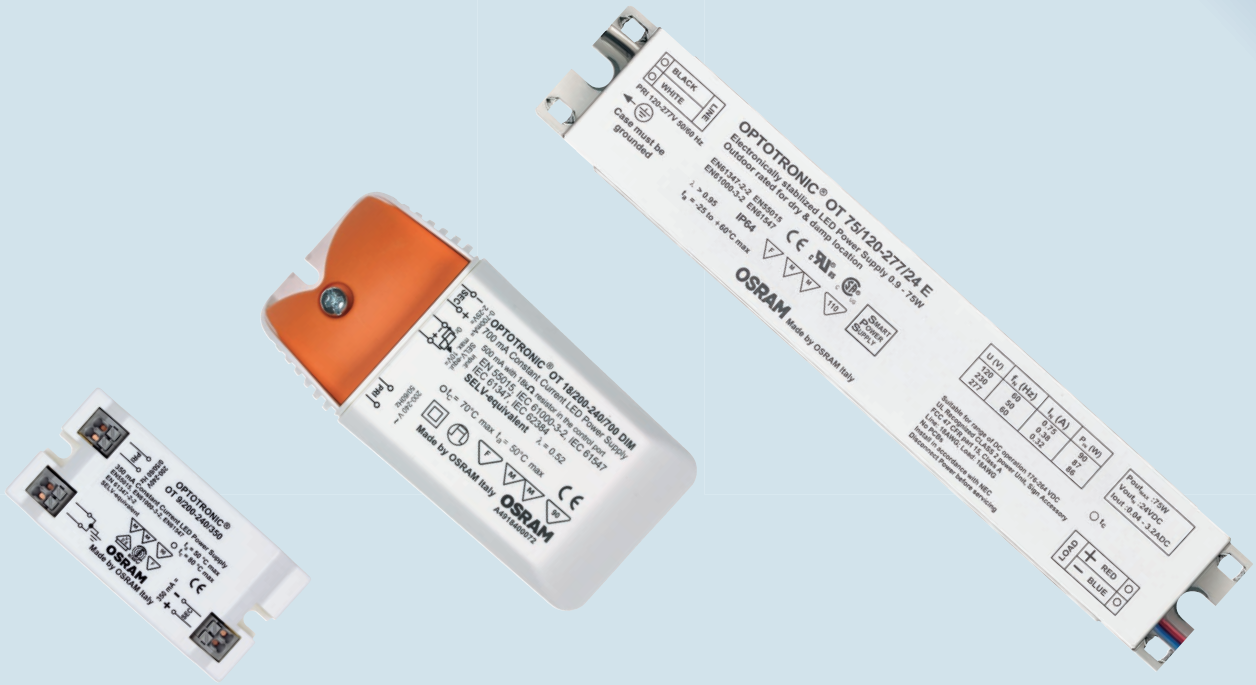


OPTOTRONIC® Technical Guide.

Electronic Power Supplies for LED-Modules.

- Basics and Operation
- Planning information
- Product overview

SEE THE WORLD IN A NEW LIGHT

OSRAM

Contents

1. Introduction

1.1 Purpose and scope of this document

This document is a compact reference guide with technical information on selecting, installing and using OSRAM's OPTOTRONIC® LED power supplies and controls. Always check the OPTOTRONIC® website at *www.osram.com/optotronic* for additional or updated information and pay special attention to supplementary instruction sheets delivered with our products.

The technical information in this document is focused on OPTOTRONIC® power supplies. For system design and configuration please also refer to the data sheets and application notes available at OSRAM's LED Systems website at *www.osram.com/led-systems* as well as the Light Management Systems website at *www.osram.com/ecg-lms*.

Structure of this guide
The remainder of this section provides you with additional information on the benefits and technology behind LED and LED modules available today.

Section 2 provides general technical information on OPTOTRONIC® products, followed by section 3 with information needed for planning, installing and operating these products.

Section 4 provides an overview of the OPTOTRONIC® product portfolio and detailed information on each individual product.

Detailed technical information and data sheets can be found in the appendix starting on page 78.

1.2 LED

1.2.1 Overview

LED (short for **L**ight **E**mitting **D**iode) are small semiconductor components that convert electrical current into visible light. LED used as a light source offer many benefits:

- Compact size
- High luminous intensity
- Saturated, vibrant colors
- Fully dimmable from 0-100 %
- Instant on/off, no accelerated aging due to switching cycles
- Long lifetime
- No direct IR- or UV-emission
- Mechanically robust, shock- and vibration-proof

Thanks to the advances made in LED research and development LED today are producing brightness levels that make it possible to realize these benefits in many applications that formerly were exclusive to classic light sources. OSRAM offers LED, LED modules and matching OPTOTRONIC® power supplies and controllers that are optimized for the use in these applications and, thanks to their flexible design and high performance, open the door for a wide range of new applications as well.

1.2.2 Basic design of a LED

The basic design of a LED consists of the actual light-emitting chip (also called die), housed in a suitable package.

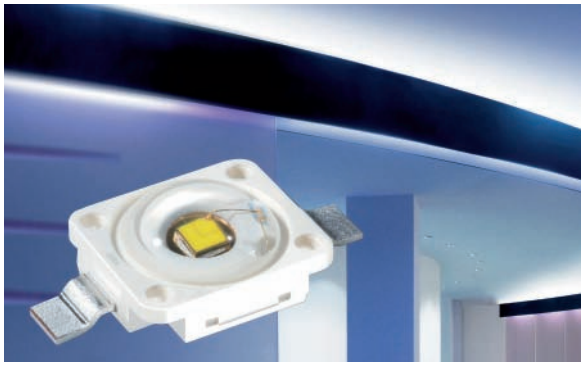


Figure 1 – Golden DRAGON® Plus

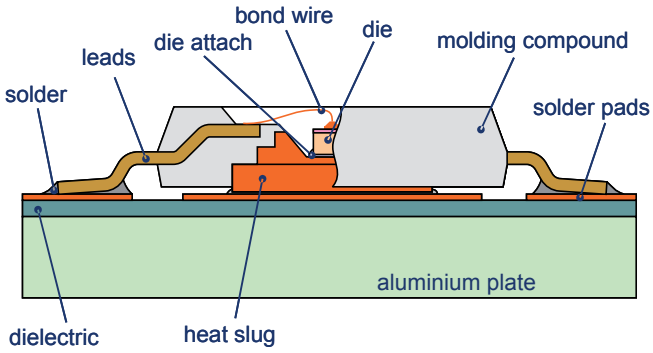


Figure 2 – Golden DRAGON® cross-section

As an example, Figure 1 above shows the Golden DRAGON® Plus LED which is ideally suited for general lighting applications. Figure 2 shows the cross-section of such a LED soldered onto a circuit board. The package provides the electrical connection to the LED chip (leads connected by bond wire and die attach) and acts as a heat sink to remove the heat generated in the chip (through the heat slug which is soldered to the circuit board). Mechanical protection is given by the molded package and the protective cast surrounding the die.

The package may also include a reflector to collect stray light emitted from the chip and additional optics to shape the LED's light emission pattern.

Other LED designs include multiple chips to create a compact RGB light source (e.g. OSRAM Opto Semiconductor's MultiLED® family, see *www.osram-os.com/multiled*) or combine multiple white chips in one package to increase the maximum output brightness (e.g. OSRAM Opto Semiconductor's OSTAR® family, see *www.osram-os.com/ostar*).

Chip design

A LED chip consists of multiple layers of semi-conducting material that create a p-n junction, i.e. a diode that allows current to flow in only one direction. When current flows through this diode light is generated in the active region of the chip.

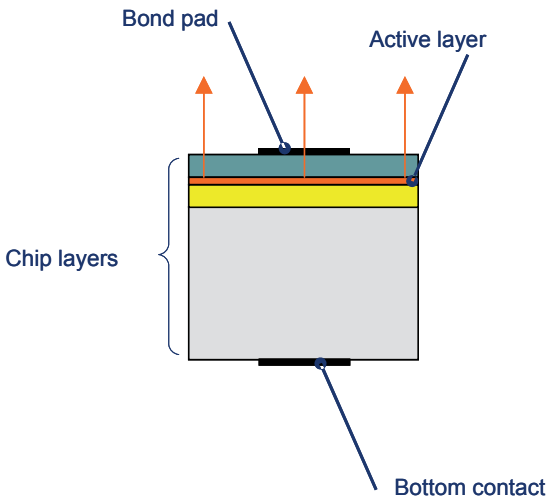


Figure 3 – Cross section of a LED chip

Without any additional, special design, the light generated in such a chip is emitted evenly in all directions of the chips, so that a package with a reflector is required to emit a maximum of light to the front of the diode. Newer generations of LED chips implement additional design features to maximize the efficiency of the LED chip and the amount of light that is emitted from the LED and are used in OSRAM Opto Semiconductor`s DRAGON® and OSTAR® families.

As compared to classical light sources which emit a wide spectrum of light, LED emit only very narrow-banded, almost monochromatic light. The emitted color is determined by the material used to produce the LED chip. Today there are two commonly used materials for producing LED, InGaAlP and InGaN.

Color	Wavelength	InGaAlP	InGaN
Hyper-red (H)	645 nm	■	
Red (R)	625 nm	■	
Super-red (S)	633 nm	■	
	630 nm	■	
	628 nm	■	
Amber (A)	617 nm	■	
Orange (O)	606 nm	■	
Yellow (Y)	587 nm	■	
Green (G)	570 nm	■	
Pure green (P)	560 nm	■	
Blue (B)	465 nm		■
	470 nm		■
True green (T)	528 nm		■
Verde (V)	505 nm		■

Table 1 – Material systems for LED

Table 1 summarizes the colors that can be produced using these materials. One important difference of these material systems is the voltage that is needed to drive a certain current (the so-called *forward-voltage*), hence the electrical power of LED of different color may differ at the same given current. As an example, a Golden DRAGON® LED using an InGaAlP chip will typically require 2.2 V to drive a current of 350 mA, while a Golden DRAGON® using an InGaN chip will typically require 3.2 V to drive the same current.

This is also important to remember when determining the maximum number of LED that can be powered from a constant-current OPTOTRONIC® power supply.

White LED

Generating white light with LED is done by mixing color – typically by mixing blue and yellow light. The blue light is generated by the LED chip, the yellow light by means of a phosphoric converter that absorbs some of the blue light and converts it into yellow light. The phosphoric converter is either placed in the protective cast surrounding the LED chip or is directly applied to the LED chip. Applying the converter directly on the LED chip improves the quality of the white light rendered, as it guarantees that the blue light is converted equally through the thin layer of phosphor. This method of conversion has been implemented in almost all of OSRAM's high-flux LED designed for use in lighting applications and guarantees best performance and color rendering. Figure 4 below shows a schematic drawing of both methods.

It is also possible to generate white light by using red, green, and blue LED chips and mixing the generated light together. However, this

method is generally less efficient and precise (i.e. tuning to particular color temperatures) than a conversion by phosphor and therefore is best used when RGB color mixing is also required in your application.

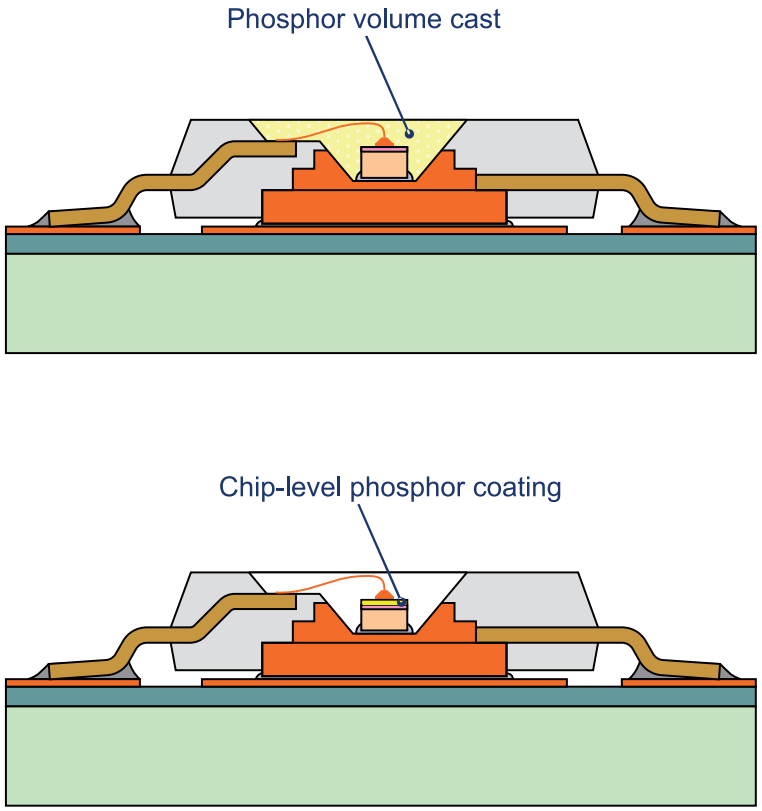


Figure 4 – White conversion

1.2.3 Driving LED

Controlling current

When driving a LED it is important to consider that a LED essentially represents a diode and shares the same electrical characteristics. Thus, when a voltage below the forward-voltage is applied to a diode (in the direction in which current can flow) the diode will not conduct. However, once the voltage exceeds the forward-voltage, the current flow through the diode increases rapidly and exponentially. Without any protective measures, the current through the diode at higher voltage levels can increase so much that the diode eventually is destroyed. Therefore, when driving a LED, it is essential that the current flow through the LED is limited to a safe value. This can be achieved by utilizing a power supply that provides a fixed current ("constant-current supply"), or by limiting the current by means of a resistor or driver IC connected to the LED. In this case, the LED can be supplied by a constant-voltage supply.

OSRAM offers suitable OPTOTRONIC® power supplies for both applications. Constant-voltage OPTOTRONIC® power supplies are described in detail in section 2.3.1.1, the constant-current products in section 2.3.1.2.

Managing temperature

Besides keeping the current through a LED within the safe limits, it is equally important to ensure that the temperature of the LED in your application does not exceed the maximum specified value. The maximum temperature allowed for each LED or LED module is specified in the respective data sheet, which can be found on OSRAM Opto Semiconductor's website or the website of OSRAM LED-Systems division, *www.osram.com/led-systems*. For LED modules this temperature must be measured on the so-called t_c point which is marked on the module. When the temperature in your application exceeds the maximum allowed value, it is required to either improve the cooling of the LED (e.g. by providing a bigger-sized heat sink) or reduce the thermal load of the LED through dimming.

Dimming

Dimming of a LED can be done by either reducing the current level through the diode (DC-dimming, analogue dimming) or by applying PWM-dimming (short for **P**ulse **W**idth **M**odulation) to the LED.

DC-Dimming

DC-dimming is a straightforward solution to reduce the thermal load (and brightness) of a LED. For example, reducing the LED's current from 350 mA down to 250 mA, will reduce the thermal load on the LED accordingly. Varying the current of LED may however have side-effects on the light output of the LED. LED can have a noticeable dependency of the output color on the current that is applied; this is also referred to as a color-shift of the LED. For white LED reducing (or increasing) the LED current may lead to a change of the white-point.

It is important to check whether any color-shift occurs with DC-dimming and whether it is acceptable in your application. If the color-shift is too strong, consider using PWM-dimming, which can help reduce this effect. In particular for RGB applications it is advisable to use devices with PWM dimming.

PWM-Dimming

PWM-dimming utilizes a different method for reducing the average current through the LED: the current applied to the LED is turned on and off at a high frequency (e.g. 300 Hz) while keeping the current level fixed (e.g. at 350 mA). The average value of the current flowing through the LED is then determined by the length of the on-period as compared to the off-period (the duty-cycle).

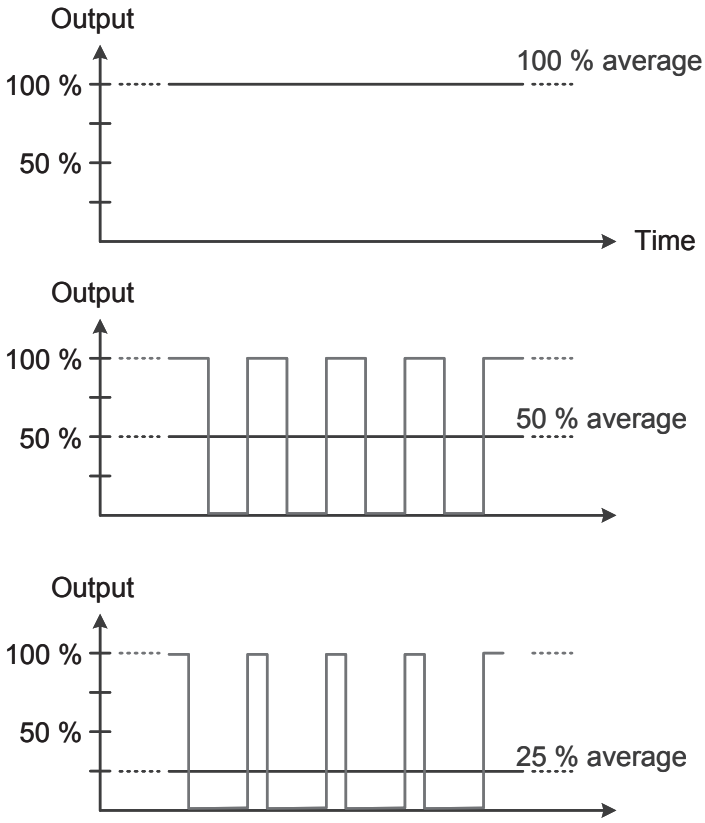


Figure 5 – PWM dimming

Figure 5 shows dimming at 25 %, 50 % and 100 % and the resulting, average current flow through the diode. Since the current through the LED remains unchanged at different dimming levels, there is also no color-shift introduced due to a change in current. This ensures best performance of the LED in both RGB and white light applications.

1.3 LED modules

OSRAM LED modules integrate single or multiple LED into one module with optional driving circuits (i.e. for limiting or controlling the current through the LED).

Some of the benefits of using LED modules are:
- Easy installation (through screw mounting or adhesive tape)
- Easy electrical connections (e.g. through plug-and-play connections)
- Simplified thermal management
- Select modules are available with optional optics for adjusting the radiation pattern to suit your application

OSRAM's LED modules are designed and optimized for use with OPTOTRONIC® power supplies with guaranteed performance and lifetime. When using OSRAM LED modules in combination with OSRAM power supplies, OSRAM guarantees up to 3 years of system life time. For further details and information please visit the OSRAM system guarantee website at *www.osram.com/system-guarantee.*

OSRAM currently offers LED modules in the following colors (in parenthesis the one-letter abbreviation of each color)

- Red (A-amber)
- Green (T-true green or V-verde)
- Yellow (Y-yellow)
- Blue (B-blue), orange (O-orange) (available for a select modules)
- White (W-white, available with different color temperatures)

LED modules from OSRAM are designed to be operated on either a constant voltage of 10.5 V (referred to as 10 V modules) or 24 V or a constant current of either 350mA or 700mA. For each LED module OSRAM offers a perfectly matching OPTOTRONIC® power supply, please refer to section 3.1.1 on page 33 for a list of recommended combinations.

For further, detailed information on all available LED modules please visit the LED Systems website at *www.osram.com/led-systems.*

2. OPTOTRONIC® – Benefits and features

2.1 Overview

OSRAM's OPTOTRONIC® devices are easy-to-use power supplies and dimmers specifically designed for operating LED modules and single LED. Power supplies and dimmers of the same type (constant-voltage or constant-current) can be combined flexibly to match your application's need for power and level of control.

Benefits

OPTOTRONIC® devices offer many convincing benefits for your application:

- OPTOTRONIC® devices have been developed for the lighting industry and meet the requirements of relevant mandatory national and international standards for electronic control gear. This simplifies and minimizes cost for acquiring the necessary approvals for your application.
- OPTOTRONIC® devices are specifically designed for operating LED modules and LED and ensure safe and reliable operation of your application.
- OPTOTRONIC® devices consume a minimum of energy thanks to designs with very high efficiency.
- OPTOTRONIC® devices are compact and require a minimum of space for installation.
- A cable clamp on select OPTOTRONIC® devices enables installation independent from lighting fixtures.
- OPTOTRONIC® devices are designed to allow long cable lengths on the output side, providing greater freedom and flexibility in installation in your application.
- OPTOTRONIC® devices can supply a large number of LED-modules, reducing system cost and installation complexity.
- OPTOTRONIC® are protected against short-circuits and electrical or thermal overload, ensuring maximum safety of your application.
- OPTOTRONIC® devices and LED modules can be combined flexible as a modular system in which power supply and light source can be selected individually for an optimal system design. This also allows updating or modifying individual component of a system e.g. to adapt a system for a different color or to benefit from improved brightness of future LED generations.
- Select OPTOTRONIC® devices are *Touch DIM* compatible and can be used to integrate LED illumination with *Touch DIM* systems (more information on *Touch DIM* is available *www.osram.com/ecg-lms*)

2.2 Operating principle

As described in section 1.2.3, driving LED safely and reliably requires a limitation of the current that flows through the LED. This is either done by a constant-current power supply (supplying e.g. a fixed current of 350 mA) or by using LED modules that have an integrated LED-driver and are operated by a constant-voltage power supply supplying e.g. 24 V.

The schematic implementation of a generic high-power power supply is shown in Figure 6 below, individual power supplies may vary to the extent each feature is implemented.

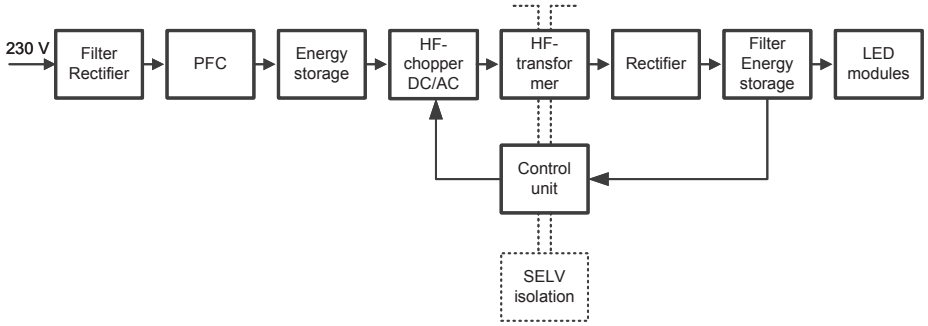


Figure 6 – Schematic layout of a SELV power supply

On the input side of an OPTOTRONIC® power supply a rectifying stage transforms the AC input voltage into a DC voltage. From this voltage the high-frequency chopper (HF-chopper) creates an AC voltage with controllable frequency, which is then transformed via the transformer into the lower voltage on the secondary side. After additional rectifying and filtering this voltage is then used to drive the load on the output side.

The feedback loop on the output side regulates the output for the desired voltage or current by adjusting the frequency of the HF-chopper accordingly.

Important design features (when applicable):

- SELV or SELV-equivalent isolation between the input and output side, guaranteeing safe operation of power supply and LED modules. For the majority of the OPTOTRONIC® power supplies the output voltage is also limited to less than 25 V, which ensures that the output side of the power supply is safe to touch at all times.
- A built-in power-factor correction for devices with a rated output power of greater 25 W
- Built-in filters on the input side for reliable operation (i.e. immunity to power surges or noise on the supply line) and on the output side (helping to ensure EMI compliance of the driver)
- A built-in control unit that guarantees optimal and safe operation of the LED modules and provides protection against shorts on the output side, thermal overload, etc.

2.3 OPTOTRONIC® types

The OPTOTRONIC® product family is divided into the following groups:

- Power supplies
- Dimmable power supplies and dimmers
- All-in-one devices

2.3.1 Power supplies

OPTOTRONIC® power supplies convert line voltage into a constant voltage or constant current on the output side. These power supplies are available with different combinations of output voltage / current, total output power, housing and IP protection options. The power supply portfolio is described in detail in section 4, the next paragraphs give you general applicable information in regards to power supplies.

Please note:
Power supplies do not provide any mechanism for dimming. OPTOTRONIC® power supplies can also not be dimmed by conventional leading-edge or trailing-edge dimmers. To add dimming capabilities to your system, consider adding suitable dimmers or use a power supply with built-in dimming capabilities (see section 2.3.2).

2.3.1.1 Constant voltage power supplies

Constant voltage power supplies are intended to be used with LED modules with matching input voltage, i.e. 10 V or 24 V modules. Please note that it is not possible to connect these power supplies directly to LED or constant-current LED modules (i.e. the DRAGONeye®, DRAGONpuck® modules), doing so may damage or destroy the attached LED.

At present constant-voltage power supplies are available with output voltages of 10 V or 24 V with a rated output power from 6 and 75 W (select devices can be connected in parallel on the output side to realize a total output power of up to 300 W).

Using constant-voltage power supplies in combination with OSRAM LED modules is the easiest way to design and install an LED-based application and offers several benefits:

- Safe-to-touch outputs: All constant-voltage power supplies are SELV or SELV-equivalent isolated devices with an output voltage of less than 25 V and guarantee that at all times it is safe to Touch any part of the installation connected to the output.

- Higher wattage power supplies: For constant-voltage power supplies keeping the output voltage below 25 V does not limit the supplies' output power, which is only limited by the maximum current that can be supplied. Constant-current power supplies on the other hand need to also respect the maximum current of attached

LED (e.g. 350 mA) and therefore are limited to a maximum output power of 25 V x I_{out}, resulting e.g. in a total maximum power of 8.5 W for a 350 mA power supply.

- Parallel wiring: LED modules operated on a constant voltage power supply can be connected in parallel, same as for other light sources. In many applications and for many users this is the easiest wiring option.

2.3.1.2 Constant current power supplies

Constant-current power supplies are intended to be used with LED modules such as the DRAGONeye®, DRAGONpuck® or other modules without integrated current limiting. They are also ideally suited to operate customer-specific designs and eliminate the need for current-limiting circuitry to be connected to the LED.

Constant-current power supplies require a serial connection of the connected LED, which should be specifically noted when designing a system and during installation.

Constant-current power supplies offer the following benefits:

- Reduced system power losses: The power conversion is done directly from line voltage to the fixed DC output current. No additional current-limiting components are required which reduces system losses.

- No additional thermal load due to current limiting devices: Connecting additional current limiting devices to high-flux LED may increase the thermal load on the LED, in particular when current limiting is done through a linear current regulator. By supplying a controlled DC-current constant-current devices eliminate the need for such components.

The majority of OPTOTRONIC® constant-current power supplies are limited to 25 V on the output side to ensure that the output side is safe to touch at all times. This however introduces a limitation of the total output power of the power supply (see 2.3.1.1 above) and how many LED can be driven by one power supply. Due to the serial connection of the LED the forward-voltage drop of the connected LED is added up and in total cannot exceed 25 V.

For typical high-flux LED this means that a maximum of 6 white, blue, or green LED can be supplied (typical forward-voltage for these InGaN-based LED is approximately 3-4 V), or a maximum of 9 amber or red LED (typical forward-voltage for these InGaAlP-based LED is approximately 2-3 V, see section 2.3.1.3.).
Adding a dimmable power supply or controller to a system opens up the possibilities of dynamic lighting for your application.

2.3.2 Dimmable power supplies and dimmers

Dynamic lighting can simply provide dimming of the brightness of an application or can provide highly sophisticated control of color in RGB decorative applications. OSRAM offers suitable devices for both uses, either as dimmable power supplies or as external dimmers.

Dimmable power supplies combine power supply and a dimmer in one device. External dimmers are linked in between power supply and the LED light sources (e.g. the LED modules).

An integrated solution as compared to a solution based on a separate power supply and dimmer offers space savings and simplifies installation. A solution based on a power supply with external dimmer on the other hand gives greater flexibility in choosing the amount of power supplied to your application.

Dimmable power supplies and dimmers are available with the following different control inputs.

2.3.2.1 Control inputs

1…10 V

The 1…10 V control input is a well established protocol in the lighting industry and primarily used for easy brightness control in an application.

Features of 1...10 V interfaces

- The output is controlled by a DC voltage signal from 10 V (maximum light output; control wires open) to <1 V (minimum light output; control wires short-circuited).
- The control voltage is supplied by each ECG itself. Each ECG can supply a maximum current of 0.6 mA.
- The voltage on the control wires is galvanically separated from the mains cables, however may not comply with the SELV requirements
- Units operated on different phases can be dimmed by one controller.

1…10 V devices can easily be integrated with standard lighting components such as sensor devices, signal amplifiers or building management gateways. For further details on 1…10 V products available from OSRAM please refer to the product pages of QUICKTRONIC® dimmable devices at *www.osram.com/quicktronic* and the “QUICKTRONIC dimmable – Technical guide” available at *www.osram.com/ecg-downloads*

Please note that on some OPTOTRONIC® devices special attention must be paid to the isolation of mains voltage and control port. For details please see page 51.

DALI

DALI ("**D**igital **A**ddressable **L**ighting **I**nterface) is a digital protocol for controlling lighting in buildings. DALI is an independent interface standard for dimmable electronic control gear and is standardized in IEC 62386. DALI has been evolved from existing ECG interfaces and offers additional features such as monitoring the status of the lighting system and providing control and real-time feedback.

DALI systems close the gap between conventional 1...10 V and more complex bus systems. DALI can provide easy solutions for local lighting applications as well as complex solutions with integration into building management, all utilizing the same components.

Features of the DALI interface

- Simplified lighting design without hard-wired groups

  A DALI controller can control up to 64 DALI ECGs by a single 2-wire control cable. Control is fully digital und allows addressing of the ECGs individually, in groups or in broadcast mode.

  During setup of an installation each ECG can be assigned to one of 16 groups available and can also belong to several groups at the same time. This assignment can be changed at any point in time and without rewiring the installation. Thanks to DALI changing the defined groups to match e.g. a change in the floor plan can be done fast and with little cost.

- Simple installation

  DALI installations are done with commercial installation material used for mains voltage. The two unused wires in a 5-core sheathed cable (i.e. NYM 5x1.5 mm^2) can be used to connect DALI devices together.

  When connecting the control inputs of DALI ECGs, it is not required to observe polarity for proper operation. This eliminates a potential source for errors and reduces installation complexity. The control wires must be approved for mains voltage, otherwise no special requirements apply.

- Flexible powering

  Controller and ballasts can be connected arbitrarily to the available phases of the mains voltage in order to achieve a better load

distribution. Independent of the powering phase all ECGs can be controlled and switched off by a single controller.

The factory-default of OSRAM's DALI ECGs is set to 100 % brightness upon initial power-up. This way even without programming by a controller an installation can be switched on and off by a circuit breaker and provides basic illumination during installation and a quick way to verify operation.

- DALI controlled switching

  No relays are needed for switching DALI units on or off. Switching and dimming is carried out exclusively via the control wires.

- Synchronized change of lighting scenes

  When DALI units with different start dimming levels are combined (e.g. when individual units are set to a new master value) the change to the master value will be synchronized by DALI so that all light sources reach the new final dimming level at the same time, resulting in a best performing dimming solution.

- Lamp status on demand

  DALI power supplies can send a lamp status report to the controller on demand so that is possible to remotely detect and report lamp failures or display the current dimming level of each lamp.

- Integrated scene storage

  The ECGs store the light levels per lighting scene assigned to a corresponding group. Independent of any definition of groups the individual ECG can store up to 16 different light levels. Transitions between scenes are synchronized so that all ECGs start and finish the transition at the same time by operating with different dimming speed.

DALI topology

The topology of a DALI installation is very simple (see Figure 7 below). DALI power supplies may be wired either in series or in parallel without having to pay attention to hard-wiring of lighting groups. It is not required to terminate the DALI signal lines.

Note:

- The total line length between any DALI device and the DALI control unit must not exceed 300 m (see section 3.1.4.2 on page 41 for details).

- Closed loops on the DALI signal line are not allowed (as marked with X in the diagram below). A closed loop on the DALI signal line may disturb communication and lead to failures in addressing the electronic control gears.

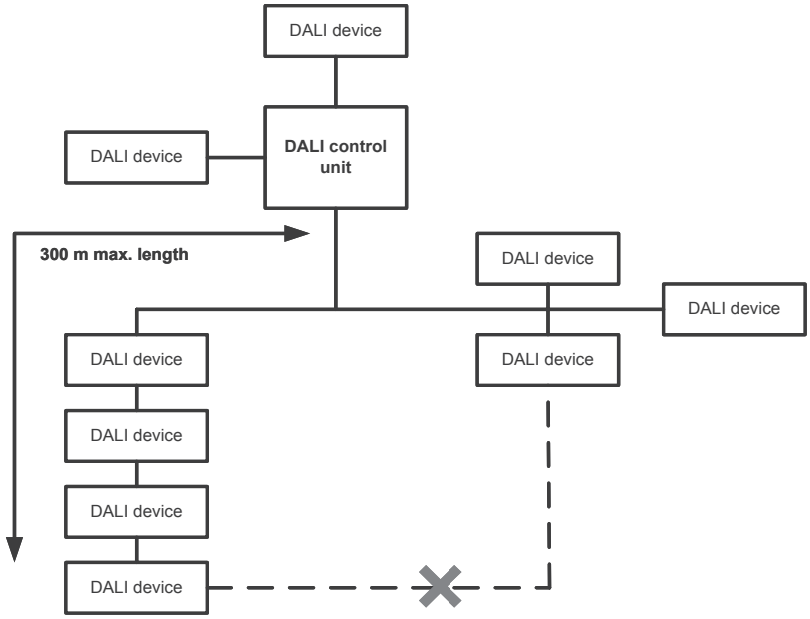


Figure 7 – Principle of a DALI topology

Distributed intelligence

During the initialization process, DALI ECGs store the following data:

- Unique, individual address for each ECG (0–63)
- Assignment to lighting groups (to a total of 16 groups, multiple assignments are possible)
- Optionally lighting levels for individual scenes (max. 16) plus special settings such as:
  - Global dimming speed
  - Behavior of ECGs when control signal interrupted (emergency lighting, system failure)
  - Behavior of ECGs after power-failure

OSRAM offers controllers and accessory parts for designing a DALI-based system, either for fluorescent lamps, compact fluorescent lamps, halogen lamps or LED. OPTOTRONIC® devices are either available with a built-in DALI control port or can be controlled via a DALI gateway (a device translating the DALI protocol to e.g. a 1…10 V signal, such as OSRAM's DALI CON 1…10).

Please check the DALI section available at *www.osram.com/ecg-lms* for a list of available DALI components.

The brochure „A systematic approach to lighting management:
LMS from OSRAM " also gives detailed information about the available OSRAM components for light management systems, including the

most important features, functions, applications as well as technical and ordering data. This brochure is also available for download in the DALI section of the OSRAM website mentioned above.

OSRAM's DALI devices can also be controlled via *Touch DIM*. *Touch DIM* uses only a pushbutton connected to the DALI inputs and allows to control on/off, dimming level and default dimming value of connected DALI ECGs. For details please see the DALI section available at *www.osram.com/ecg-lms*.

DMX

DMX is another digital control protocol and originated from applications for stage and effect lighting. DMX can be used for a large variety of devices to control options such as light levels, focus, light color or rotation of lights. Using DMX, even complex and demanding lighting systems can be designed.

In standard configuration DMX controllers can provide up to 512 addresses and are suitable for complex lighting scene sequences and are programmable via software and/or mixing desks.

The DMX512 format is a distribution/control protocol based on the electrical standard RS-485. DMX512 devices can be daisy chained together (i.e. all devices are connected in series, with the DMX signal passed from one device to the next) to form half-duplex DMX512 networks. On a DMX512 network, there is one data path that all devices must share (the DMX512 "bus"). In a typical network, a single device acts as the master device and controls all other slave devices. The DMX512 protocol is extremely fast (compared to serial RS-232 networks used for telecommunications) and can easily control the maximum number of devices at the fastest frame rate (up to 250 kbit/s according to RS-485).

The DMX512 protocol uses packets to transfer information. Each packet contains a synchronization signal followed by device data. Typically, each packet contains sufficient information to update the entire network. That is, the device data payload section contains complete information on the state of every device.

The packet begins with a break condition that must last 88 µs and is followed by a mark condition that must last at least 8 µs and up to 1 sec.

The break and mark combine to inform all DMX512 devices that a new DMX512 packet is about to be transmitted. A "start code" follows the break and mark. The interpretation of the start code is vendor dependent, but is expected to be zero in general.

After the synchronization signalling, the actual device data payload is transmitted. As many as 512 bytes may follow; in general each device on the DMX512 network uses a single byte of information to determine, for example, how much to dim a lighting fixture. Most DMX512 devices have a programmable “start address”. This start address determines which portion of the payload the unit will interpret. For example, for a device with four channels if the start address is set to seven, the device will read the seventh, eight, ninth, and tenth payload bytes and program the dimmer for each channel accordingly.

While very powerful, DMX-based solutions however may also incur higher component costs and costs required for design and installation. Furthermore, wiring of a DMX installation requires use of special three-wire cable according to AES-EBU-standard, as compared to a standard NYM-cable which can be used for a DALI installation (see section 3.2.2.7 on page 52). For smaller to medium-sized projects OSRAM’S EASY products are an attractive alternative to DMX-based solutions, giving great flexibility with lower complexity. Please refer to section 4.1.2.3 for additional details.

OSRAM offers several DMX-compatible OPTOTRONIC® devices that can be controlled by a suitable DMX controller. DMX controllers are available in the market from several suppliers (for further information also see *www.osram.com/ecg-lms* or *www.osram.com/ecg-downloads-lms*).

Both 1…10 V as well as DALI units can also be integrated into DMX installations via suitable gateways (units which “translate” the DMX protocol to another protocol). DMX gateways are available in the market from several suppliers (for further information also see *www.osram.com/ecg-lms* or *www.osram.com/ecg-downloads-lms brochures*).

Figure 8 and Figure 9 show two examples how to integrate OSRAM power supplies into DMX-systems (please refer to the product operating instruction sheets for specific information).

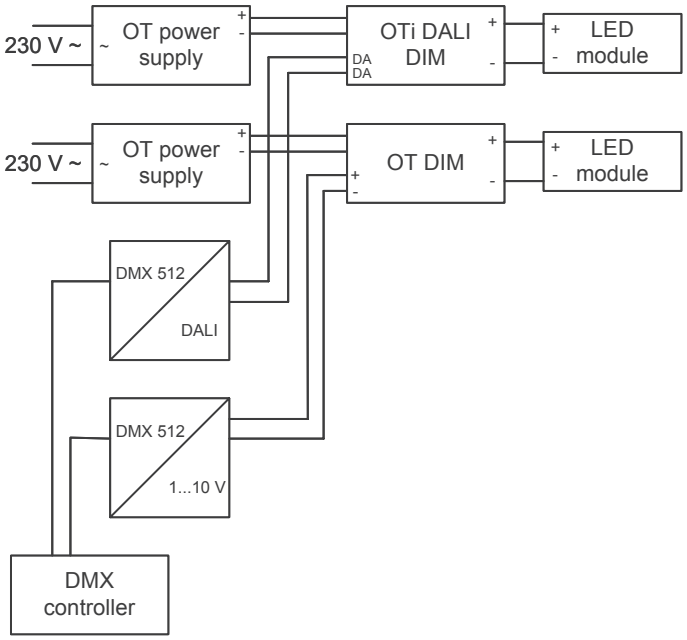


Figure 8 – Integration of OSRAM power supplies and dimmers via DMX-interface gateways

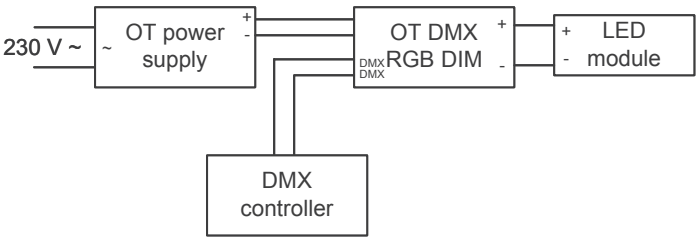


Figure 9 – Integration of OSRAM power supply and dimmer via DMX-interface without gateways

2.3.3 Stand-alone dimmers

Stand-alone dimmers such as the OPTOTRONIC® RGB Sequencer are ideally suited for designing systems for effect illumination without the need for individual control of the light effects.

The stand-alone dimmer is connected between the power supply and LED modules (typically RGB modules are used) and provides several pre-programmed color effects and scenes which can be selected by the user and are applied to the LED modules upon powering of the controller and the LED modules.

For the OT RGB Sequencer three analog inputs (1…10 V_{DC}) allow selection of pre-programmed color effects and setting of speed for color changes and the dimming level.

2.3.4 All-in-one devices

2.3.4.1 OT EASY 60

The OPTOTRONIC® EASY 60 is an easy-to-use all-in-one device that integrates a 60 W power supply with a 4-channel dimmer which controls four 24 V outputs with PWM-dimming for use with LED modules. The EASY signal is an OSRAM proprietary protocol, which also allows to connect control elements (like IR-receiver, pushbutton coupler etc.) directly on the EASY interface.

The DALI EASY II control unit converts the EASY signal to 4 (RGB+W) DALI outputs and can control conventional DALI ECGs.

Both devices can be combined to mix and control LED illumination with classic light sources such as colored fluorescent lamps.

OSRAM's EASY devices are ideally suited to design RGB applications and can easily be programmed and controlled either via an optional remote control, a pushbutton coupler or by connection to a PC via USB port.

Features of the EASY interface

- Intelligence within EASY device: "program-once, run-always"
- Multiple control options:
  - By EASY Color Control software via USB
  - By remote control (EASY RMC)
  - Through external inputs, connected via pushbutton coupler PB Coupler
- In master/slave mode, up to 16 OT EASY 60 units can be operated simultaneously via a single remote control, pushbutton coupler or PC. The EASY System Coupler expands this capability to 64 units.
- Via EASY SYS CP (System Coupler) up to 4 OT EASY 60-systems can be connected together. Consequentially up to 64 OT EASY 60 can be synchronized.

For more information on the possibilities of EASY-based systems please see *www.osram.com/ecg-easycolorcontrol*

2.4 Type designation

OPTOTRONIC® devices are named and labelled according to the following general scheme:

OT x xx/xxx-xxx/xxx xxx, e.g. OT 9/200-240/350 DIM

The meaning of each block is:

- OT
  Abbreviation for OPTOTRONIC®.

- 1st block (optional)
  Information on dimming capabilities and control input (where applicable):
  - DALI: control interface matching DALI standard
  - DMX: DMX compatible input
  - EASY: controlled by OSRAM's EASY protocol
  - i: Device with built-in *Touch DIM* functionality

- 2nd block
  Maximum output power of the device, e.g. 9 for a total output power of 9 W (note that the exact values are specified in the datasheet).

- 3rd block
  Nominal input voltage range, e.g. 200-240 for a 200-240 V input range.

- 4th block
  Output voltage or current on the output side, e.g.
  24 for 24 V or 700 for a 700 mA power supply

- 5th block (optional)
  RGB or RGB+W for 3 or 4 channel devices.

- 6th block (optional)
  Additional information on:
  - Shape of device:
    S: square, *C*: circular
  - Devices suitability for outdoor applications
    E: exterior (IP rating can be found in the datasheet)
  - Dimming:
    DIM: Device with dimming capability. Without DALI or DMX in the first block this indicates a device with 1…10 V (or 10 V max.) control input.
    SEQ: Stand-alone sequencer

The labelling of few products may vary from this general scheme due to special requirements

2.5 Safety and performance

All OPTOTRONIC® devices are designed to meet or exceed applicable standards for use in lighting applications. The next sections give an overview of safety and performance features built into OPTOTRONIC® devices. Additional information can also be found in the brochure “New standards for LED control gear” on standards regulating the use of LED power supplies, available at *www.osram.com/ecg-downloads*

Furthermore all lighting applications have to comply with the luminaire standards IEC 60598.

2.5.1 Safety

The luminaries standard IEC 60598 references the safety standard IEC 61347, for LED converters specifically to IEC 61347-2-13.

OPTOTRONIC® devices meet the requirements of the safety standard IEC/EN 61347-2-13. Devices conforming to this standard are designed to ensure the safety of the user and implement measures to protect against electric shocks and thermal overload of the electronic control gear in case of malfunction.

Almost all OPTOTRONIC® devices are designed as SELV or SELV-equivalent devices with output voltages below 25 V, which ensures that attached LED modules can be touched without any risk. SELV devices provide a high level of insolation between the primary side and secondary side and additional features that minimize the risk of electric shock to the user. The dielectric strength (galvanic insolation) between primary and secondary side is specified at 3.75 kV or more for SELV devices and is tested at a voltage of 4 kV by OSRAM. For SELV-equivalent devices the required voltage is 3 kV.

The control port of dimmable power supplies or dimmers is also isolated against the output side, however the isolation level may differ.

To minimize the risk due to thermal overload of a device in case of malfunction, all OPTOTRONIC® devices are furthermore equipped with an over-temperature shut-down feature.

2.5.2 Performance

The performance standard IEC/EN 62384 defines the optimal operation of LED with electronic control gear, ensuring that LED are only operated within their specified operating parameters. This guarantees best performance and maximum life time of suitable LED and LED modules.

All OPTOTRONIC® devices labelled with the ENEC mark are already approved according to IEC/EN 62384.

2.6 EMC compliance

EMC (electromagnetic compatibility) is specified as a series of different test criteria. The most important in connection with electronic control gear are radio interference suppression (noise), harmonic content (up to the 39th harmonic) and immunity to interference.

	IEC, international	European standard
Radio interference suppression*	CISPR 15	EN 55015
Harmonic content	IEC 61000-3-2	EN 61000-3-2
Immunity to interference	IEC 61547	EN 61547

*for frequencies up to 30 MHz, related to wiring only

The CE symbol (see section 5.3) on OSRAM devices indicate compliance with immunity to interference, harmonic content and radio interference suppression requirements.

Immunity to interference and harmonic content is determined solely by the power supply, therefore it is not necessary to repeat any measurement related to these for luminaires equipped with OSRAM OPTOTRONIC® units. This results in a significant cost saving and reduces time required for approval by the luminaire manufacturer. Radio suppression may need to be verified in each particular application.

2.6.1 Harmonic content of the mains current

Lighting equipment is subject to restrictions on harmonics. The maximum permissible threshold values are defined according to class C of the standard EN 61000-3-2 for the subclasses below 25 W and over 25 W. All OPTOTRONIC® power supplies are designed and approved according to this standard.

Power factor correction

OPTOTRONIC® devices with an input power rated at 25 W or higher are equipped with a power factor correcting feature in compliance with IEC/EN 61000-3-2. Electronic control gear must not disturb the mains supply with an “irregular current drain”, i.e. harmonics.

The power factor of each device is specified in the data sheets in section 5.5. on page 82.

2.6.2 Immunity

All OPTOTRONIC® devices comply with the immunity requirements described in EN 61547 (IEC 61547, VDE 0875 T15-2). This guarantees protection against interference from external high-frequency fields, discharge of static electricity and transient over voltages of the mains supply as defined in EN 61547.

2.6.3 Radio interference

OPTOTRONIC® power supplies and control units (independent, with built-in strain relief) comply with the limit values for radio interference voltage in accordance with IEC/EN 55015. The length of low voltage cables must not exceed the values given in the data sheets to comply with the requirements of radio interference suppression.

Devices for luminaire integration and stand-alone devices are equipped with a high-quality internal filter to ensure compliance with the radio interference values specified in EN 55015.

When installing OPTOTRONIC® in a luminaire of protection class II or plastic installation boxes, no additional measures against radio interference are required.

When installing OPTOTRONIC® units in metal case luminaries of protection class I or in metal-case installation boxes, radio interference will increase due to higher earth capacities.

Installations which combine OPTOTRONIC® power supplies and OPTOTRONIC® dimmers should also be measured to guarantee that radio interference of the system is not exceeded.

Therefore, it may be necessary to include an additional mains filter with earth connection.

Note:
The luminaire manufacturer is responsible to measure and verify EMI compliance of the complete lighting fixture as the level of radio interference will vary depending on the installation of the power supply. Especially primary and secondary cable lengths and routing may have a significant effect on radio interference.

Maximum cable lengths
All OPTOTRONIC® power supplies are tested and verified to be EMI compliant with secondary cable lengths of up to 10 m (shorter cable lengths on some devices) in accordance with applicable standard testing. For cable lengths exceeding 10 m, EMI emissions have to be verified in the application. When EMI emission exceed the allowed levels it may be possible to reduce the EMI emissions by using ferrite cores.

For further information on using ferrite cores please see section 3.1.4 on page 37.

Also note that the maximum cable length possible may be reduced due to resistance of the wire, this is also detailed in the section mentioned above.

The luminaire manufacturer is responsible to measure and verify EMI compliance of the complete lighting fixture, also see the note in section 2.6.3 above.

2.7 Audible noise

The frequency-dependent sound pressure level generated by an OPTOTRONIC® device approximates the audibility threshold, i.e. a person with normal hearing will virtually not be able to notice the noise generated by a unit in a room.

The overall sound pressure level is determined by the sound power level of the unit, the number of units in operation and the absorption properties of the room (characterized by its volume and reverberation time).

Note that for mains supplies with a high level of distortion where the mains voltage deviates significantly from a sine wave a “chirping” sound may be heard from the choke coils in the device’s input stage.

2.8 Temperature and lifetime

The lifetime of OPTOTRONIC® devices is determined by the lifetime of the electronic components used in the device. The biggest impact on the lifetime of these components comes from the temperature the components are operated at, in general an increase in operating temperature leads to a reduction of lifetime.

Every OPTOTRONIC® device is marked with a so-called t_c-point. The location of the t_c-point and the specified maximum allowed temperature at this point have been chosen such that all electronic components within are operated at safe temperatures that do not lead to a reduction in reliability or life time of the device.

For safe operation it is mandatory that the temperature at the t_c-point does not exceed the specified maximum temperature, this furthermore also ensures that OPTOTRONIC® devices achieve a nominal lifetime of 30,000 hours at a maximum of 10 % failure rate.

Select OPTOTRONIC® devices (i.e. OT 50/120-277/10 E and OT 75/120-277/24 E) are even specified with a nominal lifetime of 50,000 hours at a maximum of 10 % failure rate.

The failure rate of electronic components depends exponentially on the operating temperature. As stated before for safe operation, the permitted t_c-temperature must never be exceeded, in addition exceeding this temperature will also reduce the life of an ECG significantly or may permanently damage the components and lead to a total failure of the device. When installing a power supply outside a lighting fixture, make sure to not install it too close to any other heat source in order to avoid overheating.

The exponential dependency of lifetime on temperature however also means that the lifetime of an ECG can be extended when operating the ECG below the specified maximum value for the t_c-point at all times.

As a rule of thumb we can expect up to double the lifetime for OPTOTRONIC® devices when the temperature at t_c-point is kept 10 °C below the maximum permitted temperature at all times.

OPTOTRONIC® devices operate reliably within the temperature range specified for each device (see technical data sheets in section 5.5 on page 82).

Figure 10 below shows the typical life expectancy of an OPTOTRONIC® device (with a nominal life time of 30,000 hrs at maximum t_c of 70° C) at various t_c-temperatures.

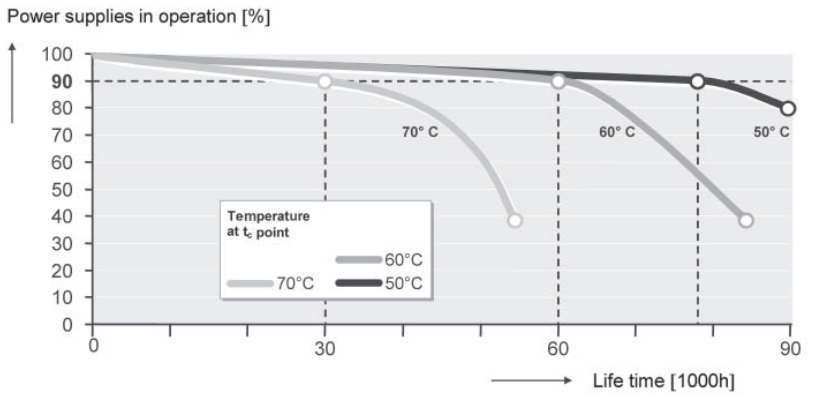


Figure 10 – Life expectancy of OPTOTRONIC® power supplies

2.9 Protection against overload, short-circuit, no-load and partial-load and over temperature operation

2.9.1 Overload

OPTOTRONIC® devices are equipped with reversible electronic overload protection, which in case of an overload condition automatically reduces the output power or disconnects the load completely to prevent damage to the device or installation. When the overload condition is removed (i.e. the connected load is reduced) the power supply returns its output to full power.

Exceeding the maximum rated load (P/P_N >1) also bears the risk of overheating the power supply and can also lead to a safety shut-down.

If a power supply is shutting down due overload, the power supply may enter a blinking mode, alternating between a complete shut-down and brief power-up of the system (in order to determine whether the overload condition is still present in the installation). This blinking mode will be observed on all constant-voltage power supplies, with the exception of the OT 8/200-240/24. For constant-current OPTOTRONIC® power supplies in overload mode the output voltage fixed at the maximum output voltage while the output current is reduced.

Warning
Operating OPTOTRONIC® continuously above maximum rated power will reduce the lifetime of the power supply and may also lead to exceeding of the maximum t_c temperature of the device!

2.9.2 Short circuit

OPTOTRONIC® devices have a reversible electronic protection against damage caused by short-circuit on the secondary side. If a short circuit is detected on the output side the power supply will cut off the output power. The power supply will be fully operational again once the cause of the short circuit has been eliminated.

2.9.3 Partial load, no load operation

The electronically stabilized output of OPTOTRONIC® devices ensures that partial load or no-load operation will not cause damage to the power supply or attached LED modules.

Note that standard transformers or power supplies not specifically designed for operating LED modules may exhibit an increase in output voltage (or current) when operating below the nominal output power which in turn may damage or destroy attached LED modules.

OPTOTRONIC® power supplies guarantee safe and reliable operation of LED modules within the complete rated load range.

2.9.4 Over-temperature

An OPTOTRONIC® power supply may become overheated due to operation of the device with high load, insufficient cooling or because of close-by heat sources heating up the device beyond the maximum allowed temperature.

Regardless of the source of overheating, OPTOTRONIC® devices are protected against permanent damage from over-temperature. When an over-temperature condition occurs the power supply will reduce output power and eventually shut down to avoid permanent damage.

When the power supply has cooled down to safe levels full output is restored automatically. Note that this may lead to a blinking mode or periodical shut-down of the power supply as once the system starts operating at full output the temperature of the devices will begin to rise again and may lead to over-temperature again.

Attention:
For safe and reliable operation and in addition to avoid a reduction in lifetime it is mandatory to keep the value of t_c below the specified maximum value at all times.

2.10 Smart Power Supply feature

Depending on the ambient temperature, LED modules may vary in power consumption (depending on the design of the LED module). For example, at low temperatures (below 0 °C) the required power to operate LED modules may be significantly higher than under standard conditions. This can lead to problems when operating LED installations at these temperatures, such as a reduction of brightness or instable operation of modules due to an overload condition of the power supply.

To address this issue, OSRAM has developed the “Smart Power Supply” (SPS) feature, which within limits can automatically compensate the increase in power consumption. Thanks to this intelligent control, over-power conditions are managed by the OPTOTRONIC® power supplies in order to guarantee optimum system reliability and thermal management even at these low temperatures. Compensation of the increased power demand does not impact the lifetime of these OPTOTRONIC® power supply.

Note:
Do not overload OPTOTRONIC® devices with Smart Power Supply feature intentionally as this may reduce lifetime or damage the device.

OPTOTRONIC devices with Smart Power Supply feature are marked with the following symbol:

2.11 Parallel connection on output side

In general OPTOTRONIC® devices can not be connected in parallel on the output side. As an exception the OT 50 E and OT 75 E are designed to allow a parallel connection of up to five OT 50 E or up to four OT 75 E. Figure 11 below shows the wiring that is possible with these power supplies.

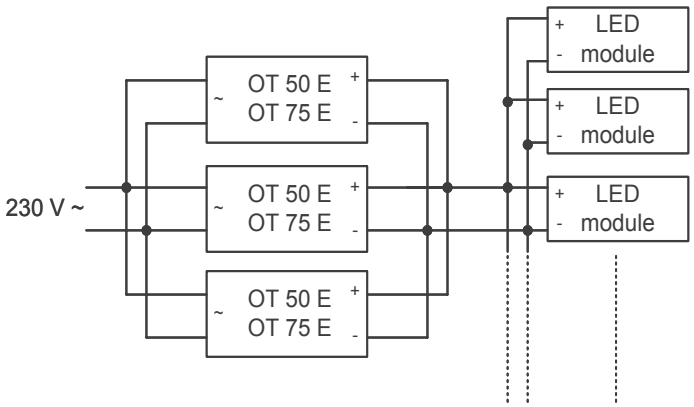
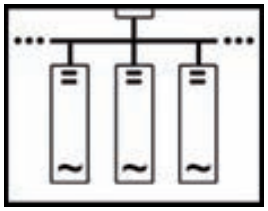


Figure 11 – Parallel connection of OT 50 E and OT 75 E

Note:
It is not possible to mix OT 50 E and OT 75 E when wiring power supplies in parallel.

This feature allows for greater flexibility of wiring and placing power supplies and LED modules in an application. It is for example possible to install the power supplies together in a suitable location and then supply the LED modules from a single low-voltage power line. Please ensure that when placing power supplies together, there is enough cooling for all devices to prevent thermal overload. Also pay special attention to the wire diameters used in the installation and ensure they are suitable for carrying the total output power.

OPTOTRONIC® devices which can be connected in parallel on the output side are marked with the following symbol:



Attention:
The parallel connection must be established by connecting the pre-wired cables of the OT 50 E / OT 75 E.

3. Planning, installation and operation

3.1 System planning

System planning must take into consideration several important factors:

1. The selection of suitable LED modules.

2. The required level of control in the application.

3. The total wattage and number of LED modules to be installed and limitations due to maximum output voltage (for systems using constant-current modules).

4. Maximum allowed cable lengths.

The importance of these factors for planning a system are first discussed in general in the next sections and are then illustrated with additional examples in section 3.1.5 below.

3.1.1 LED module selection

The very first step in planning an application is the selection of the right LED module(s).

For an overview of available LED modules for different applications please refer to the website of OSRAM'S LED Systems group, available at *www.osram.com/led-systems*

Another useful resource is the LED-Systems brochure "General lighting brochure, complete product overview" which is available at *www.osram.com/led-systems-downloads*

Table 2 listed below is also part of this brochure and can be used as a basic for a first selection of suitable power supplies and controllers for a given type of LED module.

LED modules / OPTOTRONIC® Control gear	10 V units				24 V units						350/70 0mA units					Combined units		Controllers					
	OT 6 CE – 10 V	OT 12OT 12 LE (IP-protected)	OT 50	OT 50 E (IP-protected)	OT 6 CE – 24 V	OT 8	OT 20	OT 20 S	OT 75	OT 75 E (IP-protected)	OT 9	OT 9 DIM (10-24 V)	OT 9 DIM (200-240 V)	OT 18 DIM[3]	OT 35	OT EASY 60	OT DALI 25	OT DIM[2]	OT RGB DIM[2]	OT RGB Sequencer[2]	OTi DALI DIM[2]	OT DMX RGB DIM[2]	OT DMX 3x1 RGB DIM[2]
BACKlight BL02	•	•	•	•														•	•	•	•	•	•
BACKlight BL04	•	•	•	•														•	•	•	•	•	•
CL05A COINlight® Colormix					•[1]	•[1]	•[1]	•[1]	•[1]	•[1]						•	•	•	•	•	•	•	•
CM01E COINlight®					•	•	•	•	•	•						•	•	•	•	•	•	•	•
CO06A COINlight-OSTAR®							•	•	•	•						•		•	•	•	•	•	•
DC02A DRAGONchain							•	•	•	•						•	•	•	•	•	•	•	•
DC24A DRAGONchain® Colormix								•[1]	•[1]	•[1]						•	•	•	•	•	•	•	•
DE1 DRAGONeye®											•	•	•	•									
DP3 DRAGONpuck®											•	•	•	•									
DT6 DRAGONtape®											•	•	•	•									
DX1 DRAGON-X™											•	•	•	•									
LD06A LINEARlight-DRAGON®							•	•	•	•						•	•	•	•	•	•	•	•
LD18A LINEARlight-DRAGON® Colormix							•[1]	•[1]	•[1]	•[1]						•	•	•	•	•	•	•	•
LM01A LINEARlight	•	•	•	•														•	•	•	•	•	•
LM01M LINEARlight Colormix					•[1]	•[1]	•[1]	•[1]	•[1]	•[1]						•	•	•	•	•	•	•	•
LM10A LINEARlight Flex®					•	•	•	•	•	•						•	•	•	•	•	•	•	•
LM10L LINEARlight Colormix Flex					•[1]	•[1]	•[1]	•[1]	•[1]	•[1]						•	•	•	•	•	•	•	•
LM10P LINEARlight POWER Flex					•	•	•	•	•	•								•	•	•	•	•	•
LM11A LINEARlight Flex®	•	•	•	•														•	•	•	•	•	•
OH06A OSTAR®hex														•	•								
WL01B EFFECTlight					•	•	•	•	•	•						•	•	•	•	•	•	•	•

1) RGB in combination with controllers

2) Requires separate power supply

3) Supplied with pre-installed resistor for 500 mA operation

Table 2 – Recommended combination of power supplies, controllers and LED modules

3.1.2 Level of control

The required level of control in your application determines whether the system will use any OT dimmers or can be realized e.g. based on the OT EASY device.

The level of control in an application can range from no control (i.e. fixed output), simple control (i.e. brightness) or full RGB control (i.e. multiple independently controlled channels). Besides the level of control also the preferred control protocol must be selected, section 2.3.2.1 on page 16 details the available options 1…10 V, DALI, DMX and section 2.3.4.1 on page 23 gives more information on the OT EASY system.

Combined with the type of LED modules selected in the first step, these requirements can be used to further screen the OPTOTRONIC® portfolio for suitable power supplies and dimmers.

Dimmers that are installed in between power supplies and LED modules have to be considered in planning a system for several reasons:

- Dimmers draw additional power from the power supply. Even though this amount in general is much smaller than the power drawn from the LED modules, it should be considered in the calculation. This will be addressed in section 3.1.3 below.

- Dimmers also introduce a small voltage drop along the cabling to the LED modules, which must also be taken into consideration when calculating maximum cable lengths. This point will be discussed further in the examples below.

- The maximum current rating of a controller may furthermore limit the number of modules that can be connected to a controller and to a power supply. This is discussed in greater detail in the example 3.1.5.3 below.

3.1.3 Total wattage

At a minimum the number of installed OPTOTRONIC® power supplies must be able to supply the power drawn by the attached modules and any installed controllers.

For normal operating temperatures the maximum number of LED modules which can be operated on one OPTOTRONIC® can be easily calculated by calculating the ratio between nominal wattage of the power supply and the total power consumption of the connected LED module:

$$N_{\max} = \frac{P_{N,OPTOTRONIC}}{P_{N,module}}$$

- N_{max}:
  Maximum number of LED modules that can be operated on one power supply
- P_N, OPTOTRONIC:
  Nominal power of the OPTOTRONIC® power supply. This value can be found in the data sheets (see section 5.5 on page 82)
- P_N, *module*:
  Nominal power of the connected LED module. The module wattage is specified in the data sheets of the LED module or can be found in “General lighting brochure, complete product overview” as well (see above).

In case a dimmer is connected to the OPTOTRONIC® power supply, the available power to drive the LED modules is reduced by the losses of the dimmer. The maximum losses of each dimmer are specified in the device’s data sheet (see section 5.5 on page 82). In this case the maximum number of modules per power supply is calculated using this formula:

$$N_{\max} = \frac{P_{N,OPTOTRONIC} - P_{Losses,dimmer}}{P_{N,module}}$$

The calculated maximum number of modules per power supply is valid for the best-case in which all modules can be distributed evenly across the power supplies.

For a real-world application the actual number possible may be limited by the maximum allowed cable length on the output side and the desired physical placement of the modules. This may require installing additional power supplies in your application that are not loaded to the maximum but allow the desired physical placement of the modules to be achieved.

3.1.3.1 Output voltage limitations for constant current power supplies

For systems based on constant-current modules determining the maximum number of modules per power supply must take both the maximum output power and maximum output voltage of the power supply into consideration (see also section 2.3.1.2 on page 15).

Depending on color and module type each OPTOTRONIC® power supplies the following number of LED or LED modules:

LED / LED-module color	Number of LED modules per power supply (350 mA)		
	DRAGONtape®	DRAGONpuck®	DRAGONeye®
White, blue, green	1	2	6
Yellow, red	1,5	3	9

For any other type of LED refer to the data sheet of the LED to determine the maximum forward voltage. For example for a LED with a maximum forward voltage of 3.5 V up to 6 LED can be connected to a power supply with a rated output voltage of 25 V, while respecting the maximum load of the power supply as calculated before.

3.1.4 Maximum cable lengths

3.1.4.1 Maximum output cable length

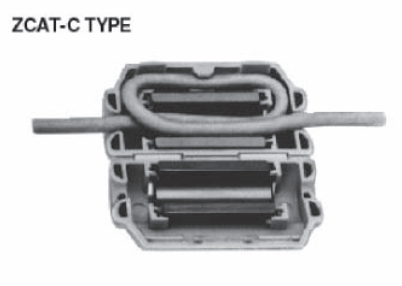
Cable length on the output side is limited by EMI and the voltage drop that occurs along the cables.

EMI compliance

All OPTOTRONIC® products are tested and comply with the limit values for radio interference according to EN 55015, for further details please see section 2.6. on page 26. The maximum cable length leading to the LED modules tested to comply with IEC/EN 55015 is given in the data sheets in section 5.5 on page 82. Please note that this is the maximum cable length between the power supply and the LED modules and includes any dimmers that may be installed in between power supply and LED module.

In some applications it may be required to extend the maximum permitted cable length. In this case special EMC filters can be applied on the secondary side (10 V and 24 V). A ferrite close to the output terminals can reduce the effect of radio interference significantly. If OPTOTRONIC® dimmers are also installed, place the filters on output wires as close as possible to the dimmer device.

Simple and easy-to-use solutions are available in the market, see pictures below. One possible ferrite is available from TDK, part number ZCAT3035-1330-BK.



EMI compliance must be verified and confirmed by the luminaire manufacturer.

Voltage drop

Besides the requirements for electromagnetic compliance the planning of LED lighting installations must also consider the resistance of secondary cables, which leads to a voltage drop along the cable and a reduced supply voltage at the LED-module. If the voltage at the LED modules drops below the minimum specified value, the module may not operate properly.

Constant-voltage power supplies

For constant-voltage power supplies the maximum cable length on the secondary side can be calculated using the following formula:

$$L_{\max} \leq \frac{1}{2\rho} \times \left(V_{OT} - V_{DIM} - V_{LED}\right) \times \frac{V_{LED}}{P_{LED}}$$

The following table explains the parameters used to calculate the maximum permitted length of secondary cables:

Parameter	**Explanation**
ρ	Resistance of cable used on secondary side (in [Ω/m]). See table below for typical values of secondary cables.
V_{OT}	OPTOTRONIC® output voltage (10.5 V or 24 V)
V_{LED}	Minimum input voltage of LED modules (typically 10 V or 23 V)
V_{DIM}	Voltage drop of OPTOTRONIC® dimmer (if used). A typical value for e.g. OT DIM is V_{DIM} ~ 0.3 V. The voltage drop of dimmers is also specified in the data sheets on page 82.
P_{LED}	Total maximum wattage of attached LED modules

Table 3 below lists typical values for the resistance of copper cables with 1.5 mm² and 0.75 mm² diameter at a copper temperature of 20 °C. These values will also be used in the examples calculated below.

cable 1.5 mm²		cable 0.75 mm²	
Ω [Ω/km]	1/ ρ [m/Ω]	ρ [Ω/km]	1/ ρ [m/Ω]
13.6	73.8	29.1	34.3

Table 3 – Typical resistance of secondary cables

Example:

OT 20/230-240/24, OT DIM, COINlight-OSTAR®, 0.75 mm² cable

$$L_{\max} \le \frac{1}{2} \times 34.3m/\Omega \times (24\,V - 0.3\,V - 23\,V) \times \frac{23\,V}{12\,W} = 23m$$

OT 20/230-240/24, OT DIM, COINlight-OSTAR®, 1.5 mm² cable

$$L_{\max} \le \frac{1}{2} \times 73.8m/\Omega \times (24\,V - 0.3\,V - 23\,V) \times \frac{23\,V}{12\,W} = 49.5\,m$$

For both examples the cable length is limited to 10 m due to the limitations of EMI and not because of cable resistance.

To guarantee a reliable and EMI compliant installation – especially when using higher wattages – these factors must be taken into account carefully and may require adapting an installation to the specific circumstances.

Constant-current power supplies
The calculation of maximum cable length for constant-current power supplies is as follows:

$$L_{\max} \le \frac{1}{2\rho} \times \frac{V_{OT} - V_{f,total}}{I_{LED}}$$

The following table explains the parameters used to calculate the maximum permitted length of secondary cables:

Parameter	Explanation
ρ	Resistance of cable used on secondary side (in [Ω/m]). See Table 3 above for typical values of secondary cables.
V_{OT}	Maximum output voltage of the OPTOTRONIC® (see data sheet)
$V_{f, total}$	Sum of the forward voltage of attached LED with a driving current of I_{LED}
I_{LED}	The driving current of the LED
P_{LED}	Total maximum wattage of attached LED modules

Example:

OT 18/230-240/700 DIM, OSTARhex®, 0.75 mm² cable

The OSTARhex® contains 6 white LED chips, with a combined maximum forward voltage of 24 V, the OT 18 DIM is a SELV-compliant device with a maximum output voltage of 25 V.

$$L_{\max} \leq \frac{1}{2} \times 34.3m/\Omega \times \frac{25V - 24V}{0.7A} = 24.5m$$

In this example maximum output length is again limited by the requirements for EMI compliance (10 m).

Maximum length of low voltage cables for various types of power supplies

The maximum length of the low voltage output cables for individual OPTOTRONIC® power supplies has been calculated for different loads and is shown in the diagrams below. The calculations are based on a wire cross section of 1.5 mm² and a cable temperature of 20 °C.

The maximum length is proportional to the wiring cross section, so the maximum length possible for differing cross sections can be calculated by multiplying the shown length with the ratio of the cable cross sections. As an example when using a cable with 2.5 mm² cross section, the maximum cable length would be extended by a factor of $\frac{2.5}{1.5} = 1.66$.

Attention

Please note that these lengths only consider the limitations of cable length due to the occurring voltage drop along the line. Independent of these calculatons, EMI compliance must be confirmed in the installation (see above).

Wiring of LED systems as bus systems

An extension of the maximum length of secondary cables may be possible if the LED modules are wired on a supply bus from which supply cables branch to the individual modules.

As a rule of thumb for such a system the total length of all wired branches may be up to twice the maximum allowed secondary cable length (assuming evenly distributed loads $L_2 = L_3 = ... = L_n$):

$L_{total} = 2 \cdot L_{max}$, where $L_{total} = L_1 + L_2 + ... L_n$

Example of a bus system wiring

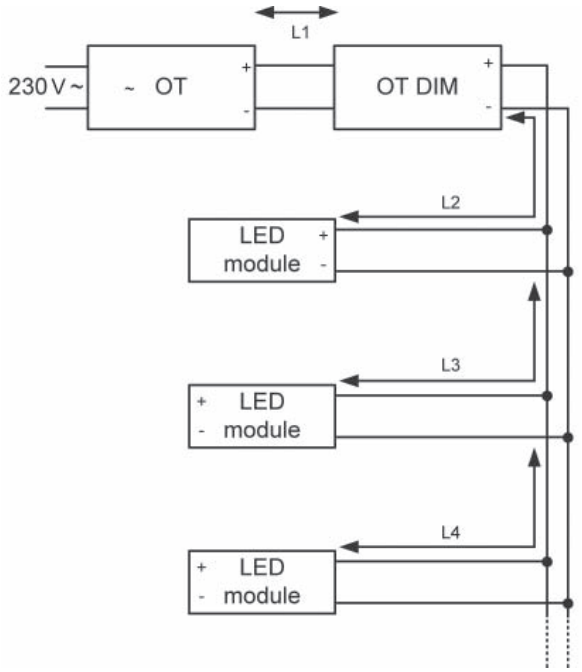


Figure 12 – Bus wiring of LED modules

In this example the total length L_{total} of secondary cables is $L_{total} = L_1 + L_2 + ... L_n$.

Attention
If the installation is wired in series and not as a bus system, the voltage drops per LED-module are added to a total, then L_{total} must be $L_{total} << L_{max}$.

3.1.4.2 Control cable, maximum length

Every control protocol (if dimmers or dimmable power supplies are used) also has a maximum allowed cable length that must be observed. Table 4 below lists the typical maximum cable length that can be achieved per control protocol without the use of repeater devices.

	Typical maximum cable length [m]
1…10 V	Control cable specific, see note below
DALI	300
Touch DIM	25 (6 devices), 100 m with transformer
DMX	300
EASY	100

Table 4 – Typical maximum control cable lengths

OSRAM offers repeater devices for the 1…10 V, DALI and EASY control protocol, further details are available at the LMS website *www.osram.com/ecg-lms.*

3.1.4.3 Maximum module lengths

Linear modules, such as e.g. the LINEARlight POWER Flex, can reach a total module length of several meters, which can be sub-divided into units of smaller length. For powering these modules there are however limitations to the maximum module length that can be powered from one supply.

In the case of the LINEARlight POWER Flex this maximum length is for example 1400 mm. Due to this maximum length it may be necessary to split a module into several pieces which are powered individually from power supplies.

Please check the data sheet of the LED modules for further details and optional accessories that facilitate splitting and wiring these modules.

3.1.5 Examples

3.1.5.1 System planning, shelf-illumination

This example demonstrates how small shelves in a showroom can be equipped with spotlights for object lighting (see the section on DRAGONeye® in the LED-Systems brochure “General lighting brochure, complete product overview”).

The planning steps:

1. The selection of suitable LED modules.

   For this example each shelf will be illuminated using white DRAGONeye® DE1-W3-854. According to the data sheet this LED module is operated at max. 350 mA with a typical power consumption of 1.2 W.

2. The required level of control in the application.

   To allow adjusting the brightness individually for each shelf a potentiometer with a dial will be used to control the output current of the OT 9 DIM.

3. The total wattage and number of LED modules to be installed.

   For this example each shelf will be illuminated using four DRAGONeye® modules. The total power consumption is 4.8 W and is well below the maximum output power of 8.5 W of the OT 9 DIM.

The total forward voltage of the four DRAGONeye® modules wired in series is 16 V at maximum and is also below the maximum output voltage of 25 V of the OT 9 DIM.

Both total wattage and forward voltage requirements can be satisfied using the OT 9 DIM.

4. Maximum allowed cable lengths.

The total distance from the OT 9 DIM and the last DRAGONeye® module is approximately 2.5 m. The wire diameter used in this application is 0.75 mm². Using the formula from section 3.1.4 above:

$$L_{\max} \leq \frac{1}{2} \times 34.3m/\Omega \times \frac{25V - 16V}{0.35A} = 54m$$

As to be expected this length exceeds the required length 2.5 m. Also 2.5 m is within the maximum length (10 m) allowed for EMI compliance.

3.1.5.2 Cove lighting (OT 75, OTi DALI DIM, LINEARlight POWER Flex)

In this example accent lighting for a cove of 4 m length can be realized (see the section on LINEARlight POWER Flex in the LED-Systems brochure “General lighting brochure, complete product overview”).

The planning steps:

1. The selection of suitable LED modules.

The cove will be illuminated using LINEARlight POWER Flex modules LM10P-W3-847, according to the data sheet this module has a total length of 2.8 m and a total wattage of 72 W.

The module can also be cut every 140 mm to fit the length to the application. Each unit of 140 mm length consumes 72 W * 140 mm / 2800 mm = 3.6 W.

2. The required level of control in the application.

Control of brightness of the cove illumination is required and will be implemented using the *Touch DIM* feature of OTi DALI DIM. According to the data sheet the dimmer is capable of controlling a maximum current of 5 A or 120 W at 24 V and this wattage introduces a voltage drop of approximately 0.3 V and an additional load of approximately 3 W to the system.

3. The total wattage and number of LED modules to be installed. In this example 28 units will be installed (4000 mm / 140 mm =

28.6), resulting in a total power of 100.8 W (28 * 3.6 W). This power can be realized by connecting two OT 75 E units in parallel on the output side, resulting in a maximum available power of 150 W. With 150 W of available power and installed controller the maximum number of modules would be even higher:

$$N_{\max} = \frac{150W - 3W}{3.6W} = 40$$

4. Maximum allowed cable lengths

The wiring of the modules on the secondary side will be done using 1.5 mm² cables. The theoretical maximum cable length can be calculated using the formula from section 3.1.4 above:

$$L_{\max} \leq \frac{1}{2} \times 73.8m/\Omega \times (24\,V - 0.3\,V - 23\,V) \times \frac{23\,V}{100.8\,W} = 5.9\,m$$

Both OT 75 and the OTi DALI DIM can be fitted in the same space as the LED modules will be installed. This length is therefore sufficient to wire the LINEARlight POWER Flex so that the maximum powered module length of 1400 mm can be respected (i.e. 3 sections consisting of 8/8/6 modules each will be wired separately to the dimmer)

The planned installation requires approximately 15 m distance between the pushbutton planned for controlling the brightness and the OTi DALI DIM, which is within the maximum length possible for *Touch DIM* control (see Table 4 above).

3.1.5.3 Dynamic colored backlighting of a large area (OT 75, OTi DALI DIM, DRAGONchain® Colormix)

In this example a backlight for an area of approximately 3 m² will be planned (see the section on DRAGONchain® Colormix in the LED-Systems brochure “General lighting brochure, complete product overview”).

The planning steps:

1. The selection of suitable LED modules.

Based on the requirements for brightness and homogeneity the DRAGONchain® Colormix DC24A-RGB modules were selected. Optical planning has determined that a total of 6 chains will be required.

The key data sheet values are: Total module power 29.5 W ; max. current at 24 V: Red 0.4 A, green 0.63 A, blue 0.2 A.

2. The required level of control in the application.

Full RGB control is required in this application. To control existing fluorescent DALI ECGs together with the LED backlighting, one OTi DALI DIM controller per channel (color) will be installed and controlled by already installed DALI EASY II units.

According to the data sheet the dimmer is capable of controlling a maximum current of 5 A or 120 W at 24 V and this wattage introduces a voltage drop of approximately 0.3 V and an additional load of approximately 3 W to the system.

The maximum current of the LED module is drawn by the green channel. Given the 5 A maximum of the OTi DALI DIM this allows controlling a maximum of 7 modules can be driven by one OTi DALI DIM (5 A / 0.63 A = 7.94).

3. The total wattage and number of LED modules to be installed.

Optical planning done in step 1 has determined that 6 chains will be required. This is equivalent to a total power of 177 W. The OTi DALI DIM units for the R, G, B channels require 3 W each, so total system power is 186 W.

Three OT 75 E devices will be wired in parallel on the output side and provide a total of 225 W.

With 225 W of available power and three installed controllers 7 chains can be powered.

$$N_{\max} = \frac{225W - 3 \times 3W}{29.5W} = 7.32$$

After first glance adding another OT 75 E to the system would allow enlarging the system to up to nine modules:

$$N_{\max} = \frac{300W - 3 \times 3W}{29.5W} = 9.86$$

Note however that the operating current of nine modules on the green channel adds up to 5.67 A (9*0.63 A). This exceeds the maximum current of the OTi DALI DIM (see 2. above).

4. Maximum allowed cable lengths

The wiring of the modules on the secondary side will be done using 1.5 mm² cables. The theoretical maximum cable length can be calculated using the formula from section 3.1.4 above:

$$L_{max} \leq \frac{1}{2} \times 73.8m/\Omega \times (24\,V - 0.3\,V - 23\,V) \times \frac{23\,V}{186W} = 3.19\,m$$

Both OT 75 E and the OTi DALI DIM can be fitted in the same space as the LED modules will be installed. This length is therefore sufficient to wire the DRAGONchain® Colormix modules so that homogenous backlighting can be realized.

The placement of the existing DALI EASY II and the OTi DALI DIM controllers requires a DALI control line of approximately 30 m, which is well below the maximum length possible for DALI control (see Table 4 above).

3.1.5.4 OSRAM EASY-based system

This example gives an outlook for more complex systems possible using OSRAM's EASY devices. In master/slave mode, up to 16 OT EASY 60 or DALI EASY II control units can be operated simultaneously via a single remote control, pushbutton coupler or PC.

The planning steps for maximum cable lengths etc. follow the examples above and are omitted for this example. The basic steps for installing an EASY-based system are detailed below, for more detailed information please refer to the OPTOTRONIC® EASY manual.

The system of EASY devices is configured as follows: (see Figure 13 below):

1. On one EASY device the input for an external switch should be left open (if required an external switch can be connected). This will put this device into master mode. In the example below this is done on the uppermost OT EASY 60.

2. On all other EASY devices the external switch input must be bridged so they will operate as slave devices.

   Important:
   These devices will enter slave mode when the bridge is in place upon power-up. Bridging a powered device will not put a device into slave mode!

3. The EASY input on all EASY devices is connected with "Y-connectors" (available as accessories). A maximum of four infrared receivers and two pushbutton couplers can be connected to the EASY bus for control.

Note:
If the EASY system coupler is used to extend the system with additional EASY devices another four infrared receivers and two

pushbutton couplers can be connected to each segment of the extended system. It is however not possible to add infrared receivers or pushbutton couplers as the only devices on a segment.

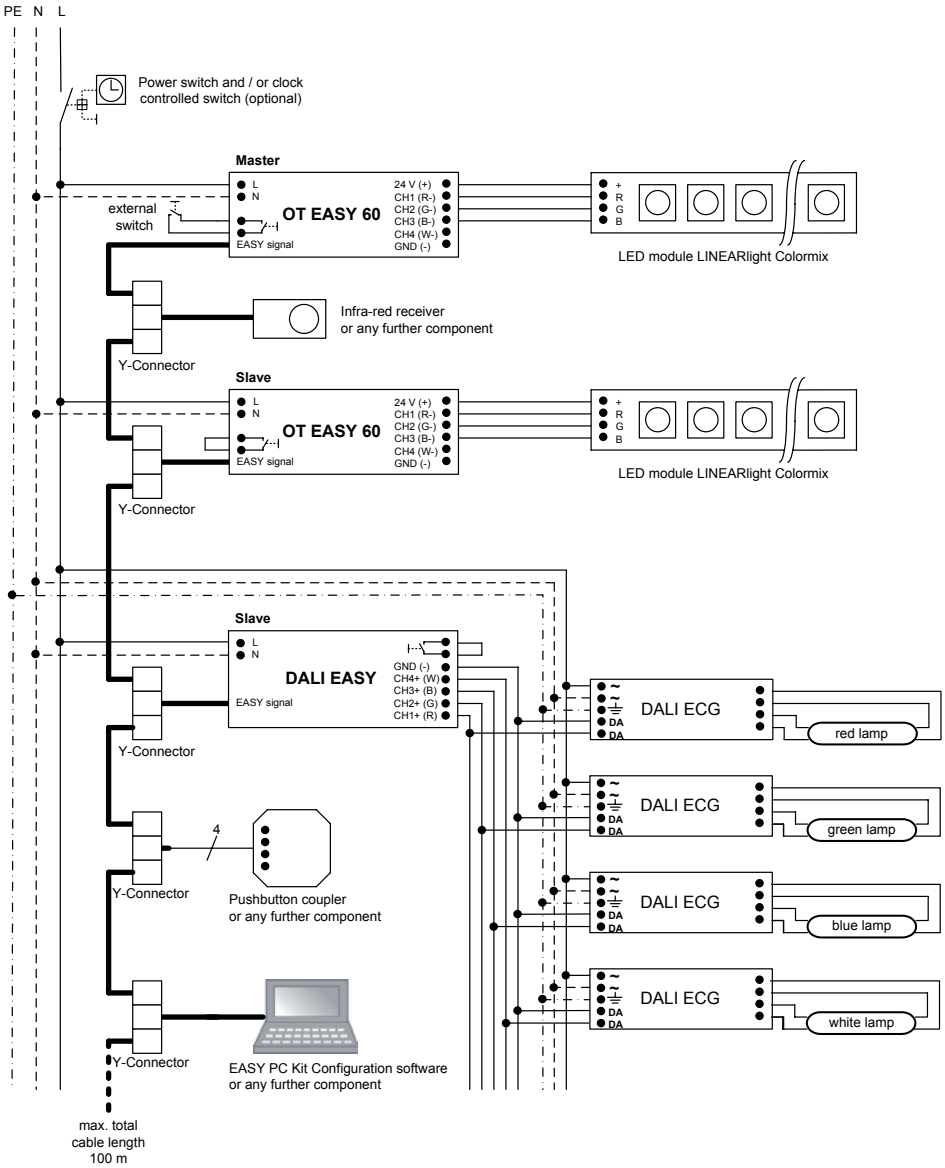


Figure 13 – EASY-based system wiring diagram

3.2 Installation

3.2.1 Mounting requirements

3.2.1.1 Independent mounting

Select OPTOTRONIC® devices are equipped with built-in cable clamps as a strain relief and are suitable for installation independent of a luminaire. All other devices are intended for luminaire installation and do not provide for strain relief.

An overview of devices with built-in strain relief is listed in the appendix in section 5.1.4 on page 79.

3.2.1.2 Outdoor mounting

Most OPTOTRONIC® devices are not designed for unprotected use in outdoor applications and are rated as IP 20 products (not protected against moisture). An exception are products marked with the extension E (for “exterior”), which are designed for outdoor application and are available with higher IP protection. The IP protection for each product is also listed in the data sheets.

Devices with IP protection of IP 64 and IP 65 are VDE approved and protected against dust. They are splash-proof or jet-proof against ingression of water. For an overview of the IP protection offered by OPTOTRONIC® devices refer to section 5.1.3 on page 79.

3.2.1.3 Mounting on wooden surfaces

Electronic power supplies can be installed in a wide variety of places, including suspended ceilings, furniture, luminaires and tube systems. Installation on wooden surfaces is permitted for products marked with . These products fulfil the requirements of VDE 0710 and VDE 0100 part 559.

3.2.2 Wiring

3.2.2.1 Recommended cables

For a safe and reliable operation of OPTOTRONIC® devices, it is mandatory to use only recommended cables on the input and output side and control port where applicable. This guarantees that the cable is suitable for the electrical load and that the mechanical connection of the wire terminals and cable clamp (when available) is safe and working properly.

Recommended cables for input and output are specified in each product’s data sheets, which are listed in section 5.5 on page 82.

Also check the instruction sheets that are delivered with the product for updated or additional information.

3.2.2.2 Cable stripping

Furthermore, to ensure a safe electrical and mechanical connection of the cable in the electrical terminals and the cable clamp respectively, it is mandatory to observe the cable stripping lengths as shown in Figure 14 below. The stripping lengths for (a) and (b) are specified for each product (where applicable) in the data sheets in section 5.5 on page 82, also check the instruction sheet that is delivered with the product for additional or updated information.

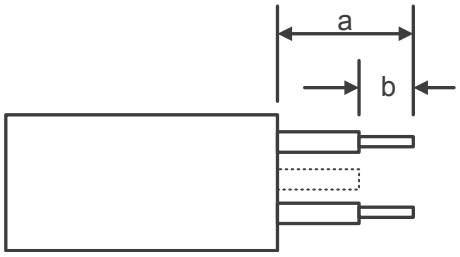


Figure 14 – Recommended cable stripping

3.2.2.3 Cable routing

To ensure good radio interference suppression and maximum safety the following rules for cable routing should be observed:

1. Mains and LED-module cables should never be routed in parallel. Keep output cables and mains cables as far away from one another as possible (e.g. 5 to 10 cm). This avoids mutual interference between mains and secondary-side cables.
2. Place output cables away from earthed metal surfaces (if possible several cm) to reduce capacitive interference.
3. Keep mains cables in the luminaire as short as possible to reduce interference.
4. Don’t route mains cables too close to the power supply (this applies in particular to through-wiring).
5. Avoid crossing mains cables and LED-module cables. Where this is not possible, cables should cross at right angles (to avoid HF interference on the mains cable).

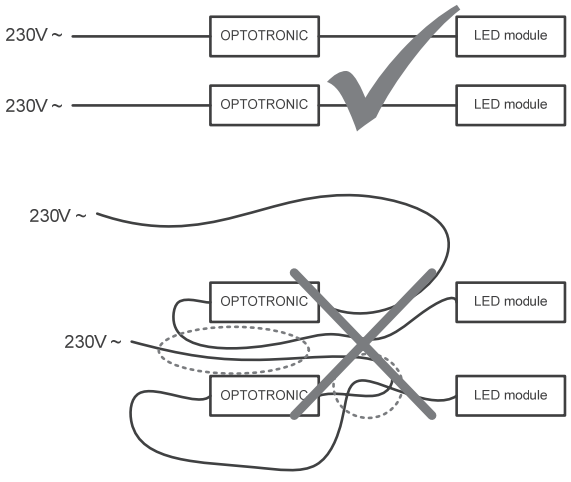


Figure 15- Cable routing of OPTOTRONIC® and LED modules

6. Cable penetrations through metal components must never be left unprotected and should be fitted with additional insolation (sleeve, grommet, edge protector, etc.).

Dimming units on the secondary side such as OT DIM usually do not affect the radio interference.

3.2.2.4 Wiring limitations

Parallel connection, wiring limitations supplies can be connected in parallel on the primary side. However, unlike conventional transformers, OPTOTRONIC® power supplies cannot be connected in parallel on the secondary side as this may lead to unequal load distribution and overload of individual power supplies. Series connection is also not permitted.

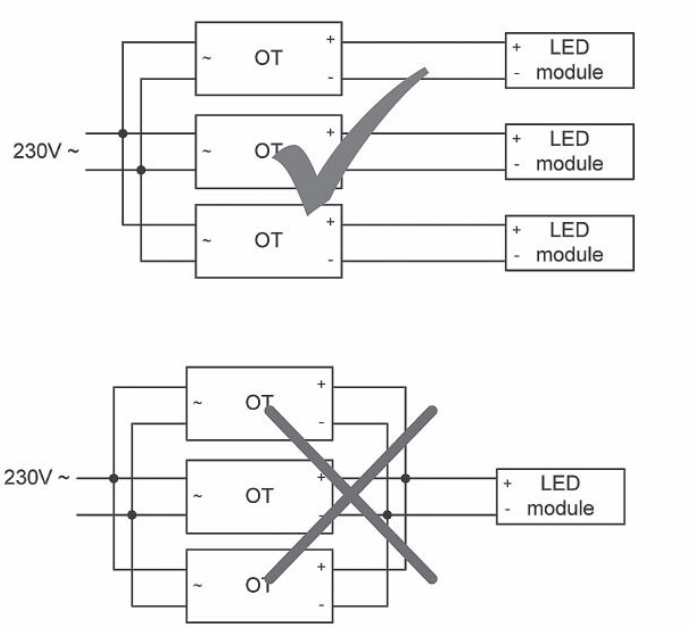


Figure 16 – Parallel connection of OPTOTRONIC®

As an exception OPTOTRONIC® OT 50/120-277/10 E and OT 75/120-277/24 E may be connected in parallel on the output side due to a special design of the power supply. The number of power supplies that can be connected in parallel is limited and detailed in section 2.11 on page 32.

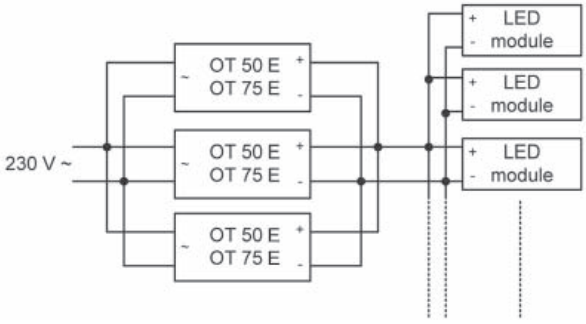


Figure 17 – Parallel connection on the secondary side of OT 50 E and OT 75 E

Note:
The parallel connection must be established by connecting the pre-wired cables of the OT 50 E / OT 75 E.

System installations
In system installations, limiting the number of devices connected in parallel on the control port or sharing a cable for one of the poles on the output side, ensures that LED or LED modules connected to the output are safe to touch at all times. Exceeding this number may lead to touch currents on the output side that exceed the maximum values as defined in the IEC/EN 61347.

The maximum number of devices that can be wired in parallel device-dependent can be verified on the instruction sheets delivered with all products.

3.2.2.5 1…10 V, 10 V max. control port

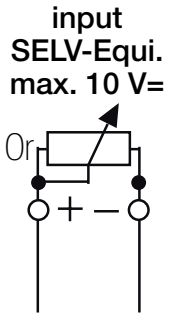
Select OPTOTRONIC® devices are equipped with control port that match the characteristics of 1…10 V devices, but are not intended to be operated with standard 1…10 V components connected to line voltage due to possible differences in the isolation present between control port and output voltage in the device.

1…10 V components suitable to control these OPTOTRONIC® devices must provide double isolation between control port and their connection to line voltage.

With „10 V max.“ devices OSRAM's DIM MCU may be used only as a potentiometer (i.e. the mains input on the DIM MCU must not be connected).

Always ensure a distance of at least 6 mm between control input and line voltage to ensure the requirements of double isolation.

The control port of these devices is marked with the following symbol:



Always check the instruction sheets for additional or updated information.

3.2.2.6 DALI wiring instructions

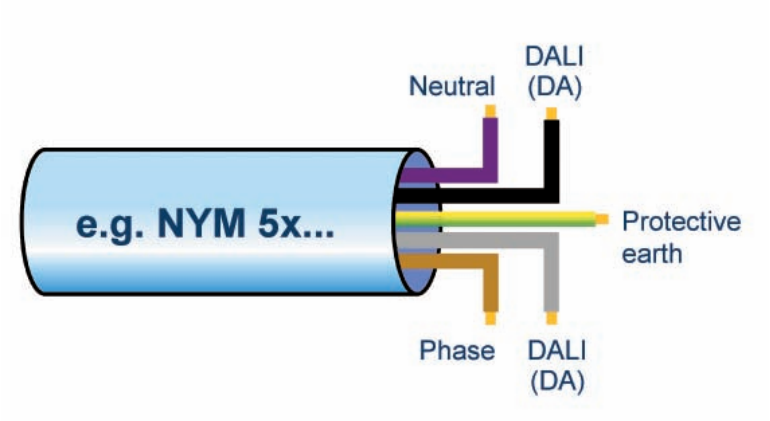
Overall, the requirements that the transmission line has to meet are very modest. When choosing a cable, make sure that the voltage drop on the line does not exceed 2 V at 250 mA. As with 1...10 V systems, the power supply and the control line can be run in the same cable. This means for example that a 5-core NYM cable can be used without problems to power and control DALI ECGs.

The maximum permitted length of cable between the controller and the connected ECGs is 300 m in total, the required cable cross-section depending on cable length is listed in Table 5 below.

Cable length	Up to 100 m	100 to 150 m	150 to 300 m
Cable cross-section	0.5 mm²	0.75 mm²	1.5 mm²

Table 5 – Recommended cable cross sections for DALI control wire

Wiring diagram for DALI ECGs:
For reasons of clarity, it is best to use the two free cables for DALI



Note:
Controllers and ECGs can be connected to different power supply phases.

For more information please also refer to DALI Technical Guide available at:
www.osram.com/ecg-downloads

3.2.2.7 DMX wiring instructions

The DMX512 protocol uses XLR style connectors (see below) to transmit RS-485 data. When running DMX512 cabling, be sure to use twisted pair wire (the differential RS-485 standard performs best with twisted pair). Also, the final unused XLR connector in a DMX512 daisy chain network should be terminated with a 120 Ω resistor (to prevent ringing and device malfunction).

Figure 18- Typical DMX connector

Pin	Funktion
1	Ground (shielding)
2	DMX-
3	DMX+
4	NC or 2nd link (optional), DMX-
5	NC or 2nd link (optional), DMX+

3.2.3 Avoiding noise

To avoid noise from dimming, OPTOTRONIC® devices that provide dimming capability should be installed in a way that prevents vibrations to be transferred to any resonance surface.

3.2.4 Start-up current, maximum number of devices per circuit breaker

When switching on an ECG, a starting current pulse I_p of very short duration (TH < 1 ms) is generated as the storage capacitor used for internal power supply is charged. When a large number of units are switched on simultaneously (particularly if they are switched on at the peak of the AC input voltage) a large starting current will flow that may falsely trigger automatic circuit breaker. To avoid false tripping of the circuit breakers, the number of OPTOTRONIC® devices connected may therefore have to be limited.

The maximum possible number is device-dependent and listed in the respective data sheet in section 5.5 on page 82.

This maximum number is based on the following assumptions:

- Switching is assumed to occur at the peak of the rated AC input voltage, which is the worst-case in terms of the starting current pulse.
- The type of circuit breakers is “N” automatic circuit breakers (e.g. Siemens type 5SN I-2 and 5SX) with “B” tripping characteristics.
- The specified maximum number listed applies to single-pole automatic circuit breakers. When using multi-pole automatic circuit breakers (2-pole, 3-pole) the permitted number of units is reduced by 20 %.

3.2.5 Supply requirements

OPTOTRONIC® devices are available with different nominal input voltage ranges of e.g. 120 V to 277 V or 220-240 V AC at 50 or 60 Hz. Please refer to the data sheets available in section 5.5 on page 82 for individual ratings of each power supply.

OPTOTRONIC® devices operate reliably within -5 % / +10 % of the nominal input voltage range. Supply voltage variations within this range do not affect the output voltage or current as it is electronically controlled.

Warning:
Operating OPTOTRONIC® devices outside the rated voltages may reduce life time, lead to reliability problems or damage the device.

All OPTOTRONIC® devices are protected according to IEC/EN 61547 against short-time (transient) over-voltages, for example as occurring when inductive loads such as fluorescent lamps operated with magnetic ballasts are switched off.

3.2.5.1 DC operation

OPTOTRONIC® devices marked with "~=" or listed with 0 Hz as acceptable mains frequency in the data sheet section can be operated with DC voltage. Please note that EMI compliance for DC operation is not guaranteed to be same as for AC operation and must be verified by the luminaire manufacturer in addition to compliance in AC mode.

The output power of these devices remains constant, regardless of whether they are operated on an AC or DC supply, guaranteeing that the light output of attached LED modules remains constant.

3.2.6 Installing control units

3.2.6.1 1. . . 10 V

Control units for 1…10 V devices are easy to install and operate, however a few points should be considered for installation:

1. Control wires must be connected with right polarity (+/-) and must not switch polarity between devices.

2. All components of the main circuit and the control circuit must be designed for 250 V against earth.

3. Do not use telephone or "bell wires" like 2 x 2 x 0.6 J-Y(St)-Y or YR as control wires, because the 1…10 V control voltage does not comply with SELV.

Detailed information regarding selection of cables and installation can be found in the latest editions of the international or national standards for electrical installations. According to DIN VDE 0100 part 520 section 528.11 main circuits and auxiliary circuits can be routed in parallel even if the voltage of the auxiliary circuits is lower than the voltage of the main circuits.

4. The control wires are galvanically separated from the mains cables, however may not comply with SELV requirements. For installation purposes use only cables and terminals approved for 230 V.

5. The control voltage can be limited upwards and downwards; several controllers can be combined.

6. The 1…10 V interface only allows for control of the OPTOTRONIC® dimming level, switching must be done via mains cables.

   If the control unit provides built-in switching, ensure that the maximum rated load of the control unit's relay is not exceeded.

7. The installed control unit must be able to carry the current provided by the ECGs (0,6 mA, for calculation purposes this is typically assumed to be 1 mA) into the control wires and reduce the control voltage to ≤ 1 V.

   This requirement is fulfilled by a potentiometer dimensioned accordingly (see section Potentiometer below) and by OSRAM control gear used according to data sheet.

To verify an installation is working properly the following should be tested:

1. With open control wires (not connected to any control gear) the LED modules should operate at full brightness.
2. With short-circuited control wires, the LED modules should be dimmed to the minimum output level.
3. With the control gear set to the lowest dimming value the voltage on the control cables should be reduced to less than 1 V. If a voltage higher than 1 V is measured, the control gear will not be able to set the ECGs to the lowest dimming value.

The following points are important for cable routing:

1. Only cables may be used which are isolated according to the highest operating voltage used in the particular installation. Alternatively, each conductor in a multi-wire cable is isolated against the voltage carried in the cable next to it.
2. When routing wires in tubes or ducts for electrical installation only cables of a main circuit and related auxiliary circuit may be routed together.

3. In one cable several main circuits including the according auxiliary circuits may be combined.

Note:
- OPTOTRONIC® power supplies cannot be dimmed via mains cables (for example it is not possible to dim by leading edge phase cutting or control impulse)!
- Observe important limitations of OPTOTRONIC® devices with a “10 V max.” port, see section 3.2.2.5 on page 51.

Potentiometer

Commercial potentiometers designed for use in lighting control (available through electric wholesale) can be used for easy control of 1…10 V and 10 V max. devices. When connecting more than two 1…10 V units and 10 V max the installation of OSRAM’s manual controller DIM MCU is recommended (see DIM MCU below).

The OPTOTRONIC® device interface is providing the control voltage required for the potentiometer. The resistance depends on the number n of the units connected; for general applications a suitable resistance can be calculated using the formula below:

$$R_{potentiometer} = \frac{100\,k\Omega}{n}$$

If the calculated value is not available, a potentiometer with higher resistance should be chosen. Otherwise it may not be possible to reach the full output power of the LED modules. To properly match the dimming characteristic of the OPTOTRONIC®, it may be necessary to limit the mechanical range of the potentiometer.

Both linear or logarithmic potentiometers can be used. To mimic the sensitivity of the human eye, a logarithmic potentiometer is recommended.

The potentiometer must be at least designed for a total wattage of *n* x 2.8 mW.

The following diagram gives an example for a wiring with potentiometer connected to the control input of an OT DIM.

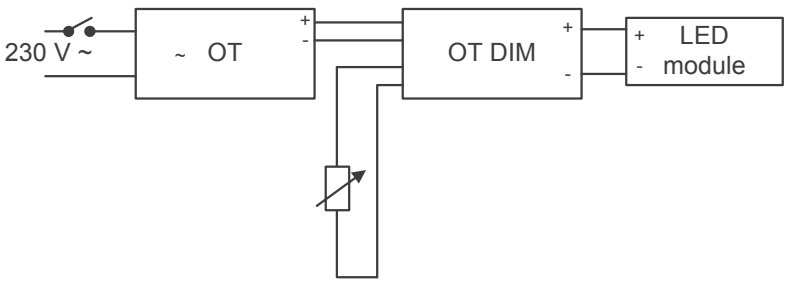


Figure 19 – Dimming of OT DIM with a potentiometer

Note:
Also see the application notes for the OPTOTRONIC® devices with 1…10 V and 10 V max interface in section 4 for information on specific resistor values.

DIM MCU
When connecting more than two 1…10 V units, the installation of OSRAM's manual controller DIM MCU is recommended.

The DIM MCU is a standard solution for lighting control with one control point (for example in small to mid-size rooms with one door). One DIM MCU can control a maximum of fifty 1…10 V units.

A pushbutton is integrated into the DIM MCU (galvanically insulated from the lighting control, however not complying with SELV requirements) which can be used to switch line voltage. This contact can also be used to control relays in order to simultaneously switch units on different circuits.

The following diagram shows the wiring of a DIM MCU controlling multiple OT DIM in parallel.

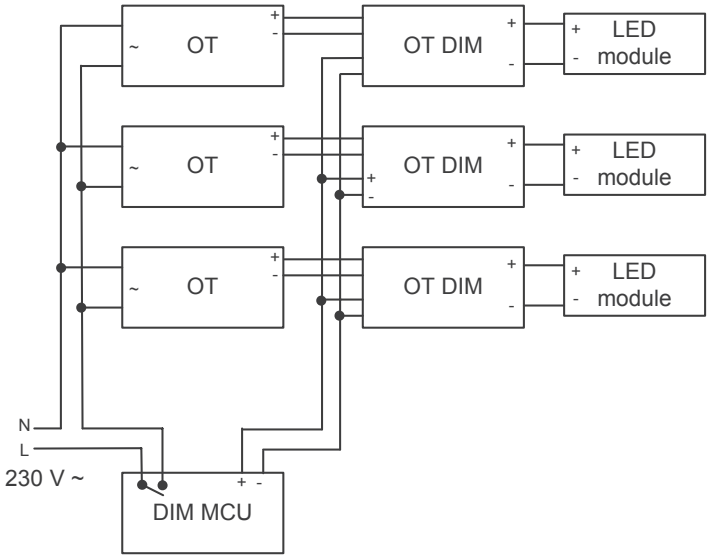


Figure 20 – Controlling multiple OT DIM with DIM MCU

The data sheet of DIM MCU can be found on the LMS website in the section for 1…10 V control devices: *www.osram.com/ecg-lms*

This website also provides information on auxiliary devices (such as sensors, repeaters) etc. that allow to further extend the possibilities of controlling 1…10 V devices.

Specific information on planning installing and using 1…10 V devices can also be found in the technical guide "QUICKTRONIC dimmable" available at the website below:
www.osram.com/ecg-downloads

Note:
Not all OPTOTRONIC® devices are suitable to be connected to 1…10 V controllers. For details please refer to the application notes of the OPTOTRONIC® devices in section 4 and the instruction sheets delivered with the products.

3.2.7 Thermal management

OPTOTRONIC® power supplies are designed for very high efficiency and reliable operation even at elevated ambient temperatures. Thermal management of these devices is nonetheless important and can greatly improve the lifetime of the power supplies in an installation.

To avoid overheating, the electronic converter should be installed as far away as possible from any external heat source (e.g. the LED modules, other ECGs) as possible. When installing OPTOTRONIC® in a luminaire, a good thermal connection between the power supply and the housing of the lighting fixture is required. An installation in a sealed plastic IP-box without ventilation may lead to overheating, to improve thermal behaviour use a metal base plate connected to the outside or metallic boxes altogether.

Proper thermal management is best verified by measuring the temperature at the OPTOTRONIC®'s t_c point in steady-state operation at maximum load. The measured temperature must not exceed the maximum specified value of the OPTOTRONIC® device for the operating temperature of the luminaire.

3.2.8 Output switching

In certain applications it may be necessary or useful to implement switching on the secondary side, i.e. disconnecting all or parts of the connected LED modules by means of switching.

For constant-voltage based systems this can be done, however the following points should be considered:

1. Even when the complete load is disconnected on the secondary side, there is still a small amount of energy used by the OPTOTRONIC® in stand-by operation. This is a loss of energy that can be avoided by switching the power supply on mains line.

2. EMI compliance of the luminaire may change at different load level and should be checked by the luminaire manufacturer.

The same considerations are valid for constant-current based systems, in addition there may also be a short current spike when a device operated without load is reconnected to the load when internal capacitors start discharging through the load. In general however, this will not lead to a damage of the LED in a typical application, but should be checked by the luminaire manufacturer for a particular application.

4. OPTOTRONIC® portfolio

This section provides an overview of the OPTOTRONIC® portfolio and highlights special features and specific information for each device. The naming scheme of OPTOTRONIC® devices is detailed in section 2.4. on page 12 and lets you quickly derive the most important parameters of each device (i.e. rated power, input voltage range, output voltage/current, etc.) from the product name.

For detailed technical specifications please refer to the data sheets in section 5.5 on page 82.

To find the best matching OPTOTRONIC® for a specific LED module, refer to section 3.1.1 on page 33.

For your convenience you may also refer to the product reference tables in section 5.1 on page 78 where you can quickly find available products by output type, wattage and housing type.

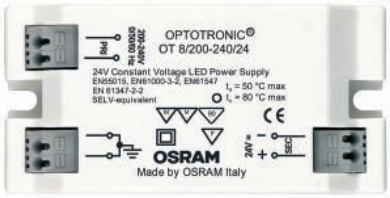
4.1 Products

4.1.1 OPTOTRONIC® OT 6 family

Available as 10 V and 24 V versions:
- OT 6/100-120/10 CE
- OT 6/100-120/24 CE
- OT 6/220-240/10 CE
- OT 6/220-240/24 CE

Features:
- Power supply with round form-factor, suitable for installation in flush-type boxes
- Equipped with cables for easy installation
- IP 65 rated, suitable for outdoor operation
- Class II device

4.1.2 OPTOTRONIC® OT 8/200-240/24



Available as 24 V version:
OT 8/200-240/24

Features:
- Small form-factor for luminaire integration
- Wire connection via push-in terminal
- Suitable for class II and class I (using functional ground) installation

4.1.3 OPTOTRONIC® OT 12/230-240/10

Available Available as 10 V version:
OT 12/230-240/10

Features:
- Device for independent installation with cable clamp and robust housing
- Wire connection via screw terminal
- Class II device

4.1.4 OPTOTRONIC® OT 12/200-240/10 LE

Available as 10 V version:
OT 12/200-240/10 LE

Features:
- Thin, long form-factor especially suited for installation in backlighting applications (i.e. channel letters)
- Equipped with cables for easy installation
- IP 65 rated, suitable for outdoor operation
- Suitable for class II installation

4.1.5 OPTOTRONIC® OT 20/230-240/24

Available as 24 V version:
OT 20/230-240/24

Features:
- Device for independent installation with cable clamp and robust housing
- Wire connection via screw terminal.
- Class II device

4.1.6 OPTOTRONIC® OT 20/120-240/24 S

Available as 24 V version:
OT 20/120-240/24 S

Features:
- Compact device especially suited for installation in lighting fixtures.
- Wire connection via screw terminal.
- Class II device.

4.1.7 OPTOTRONIC® OT 50/220-240/10

Available as 10 V version:
OT 50/220-240/10

Features:
- Device for independent installation with cable clamp and robust housing
- Wire connection by screw terminal.

- High efficiency and optimized thermal performance for maximum lifetime.
- Wire connection via screw terminals
- Smart Power Supply (see section 2.10, page 31)
- Class II device.

4.1.8 OPTOTRONIC® OT 50/120-277/10 E

Available as 10 V version:
OT 50/120-277/10 E

Features:
- Equipped with cables for easy installation
- High efficiency and optimized thermal performance for maximum lifetime
- Parallel wiring on output possible, up to 5 OT 50 E can be connected in parallel (see 2.11, page 32)
- Smart power supply (see 2.10, page 31)
- IP 64 rated, suitable for outdoor operation
- Class I device

4.1.9 OPTOTRONIC® OT 75/220-240/24

Available as 24 V version:
OT 75/220-240/24

Features:
- Device for independent installation with cable clamp and robust housing
- Wire connection by screw terminal.
- High efficiency and optimized thermal performance for maximum lifetime.
- Smart Power Supply (see section 2.10, page 31)
- Class II device.

4.1.10 OPTOTRONIC® OT 75/120-277/24 E

Available as 24 V version:
OT 75/120-277/24 E

Features:
- High efficiency and optimized thermal performance for maximum lifetime.
- Equipped with cables for easy installation.
- Parallel wiring on output possible, up to 4 OT 75 E can be connected in parallel (see 2.11, page 32)
- Smart Power Supply (see section 2.10, page 31)
- IP 64 rated, suitable for outdoor operation
- Class I device

4.1.11 OPTOTRONIC® OT 9 family

Available as 350 mA version:
OT 9/100-120/350 E
OT 9/200-240/350

Features:
- Small form-factor for luminaire integration
- Wire connection via push-in terminal
- Suitable for class II and class I (using functional ground) installation

4.1.12 OPTOTRONIC® OT 9/200-240/350 DIM

Available as 350 mA version:
OT 9/200-240/350 DIM

Features:

- Device for independent installation with cable clamp and compact, robust housing
- Wire connection via screw terminal.
- Built-in control port (adjustment through resistor or 10 V control signal) for current adjustment from 0–100 % (see section 2.3.2.1, page 16)
- Class II device.

Application notes:

- Table 6 below lists the approximate resistor values to be used for a given output current value (for a single OT 9/200-240/350 DIM)

I_{out} [mA]	R [kΩ]
100	8.2
200	14.1
300	20.1
350	> 23.0

Table 6 – OT 9/200-240/350 DIM – Typical resistor values

- Typical potentiometers with 20, 47, or 100 kΩ log. can be used to control the OT 9/200-240/350 DIM. The mechanical range of the potentiometer may need to be adjusted accordingly.

- When controlling multiple OT 9/200-240/350 DIM in parallel the resistor value listed in Table 6 above must be divided by the number of devices controlled in parallel to achieve the desired output current. Only a limited number of OT 9/200-240/350 DIM may be wired in parallel, check the instruction sheet delivered with the product for details.

4.1.13 OPTOTRONIC® OT 18/200-240/700 DIM

Available as 700 mA version:
OT 18/200-240/700 DIM

Special features:

- Device for independent installation with cable clamp and compact, robust housing
- Wire connection by screw terminal.

- Built-in control port for current adjustment from 0-100 % (see section 2.3.2.1, page 16)
- Delivered with pre-installed resistor for 500 mA output current

Application notes:

- Table 7 below lists the approximate resistor values to be used for a given output current value (for a single OT 18 DIM)

I_{out} [mA]	R [kΩ]
100	5,2
200	8,2
300	11,2
350	12,7
400	14,1
500	17,1
600	20,1
700	> 23,0

Table 7 – OT 18/200-240/700 DIM – Typical resistor values

- When controlling multiple OT 18/200-240/700 DIM in parallel the resistor value listed in Table 7 above must be divided by the number of devices controlled in parallel to achieve the desired output current. Only a limited number of OT 18/200-240/700 DIM may be wired in parallel, check the instruction sheet delivered with the product for details.

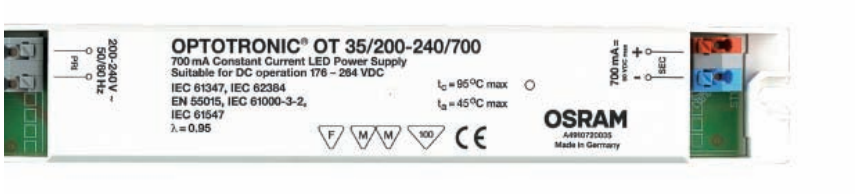
- Typical potentiometers with 20, 47, or 100 kΩ log. can be used to control the OT 18/200-240/700 DIM. The mechanical range of the potentiometer may need to be adjusted accordingly.

- To operate the OT 18/200-240/700 DIM with a limited maximum output current of either 500 mA or 350 mA the pre-installed resistor must be replaceed with the fixed resistor value given in Table 8 below.

Max. I_{out} [mA]	$R_{potentiometer}$ [kΩ log]	R_{fixed} [kΩ]
500 mA	100	21.95
	47	29.17
	20	180
350 mA	100	14.4
	47	17.2
	20	34

Table 8 – Resistor values for OT 18 DIM with output current limited

4.1.14 OPTOTRONIC® OT 35/200-240/700

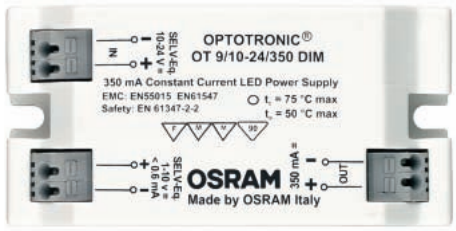


Available as 700 mA version:
OT 35/200-240/700

Features:
- Device for luminaire integration
- Form-factor compatible with QUICKTRONIC® devices
- Output voltage < 50 V
- Suitable for class II installations

Application notes:
Output is not a touchable SELV output. The luminaire manufacturer must ensure output and LED are isolated and secured against touching accordingly.

4.1.15 OPTOTRONIC® OT 9/10-24/350 DIM



Available as 350 mA version:
OT 9/10-24/350 DIM

Features:
- Designed for nominal DC supply voltage 10-24 V (max. input voltage range 9-32 V)
- Ideally suited to integrate 350 mA LED modules in systems utilizing constant voltage power supplies
- Intelligent dimming automatically switches between PWM- and DC-dimming to guarantee optimal dimming performance
- Small form-factor for luminaire integration.
- Class II device
- Integration in DALI, DMX-, EIB- or LON installation with 1…10 V converter

Application notes:
- Table 9 below lists the approximate resistor values to be used for a given output current value (for a single OT 9/10-24/350 DIM)

I_{out} [mA]	R [kΩ]
100	9.4
200	15.7
300	22.0
350	> 25.0

Table 9 – OT 9/10-24/350 DIM– Typical resistor values

- For system planning purposes the power consumption of the OT 9/10-24/350 DIM can be assumed as follows:
  - Below 50 % of full-load approximately 1 W
  - Above 50 % of full-load approximately 2.5 W

4.1.16 OPTOTRONIC® OT DIM

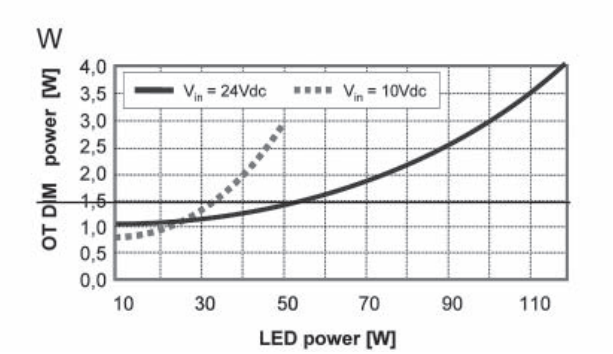
Suitable for 10 V and 24 V LED modules:
OT DIM

Special features:
- Device in slim housing for independent installation with cable clamp, wire connection by screw terminals
- Maximum output current 5 A, maximum output power 50 W for 10 V LED modules and 120 W for 24 V LED modules
- Fast and linear PWM-dimming of 10 V and 24 V modules on the output side, full dimming range from 0 % to 100 %.
- PWM frequency of 135 Hz guarantees flicker-free dimming performance
- Dimming control via 1...10 V interface
- 1...10 V interface can be connected to standard dimmers (like DIM MCU), potentiometers or digital signals to control dimming. The dimming interface is isolated against the LED-voltage according SELV equivalent requirements
- Integration in DALI, DMX-, EIB- or LON installation with 1…10 V converter

Application notes:

Power consumption

- For system planning purposes the power consumption of the OT DIM can be assumed as follows:
  - Below 50 % of full-load approximately 2 W
  - Above 50 % of full-load approximately 4 W



- At maximum load the OT DIM introduces a voltage drop of approximately 0.3 V to the system.

Luminous flux

The Φ–U_c-characteristic curve shows how the luminous flux depends on the control voltage of an OT DIM. From the diagram can be seen that the luminous flux is reduced to 0 % without applied control voltage.

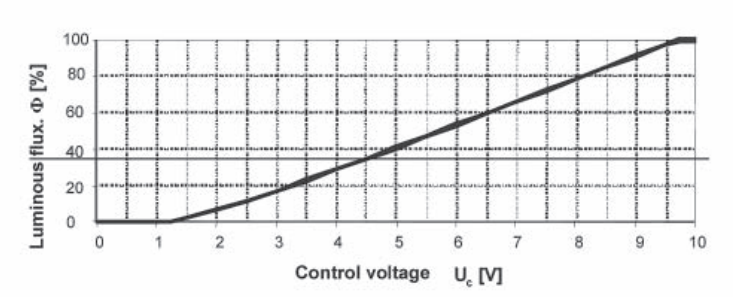


Figure 21 – OT DIM dimming curve

RGB control using OT DIM

When connecting OT DIM for RGB control please note that the anode (+ pole) is on common terminals; the wire diameter of this connection must be chosen so that the total power can be carried. In this case, the control can be done via 1...10 V interface.

4.1.17 OPTOTRONIC® OT RGB Sequencer

Suitable for 10 V and 24 V power LED modules:
OT RGB Sequencer

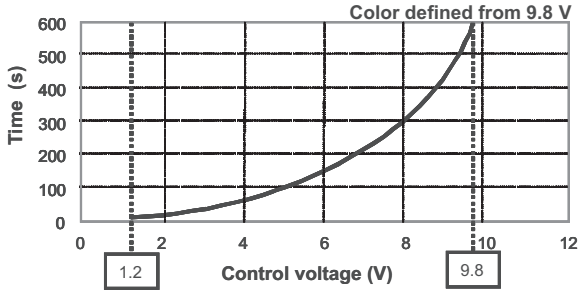
Special features:
- Device in slim housing for independent installation with cable clamp, wire connection by screw terminals
- Maximum output current 2 A per channel. Maximum output power 3 x 20 W for 10 V LED modules and 3 x 48 W for 24 V LED modules
- Fast and linear PWM-dimming of 10 V and 24 V modules on the output side, full dimming range from 0 % to 100 %.
- PWM frequency of 350 Hz guarantees flicker-free dimming performance
- Built-in 3-channel sequencer for dynamic color changes on RGB LED modules with controllable speed
- Speed of the color sequence can be controlled via 1...10 V control input
- One of 8 pre-defined color sequences can be selected via 1...10 V control input (see application note)
- Brightness of the LED modules can be selected via 1...10 V control input (all channels are dimmed simultaneous)
- 1...10 V interfaces can be connected to standard dimmers, potentiometers or digital signals to control dimming
- Integration in DALI, DMX-, EIB- or LON installation with 1…10 V converter

Application notes:
Power consumption
For system planning purposes the power consumption (per channel) of the OT RGB Sequencer can be assumed as follows:
- Below 50 % of full-load approximately 2 W
- Above 50 % of full-load approximately 4 W

Color sequences
The speed of the color change is controlled by the input voltage on the control port. The dependency of the speed on the input voltage is as follows:

- < 1.2 V: Sequencer stopped, outputs turned off
- 1.2 – 9.8 V: Speed of sequence 5 sec – 10 min
- > 9.8 V: Sequencer stopped, outputs turned on, color held-current output For one sequence a full cycle corresponds to 6 time units where one time unit can be set between 5 seconds and 10 minutes. In accordance with the chosen set-up the lumen output will follow as shown in the figure below.

There is no linear dependence between the time period and control voltage (from threshold voltage 1.2 V to fixed color at 9.8 V) according to the diagram below.



Attention:
Synchronization of more than one sequencer or a sequencer with another device is not possible. Large installation that would require synchronization across sequencers can easily be implemented using the OPTOTRONIC® EASY system, see page 82 for details.

Pre-defined RGB color sequences:

Sequences	scene 1	scene 2	scene 3	scene 4	scene 5	scene 6	scene 7	scene 8	scene 9	control voltage	Ω value
standard							n/a	n/a	n/a	> 8V	> 80 kΩ
warm									n/a	< 2 V	< 20 kΩ
cold								n/a	n/a	2-3 V	20-30 kΩ
intense							n/a	n/a	n/a	3-4 V	30-40 kΩ
pastel										4-5 V	40-50 kΩ
summer						n/a	n/a	n/a	n/a	5-6 V	50-60 kΩ
sunset							n/a	n/a	n/a	6-7 V	60-70 kΩ
Tai Chi									n/a	7-8 V	70-80 kΩ

Backward compatibility:
The OT RGB Sequencer with three control inputs is compatible with the first generation OT RGB Sequencer (with one control input) when color sequence and dimming control inputs are left unconnected. The standard sequence selected by default is identical with the original sequence of the first generation OT RGB Sequencer. Figure 22 below shows the wiring diagram of a stand-alone RGB running light using e.g. LINEARlight® Colormix LED modules.

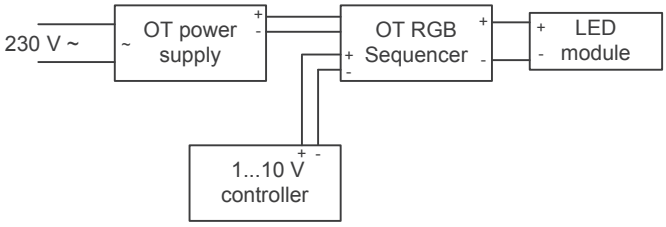


Figure 22 – Standalone RGB running light

4.1.18 OPTOTRONIC® OT RGB DIM

Suitable for 10 V and 24 V LED modules:
OT RGB DIM

Special features:
- Device in slim housing for independent installation with cable clamp, wire connection by screw terminals
- Maximum output current 2 A per channel. Maximum output power 3 x 20 W for 10 V LED modules and 3 x 48 W for 24 V LED modules

- Fast and linear PWM-dimming of 10 V and 24 V modules on the output side, full dimming range from 0 % to 100 %
- PWM frequency of 350 Hz guarantees flicker-free dimming performance
- 3 independent 1…10 V control inputs for controlling PWM dimming of output channels.
- 1...10 V interface can be connected to standard dimmers, potentiometers or digital signals to control dimming.
- Integration in DALI, DMX-, EIB- or LON installation with 1…10 V converter

Application notes:

Power consumption

For system planning purposes the power consumption of the OT RGB 3-channel DIM can be assumed as follows:

- Below 50 % of full-load approximately 2 W
- Above 50 % of full-load approximately 4 W

4.1.19 OPTOTRONIC® OT DALI 25/220-240/24 RGB

Available as 24 V version:

OT DALI 25/220-240/24 RGB+W

Special features:

- Power supply with integrated DALI control and PWM controller for PWM dimming of 3 channels on the output side
- Flexible addressing:
  - The output channels can be assigned to 3 individual DALI addresses, total combined wattage is 25 W.
  - After assignment of short addresses for 3 channels, the channels can be controlled individually. e.g. red – short address 0; green – short address 1; blue – short address 2
  - Without assigned 3 addresses the device operates as a 1-channel dimmable ECG with a maximum wattage of 25 W in broadcast mode.
  - Operation as stand-alone sequencer, particular colors can be programmed in combination with a DALI controller such as DALI EASY. After the programming is completed, the controller can be disconnected and the sequence can be run independently.

Application notes:

Stand-alone operation

OT DALI 25/220-240/24 RGB can also be used as stand-alone sequencer without DALI interface. In this case, the unit recalls all stored color scenes with a specified speed. To use it as stand-alone sequencer it is important whether a voltage is applied to the DALI-interface terminals or not.

Activation of stand-alone sequencer:

- Sequencer status is activated if no voltage is applied to the DALI interface terminal when switching on.

Deactivation of stand-alone sequencer:

- Sequencer mode will be quit instantly if a voltage is detected at the DALI-interface terminal when switching on or during operation.

Note:
A loss of voltage during operation does not result in activation.

Configuration of the stand-alone sequencer

When programming a sequencer via DALI-interface transition time, duration and color values have to be taken into consideration. Note that the desired values are stored in the scene memory of the device, there are no other special DALI commands or parameters used to program the device.

Transition time:

Transition time is calculated as the product of fade time and fade rate:

Transition time = DALI Fade Time (s) * DALI Fade Rate

DALI Fade Time (s)	0	1	2	3	4	5	6	7
	<0.707	0.707	1	1.414	2	2.828	4	5.657
DALI Fade Time (s)	8	9	10	11	12	13	14	15
	8	11.314	16	22.627	32	45.255	64	90.51

Example:
DALI fade time 4 = 2 s
DALI fade rate 10
➔ transition time = 2 s * 10 = 20 s

Duration:
Duration is calculated as the product of the value stored in scene 15 multiplied by 0.25 s

Example:
DALI value in scene 15 = 85
➔ Duration = 85 * 0.25 s = 21.25 s

Color-values:
Color values are stored in scene 0…14, a DALI-value of 255 indicated that the scene will be skipped.

Factory defaults:
The factory pre-set values for fade time and fade rate can be found in the following table:

DALI fade rate	DALI fade time	Transition time (s)	Duration (s)
15	4 (2.0 s)	30	1

Channel	Scene 0	Scene 1	Scene 2	Scene 3
R	254	180	10	10
G	10	10	10	254
B	10	180	254	254
Channel	**Scene 4**	**Scene 5**	**Scene 6**	**Scene 7**
R	10	254	254	254
G	254	254	150	254
B	10	10	10	254
Channel	**Scene 8**	**Scene 9**	**Scene 10**	**Scene 11**
R	255	255	255	255
G	255	255	255	255
B	255	255	255	255
Channel	**Scene 12**	**Scene 13**	**Scene 14**	**Scene 15**
R	255	255	255	4
G	255	255	255	4
B	255	255	255	4

Scenes 8 to 14 will be skipped as they are loaded with 255.

Attention:
In stand-alone operation several OT DALI 25 cannot be synchronized without using a DALI controller.

Above described options to control with DALI can be extended by OSRAM's 4-channel lighting control system DALI EASY II for example to store lighting scenes or to operate with IR remote control. DALI EASY II is designed to connect with a maximum of 32 OT DALI 25 which corresponds to a maximum output wattage for LED-modules 800 W (32 * 25 W). The OT DALI 25 units are connected with a common + pole on the secondary side.

If needed this setup can be further extended by operating multiple DALI EASY II in master/slave mode.

4.1.20 OPTOTRONIC® OTi DALI DIM

Suitable for 10 V and 24 V LED modules:
OTi DALI DIM

Special features:

- Complete DALI functions. Control by DALI control units, like e.g. DALI EASY II
- Integrated *Touch DIM* function
- Maximum output current 5 A. Maximum output power 50 W for 10 V LED modules and 120 W for 24 V LED modules
- Fast and linear PWM-dimming of 10 V and 24 V modules on the output side, full dimming range from 0 % to 100 %
- PWM frequency of 350 Hz guarantees flicker-free dimming performance
- Device in slim housing for independent installation with cable clamp, wire connection by screw terminals
- Integration in 1…10 V, DMX-, EIB- or LON installation with DALI converter
- The control input is isolated against the LED voltage according SELV requirements.

4.1.21 OPTOTRONIC® OT DMX RGB DIM

Suitable for 10 V and 24 V power LED modules:
OT DMX RGB DIM

Special features:

- Dimming control via DMX control unit
- Device in slim housing for independent installation with cable clamp, wire connection by screw terminals
- Maximum output current: 3 PWM outputs with up to 2 A each
- Fast and linear PWM-dimming of 10 V and 24 V modules on the output side, full dimming range from 0 % to 100 %
- PWM frequency of 350 Hz guarantees flicker-free dimming performance
- Decode rotary switches for address adjustment

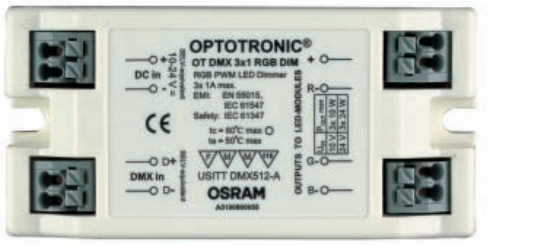
Application notes:

Function check without a connection to the DMX signal:

- Address adjustment 000 means 100 % light output
- Address adjustment 901-000 means recall of the dimming values 1 – 100 %
- Any other starting address is assigned to red channel. The blue channel is assigned to the starting address +1 and the green

channel to the starting address +2.

4.1.22 OPTOTRONIC® OT DMX 3x1 RGB DIM



Suitable for 10 V and 24 V LED modules:
OT DMX 3x1 RGB DIM

Special features:

- Dimming control via DMX control unit
- Device in slim and compact housing for limited space applications
- Three PWM-controlled outputs with maximum output current 1 A each
- Very fast (without virtually no delay to DMX command) and linear PWM-dimming of 10 V and 24 V modules on the output side, full dimming range from 0 % to 100 %
- Dip switches for address adjustment

Application notes:
DMX address selection via DIP switches
The DMX address of the devices can be set by DIP switches on the bottom of the OT DMX 3x1 RGB DIM. The selected DMX address is used for the red-channel, the green and blue channel will be assigned with consecutive addresses. By selecting address 001 on the bottom of the device the red channel will be available on address 001, the green channel on address 002 and the blue channel on address 003.

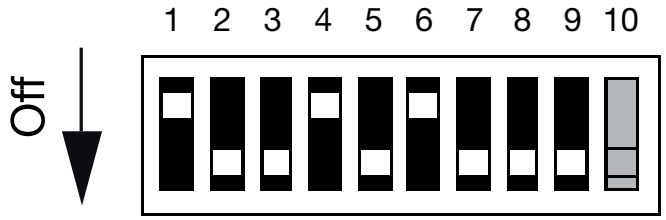


Figure 23 – OT DMX 3x1 RGB DIM DIP switches

The setting of the 9 DIP switches can be read from Table 10 below. First select the desired DMX address in the table and then read the setting for DIP switches 1–5 in the first column of the same row. The settings for DIP switches 6–9 can be found in the first row in the same column as well.

As an example for DMX address 365, the DIP switches 1-5 would need to be set ↑↓↑↑↓ and DIP switches 6-9 ↑↑↓↑.

Reserved addresses

- Address 000: not used
- Addresses 511 and 512 cannot be used (since consecutive addresses for green and blue channels will not be available)
- DIP switch 10:
  - Set to Off (↓) for normal operation.
  - Set to ON (↑) for test mode. Test mode cycles between red, green, and blue two times per second.

6789 / 12345	↓↓↓↓	↑↓↓↓	↓↑↓↓	↑↑↓↓	↓↓↑↓	↑↓↑↓	↓↑↑↓	↑↑↑↓	↓↓↓↑	↑↓↓↑	↓↑↓↑	↑↑↓↑	↓↓↑↑	↑↓↑↑	↓↑↑↑	↑↑↑↑
↓↓↓↓↓…		32	64	96	128	160	192	224	256	288	320	352	384	416	448	480
↑↓↓↓↓…	1	33	65	97	129	161	193	225	257	289	321	353	385	417	449	481
↓↑↓↓↓…	2	34	66	98	130	162	194	226	258	290	322	354	386	418	450	482
↑↑↓↓↓…	3	35	67	99	131	163	195	227	259	291	323	355	387	419	451	483
↓↓↑↓↓…	4	36	68	100	132	164	196	228	260	292	324	356	388	420	452	484
↑↓↑↓↓…	5	37	69	101	133	165	197	229	261	293	325	357	389	421	453	485
↓↑↑↓↓…	6	38	70	102	134	166	198	230	262	294	326	358	390	422	454	486
↑↑↑↓↓…	7	39	71	103	135	167	199	231	263	295	327	359	391	423	455	487
↓↓↓↑↓…	8	40	72	104	136	168	200	232	264	296	328	360	392	424	456	488
↑↓↓↑↓…	9	41	73	105	137	169	201	233	265	297	329	361	393	425	457	489
↓↑↓↑↓…	10	42	74	106	138	170	202	234	266	298	330	362	394	426	458	490
↑↑↓↑↓…	11	43	75	107	139	171	203	235	267	299	331	363	395	427	459	491
↓↓↑↑↓…	12	44	76	108	140	172	204	236	268	300	332	364	396	428	460	492
↑↓↑↑↓…	13	45	77	109	141	173	205	237	269	301	333	365	397	429	461	493
↓↑↑↑↓…	14	46	78	110	142	174	206	238	270	302	334	366	398	430	462	494
↑↑↑↑↓…	15	47	79	111	143	175	207	239	271	303	335	367	399	431	463	495
↓↓↓↓↑…	16	48	80	112	144	176	208	240	272	304	336	368	400	432	464	496
↑↓↓↓↑…	17	49	81	113	145	177	209	241	273	305	337	369	401	433	465	497
↓↑↓↓↑…	18	50	82	114	146	178	210	242	274	306	338	370	402	434	466	498
↑↑↓↓↑…	19	51	83	115	147	179	211	243	275	307	339	371	403	435	467	499
↓↓↑↓↑…	20	52	84	116	148	180	212	244	276	308	340	372	404	436	468	500
↑↓↑↓↑…	21	53	85	117	149	181	213	245	277	309	341	373	405	437	469	501
↓↑↑↓↑…	22	54	86	118	150	182	214	246	278	310	342	374	406	438	470	502
↑↑↑↓↑…	23	55	87	119	151	183	215	247	279	311	343	375	407	439	471	503
↓↓↓↑↑…	24	56	88	120	152	184	216	248	280	312	344	376	408	440	472	504
↑↓↓↑↑…	25	57	89	121	153	185	217	249	281	313	345	377	409	441	473	505
↓↑↓↑↑…	26	58	90	122	154	186	218	250	282	314	346	378	410	442	474	506
↑↑↓↑↑…	27	59	91	123	155	187	219	251	283	315	347	379	411	443	475	507
↓↓↑↑↑…	28	60	92	124	156	188	220	252	284	316	348	380	412	444	476	508
↑↓↑↑↑…	29	61	93	125	157	189	221	253	285	317	349	381	413	445	477	509
↓↑↑↑↑…	30	62	94	126	158	190	222	254	286	318	350	382	414	446	478	510
↑↑↑↑↑…	31	63	95	127	159	191	223	255	287	319	351	383	415	447	479	511

Table 10- OT DMX 3x1 RGB DIM – DIP switch settings

4.1.23 OPTOTRONIC® EASY 60

Available as 24 V version:
OT EASY 60/220-240/24 RGB+W

Special features:

- Power supply with integrated EASY control and PWM controller for PWM dimming of 4 channels on the output side
- Up to four free configurable lighting scenes can be stored and retrieved with the remote control
- Up to sixteen scenes are available with the EASY Color Control software.
- With OT EASY 60 it is possible to set up a color mixing lighting system in which LED with the same color (red, green, blue and white) are connected to the corresponding output channel.
- OT EASY 60 can be synchronized with up to 63 other OT EASY 60 units via a master-slave connection using EASY SYS CP resulting in up to 256 RGBW channels.
- Expansion of EASY signal length in total is possible to up to 400 m
- A maximum of 3840 W of LED power can be provided and controlled.

Operation modes:

Lighting control mode
The lighting levels and the lighting scenes are adjusted manually. In lighting control mode up to four static lighting scenes can be stored and retrieved with the EASY remote control.

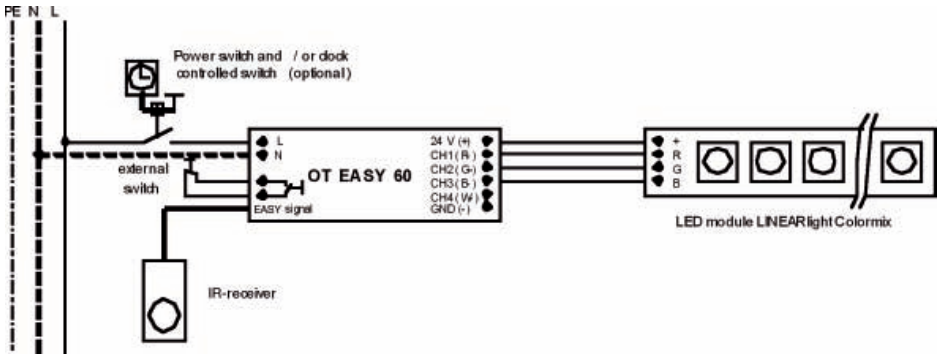
Sequencer mode
In sequencer mode the lighting scenes stored by the user are called up automatically one after the other. EASY Color Control Software enables facile configuration of RGB sequences of up to 16 lighting scenes with individual hold and cross fade times.

Daylight simulation
Daylight simulation operates in much the same way as the sequencer mode. The difference is in the use of lighting scenes that correspond to the lighting conditions as they change during the course of a day. The duration of the entire cycle (in other words a simulated day) and the predefined lighting scenes can be changed.

Application notes:

Stand-alone operation

OT EASY 60 can also be used as stand-alone device controlled by remote control with IR receiver. In this case it is possible manage 60 W of RGBW LED light.



Make sure that there is a line of sight between the IR-receiver and the remote control. Up to 4 IR-receivers may be connected. To ensure that the remote control function operates properly, the IR receiver must not be exposed to direct light. Wherever possible, mount the IR-receiver in a shaded location.

Master-Slave operation

In master/slave mode, up to 16 OT EASY 60 or DALI EASY Control units can be operated simultaneously via a single remote control, pushbutton coupler or PC.

Standard set up of master/slave mode (see wiring diagrams):

1. For one OT EASY 60 device you should proceed as follows: If required, connect an external switch or leave the switch input free.

This device will act as the master.

2. For all the other OT EASY 60 devices, bridge the input of the external switch. These devices will be automatically recognised as slaves when mains voltage is applied.

3. Connect the individual OT EASY 60 lighting controllers using the connecting cable provided. Use “Y-Connector” (available as an accessory) for branching.

4. Connect the infrared receiver to one of the “Y-Connector” units.

The special case of expert mode: different sequences for master and slaves

For each OT EASY 60, sequences with different lighting scenes can be set by the following two methods: The master determines the fade time and ensures that the individual sequences run in sync.

a) Configuration via PC

Detailed information is available in the EASY Color Control software operating manual.

b) Configuration via remote control (RMC):

1. Remove the bridges from the external switch inputs on all the converters.

2. Disconnect the OT EASY 60 device to be set up from all other devices and connect the infra-red receiver to it.

3. Set up the lighting scenes you require and store them.

4. Repeat steps 2 and 3 for all the other OT EASY 60 lighting controllers separately. Disconnect mains voltage at all devices.

5. For one OT EASY 60 you should proceed as follows: If required, connect an external switch or leave the switch input free. This device will act as the master.

6. For all the other OT EASY 60 devices, bridge the input of the external switch. These devices will be automatically recognised as slaves when mains voltage is applied

7. Connect the individual OT EASY 60 lighting controllers using the connecting cable provided. Use “Y-Connector” (available as an accessory) for branching.

8. Connect the infrared receiver to one of the “Y-Connector” units.

9. Activate the scene lock so that the lighting scenes already set are not changed by mistake. To do this, set DIP switch 2 on the remote control to OFF. Reconnect mains voltage to all devices.

5. Appendix

5.1. Product reference tables

5.1.1 Available OPTOTRONIC® by output type

10 V	24 V	350 mA	700 mA
OPTOTRONIC® OT 6, page 59 OPTOTRONIC® OT 12, page 60 OPTOTRONIC® OT 12/200-240/10 LE, page 60 OPTOTRONIC® OT 50, page 61 OPTOTRONIC® OT 50/120-277/10E, page 61	OPTOTRONIC® OT 6, page 59 OPTOTRONIC® OT 8, page 60 OPTOTRONIC® OT 20, page 60 OPTOTRONIC® OT 20/120-240/24 S, page 61 OPTOTRONIC® OT 75, page 61 OPTOTRONIC® OT 75/120-277/24 E, page 62 OPTOTRONIC® EASY 60, page 75	OPTOTRONIC® OT 9, page 62 OPTOTRONIC® OT 9/200-240/350 DIM, page 62 OPTOTRONIC® OT 9/10-24/350 DIM, page 65	OPTOTRONIC® OT 18/200-240/700 DIM page 63 OPTOTRONIC® OT 35/200-240/700, page 65

Note:
All controllers can supply 10 V or 24 V modules (in combination with a matching OPTOTRONIC® 10 V or 24 V power supply).

5.1.2 Available OPTOTRONIC® by output power

Up to 15 W	Up to 25 W	Up to 50 W	Up to 75 W
OPTOTRONIC® OT 6, page 59 OPTOTRONIC® OT 8, page 60 Introduction, page 60 OPTOTRONIC® OT 9/10-24/350 DIM, page 65 OPTOTRONIC® OT 9, page 62 OPTOTRONIC® OT 9/200-240/350 DIM, page 62 OPTOTRONIC® OT 12, page 60 OPTOTRONIC® OT 12/200-240/10 LE, page 60	OPTOTRONIC® OT 18/200-240/700 DIM, page 63 OPTOTRONIC® OT 20, page 60 OPTOTRONIC® OT 20/120-240/24S, page 61	OPTOTRONIC® OT 35/200-240/700, page 65 OPTOTRONIC® OT 50, page 61 OPTOTRONIC® OT 50/120-277/10E, page 61	OPTOTRONIC® OT 75, page 61 OPTOTRONIC® OT 75/120-277/24E, page 62 OPTOTRONIC® EASY 60, page 75

5.1.3 Available OPTOTRONIC® by housing protection

IP 20	IP64	IP65
OPTOTRONIC® OT 9/10-24/350 DIM, page 65 OPTOTRONIC® OT 9, page 62 OPTOTRONIC® OT 9/200-240/350 DIM, page 62 OPTOTRONIC® OT 18/200-240/700 DIM, page 63 OPTOTRONIC® OT 12, page 60 OPTOTRONIC® OT 20, page 61 OPTOTRONIC® OT 20/120-240/24S, page 61 OPTOTRONIC® OT 35/200-240/700, page 65 OPTOTRONIC® OT 50, page 61 OPTOTRONIC® OT 75, page 61 OPTOTRONIC® EASY 60, page 75	OPTOTRONIC® OT 50/120-277/10 E, page 61 OPTOTRONIC® OT 75/120-277/24 E, page 62	OPTOTRONIC® OT 6, page 59 OPTOTRONIC® OT 12/200-240/10 LE, page 60

5.1.4 Available OPTOTRONIC® for independent installation

Power supplies listed below feature built-in cable clamp. All other devices are not intended to be used for independent installation.

For proper functioning of cable clamp refer to the data and instruction sheets for information on suitable cable types, wire striping and installation.

Power supplies suitable for independent installation
OT 12/230-240/10
OT 50/220-240/10
OT 20/230-240/24
OT 75/220-240/24
OT DIM
OT RGB DIM
OT RGB Sequencer
OTi DALI DIM
OT DMX RGB DIM
OT EASY 60/220-240/24
OT 9/200-240/350 DIM
OT 18/200-240/700 DIM

Note:
All controllers for 10 V or 24 V modules are equipped with a cable clamp and are suitable for independent installation.

5.2 Abbreviations

AlInGaP	**Al**uminium **In**dium **Ga**llium **P**hosphate
DALI	**D**igital **A**ddressable **L**ighting **I**nterface
ECG	**E**lectronic **C**ontrol **G**ear
InGaN	**In**dium **Ga**llium **N**itrite
IP	**I**ngress **P**rotection
LED	**L**ight **E**mitting **D**iode
LMS	**L**ight **M**anagement **S**ystem
OT	**O**PTO**T**RONIC®
PWM	**P**ulse **W**idth **M**odulation
RMS	**R**oot **M**ean **S**quare
SELV	**S**afe **E**xtra **L**ow **V**oltage
SPS	**S**mart **P**ower **S**upply

5.3 Device labels, symbols

The following information can be found on OPTOTRONIC® product labels. Also see section 2.4 on page 23 for an explanation of the OPTOTRONIC® naming scheme.

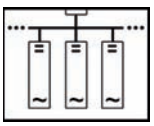
Standards	IEC/EN 61347	Safety
	EN55015	Radio interference
	IEC/EN 61000	Harmonic content
	IEC/EN 61547	Immunity
	IEC/EN 62384	Perfomance

CE — Conformity with European standards

VDE — VDE approval mark (electrical safety)

VDE EMV — VDE approval mark for EMC (electromagnetic compatibility)

OSRAM labels



Can be connected in parallel on the secondary side

SMART POWER SUPPLY

Units with electronically controlled constant output voltage (see 2.10 on page 31)

Other labels		Earth connector
		Luminaire with discharge lamps for installation on hardly inflammable material.
		Installation on inflammable materials with unknown properties where temperatures under normal conditions do not exceed 95° C and under abnormal conditions do not exceed 115 °C.
		max. housing temperature in case of abnormal operation (110°C)
Lambda λ		Power factor
t_a		Ambient temperature
t_c		Case temperature (measuring point) (see section 2.8 on page 28) in °C

5.4 Tender documents

Tender documents for OPTOTRONIC® devices are available online at: *www.osram.com/ecg-tender*

Type	OT 6/200-240/10CE	OT 12/230-240/10	OT 12/220-240/10 LE	OT 50/220-240/10	OT 50/120-277/10E
LED-module	10 V modules				
Mains voltage, nominal	200 – 240 V	230 – 240 V	220 – 240 V_{AC}	220 - 240 V_{AC}	120 -277 V_{AC}
Nominal current	0.7 ARMS @ 230 V_{RMS}	0.07 Aeff	0.11 A (@230 input V_{RMS})	0.260 A_{eff} @ 230 V_{AC}	0.260 A_{eff} @ 230 V_{AC}
Mains frequency	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz
Output voltage	DC voltage, 10.5 V ± 0.5 V electronically controlled, Output ripple max. ± 0.2 V (with 100/120 Hz)	DC voltage, 10.5 V ± 0.5 V electronically controlled, Output ripple max. ± 0.2 V	DC voltage, 10.5 V ± 0.5 V electronically controlled	DC voltage, 10.5 V ± 0.5 V lectronically controlled, Output ripple max. ± 0.2 V	DC voltage, 0.5 V ± 0.5 V electronically controlled, Output ripple max. ± 0.2 V
Max. module wattage	6 W	12 W	0.5 W – 12 W	50 W	50 W
Losses	Max. 1.5 W	Max. 3.5 W	Max. 3 W	Max. 5.5 W	Max. 8.8 W
Partial load	0.4 … 6 W	0.4 W – 12 W	0.5 W – 12 W	0.4 W – 50 W	0.4 W – 50 W
Power factor	0.5 @ 230 V_{RMS}	0.9		0.97	> 0.95
DC voltage operation	Yes (176 V – 264 V)	Yes (176 V – 264 V)		Yes (176 V – 264 V)	
Safety	IEC 61347				IEC 61347, IEC 60598, UL 1310, UL 48, UL879A, SAM
Performance	IEC 62384 – in preparation		IEC 62384	IEC 62384 – in preparation	IEC 62384 – in Vorbereitung
Radio interference	EN 55015				EN 55015, FCC 47 Part 15 Class A
Harmonic content	EN 61000-3-2	IEC 61000-3-2	IEC 61000-3-2	IEC 61000-3-2	IEC 61000-3-2
Flickering		IEC 61000-3-3			
Immunity	EN 61547	IEC 61547	IEC 61547	IEC 61547	IEC 61547, ANSI C62.41 Class B
Temperature range	-20 °C to +50 °C	-20 °C to +50 °C	-20 °C to +50 °C	-20 °C to +50 °C	-25 °C to +60 °C
Max. temperature at tc point		70° C	70° C	75 °C	90 °C
Galvanic insolation between primaryand secondary side	3 kVRMS (SELV-equivalent)	3 kVeff	3 kV_{RMS} (SELV equivalent)	3 kVeff	3.75 kVeff
Open circuit proof	Yes				
Short circuit protection	Yes, automatic shut-down, reversible				
Overload protection	Yes, automatic shut-down, reversible				Smart Power Supply
Overheating protection	Yes, automatic shut-down, reversible				
Dimming	Suitable for use with OPTOTRONIC® dimmers				
Connectors	Pre-wired	Screw terminals	Pre-wired cables, 125 mm	Screw terminals	Pre-wired cables, 23 mm
Length of secondary cables	Max. 10 m	Max. 4 m	Max. 10 m	Max. 10 m	Max. 10 m
Wiring cross section, primary	1 mm^2, solid wire	NYM 3 x 1.5 mm^2/ H03VV – F2 x 0.75 mm^2	1.02 mm^2	DIN 57281 H03VV-F 2x0.50 mm^2; H03VV-F 2x0.75 mm^2; H05VV-F 2x0.75 mm^2; Nym 3x1.5 mm^2	AWG #18 – 0.83 mm^2, massive leads
Wiring cross section, secondary	1 mm^2, solid wire	0.75 mm^2 – 1.5 mm^2	0.95 ± 0.5 mm^2 (stranded 3x0.4, tinned)	DIN 57281 H03VV-F 2x0.75 mm^2; H05VV-F 2x0.75 mm^2; H05VV-F 2x1.00 mm^2; H05VV-F 2x1.5 mm^2; H05VV-F 2x2.5 mm^2	AWG #18 – 0.83 mm^2, massive leads
Parallel wiring on output side	No				Yes, up to 5 devices (connect at pre-wired cables)
Cable stripping (3.2.2.2)	n/a	a: 1.2 cm b: 0.6 cm			n/a
Protection class	Suitable for luminaires with protection class II				I
IP rating	IP 65	IP20	IP 65	IP20	IP 64
Dimensions (l x b x h)	50.8 mm x 51.8 mm x 22.3 mm	109 mm x 50 mm x 35 mm	190 (177) mm x 20 mm x 20 mm (length without mounting latches)	220 mm x 46.2 mm x 43.6 mm	241 mm x 43 mm x 30 mm
Approvals	in preparation	in preparation		in preparation	in preparation

5.5.2 24 V constant voltage OPTOTRONIC® power supplies

Type	OT 6/200-240/24 CE	OT 8/200-240/24	OT 20/230-240/24
LED modules	24 V LED modules		
Mains voltage, nominal	200 - 240 V_{RMS}	200 – 240 V_{RMS}	230 V / 240 V
Nominal current	0.7 A_{RMS} @ 230 V_{RMS}	0.1 A_{RMS} @ 230 V	0.2 Aeff
Mains frequency	50-60 Hz	50-60 Hz	50 – 60 Hz
Output voltage	DC voltage, 24 V ± 0.8 V electronically controlled, Output ripple max. ± 0.2 V (with 100/120 Hz)	DC voltage, 24 V ± 1.0 V electronically controlled, Output ripple max. ± 0.2 V (with 100/120 Hz)	DC voltage, 24 V ± 1.0 V electronically controlled, Output ripple max. ± 0.2 V (with 100/120 Hz)
Max. module wattage	6 W	8 W	20 W
Losses	Max. 1.5 W	Max. 2.5 W	Max. 4.0 W
Partial load operation	0.4 .. 6 W	0.6 – 8 W	1.2 W – 20 W
Power factor	0.5 @ 230 V_{RMS}	0.5 @ 230 V	0.8
DC voltage operation	Yes (176 -264 V)	Yes (176 -264 V)	176 V – 264 V_{DC}
Safety	IEC 61347	IEC 61347	IEC 61347
Performance	IEC 62384 – in preparation	IEC 62384 – in preparation	IEC 62384 – in preparation
Radio interference	EN 55015	EN 55015	EN 55015 (DC operation: Connect positive pole to outer terminal, negative pole to inner terminal)
Harmonic content	EN 61000-3-2	IEC 61000-3-2	IEC 61000-3-2
Flickering			IEC 61000-3-3
Immunity	EN 61547		
Temperature range	-20 °C to +50 °C	-20 °C to +50 °C	-20 °C to +45 °C
Max. temperature at t_c point		80° C	70° C
Galvanic insolation between primary and secondary side	3 kV_{RMS} (SELV equivalent)	3 kVRMS	3 kVeff
Open circuit proof	Yes		
Short circuit protection	Yes, automatic shut-down, reversible		
Overload protection	Yes, automatic shut-down, reversible		
Overheating protection	Yes, automatic shut-down, reversible		
Dimming	Suitable for use with OPTOTRONIC® dimmers	Suitable for use with select OPTOTRONIC® dimmers (check application notes)	Suitable for use with OPTOTRONIC® dimmers
Connections		Push-in terminals	Screw terminals
Length of secondary cables	Max. 10 m	Max. 10 m; 80 cm for luminaires with protection class I	Max. 10 m
Wire cross section, primary	1 mm^2, solid wire	0.5 mm^2 – 1.5 mm^2 solid 0.5 mm^2 – 1 mm^2 stranded	NYM 3 x 1.5 mm^2/ H03VV – F2 x 0.75 mm^2
Wire cross section, secondary	1 mm^2, solid wire	0.5 mm^2 – 1.5 mm^2 solid 0.5 mm^2 – 1 mm^2 stranded	0.75 mm^2 – 1.5 mm^2
Parallel wiring on output side	No	No	No
Cable stripping (see section 3.2.2.2)			[a: 1.2 cm, b: 0.6 cm]
Protection class	Suitable for luminaires with protection class II	Suitable for: - luminaires protection class I (use of functional earth recommended) - luminaires protection class II	
IP rating	IP 65	IP 20	IP 20
Dimensions (l x b x h)	50.8 mm x 51.8 mm x 22.3 mm	80 mm x 40 mm x 22 mm	109 mm x 50 mm x 35 mm
Approvals	CE, ENEC 10 in preparation	CE, ENEC, EMV 10 in preparation	CE, ENEC, EMV 10 in preparation

Type	OT 20/120-240/24 S	OT 75/220-240/24	OT 75/120-277/24E
LED modules	24 V LED modules		
Mains voltage, nominal	120 – 240 V	220 V-240 V_{AC}	120-277 V_{AC}
Nominal current	0.35Aeff at 120 V/60Hz 0.23Aeff at 240 V/50Hz	0.370 Aeff @ 230 V_{AC}	0.38 Aeff @ 230 V_{AC}
Mains frequency	50-60 Hz	50-60 Hz	50-60 Hz
Output voltage	DC voltage, 24 V ± 1.0 V electronically controlled, Output ripple max. ± 0.2 V (with 100/120 Hz)	DC voltage, 24 V ± 1,0 V electronically controlled, Output ripple max. ± 0.2 V	DC voltage, 24 V ± 1.0 V electronically controlled, Output ripple max. ± 0.2 V
Max. module wattage	20 W	75 W	75 W
Losses	Max. 4 W	Max. 8.5 W	Max. 11 W
Partial load operation	0.9 W – 20 W	0.9 W – 75 W	0.9 W – 75 W
Power factor	0.5 bei 120 V 60 Hz 0.4 bei 240 V 50 Hz	0.97	> 0.95
DC voltage operation	176 – 264 V_{DC}	Yes (176 – 264 V)	Yes (176 – 264 V)
Safety	IEC 61347, UL 1310 recognized	IEC 61347	IEC 61347, IEC 60598, UL 1310, UL 48, UL879A, SAM
Performance	IEC 62384 – in preparation	IEC 62384 – in preparation	IEC 62384 – in preparation
Radio interference	EN 55015, FCC47 CFR part15, Class B	EN 55015	EN 55015, FCC 47 Part 15 Class A
Harmonic content	IEC 61000-3-2	IEC 61000-3-2	IEC 61000-3-2
Flickering	IEC 61000-3-3		
Immunity	EN 61547	IEC 61547	IEC 61547, ANSI C62.41 Class B
Temperature range	-20 °C to +50 °C	-20 °C to +50 °C	-20 °C to +60 °C
Max. temperature at t_c point	75° C	80° C	90° C
Galvanic insolation between primary and secondary side	3 kVeff	3 kVeff	3.75 kVeff
Open circuit proof	Yes		
Short circuit protection	Yes, automatic shut-down, reversible		
Overload protection	Yes, automatic shut-down, reversible		
Overheating protection	Yes, automatic shut-down, reversible		
Dimming	Suitable for use with OPTOTRONIC® dimmers		
Connections	Screw terminals	Screw terminals	Pre-wired cables (23 cm)
Length of secondary cables	Max. 10 m	Max. 10 m	Max. 10 m
Wire cross section, primary	NYM 3 x 1.5 mm²/ H03VV – F2 x 0.75 mm² / 0.75 mm² – 4.0 mm²	DIN 57281 H03VV-F 2x0.50 mm²; H03VV-F 2x0.75 mm²; H05VV-F 2x0.75 mm²; Nym 3x1.5 mm²	AWG #18 – 0.83 mm²
Wire cross section, secondary	0.75 mm² – 2.5 mm²	DIN 57281 H03VV-F 2x0.75 mm²; H05VV-F 2x0.75 mm²; H05VV-F 2x1.00 mm²; H05VV-F 2x1.5 mm²; H05VV-F 2x2.5 mm²	AWG #14 – 2.1 mm²
Parallel wiring on output side	No	No	Yes, up to 4 devices (connect at pre-wired cables)
Cable stripping (see section 3.2.2.2)	a: 1.2 cm; b: 0.6 cm		n/a
Protection class			I
IP rating			IP 64
Dimensions (l x b x h)	60 mm x 60 mm x 30.5 mm	220 mm x 46.2 mm x 43.6 mm	241 mm x 43 mm x 30 mm
Approvals	CE VDE cURus 10 in prepartion	CE VDE 10 in preparation	CE VDE cURus SP EMV 10 in preparation

Type	OT 9/100-120/350E	OT 9/200-240/350	OT 9/200-240/350 DIM	OT 18/200-240/700 DIM	OT 35/200-240/700
LED modules	DRAGONpuck, DRAGONeye, DRAGONtape, DRAGON-X and 350 mA high-flux LEDs			OSTAR®-Lighting and 700 mA high-flux LED	
Mains voltage, nominal	100 – 120 VRMS	200 – 240 VRMS	200 – 240 VAC	200 – 240 VAC	200-240 VAC
Nominal current	0.18 ARMS @ 120 V	0.1 A_{RMS} @ 230 V	< 0.1 A	< 0.2 A	0.18 A @ 200 V
Mains frequency	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz
Output voltage	1.8 – 25 VDC	1.8 – 25 VDC	2 – 25 VDC	2 – 25 VDC	< 50 V_{DC}
Output current	DC current 350 mA ± 17.5 mA, electronically controlled			DC current 700 mA ± 35 mA, electronically controlled	
Max. module wattage	8.5 W			17 W	35 W
Max. number of LED (see application notes)	max. 6 DRAGON® LED white, blue, green max. 9 DRAGON® LED amber, yellow			1 OSTAR®-Lighting 4-chip or 6-chip	Up to 3 OSTAR-Lighting 4-chip or up to 2 OSTAR-Lighting 6-chip
Max. losses.	3 W	2.7 W	2.4 W	3.3 W	5.5 W
Partial load operation	0.6 … 8.5 W	0.6 … 8.5 W			
Permitted input voltage range	90 – 132 VRMS	180 – 254 VRMS			180 – 264 V_{AC}
Power factor	≥ 0.5	≥ 0.5	0.5	0.52	
DC voltage operation		Yes (176 – 264 V)			Yes (176 – 264 V)
Safety	UL 1310; UL 48; UL 879A; SAM	IEC 61347			IEC 61347: IEC 60598
Performance		IEC 62384 – in preparation	IEC 62384 (using white, green and blue LED)		IEC 62384 i – in preparation
Radio interference	FCC 47 part 15 class A	EN 55015			
Harmonic content		IEC 61000-3-2			
Immunity	ANSI C 62.41 class B	IEC 61547			
Other		DIN 57710 / VDE 0710			
Temperature range	-20 °C to +50 °C		-20 °C to +55 °C	-20 °C to +50 °C	-20 °C to +45 °C
Max. temperature at tc point	80 °C				95° C
Galvanic insolation between primary and secondary side	3 kVRMS		3 kVRMS SELV-equivalent		
Open circuit test	Yes				
Short circuit protection	Yes, automatic shut-down, reversible				
Overload protection	Yes, automatic shut-down, reversible				
Overheating protection	Yes, automatic shut-down, reversible				
Dimmable	No		Yes (analog dimming 0-100 %)		No
Connections	Push-in terminals		Screw terminals		Push-in terminals
Connections on the primary side	Mains	Mains, functional earth	Mains		Mains
Wire cross section, primary	0.5 mm² – 1.5 mm² solid 0.5 mm² – 1 mm² stranded		H05VV-H2F(2x0.75) mm²; H0VV-F(3x1.5) mm²: H0VV-F(3x0.75) mm²; NYM (3x1.5) mm²		0.5 mm² bis 1.5 mm² solid 0.5 mm² bis 1 mm² stranded
Connections on the secondary side	LED module		LED modules, control port (10 V max)		LED module
Wire cross section, secondary	0.5 mm² – 1.5 mm² solid 0.5 mm² – 1 mm² stranded		H05VV-H2F(2x0.75) mm²; H0VV-F(3x1.5) mm² H0VV-F(3x0.75) mm²; NYM (3x1.5) mm²		0.5 mm² bis 1.5 mm² solid 0.5 mm² bis 1 mm² stranded
Length of secondary cables	Max. 10 m (1.5 mm² solid wire)	Max. 10 m for luminaires of protection class II (1.5 mm² wires) 80 cm for luminaires of protection class I (use of functional earth recommended)	Max. 10 m	Max. 10 m	Max. 10 m
Protection class with regard to insolation		Suitable for luminaires class I and II			
IP rating	IP 20, coated	IP 20			
Dimensions (l x b x h)	80 mm x 40 mm x 22 mm		109 mm x 53 mm x 33 mm		109 mm x 30 mm x21 mm
Approvals	CE cURus	CE in preparation	CE		CE iin preparation

Type	Constant voltage	Constant voltage	Constant voltage
	OT DIM	**OT 9/10-24/350 DIM**	**OTi DALI DIM**
LED modules	10 V and 24 V modules	350 mA LED modules and LED	10 V and 24 V modules
Nominal input voltage range	10.5 – 24 VDC	10 – 24 VDC	10 – 24 VDC
Max. input voltage range	9.5 – 25 VDC	9 – 32 VDC	9.5 – 25 VDC
Max. input current	5.3 A	1.1 ADC @ 10 V	5 A
Output voltage		0 – 24.5 VDC	
Control voltage	1 – 10 VDC	1 – 10 VDC	
Max. control current	0.6 mA	0.6 mA	
Galvanic insolation between primary side, control input and LED-module output	3 kVeff SELV-equivalent		
Dimming mode	PWM		
Operating frequency	135 Hz typ.	244 Hz typ.	350 Hz typ.
Dimming range	0 – 100 %		
Max.output current	5 A	DC currant 350 ± 17.5 mA, electronically stabilized	5 A
Losses (Dimming rate = 95 % load)	Min. 0.4 W at 10.5 V_{DC} / Min. 1.2 W at 24 V_{DC} Max. 3 W at 10.5 VDC / Max. 4 W at 24 VDC	Max. 2.5 W	Min. 0.7 W at 10 V_{DC} / Min. 1.2 W at 24 V_{DC} Max. 2.2 W at 10 VDC / Max. 2.6 W at 24 VDC
Maximum voltage drop			
Max. module wattage	52.5 W for 10.5 V_{DC}-Module 120 W for 24 V_{DC}-Module	8.5 W	0 – 50 W for 10 V_{DC}-Module, 0 – 120 W for 24 V_{DC}-Module
Safety	EN 61046 ; IEC 61347-2-11, UL 508	EN 61347-2-11	IEC 61347-2-11
Performance	n/a		
Radio interference	EN 55015 (in combination with OPTOTRONIC® power supplies)		
Immunity	IEC 61547		
Temperature range	-20 °C bis +50 °C		
Max. temperature at t_c point	70° C	75° C	70° C
Open circuit proof	Yes		
Short circuit protection	In combination with OPTOTRONIC® supply		
Overload protection	Yes, automatic shut-down, reversible		
Overheating protection	Yes, automatic shut-down, reversible		
Wire cross section	0.75 mm² – 1.5 mm²		0.75 mm² bis 1.5 mm²
Wire cross section, primary	NYM 3x1.5 mm² / H03VV-F2x0.75 mm²	0.5 mm² – 1.5 mm² solid 0.5 mm² – 1 mm² stranded	NYM 3x1.5 mm² / H03VV-F2x0.75 mm²
Control wires	NYM 3x1.5 mm² / H03VV-F2x0.75 mm²		NYM 3x1.5 mm² / H03VV-F2x0.75 mm²
Secondary LED	NYM 3x1.5 mm² / H03VV-F2x0.75 mm²	0.5 mm² – 1.5 mm² solid 0.5 mm² – 1 mm² stranded	NYM 3x1.5 mm² / H03VV-F2x0.75 mm²
Length of secondary cables	As per OPTOTRONIC® supply	10 m mit 1.5 mm² massive leads	As per OPTOTRONIC® supply
Dimensions (l x b x h)	172 mm x 42 mm x 20 mm	80 mm x 40 mm x 22 mm	172 mm x 42 mm x 20 mm
Approvals	VDE, EMV, cURus	CE	CE

Type	Constant voltage	Constant voltage	Constant voltage
	OT RGB Sequencer	**OT RGB DIM**	**OT DALI 25/220-240/24RGB**
LED modules	10 V and 24 V LED modules		
Nominal voltage	10.5 – 24 VDC	10.5 – 24 VDC	220-240 V
Input voltage range	9.5 – 25 VDC	9.5 – 25 VDC	198-254 V
Max. input current	6.0 A	6,0 A	0.13 A_{eff}
Control voltage	1...10 VDC	1 – 10 VDC	DALI
Max. control current	0.6 mA	0.6 mA	
Galvanic separation between primary side control input and LED-module output			4 kV_{eff} SELV
Control inputs	3 x 1…10 V control inputs	1…10 V control inputs	DALI
Dimming mode	PWM		
Operation frequency		350 Hz typ.	
Dimming range	0 – 100 %		
Max. output current	2 A per channel		
Output wattage range	0 – 21 W per channel at 10.5 VDC 0 – 48 W per channel at 24 VDC		8 W per channel
Nominal current	6 A total		0.13 Aeff
Mains frequency	n/a		0/50/60 Hz
Nominal output voltage			24 V DC
Efficiency			82 %
Losses	Max. 4 W	Max. 4 W	Max. 3 W
Maximum voltage drop in device			
DC voltage operation			Yes (200 – 240 VDC, after start-up reduction to 160 V_{DC} possible)
Safety	IEC 61347-2-11	IEC 61347-2-11	EN 61347
Radio interference	EN 55015 (in combination with OPTOTRONIC® supply)		EN 55015
Harmonic content			EN 61000-3-2
Immunity	EN 61547		
Protection class with regard to insolation			
Temperature range	-20 °C to +50 °C	-20 °C to +50 °C	-25 °C to +45 °C
Max. temperature at tc point	70° C	70° C	
Galvanic insolation between primary and secondary side			4 kVeff (SELV)
Open circuit proof	Yes		
Short circuit protection	Yes, automatic shut-down, reversible (per channel)		
Overload protection	Yes, automatic shut-down, reversible (per channel)		
Overheating protection	Yes	Yes	Yes (reversible)
Primary cables	0.75 mm^2 – 1.5 mm^2	0.75 mm^2 – 1.5 mm^2	One pair of cable clamp for mains and DALI
Wire cross section, control/primary side	0.75 mm^2 – 1.5 mm^2	0.75 mm^2	0.5 mm^2 – 1.5 mm^2 solid 0.5 mm^2 – 1 mm^2 stranded
Wire cross section, output/secondary side	0.75 mm^2 – 1.5 mm^2	0.75 mm^2 – 1.5 mm^2	0.5 mm^2 – 1.5 mm^2 solid 0.5 mm^2 – 1 mm^2 stranded
Max. length of secondary cables	As per OPTOTRONIC® supply	As per OPTOTRONIC® supply	10 m
Dimensions (l x b x h)	172 mm x 42 mm x 20 mm	172 mm x 42 mm x 20 mm	167 mm x 42 mm x 31 mm
Fixing screws	Ø 3 mm or Ø 3.5 mm	Ø 3 mm or Ø 3.5 mm	
Approvals	CE $_{C}UR_{US}$	CE $_{C}UR_{US}$	CE

Type	Constant voltage	Constant voltage
	OT DMX RGB DIM	**OT DMX 3x1 RGB DIM**
LED modules	10 V and 24 V modules	
Nominal voltage	10.5 – 24 VDC	10.5 – 24 VDC
Input voltage range	9.5 – 25 VDC	7.5 – 25 VDC
Max. input current	6.0 A	3 A (per Kannal)
Control	DMX (SELV equivalent)	
Protocol specification	USITT DMX-512A, DMX 512 (DIN 56930-2)	
Electrical specification	ANSI/TIA/EIA-485-A-1998	
Max. input voltage range	-7 – +12 V_{DC} (no damage to device)	
Channel setting	3 decimal coded dials (100/10/1)	Binary setting via 10 DIP switches
Dimming mode	PWM	
Operation frequency		
Dimming range	0 – 100 %	
Dimming characteristic	Based on EN 60929:2004 E.4.3.7	
Max. output current	2 A per channel	1 A per channel
Output wattage range	0 – 21 W per channel at 10.5 VDC 0 – 48 W per channel 24 VDC	0 – 10 W per channel at 10.5 VDC 0 – 24 W per channel at 24 VDC
Mains frequency	n/a	
Nominal output voltage	10.5/24V	
Efficiency		
Losses	< 4 W	1.5 W
DC voltage operation		
Safety	IEC 61347-2-11	IEC 61347
Radio interference	EN 55015 (in combination with OPTOTRONIC® supply)	
Harmonic content		
Immunity	IEC 61547	
Protection class with regard to insolation		II
Temperature range	-20 °C – +50 °C	
Maximum case temperature	70° C	
Galvanic insolation between primary and secondary side	No, SELV required (according EIA-485)	
Open circuit proof	Yes	
Short circuit protection	Yes, automatic shut-down, reversible (per channel)	
Overload protection	Yes, automatic shut-down, reversible (per channel)	
Overheating protection	Yes	
Primary cables	NYM 3x1.5 mm² / H03VV-F2x0.75 mm²	
Wire cross section, control/primary side	NYM 3x1.5 mm²/ H03VV-F2x0.75 mm²	0.5 mm² to 1.5 mm² solid 0.5 mm² to 1 mm² massive
Wire cross section, output/secondary side	NYM 3x1.5 mm²/ H03VV-F2x0.75 mm²	0.5 mm² to 1.5 mm² massive solid 0.5 mm² to 1 mm² stranded
Max. length of secondary cables	As per OPTOTRONIC® power supply	10 m using 1.5 mm² solid
Wire stripping		a = 12 mm b = 7 mm
Dimensions (l x b x h)	172 mm x 42 mm x 20 mm	80 mm x 40 mm x 22 mm
Fixing screws	Ø 3 mm oder Ø 3.5 mm	
Approvals	CE $_{C}$UR$_{US}$	CE

5.5.5 OPTOTRONIC® OT EASY 60

Reference	OT EASY 60
LED modules	24 V modules
Mains voltage, nominal	220 V-240 V_{AC}
Nominal current	0.33 A @ 230 V
Mains frequency	50-60 Hz
Output voltage	24 V_{DC}
Max. module wattage	60 W, can be assigned arbitrarily to 4 channels
Losses	Max. 7 W @ 230 V
Partial load operation	0.2 W – 60 W
Power factor	> 0.95
DC voltage operation	Yes (176 – 264 V at t_a < 45 °C)
Safety	IEC 61347
Radio interference	EN 55015
Harmonic content	EN 61000-3-2
Flickering	
Immunity	EN 61547
Temperature range	-20 °C bis +50 °C
Galvanic insolation between primary and secondary side	
Open circuit test	Yes
Short circuit protection	Yes, automatic shut-down, reversible
Overload protection	Yes, automatic shut-down, reversible
Overheating protection	Yes, automatic shut-down, reversible
Dimmable	Yes
Connections	Screw terminals
Length of secondary cables	Max. 10 m
Power line	Screw terminals
Wire cross section, primary	NYM 3x1.5; HO5VV-F 3x1.5
Wire cross section, secondary	Y-OZ 3x0.5; Y-OZ3x0.75
Dimensions (l x b x h)	220 mm x 46.2 mm x 43.6 mm
Approvals	CE

5.6 Index

Global presence.

OSRAM supplies customers in around 150 countries.
- 73 companies and sales offices for 111 countries
- 38 countries served by local agents or OSRAM GmbH, Munich

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OSRAM GmbH
Head Office
Hellabrunner Strasse 1
81543 MUNICH
GERMANY
Fon +49 (0)89-6213-0
Fax +49 (0)89-6213-20 20
www.osram.com

member of voltimum .de

130T008GB OSRAM EC MK 02/09 PC-P Printed on paper treated with chlorine-free bleach.