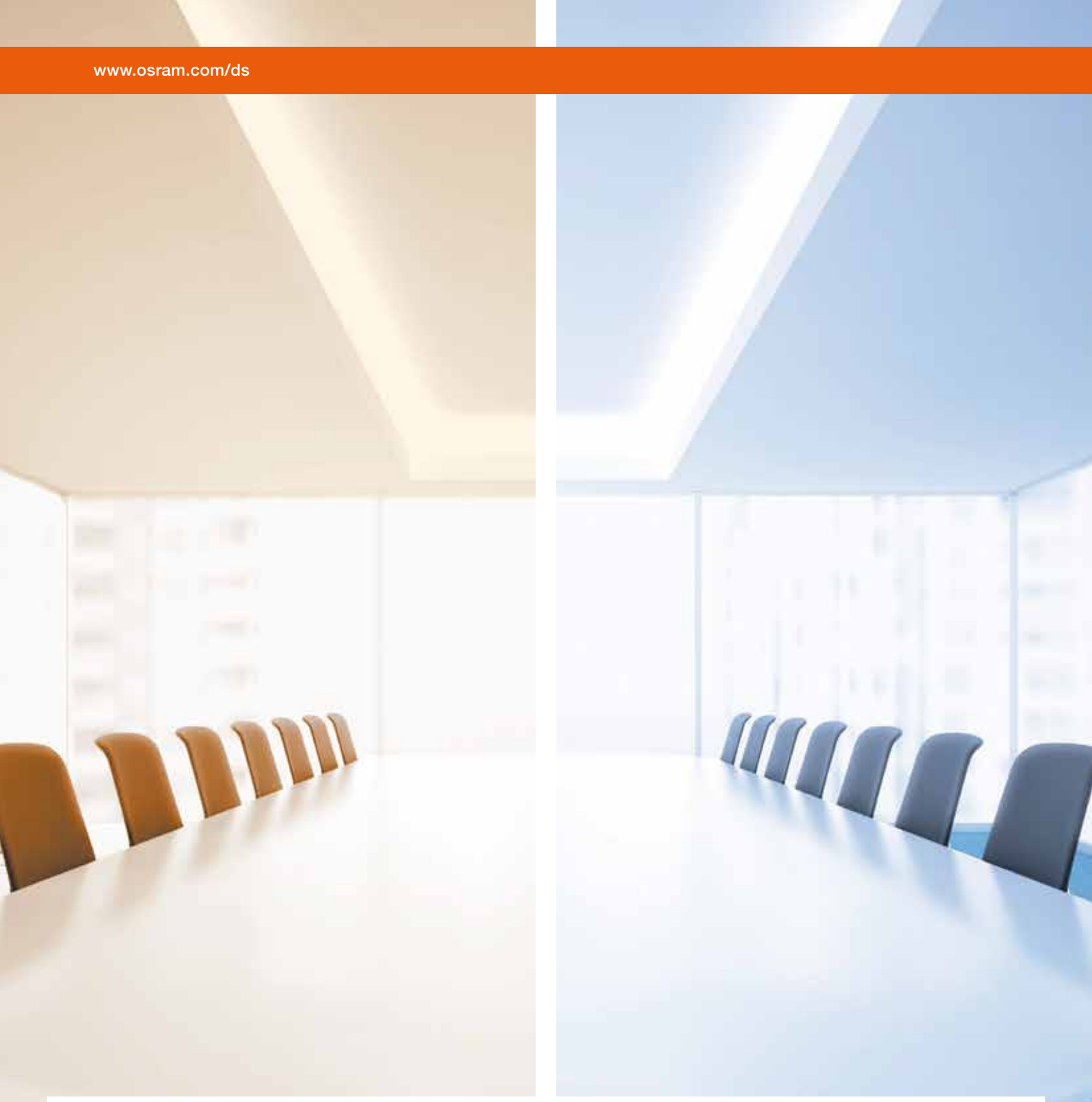


Technical application guide

Dynamic Tunable White LED systems with constant-current drivers

Light is OSRAM

OSRAM

Contents

Please note:
All information in this guide has been prepared with great care. OSRAM, however, does not accept liability for possible errors, changes and/or omissions. Please check www.osram.com or contact your sales partner for an updated copy of this guide. This technical application guide is for information purposes only and aims to support you in tackling the challenges and taking full advantage of all opportunities the technology has to offer. Please note that this guide is based on own measurements, tests, specific parameters and assumptions. Individual applications may not be covered and need different handling. Responsibility and testing obligations remain with the luminaire manufacturer/OEM/application planner.

1 Introduction

1.1 Content and intention

This application guide for dynamic Tunable White LED systems with constant-current drivers informs about technical basics of light and necessary system components and configurations.

TW systems enable the creation of “white light” within a bandwidth of two different color temperatures by using LED modules equipped with LEDs that have two different color temperatures.

TW systems provide basic technical components for Human Centric Lighting (HCL) solutions. The usage of such components and systems enables the generation of biologically effective white light in terms of dynamic brightness and variable color temperature settings.

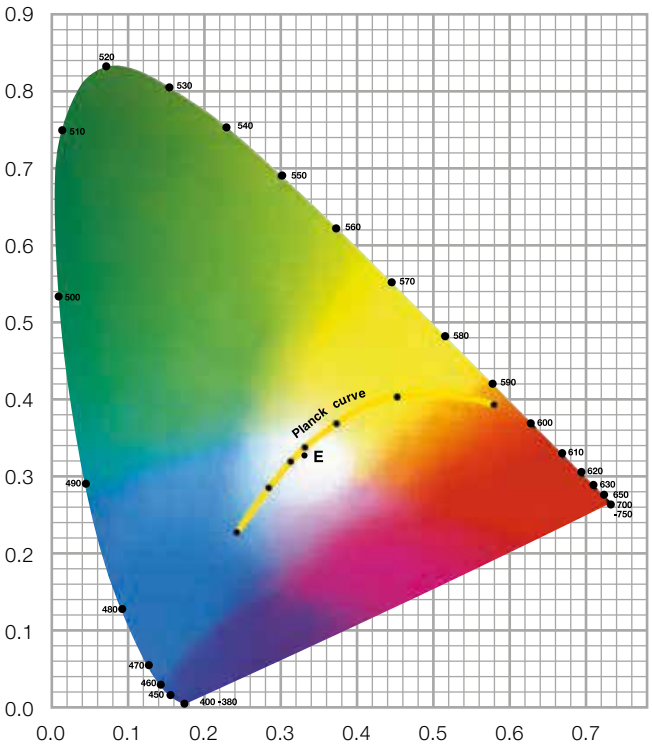
Targeted Human Centric Lighting solutions are the result of tailor-made lighting planning and create a balance between visual comfort, emotional perception and biological effects.

Human Centric Lighting provides targeted and long-term support for health maintenance, well-being and efficiency of human beings through holistic planning and consideration of visual, emotional and especially biological effects of light. Each human being with his or her needs concerning life, work and leisure is consistently placed in the focus of attention. The interdisciplinary balance between the parameters of artificial lighting, natural daylight, architecture and technology creates the right light at the right time.

Leading luminaire manufacturers and OSRAM Lighting Solutions develop tailor-made Human Centric Lighting concepts based on scientific expertise and with consideration of the set of standards for indoor lighting. You can find more information here: www.osram.com/hcl

2 Physical and technical background/ basics

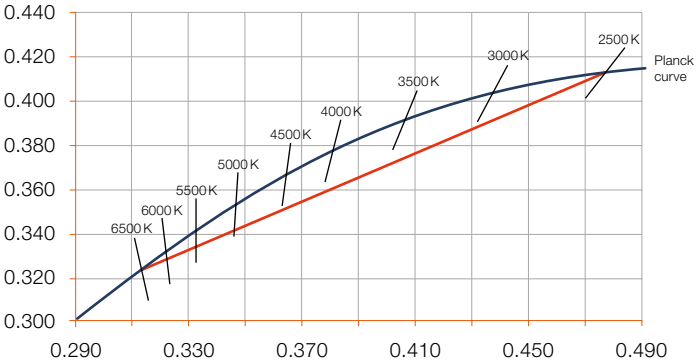
2.1 Color space



Color space with Planck curve

The color space visualizes all visible colors that a human eye can perceive. Color locations that lie on the Planck curve are designated as white light. This curve is characterized by the fact that the color temperature corresponds to the light emission of a solid body at the respective temperature. Color locations outside of the Planck curve can also be referred to as white light; constant color temperatures are located on the Judd straight lines. Color locations which are more than approx. 10 threshold units away from the Planck curve are usually not considered to be white light.

2.2 Color mixing in the color space



Color mixing of two white tones

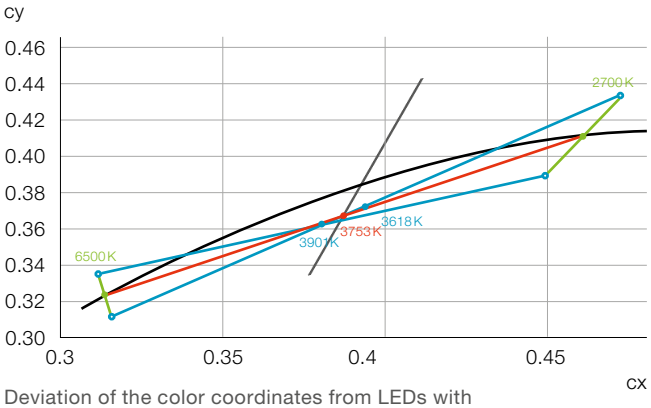
LED modules providing light with adjustable color temperature are equipped with LEDs that have two different color temperatures. The adjustable color locations are addressable by supplying suitable current levels to the respective LEDs.

Principally, only color locations that lie on the connecting line between both LED color locations can be addressed.

It should be considered that the color coordinates of LEDs do not necessarily lie on the Planck curve.

The deviation between the cx/cy coordinates of the applied LEDs and the intersection of the Judd line with the Planck curve can lead to color coordinates of the mixed light that differ significantly from a desired target color location.

The following picture exemplarily shows that the color temperature of the mixed light depends on the actual color coordinates of the LEDs, although their nominal color temperature and forward current are the same.



Deviation of the color coordinates from LEDs with identical nominal color temperature

2.3 Melanopic effect

The melanopic effect determines the circadian effect of a light source and influences the wellness of human beings. The melanopic values describe how strong the melanopin-containing retinal ganglion cells (ipRGC) are stimulated by light. In analogy to the definition of the V (λ) curve for the spectral sensitivity of the photoreceptor cells, S_{mel} (λ), which expresses the spectral sensitivity for these photoreceptors, was defined.

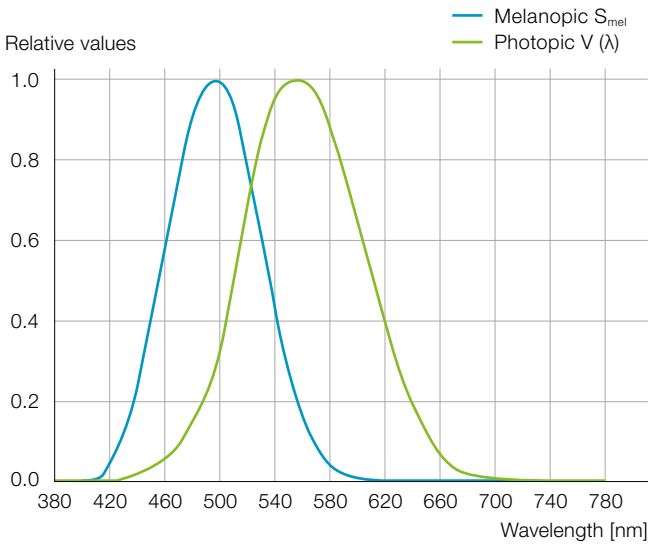
According to this, the melanopic luminous flux describes the radiant flux of a light source, evaluated with the spectral sensitivity of the melanopic (non-visual) photoreceptors.

The melanopic factor describes the ratio between the melanopic and the photometrically effective amount of radiation. This factor is higher when a light spectrum stimulates the non-visual system more strongly.

Daylight-equivalent values practically represent a benchmark with reference to natural daylight.

Thus, the melanopic daylight-equivalent luminous flux related to 1000 lm indicates how many lumen of daylight are needed to achieve an equally large non-visual stimulation as with the mentioned artificial light.

Spectral sensitivity



Spectral sensitivity – melanopic/photopic

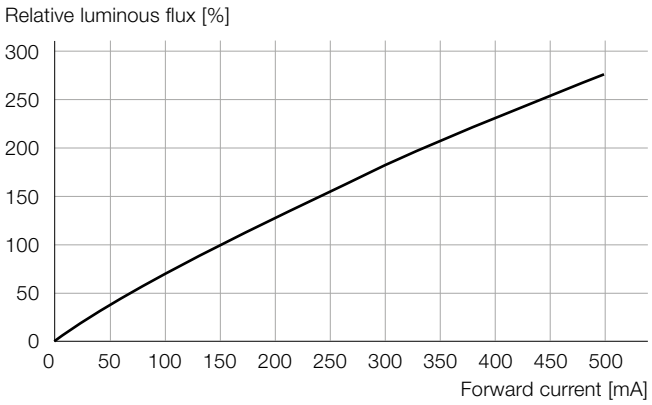
2.4 Temperature and current dependency of color coordinates and efficacy of LEDs

2.4.1 Typical properties of LEDs

The luminous flux and the color coordinates of an LED are not only subject to manufacturing tolerances, but also depend on its operating conditions.

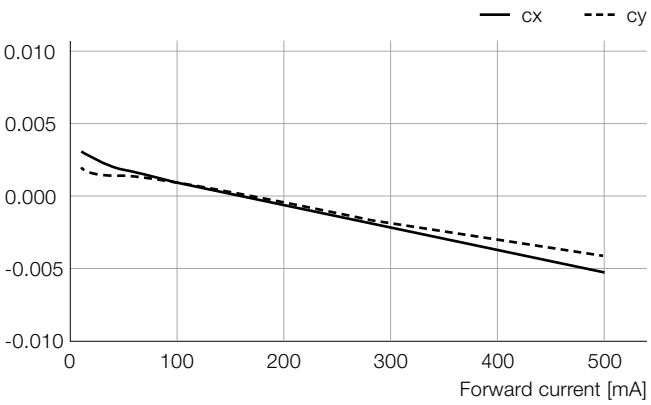
The following pictures show typical curves for the dependency of luminous flux and color locations on forward current or temperature:

Relative luminous flux vs. forward current



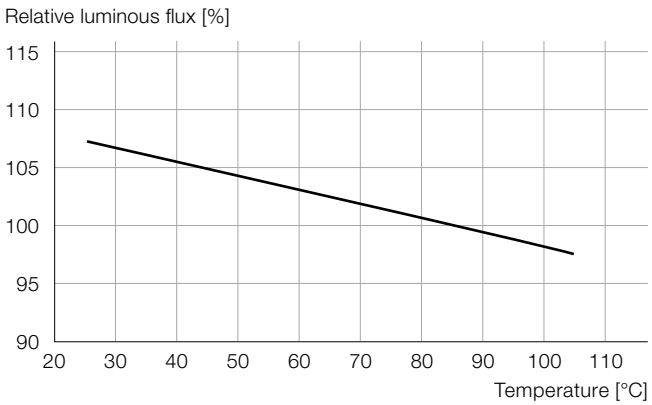
Relative luminous flux as a function of forward current

cx, cy vs. forward current



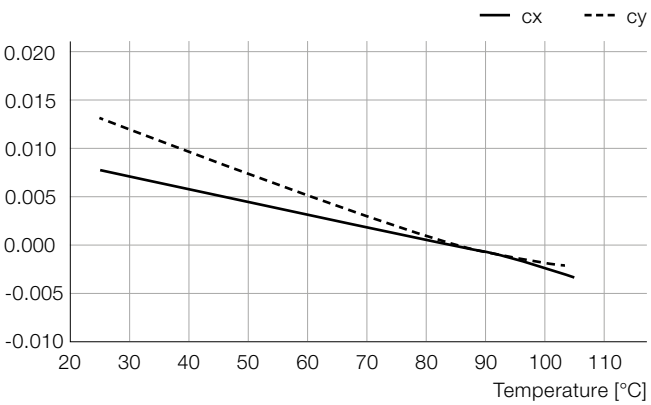
Color coordinates as a function of forward current

Relative luminous flux vs. temperature



Relative luminous flux as a function of temperature

cx, cy vs. temperature



Color coordinates as a function of temperature

To achieve the best possible match between the desired and the achieved color coordinates of mixed light, non-linear dependencies must be considered when calculating the LED currents.

2.4.2 Data models for LED modules

To match the various requirements with regard to simple operation and high color quality, three data modes for LED modules are available for configuring OSRAM TW drivers.

The focus here is on enabling sufficient color accuracies with a simple set-up as well as very good color accuracies by using typical LED and module data.

Basic Mode

In the Basic Mode, the values of the color temperatures of both applied LED types must be entered, e.g. 2700 K and 6500 K. In addition, forward currents must be entered for both channels that lead to luminous flux (100 % values) equity.

The Tuner4TRONIC® (T4T) configuration software transmits these values to the drivers, which then adjust both output currents in dependence of the desired color location following the ratio between the target color location and the two LED color temperatures.

However, this very simple model also shows some disadvantages:

1. Since the color coordinates of LEDs are usually not exactly on the Planck curve, the input of the nominal color temperature already implies deviations, see chapter 2.4.1.
2. A purely proportional setting of the LED currents causes a deviation from the target color location because the connecting line between both LED color locations is only an approximation to the Planck curve. Since the Judd straight lines do not vertically intersect the Planck curve and the connecting line, deviations of up to several 100 K are possible.
3. The dynamic behavior of the LEDs is not considered, which means that resulting color coordinates may shift when the temperature changes, e.g. during dimming, see also chapter 2.4.1.

Advanced Mode

In the Advanced Mode, in addition to the nominal cx and cy coordinates of the LEDs, the data which represent the operating conditions of the LEDs in the projected application must also be entered.

The calculation of the output currents is not carried out only once in relation of the target color coordinates to the nominal color temperature of the applied LEDs, but follows an iterative process. In this process, the currents are iteratively calculated as a function of the specified operating conditions, the color coordinates of the LEDs and simplified LED characteristics.

Advantages of the Advanced Mode include:

1. Entering the real color coordinates of the LEDs instead of the nominal color temperature values eliminates color deviations that already occur due to the deviation of the LED color coordinates from the Planck curve.
2. By performing the iterative calculation process of the output currents of the driver, a higher color accuracy is achieved by considering the positions of the intersections of the Judd lines with the connecting line.

Premium Mode

In the Premium Mode, the output currents of the driver are calculated in the same way as in the Advanced Mode, but real dynamic LED characteristics are used instead of simplified LED characteristics.

As in the Advanced Mode, the operating conditions of the LED module in a projected application must be entered to enable a high color accuracy.

In order to enter the LED characteristics, it is necessary to determine three operating points of a single LED for each criterion using the LED data sheets and to implement them by using the T4T configuration software.

For each type of LED, the following data must be fixed:

1. Three value pairs each for cx and cy coordinates as a function of the forward current
2. Three value pairs for luminous flux as a function of the forward current
3. Three value pairs each for cx and cy coordinates as a function of the LED temperature
4. Three value pairs of luminous flux as a function of the LED temperature

All value pairs to be entered can be selected completely independently from the operating conditions in a projected application, since they only have to reflect the characteristics of the LEDs but not the operating points of the LEDs in an application.

Generally, when OSRAM TW modules are used, the Premium Mode is always used. All necessary LED and module data are already stored in the T4T.

If other TW modules freely available on the market are used, the LED data required for the Premium Mode must be obtained.

In addition to the Advanced Mode, the Premium Mode offers the following advantages:

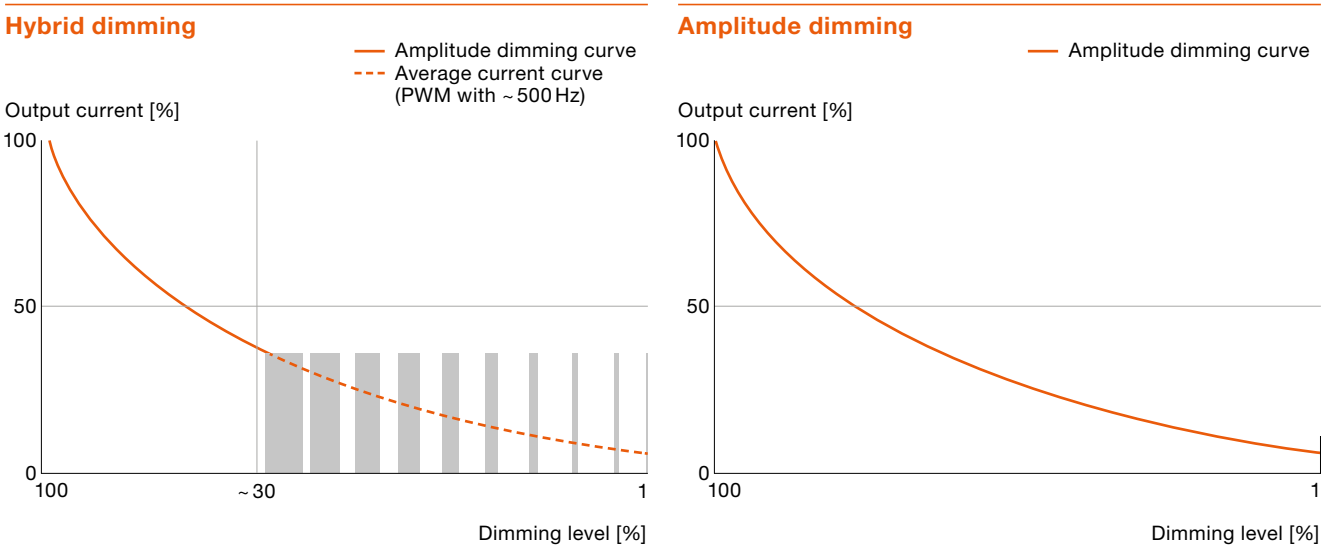
1. When calculating the output currents, the non-linear dependencies of the luminous flux and the color coordinates of the LEDs on forward current and temperature are taken into account.
2. A high color homogeneity is achieved in a system in which the modules are operated under different conditions, e.g. at different dimming levels or ambient temperatures.
3. The absolute color accuracy essentially depends only on the tolerances of the LEDs used in relation to their nominal data. Usually, LEDs with a color tolerance up to three MacAdam steps are available.

3 System components

3.1 TW modules

3.1.1 Amplitude/hybrid dimming

The OSRAM OTi DALI TW drivers offer the possibility to choose the dimming mode between amplitude dimming (default) and hybrid dimming. The picture below shows the difference between these two dimming modes.

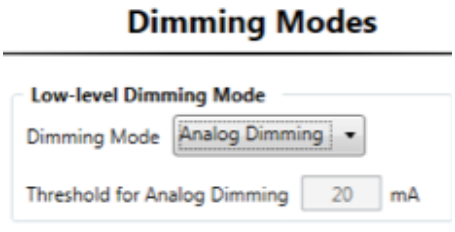


Hybrid dimming and amplitude dimming

At low dimming levels, amplitude dimming shows a significantly lower light modulation, while at the same time a higher efficiency is achieved.

In the low dimming range, amplitude dimming can lead to (small) color deviations and brightness differences on the LED module. This can be avoided with hybrid dimming, in which the driver changes from amplitude dimming to PWM dimming when the output current falls below 20 mA.

The picture below shows how the dimming mode can be set in the T4T software:



Tuner4TRONIC®: Setting of dimming mode

3.1.2. Emergency lighting settings of TW drivers (ex factory)

Ex factory, like all OSRAM indoor drivers, the TW drivers provide an active DC detection and adjust the light level/luminous flux to 15 % (DALI value 185). The color temperature is always set to 4000 K, regardless if OSRAM TW modules or TW modules from other manufacturers are used. If higher luminous fluxes are required for emergency lighting, this can be programmed using the T4T configuration tool. Generally, the DC detection can be deactivated if required.

3.2 Configuration tool Tuner4TRONIC® (T4T)

To achieve a good performance of a TW system with an intended color precision, it is necessary to balance drivers with the operated LED modules. Therefore, the T4T also supports data management for TW modules.

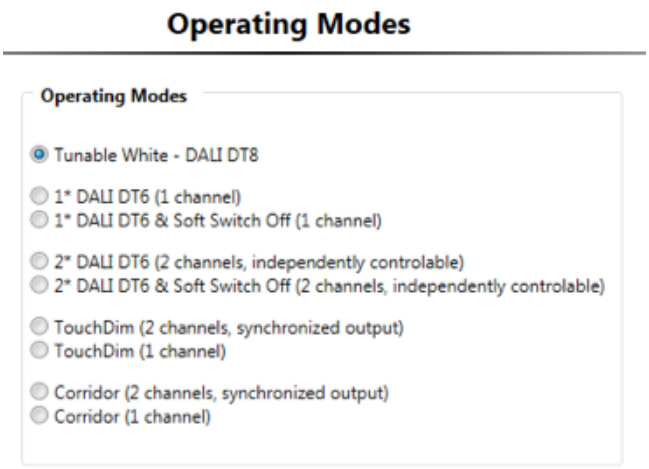
This balancing ensures that the calculation of the output currents of the driver considers the specific behavior of the operated LED module in a projected application.

All necessary data, such as LED module data and driver settings, can be implemented and stored in the T4T software.

Data of OSRAM PrevaLED® TW modules are automatically provided by the T4T and can simply be called up.

Since device descriptions of all TW drivers are also stored in the T4T, all possibilities to configure these drivers are provided.

The configuration of a TW driver is always carried out in a project. To start a TW project, one of the stored TW drivers must be chosen and afterwards the operating mode “Tunable White – DALI DT8” must be selected:



Tuner4TRONIC®: Setting of driver operating mode

Under the tab "LED Module Data", PrevaLED® TW modules can be selected in various combination options for different designs.

1	560			
2	560	280		
3	560	560		
4	560	560	280	
5	560	560	560	
6	560	560	560	280
7	560	560	560	560

Possible combinations of LED modules (with module lengths in mm)

The combinations of PL-LIN-Z1 modules shown above represent any possible total module length that drivers with a maximum output voltage of 240 V can operate. For applications that require other combinations, e.g. 6 modules with 1100 lm, the selection must be made so that the total length of the selected module combination corresponds to the total length of the modules in the application.

3.2.1 Administration of module data: Loading and creation of module data

To call up previously stored LED modules that are intended to be used in a new project, or to generate a new data set for an LED module, the "LED Module Data" tab must be selected.

3.2.1.1 Loading of stored TW modules

In case the required module is already stored, it can simply be selected in this pull-down menu:

Tuner4TRONIC®: Selection of the LED module

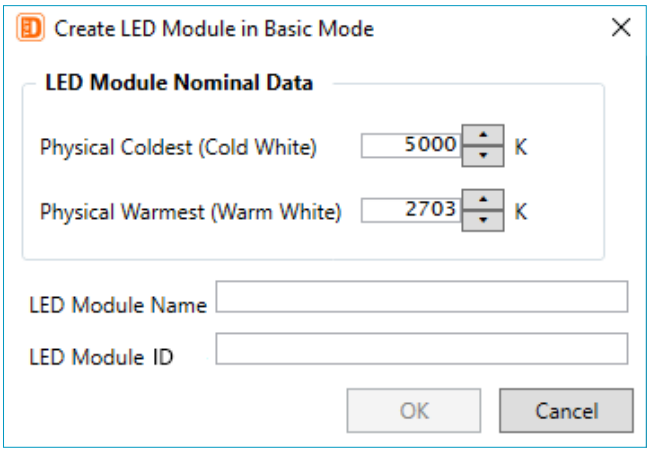
3.2.1.2 Creation of new TW modules

In case a new data set for an LED module is to be created, the button “Create a new LED Module” must be clicked after having chosen the desired data model:

Tuner4TRONIC®: Generation of a new LED module

As described in chapter 2.4.2, different types of data models for the description of a TW module can be selected.
Depending on the selected data model, a dedicated window pops up, where the data of the TW module can be implemented.
Independent of the selected data model, the newly created data set can be stored with an individual name and ID number (see also chapter 3.2.1.2.4).

3.2.1.2.1 Input data for data model “Basic Mode”

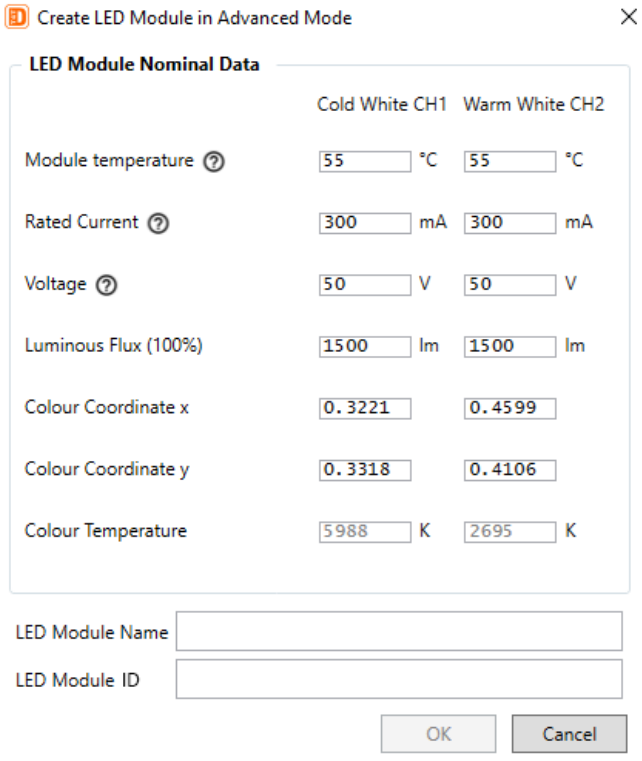


Tuner4TRONIC®: Creation of a data set for a new LED module in the Basic Mode

In the Basic Mode, the CCT values of the two LED types assembled on a TW module must be implemented.

How to save newly created TW modules on the PC is described in chapter 3.2.1.2.4 “Creation of new TW modules using the editing mode”.

3.2.1.2.2 Data entry for the “Advanced Mode”



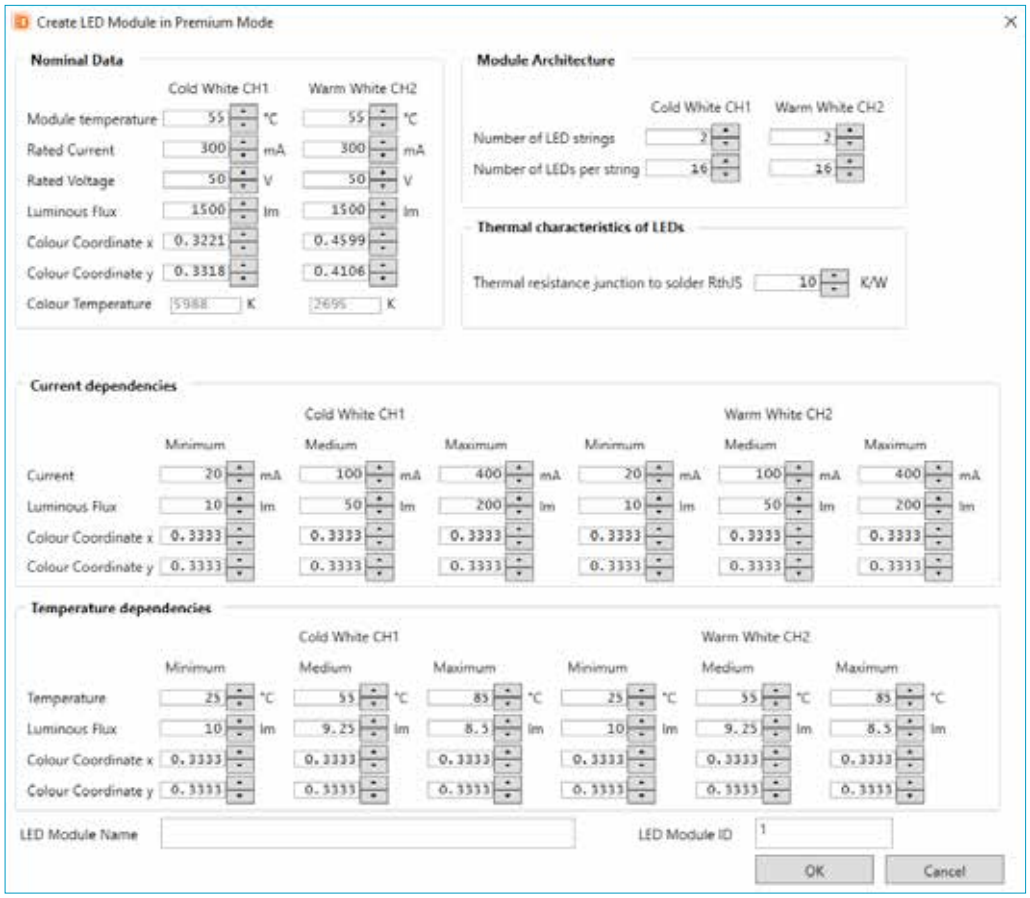
Tuner4TRONIC®: Creation of a data set for a new LED module in the Advanced Mode

In the Advanced Mode, the data shown above, representing a specific operating point of the module, must be implemented.

a) Module temperature: The values to be implemented should reflect the temperature that the module reaches when only one channel is operated at nominal (100 %) light output. This allows the different efficacies of both channels to be considered by the current calculation of the driver. While producing equal light levels, the module temperature is usually slightly higher when light is produced by warm white LEDs (compared to cold white LEDs).
b) The combination of all data shall describe one unique operating point of the TW module for each channel. It is advantageous to implement comparable values for the operating current of both channels.
c) The correlated color temperature (CCT) is calculated automatically by the T4T, based on the implemented color coordinates.

How to save newly created TW modules on the PC is described in chapter 3.2.1.2.4 “Creation of new TW modules using the editing mode”.

3.2.1.2.3 Input data for data model “Premium Mode”

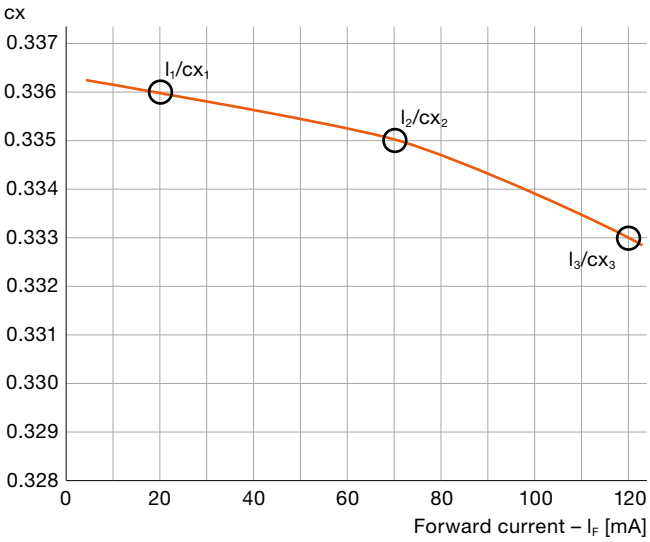


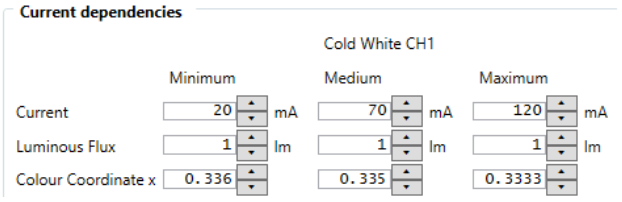
Tuner4TRONIC®: Data set creation for a new LED module in the Premium Mode

In the Premium Mode, the data listed above must be implemented. The operating point of the module must be implemented in the same way as in the Advanced Mode (see chapter 3.2.1.2.2). Additionally, characteristic data of the applied LEDs must be derived from the relevant LED data sheets and implemented. Therefore, data points must be collected from the characteristic curves of the LEDs (see chapter 2.4.1).

Example: Three value pairs for the color coordinate cx are derived from the LED data sheet and implemented in the T4T (cx_1/I_1, cx_2/I_2, cx_3/I_3).

How to save newly created TW modules on the PC is described in chapter 3.2.1.2.4 “Creation of new TW modules using the editing mode”.

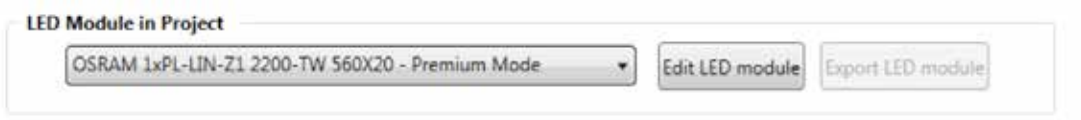




Tuner4TRONIC®: Input of cx coordinates as a function of the forward current

3.2.1.2.4 Creation of new TW modules using the editing mode

The data set of a new TW module can also be generated by editing an already stored module. For this, the button “Edit LED module” must be clicked after having selected a stored module:



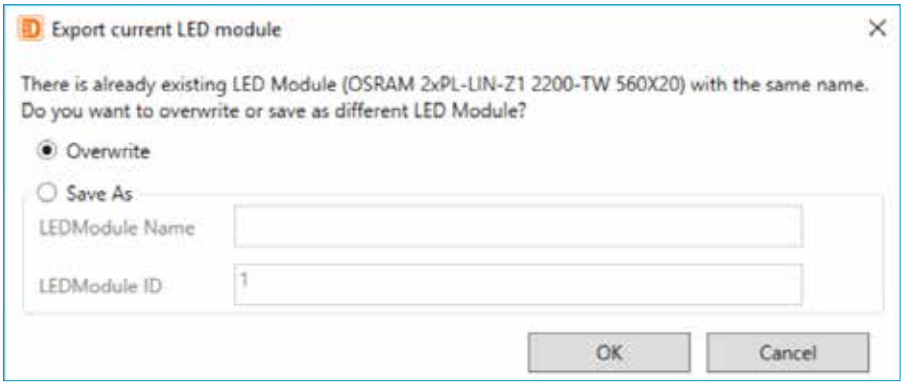
Tuner4TRONIC®: Editing a stored LED module

T4T then opens a window in which all parameters of the selected module are displayed and can be edited. Once all the changes have been made, the “OK” button must be clicked. The changed data will now be used for the configuration of the driver in the current project. The generated TW module is now part of the list “LED Module in Project” and is marked with a *.

To save the newly created TW module on the PC, the button “Export LED module” must be clicked:

Tuner4TRONIC®: Saving the data set of an LED module

T4T then opens a window to determine how the newly created TW module should be stored:



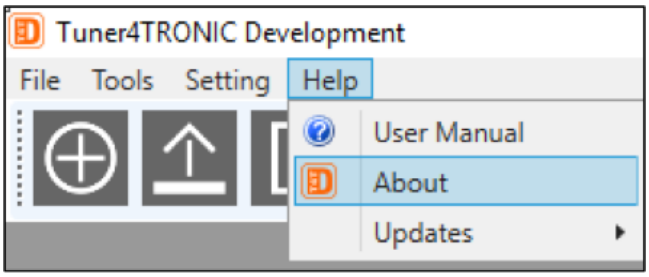
The newly created TW module can be stored using the same name and the same ID as the originally chosen TW module. This should be done if the changes were corrections of incorrectly entered data. To do so, the button “Overwrite” must be clicked.

Alternatively, a new name and ID can be entered to be assigned to the newly created module. This should be done when the originally selected TW module and also the newly created TW module must be available in the database. To do so, the button “Save As” must be clicked.

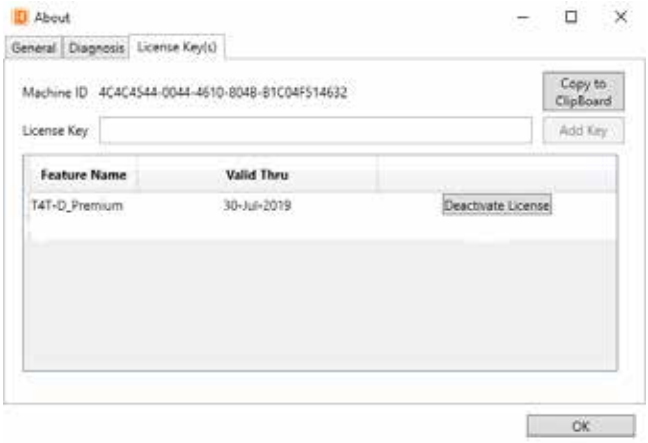
As default setting for the module ID, T4T always shows the lowest number that is not in use in the database of the PC. If already used module names or module IDs are entered, T4T displays a warning. In this case, alternative entries shall be made.

Activation of the T4T Premium license
To edit and create LED modules using the Premium Mode data model, a Tuner4TRONIC® Premium software license must be purchased from a local OSRAM sales representative. The Tuner4TRONIC® Premium license bundles the following new premium functionalities:
- Luminaire Info
- Monitoring Data Premium
- Tunable White Premium Mode
- Service Key

To get access to the Tuner4TRONIC® Premium license, open Tuner4TRONIC® Development and choose the menu Help → About → License Key(s):



T4T displays the unique machine ID of your computer in this window:



Tuner4TRONIC®: Retrieving the machine ID/entering the license key

When ordering a license, this machine ID needs to be sent to the local OSRAM sales representative.

It is recommended to use the “Copy to ClipBoard” button to copy the machine ID and insert it into your e-mail to avoid any typing errors. Based on this machine ID, OSRAM generates a unique license key specifically designed for this computer. This means that the license key can only be used on this computer.

Once you have the license available, please enter it into the “License Key” field and click the “Add Key” button to activate the license. The corresponding features will be available now for use in Tuner4TRONIC®.

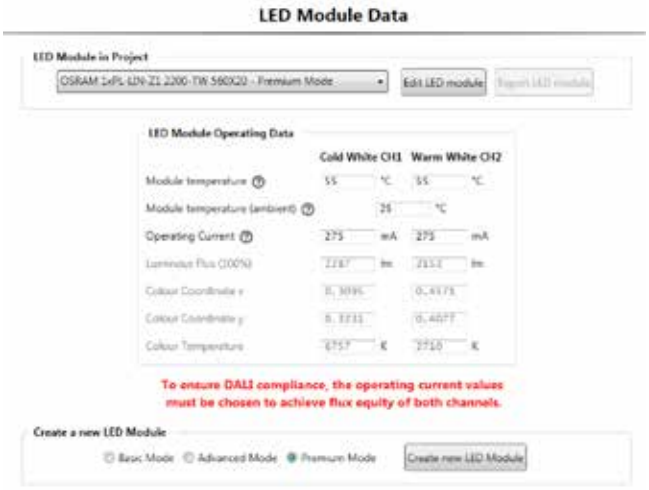
All entered licenses are shown comprehensively in the window shown above, including their expiration dates.

3.2.2 Configuration of TW drivers

3.2.2.1 Adjustment of 100 % operating current and balancing with TW module

To configure the driver according to the application (project) and to enable the balancing of driver and TW module, an LED module must be selected for each project. Balancing is then provided automatically by the T4T. Based on the selected TW module, the T4T displays the characteristic data that can be expected in this project, depending on the implemented operating currents (100 % values) and temperatures. Each time an editable value is changed, T4T recalculates all depending data.

To fulfill the requirements of the DALI standard, current values shall be chosen that lead to a flux equity of both channels. Otherwise, a change of the CCT would lead to a different total light output of the TW module. If compliance with the DALI standard is not intended, different current values can also be implemented. This can be done when, for example, an application requires a higher luminous flux with cold white light than with warm white light.

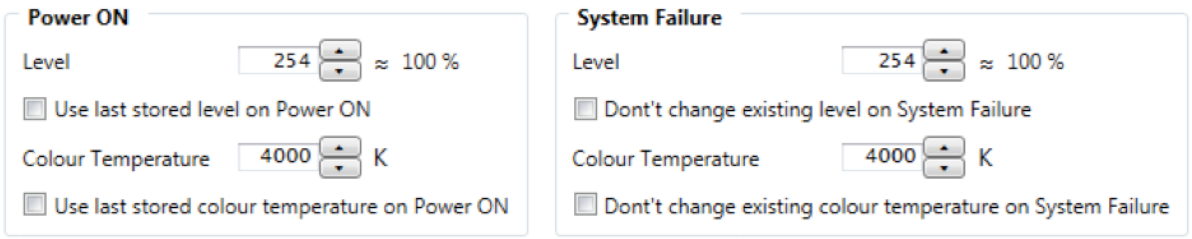


Tuner4TRONIC®: Input of the operating parameters of the LED module used in the project

The current values to be entered represent the respective non-dimmed operation of the two channels.

3.2.2.2 Additional DALI settings for LED drivers supporting Tunable White

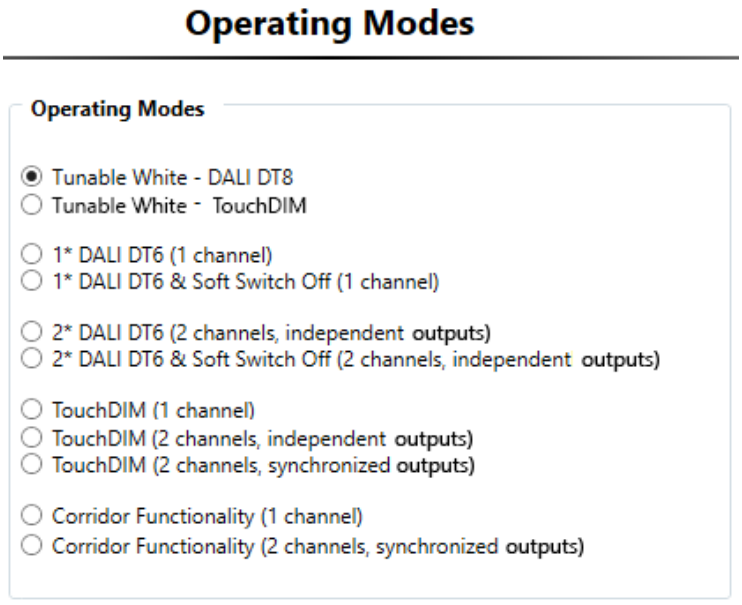
LED drivers that support Tunable White provide the ability to maintain or set the color temperature and the dimming level when the driver is turned on and after a system failure has occurred.



Tuner4TRONIC®: Input of initial operating conditions

3.2.2.3 Driver operation in single-color operation modes

The driver can also be set for the 2-channel or 1-channel mode for standard applications that only provide light in one color. The appropriate selection must be done in the “Operating Modes” tab of the T4T.



Tuner4TRONIC®: Setting of the driver operating mode

Different types of DALI drivers are defined in the DALI standard as Device Types DTx. Relevant types for LED applications are:

- DALI DT6: For “standard” LED drivers (one DALI address is used for each DALI driver/each channel, DALI only provides dimming and switching commands).
- DALI DT8: For color control (2-channel control gear, one DALI address per driver, DALI provides commands for dimming, switching and color temperature).

Typical applications for 2 x DT6 are: direct/indirect luminaires (2 channels, independently controllable). In this operating mode, the LED driver behaves like two individual LED drivers. Both output channels can be operated almost independently. In function tabs (e.g. operating current), the settings for each channel can be defined individually.

3.3 Light management systems (LMS)

Lighting concepts from OSRAM can be easily installed and conveniently configured. To cover the entire spectrum of applications, OSRAM has various light management systems for every project size and requirement. This opens the door to a cost-effective entry into Tunable White/HCL applications and offers the possibility of selecting more complex and comprehensive solutions adapted to the application and functionalities.

Especially with DALI TW drivers operating in DT8 mode (one DALI address for 2 channels), DALI addresses (compared to 2 DT6 per light point), programming time and costs can be saved in larger lighting installations.

3.3.1 DALI MCU Tunable White G2

The DALI MCU TW G2 is a simple manual control device for DALI DT8 drivers in the shape of a classic rotary dimmer. It can control the brightness and also the color temperature of light.

DALI MCU TW G2

Product features

- Up to 4 DALI MCUs can be connected in parallel to set up multiple control points
- Automatic synchronization between the control points
- Cover and rotary switch in neutral white
- Length of the DALI control cable: up to 300 m

Functionality/operation

The brightness is adjusted by turning the knob. The color temperature is set by turning and simultaneously pressing the rotary knob.

Product benefits

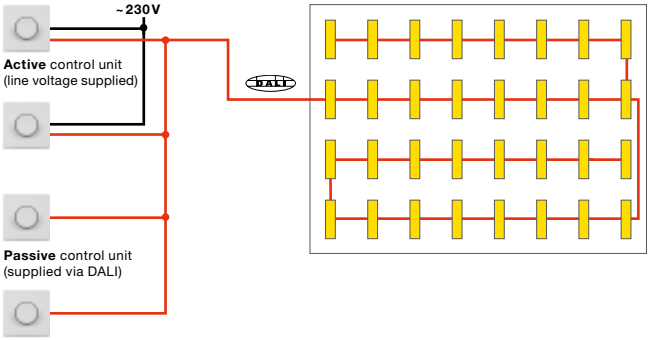
- Intuitive manual dimming, switching of light and changing of its color temperature
- Individual setting of minimum brightness level
- Individual setting of color temperature range

Areas of application

- Conference rooms
- Restaurants
- Shop lighting
- Residential

Equipment/accessories

- Suitable for up to 25 electronic control gears per active DALI MCU TW G2, up to 100 ECGs in total with four active DALI MCU TW G2
- Cover and rotary knob included (device is also compatible with covers from Jung, Berker, Gira, Siemens and SCHNEIDER Electric)



Wiring example DALI MCU TW G2

For more information, please refer to the data sheet and instruction sheet at www.osram.com/mcu-tw.

3.3.2 DALI ACU BT, DALIeco BT Control and DALIeco BT RTC Control

The DALI ACU BT and the DALIeco BT Control are DALI control devices for DALI DT8 drivers, which allow users to control brightness and CCT and to store and recall light scenes with a smartphone via Bluetooth. The DALIeco BT control can work together with sensors for motion, presence and light detection. DALIeco BT RTC enables HCL applications for time-controlled brightness and color temperature adjustment thanks to the integrated clock. Time-controlled switching (on/off) and dimming of the lighting is also possible without HCL application.

Bluetooth®



Product features	DALI ACU BT	DALIeco BT	DALIeco BT RTC
Compact lighting control device with DALI interface	■	■	■
Bluetooth interface for configuration and control via app	■	■	■
Integrated clock for time-controlled brightness and color temperature (HCL)			■
Adjustable HCL characteristic with up to 24 points			■
One DALI output channel (broadcast or groupcast)	■	■	■
Up to 32 DALI luminaires can be connected	■	■	■
Can be combined with OSRAM DALI sensors and DALI pushbutton couplers	■	■	
Supports up to four OSRAM DALI sensors and DALI pushbutton couplers			■
Daylight-dependent adjustment and presence-dependent lighting control	■	■	■
Separate pushbutton input for operation via standard pushbutton	■	■	
Pushbutton interface for separate operation of brightness and color temperature			■
Supports DALI DT8 Tunable White drivers	■	■	■
Outputs with electronically reversible overtemperature, short-circuit and overload protection	■	■	■
Cable length of the DALI control line: up to 300 m	■	■	■
Cable length to the pushbutton: up to 50 m	■	■	■
Suitable for switch box integration	■		
Suitable for luminaire integration		■	■
Product benefits			
Daytime-dependent adjustment of brightness and color temperature (HCL)			■
Suitable for Human Centric Lighting (HCL) applications			■
Lighting control via smartphone	■	■	■
Adjustment of all setting options via smartphone	■	■	■
Up to four timers with adjustable on/off time and weekday			■
Plug and play: Basic functions available without app	■	■	
Simplified commissioning thanks to pre-defined function modes	■	■	■
Intuitive manual dimming, switching and setting of color temperature	■	■	■
Separate control of up to four groups	■	■	■
Adjustable offset for different groups	■	■	■
Easy scene generation in the app	■	■	■
Scene recall possible via OSRAM DALI PRO PB pushbutton coupler	■	■	■
Wireless firmware update possible via Bluetooth	■	■	■
Integrated DALI supply	■	■	■
Control of Standard White or Tunable White light according to DALI Device Type 8 (DT8)	■	■	■
Selected DALI parameters adjustable via app	■	■	■
Areas of application			
Floor-standing lamps		■	■
Offices	■	■	■
Conference rooms	■	■	■
Training rooms	■	■	■
Classrooms	■	■	■
Corridors	■	■	■
Shop lighting	■	■	■
Equipment/accessories			
Free app for iOS and Android available in the App Store	■	■	■
Ceiling integration or independent installation possible via ECO CI KIT		■	■

3.3.3 DALI PRO RTC

The DALI PRO RTC is a fully programmable DALI control system for medium to large DALI installations. It can also control DT8 devices and is controllable with a smartphone via WiFi. The DALI PRO RTC can also perform daylight simulation.

Product features

- Interconnection of up to four DALI PROFESSIONAL control units
- Configuration via LAN/WLAN/USB
- RGB color sequences
- Time-of-day-dependent color temperature adjustment (Human Centric Lighting)
- Controller for four DALI lines
- Up to 50 pushbutton/sensor couplers can be integrated
- Integrated DALI supply
- Four freely programmable switchover relays; load contact: 4 x 5 A
- Daylight-dependent and/or presence-dependent or manual control
- Up to 4 x 16 groups can be controlled
- Integrated clock for event control
- Weekly scheduler
- Connection via push-in terminals
- Control of lighting scenes and sequences (recall/store)
- Housing for series installation
- Length of the DALI control cable: up to 300 m

Product benefits

- Easy and intuitive control via app
- Control of up to 1024 DALI ECGs via LAN inter-connectivity
- Plug and Play preconfigured for instant use without any startup procedure
- Mains voltage interruption buffer battery
- All the luminaires in the system can be dimmed or switched
- Simple creation of scenes and sequences
- Switching and dimming of up to 256 DALI ECGs per DALI PROFESSIONAL control unit
- A setpoint for daylight-dependent control can be stored by double clicking
- Sensor integration in DALI
- Remote access/remote maintenance
- Due to the KNX interface, DALI PROFESSIONAL can also be integrated into building management systems

Areas of application

- Room control, floor control, daylight-dependent control
- Connection of light and presence sensors in DALI systems
- Conference rooms
- Offices: Individual and group workplaces
- Production and assembly facilities
- Suitable for indoor applications
- Large luminaire groups
- Industry
- Corridors
- Strip lighting
- Logistics centers
- Classrooms
- Sports halls
- Training rooms

Equipment/accessories

- Free smartphone app for iOS and Android
- Suitable for up to 256 electronic control gears with DALI interfaces
- Graphic configuration software with Windows user interface

For more information, please refer to the data sheet and instruction sheet at www.osram.com/dalipro.

DALI Pro Control app

With the DALI Pro Control app, the functions of the DALI PROFESSSIONAL system can be conveniently adapted. Several users can access the control system in parallel.

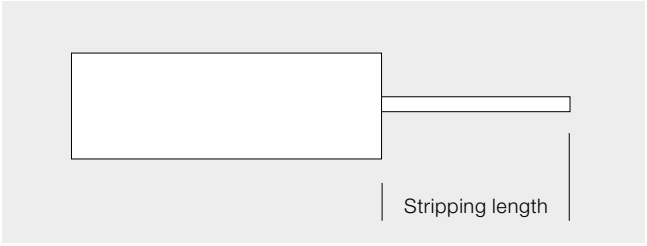
The app features at a glance

- Convenient switching and dimming of lighting with status display
- Clear structure through grouping in rooms
- Access restriction with individual release of each control element for each user
- Activating/overriding daylight controls
- Calling up static lighting scenes and dynamic sequences
- Control element for colored light (RGB)
- Control element for changing the color temperature (TW)

4 Handling

4.1 Wiring

The terminals of the PrevaLED® Linear Tunable White LED module (see picture above) are suitable for rigid and flexible conductors with a cross-section of 0.2 mm² to 0.75 mm² (AWG 24-18). The usage of rigid wires is recommended.



Wire stripping length

The conductors must be stripped to a length of 8 to 9 mm and inserted axially into the terminal with an orientation of 0°.

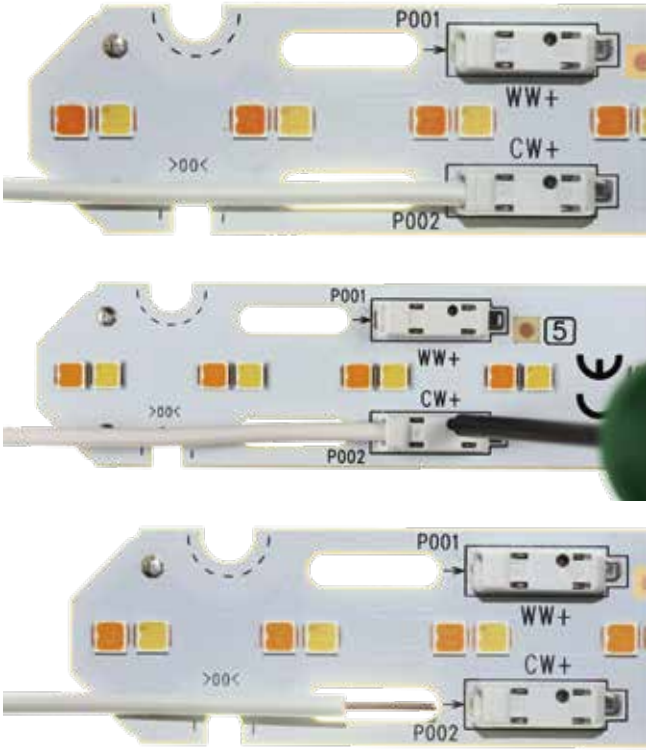
The PrevaLED® Linear TW modules have bushings (see picture). These allow wiring from the rear to avoid unwanted shadows.

Cable entry from the rear

4.2 Release connections

The connectors provide a simple insertion and release mechanism. Solid wires can be easily inserted into the connector. When using stranded wires, it is recommended to push the release mechanism on the top side of the connector to simplify the insertion. The release mechanism can also be used to easily release the wire.

The following pictures show the removal of a wire.



Disconnecting the connection cable

4.3 Electrostatic discharge (ESD)

The PrevaLED® modules meet the requirements of IEC/EN 61547. It must be considered that an electrostatic discharge exceeding 2 kV HBM (Human Body Model) can lead to a damage or even a complete failure of the module.

OSRAM therefore recommends that the storage and handling of PrevaLED® Linear TW modules are carried out in accordance with the acknowledged methods for protection against ESD damage.

4.4 Possible combinations (non-isolated)

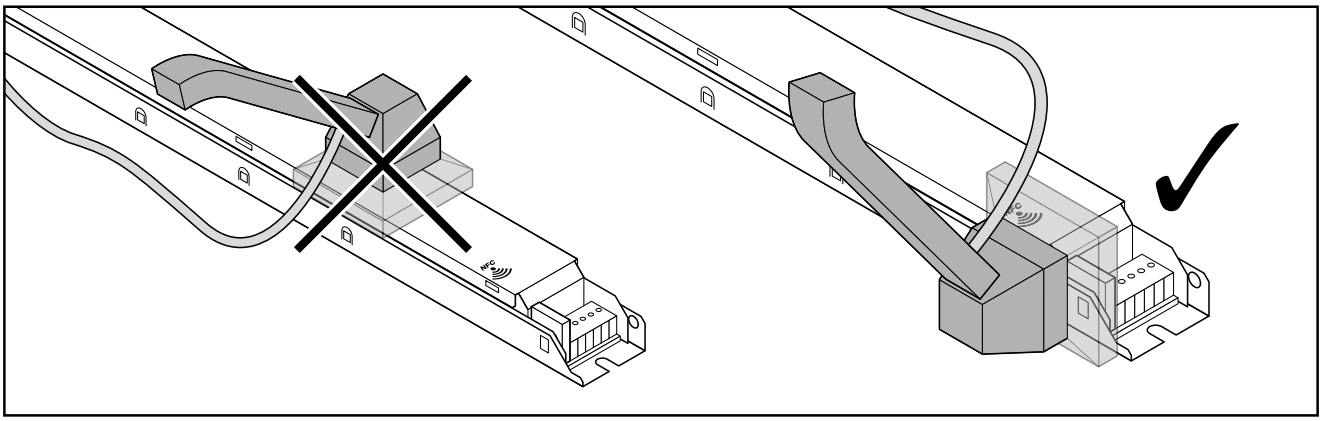
OTi DALI TW driver – non-isolated
PrevaLED® Linear TW modules are designed for operation with OTi DALI drivers. To avoid deviating color temperatures or brightness levels of the TW modules, a driver shall only operate them in series connection. The current setting of OTi DALI is done with the Tuner4TRONIC® configuration tool.

Possible number of PrevaLED® Linear TW modules operated by one driver

		OTi DALI 35/220-240/400 D NFC TW L	OTi DALI 75/220-240/700 D NFC TW L
	Current	**75–400 mA**	**125–700 mA**
PL-LIN-Z1 1100-TW 280X20	275	2–4	4–8
	400	2	4–6
PL-LIN-Z1 2200-TW 560X20	275	1–2	2–4
	400	1	2–3

All TW modules in series connection

4.5 NFC programming



Positioning of the NFC device on the LED driver

The NFC programmer must be positioned as shown. NFC programming is only possible while mains voltage is not connected at the LED driver.

Further information can be found in the T4T manual:
www.osram.com/t4t/

4.6 Exemplary assembly of a five-foot TW luminaire with 5500 lm

Exemplary wiring diagram for a five-foot TW luminaire

Modules 1 and 2 (560 mm)
Electrical parameters of PL-LIN-Z1 2200-TW 560X20:
Forward current I_f = 275 mA, forward voltage V_f = 51.2 V

Module 3 (280 mm)
Electrical parameters of a PL-LIN-Z1 1100-TW 280X20:
Forward current I_f = 275 mA, forward voltage V_f = 25.7 V

Series connection of the three modules
Forward current: I_f = 275 mA
Forward voltage: V_f = 2 x 51.2 V + 25.7 V = 130.1 V

From the OSRAM LED driver portfolio, the OTi DALI 75/220-240/700 D NFC TW L with its operating range perfectly fits this module selection.

5 Thermal considerations

No additional heat sink is necessary to avoid that $t_{c\ max}$ = 75 °C is exceeded when a PrevaLED® Linear TW G4 is operated at nominal operating conditions and mounted onto or into a luminaire housing with heat exchange to the ambience.

To avoid overheating, it is nevertheless strongly recommended to check the LED module temperature in any newly designed luminaires.

It should also be mentioned that lower t_c point temperatures of the LED module increase the module's efficiency. Therefore, efficient cooling for the PrevaLED® Linear G4 LED modules increases the system efficiency of the luminaire/application.

5.1 Introduction and definitions

For any LED module, including the PrevaLED® Linear G4 family, different temperatures (t_p, t_c, $t_{c\ max}$ etc.) are mentioned in the data sheet. They are sometimes mixed up, therefore a short overview is given:

- t_p is the performance temperature of the module. This means that all the tables, diagrams and numbers in the data sheet (and in this technical application guide) refer to the performance temperature t_p (if not mentioned otherwise).
- $t_{c\ max}$ is the absolute maximum temperature up to which the operation of the LED module is allowed.

All temperature values mentioned above are measured at the same position on the LED module, which is called the "t_c point" of the LED module. Its position on the PrevaLED® Linear G4 LED modules is shown on the next page.

5.2 t_c point position and measurement

Proper thermal design of an LED luminaire is essential for achieving best performance and ensuring a long lifetime of all components. To achieve a lifetime of 50,000 hours (L80B10), the sufficient thermal dissipation of the light engine has to be verified by measuring the temperature at the t_c point.

The maximum temperature reached at the t_c point must not exceed 75 °C. This reference point for the temperature measurement of PrevaLED® Linear G4 is shown in the following picture for the 1100-lm/280-mm LED module type (for other similar LED module types, the position is similar).

Position of the t_c measurement point on PrevaLED® Linear TW modules

The easiest way to measure the temperature at the t_c point is to use a thermocouple. It is recommended to use a thermocouple that can be glued onto the LED module. Make sure that the thermocouple is fixed with direct contact to the t_c point and that it does not touch any conductive parts of the module.

Examples of suitable thermocouples

Thermo wire NiCr–Ni Miniature connector “K”

K-type thermocouple with miniature connector

Different thermocouples

Illustration	Description	Temperature range [°C]
	PVC-insulated thermocouple	-10 … +105
	PFA-insulated thermocouple	-75 … +260
	Sprung thermocouple	-75 … +260

PrevaLED® Linear TW module with glued-on thermocouple

Thermal considerations for LED drivers

Position of the t_c measurement point on an OTi DALI TW

OTi DALI TW with mounted thermocouple

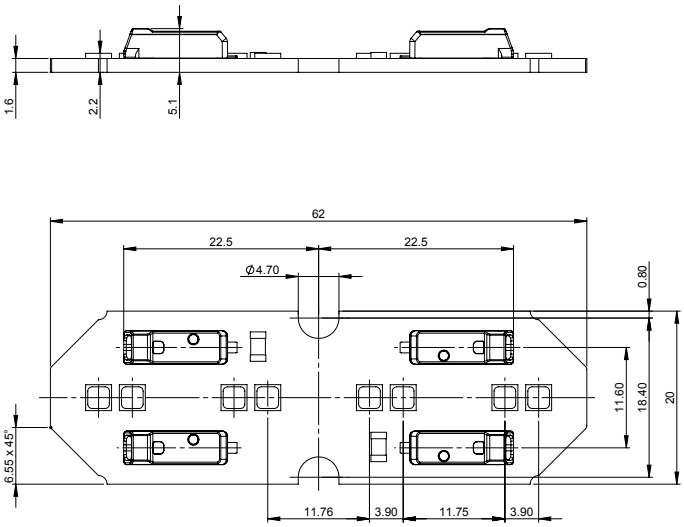
6 Mechanical considerations

6.1 LED module dimensions

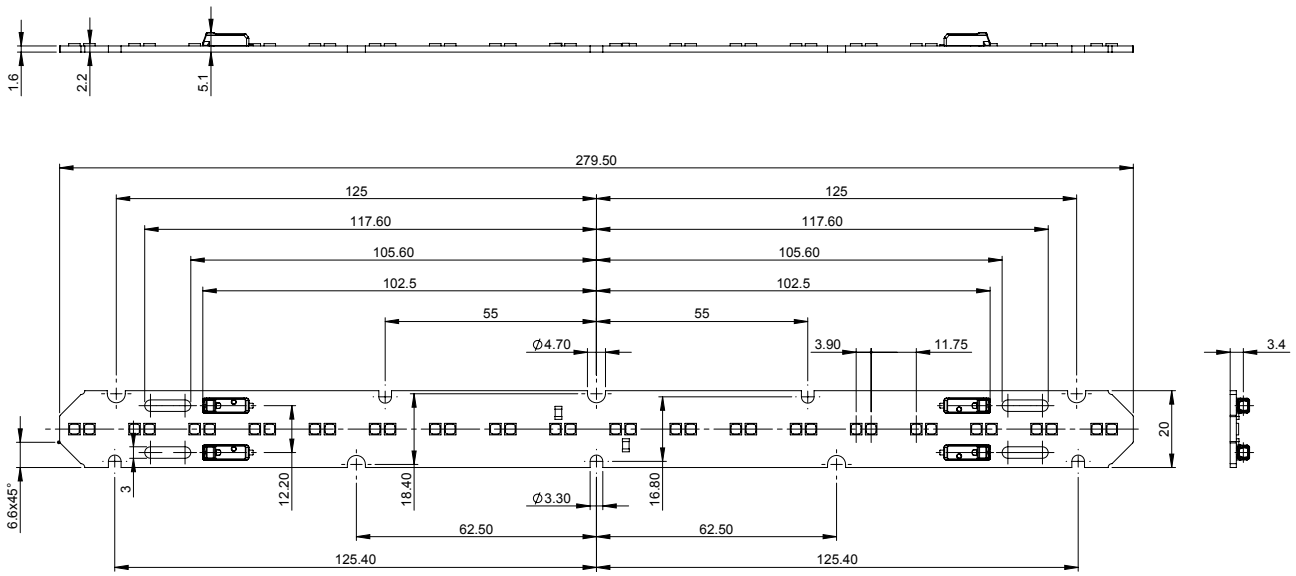
The PrevaLED® Linear TW family has three types of dimensions:

- 62 mm x 20 mm x 5 mm
- 280 mm x 20 mm x 5 mm
- 560 mm x 20 mm x 5 mm

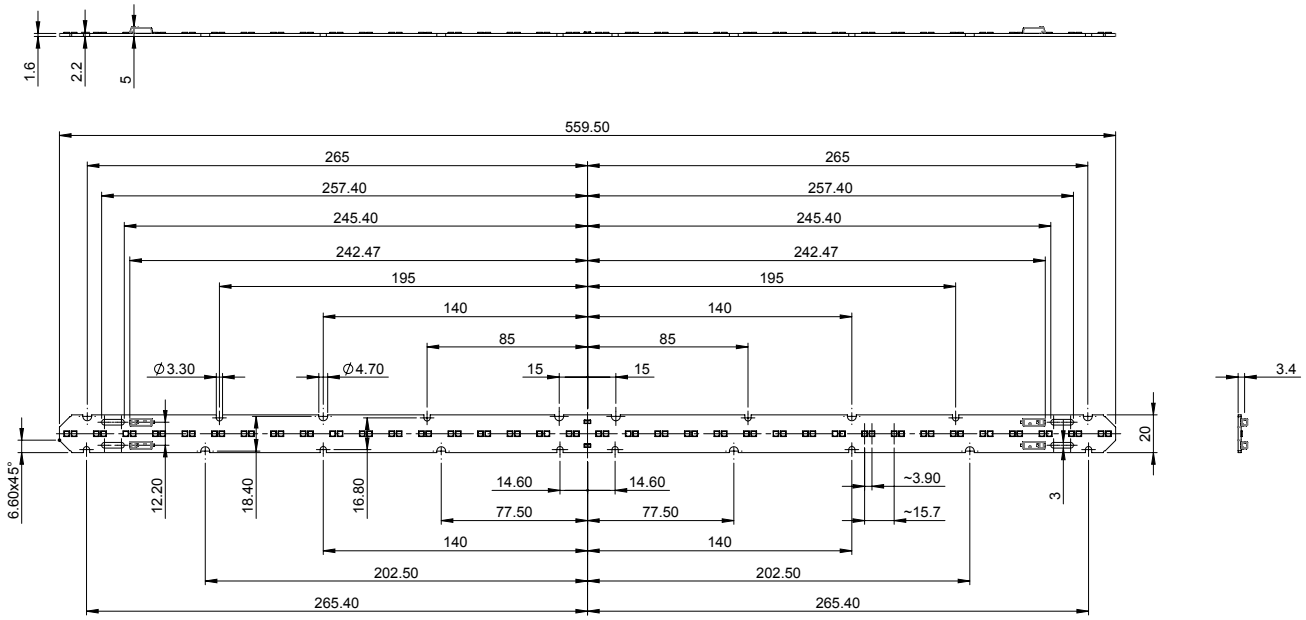
PL-LIN-Z1 245-TW 62X20



PL-LIN-Z1 1100-TW 280X20



PL-LIN-Z1 2200-TW 560X20



TW module dimensions overview

	L [mm]	W [mm]	H1 (PCB thickness) [mm]	H2 (LED module height) [mm]
PL-LIN-Z1 245-TW 62X20	62	20	1.60	5.1
PL-LIN-Z1 1100-TW 280X20	279.50	20	1.60	5.1
PL-LIN-Z1 2200-TW 560X20	559.50	20	1.60	5.1

Number of LEDs and LED pitch for the different modules in the PrevaLED® Linear TW family

	Number of LEDs	Pitch [mm]
PL-LIN-Z1 245-TW 62X20	8 (4 x 2700 K + 4 x 6500 K)	15.6
PL-LIN-Z1 1100-TW 280X20	36 (18 x 2700 K + 18 x 6500 K)	15.6
PL-LIN-Z1 2200-TW 560X20	72 (36 x 2700 K + 36 x 6500 K)	15.6

6.2 Mechanical protection

For operation in damp, wet or dusty environments, adequate ingress protection (IP) must be ensured with a suitable luminaire.

6.3 Mounting instructions

Please apply force only to the dedicated mounting positions. Strong mechanical stress can lead to an irreversible damage of the LED module. To fix the module into the luminaire housing, M4 screws according to DIN 7984 should be used.

When no isolating washer is used between the screw and the mounting hole, the maximum permissible screw head diameter is 7.5 mm. With larger screw heads, the minimum distance between the screw and other conductive parts on the PrevaLED® Linear TW LED module can fall below the required creepage distances.

The maximum torque that should be applied to the screws depends on factors such as the screw type and the luminaire material. It is also influenced by the usage of washers. In most cases, a torque between 0.5 Nm and 1 Nm is enough to fix the LED module in the luminaire housing and will not damage the module.

Cylinder head, torx drive M4 screw (ISO 4762)

Diameter	4.0 mm
Head diameter	7.0 mm
Head height	4.0 mm

Torx, hexagon socket, button head M4 screw (ISO 7380)

Diameter	4.0 mm
Head diameter	7.5 mm
Head height	2.1 mm

It is also possible to use clips instead of screws, e.g. the push-to-fix (P2F) connectors from BJB: www.bjb.com.

To achieve optimal fixation of the LED module and optimal thermal management, it is recommended to use all mounting holes in the PrevaLED® Linear G4 LED modules. Nevertheless, it is possible to reduce the number of screws. In this case, however, thermal behavior and mechanical strength should be verified.

In any case, it is strongly recommended to perform mechanical and thermal testing of the LED modules in the luminaire.

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