

USER MANUAL

LT2PR Series

**LED pattern projectors**



LIGHTING

v1.2 - eng

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# 1 GENERAL INFORMATION

## 1.1 Disclaimer

Always use and store Opto Engineering® products in the prescribed conditions in order to ensure their proper operation: failing to comply with the prescribed conditions may shorten the product lifetime and/or result in malfunctioning, performance degradation or failure.

Be aware that incorrect operation of this equipment may cause dangerous situations or significant financial losses. It is essential that the users ensure that the operation of the product is suitable for their applications.

All trademarks mentioned herein belong to their respective owners.

Except where prohibited by law:

- All hardware, software and documentation are provided on an "as is" basis.
- Opto Engineering® accepts no liability for consequential loss, of any kind.

Upon receiving your Opto Engineering® product, visually examine it for any damage that could be occurred during shipping. If the product is damaged upon receipt, please notify Opto Engineering® immediately.

## 1.2 Forbidden use

Please read the following notes before using this product.  
Contact your distributor or dealer for any doubts or further advice.

- Do not disassemble, modify or repair the product yourself. It may cause permanent malfunctioning, fire hazard or electric shock, possibly resulting in serious injury;
- Do not place the product in dusty, humid or hot places or near flames. These conditions may cause malfunctioning and damage, fire or electric shock, possibly resulting in serious injury;
- Do not spray or apply pesticides or other volatile chemicals on or in the proximity the product;
- This device must not be used in applications where its failure could pose a safety hazard or damage to other equipment. Keep in mind that if the device is used in a manner not foreseen by the manufacturer, the protection provided by its circuits and by its enclosure may be impaired;
- This is a low voltage device. As such, the voltage between any combination of applied signals must not exceed the supply voltage at any time;
- Higher voltages may cause a fault and could pose a safety hazard;

- This device has limited protection against transients caused by inductive loads. If necessary, use external protection devices like fast diodes or other specific transient protectors;
- Do not allow foreign objects to enter the unit or drop into holes, terminals and other openings or gaps. This may cause fire or electric shock, possibly resulting in serious injury;
- Disconnect the power cable before moving the product. Failure to comply with this precaution may damage the power cable or cause fire or electric shock, possibly resulting in serious injury;
- Do not scratch, cut, open or twist the power cables. It may cause malfunctioning, fire or electric shock, possibly resulting in serious injury;
- If the power cable is damaged or cracked, please contact our technical support and do not use the product. Damaged cables may cause malfunctioning, fire or electric shock, possibly resulting in serious injury;
- Do not insert or remove the plug of the power cable with wet hands. It may cause electric shock, possibly resulting in serious injury;
- Do not use the product in presence of flammable gas. It may cause outbreaks and flames, possibly resulting in serious injury;
- If you notice any abnormality such as smell, smoke or overheating, turn off the power and disconnect the power cables. Continuing to use the product in these conditions may cause fire or electric shock, possibly resulting in serious injury;
- If you have dropped the product or damaged the product case, turn off the power and disconnect the power cables. Continuing to use the product in these conditions may cause fire or electric shock, possibly resulting in serious injury.

### 1.3 Revisions

In Table 1 are listed all the user manual revisions.

In the column *Description* are listed all the relevant differences between different revisions.

Rev.	Date	Description
1.0	22/09/2023	First manual release
1.1	18/12/2023	Added absolute maximum ratings
1.2	12/02/2024	Operating conditions, electrical protections and analog input specifications updated

Table 1: Manual revisions

## 1.4 Ordering code

The product part number is composed as follows:

### LT2PRZZ-X-Y

The ordering code is explained in Table 2.

Code	Description	Options	Value
ZZ	Power	XP	~40W pulsed / ~20W continuous
		UP	~90W pulsed / ~45W continuous
X	LED color	W	white, 5700 K
		CG	Conversion green (only for UP version)
		UV405	UV, 405 nm
		B	blue, 465 nm
		G	green, 525 nm
		R	red, 625 nm
		IR850	IR, 850 nm
-Y	Variant	none	Standard
		-C	Compact version (no integrated driver, only for XP version)

Table 2: Ordering code

## 2 WARRANTY AND CERTIFICATIONS

### 2.1 Warranty

The device warranty is 12 months from the effective delivery date with reference to the device serial number.

Warranty covers the replacement or the repair of the defective part (components, device or part of it) with the exclusion of dismantling and shipping costs.

The replacement of one or more components does not renew the warranty period of the entire device.

The electronics and parts subjected to normal use or deterioration due to atmospheric agents and external environment are excluded from the warranty. Also, all failure caused by the lack of, insufficient or incorrect maintenance performed by unskilled or unauthorized personnel or due to unintended use or unauthorized replacements, alterations or repairs is excluded from the warranty.

The general validity of the warranty depends on:

- Maintenance being performed correctly as described in the device manual;
- The intended use of the device as specified in this manual.

### 2.2 CE Declaration

The LT2PR family is conformal to the EMC directive 2014/30/EU and therefore comply with the following standards:

Standard	Date of issue	Description
EN 61326-1	2013	Electrical equipment for measurement, control and laboratory use - EMC requirements
EN 62471	2008	Photobiological safety of lamps and lamp systems

### 2.3 FCC Declaration

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## 2.4 RoHS, REACH and WEEE

LT2PR products are conformal to the following directives and standards:

- RoHS 2011/65/EU
- REACH 1907/2006/EC
- WEEE 2012/19/EU

## 2.5 Product EoL (end-of-life) handling

Observe the following guidelines when recycling this equipment or its components. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



## 3 INTRODUCTION

### 3.1 Manual and conventions

Opto Engineering® SpA, with its registered office in Strada Circonvallazione Sud 15, 46100 Mantova (Mn) - Italy, hereinafter the manufacturer, provides all the necessary information in this installation, use and maintenance manual in a clear and simple way to install, use and service the LT2PR products.

The recipients of this manual are all those who have the knowledge, experience and capability of understanding the standards, prescriptions and safety measures indicated in this manual. Such people will be later identified as qualified personnel who are authorized to transport, install, use and service the products described in this manual.

This material can only be used by the customer whom this manual has been delivered to, in order to install, use and service the product.

The manufacturer will retain the right to modify or improve the manual and/or the product referred to in this manual without any prior notice.

The following typographical conventions are used in this document:

**NOTE:** notes contain important information. Highlighted outside the text to whom they refer



**CAUTION:** these indications highlight procedures that, if not observed in their entirety or in part, can cause damage to the machine or to the appliances



**HAZARD:** these indications highlight procedures that, if not observed in their entirety or in part, can cause injuries or affect the health of the operator

### 3.2 Product identification data

LT2PR LED projectors are identified with a label placed on the lateral side of the packaging box and on the back side of the cable tag, attached to the product.

This label is used to identify the part number and serial number of the product and contain some basic information on power consumption and current draw. A box label example is shown in Figure 1. A cable tag label example is shown in Figure 2.

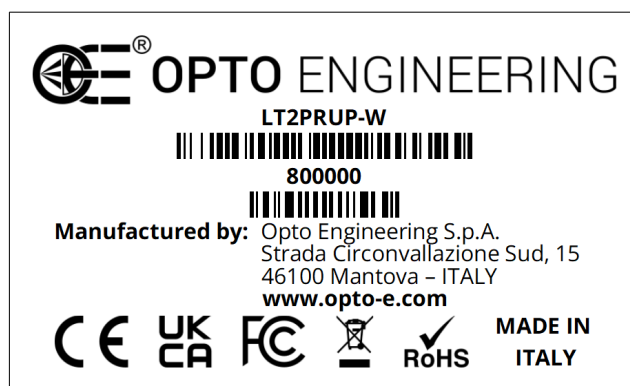


Figure 1: Example of box label.

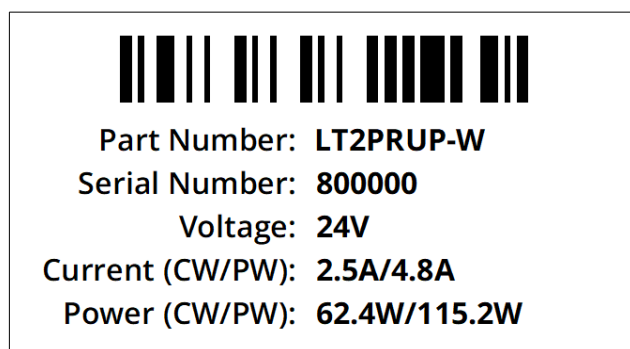


Figure 2: Example of cable tag label.

### 3.3 Storage and use conditions

#### 3.3.1 Storage conditions

Avoid thermal shock by not exposing the product to sudden changes in temperature.  
Store the product in a dry place: storage environment with relative humidity (RH) less than 80% (no condensation).

#### 3.3.2 Operating conditions

Extreme temperatures affect the product functionality, compromising LED irradiance and lifetime.  
Avoid any thermal shock and exposure of the product to sudden changes in temperature.  
The product includes high power LEDs: it's very important to dissipate an appropriate amount of

heat (if necessary, operate the device with a forced air cooling system).

Environment specifications	Values
Operating temperature	0-40 °C
Storage temperature	0-50 °C
Operating temperature humidity	20-85%, non condensing
Installation	Indoor use only
IP rating	IP30

Table 4: Environment operating specifications.

In general, avoid to store and use the product in the following environments:

- Environments with strong electric/magnetic fields.
- Places exposed to direct sunlight, rain or snow.
- Environments exposed to particular gas and dangerous substances.
- Extremely vibrating systems.
- Dusty places.
- Extremely humid places.
- Excessive hot/cold environments.

On the outer surface of the device you will find the following label to indicate the presence of hot surfaces:



Figure 3: Hot surface label located on the outer surface of the device



**HAZARD:** The entire outer surface of the product can reach high temperatures due to internal power dissipation. Do not handle with bare hands when operating and wait for a sufficient amount of time after shutdown before handling the product.



**CAUTION:** Product case temperatures can highly differ in case of poor heat dissipation. The product implements a thermal shutdown protection in order to avoid excessive damage to the internal electronics.



**CAUTION:** If used outside of the specified temperature range, the expected life of the product might consistently decrease. Opto Engineering® will not be responsible for product life reduction due to excessive thermal stress.

### 3.4 Photobiological safety

LT2PR series has been tested against EN 62471:2008 (photobiological safety of lamps and lamp system). The norm classifies LED lightings in 4 distinct groups, according to their hazardousness degree. For LT2PR series, the risk group is reported in Table 5.



**HAZARD:** Never look directly at the source with your eyes. Despite infrared light is invisible to the eyes, eye damage may occur. To know if the illuminator is ON, please refer to led indicator (Section 5.8). In all cases, Opto Engineering recommends the use of protection glasses.

Part number	Risk Group	Risk phrase
LT2PRXP-W	2	CAUTION. Possibly hazardous optical radiation emitted from this product. Do not stare at operating lamp. May be harmful to the eye.
LT2PRXP-UV405	3	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded products.
LT2PRXP-B	3	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded products.
LT2PRXP-G	1	
LT2PRXP-R	1	
LT2PRXP-IR850	2	CAUTION. IR emitted from this product. Do not stare at operating lamp.
LT2PRXP-W-C	1	
LT2PRXP-UV405-C	3	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded products.
LT2PRXP-B-C	2	CAUTION. Possibly hazardous optical radiation emitted from this product. Do not stare at operating lamp. May be harmful to the eye.
LT2PRXP-G-C	1	
LT2PRXP-R-C	Exempt	
LT2PRXP-IR850-C	1	NOTICE. IR emitted from this product. Use appropriate shielding or eye protection.
LT2PRUP-W	3	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded products.
LT2PRUP-UV405	3	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded products.
LT2PRUP-B	3	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded products.
LT2PRUP-G	1	
LT2PRUP-CG	1	
LT2PRUP-R	1	
LT2PRUP-IR850	3	WARNING. IR emitted from this product. Do not look at operating lamp.

### 3.5 Cleaning and maintenance

When cleaning the product, please remember:

- To avoid disassembling the product.
- To avoid liquids or inappropriate cleaning chemicals like benzene, alcohol, spray-like cleaners.
- To use an appropriate soft cloth or soft brush.

The lens of the product can be cleaned using compressed air or a cotton swab soaked with isopropyl alcohol or acetone.

## 4 GETTING STARTED

### 4.1 Overview

LT2PR products are **LED pattern projectors** with on-board controller<sup>1</sup>.

L2PR pattern projector are designed to operate in both continuous and pulsed mode with an easy hardware interface. LT2PR pattern projector can operate with mostly of the C-mount lenses available on the market.

### 4.2 Product installation

The pattern projector is provided with two M3 threaded holes on each side, allowing for flexible and robust mounting. It is recommended to mount the pattern projector to a metal object using a metal bracket in order to facilitate the heat dissipation. Before installing the product make sure to align it correctly, as requested by your application.

Room should be provided to ensure a good cables setting on the back of the pattern projector as well as free air flux in order to dissipate the generated heat.

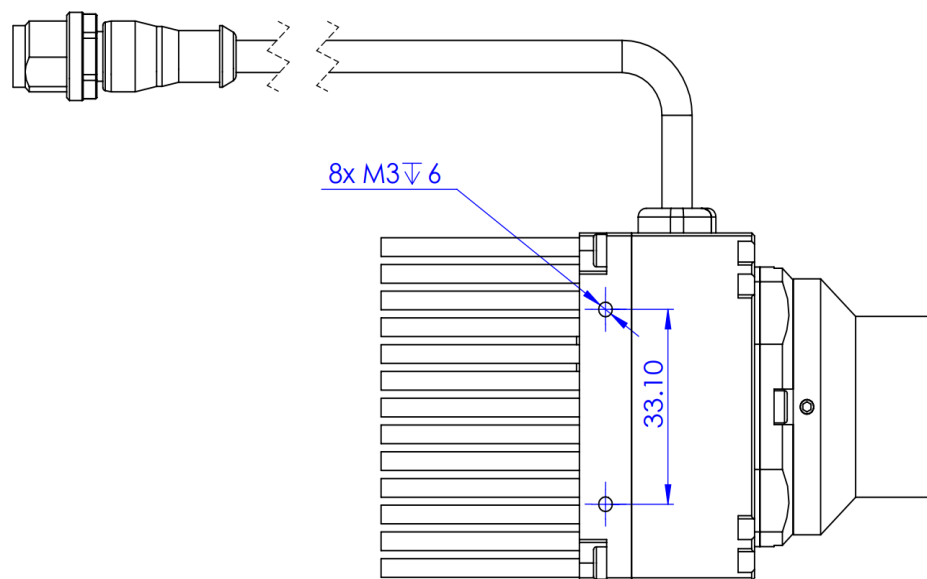


Figure 4: Schematic drawing of LT2PRXP device with the M3 threaded holes highlighted.

<sup>1</sup>Does not apply to -C versions.

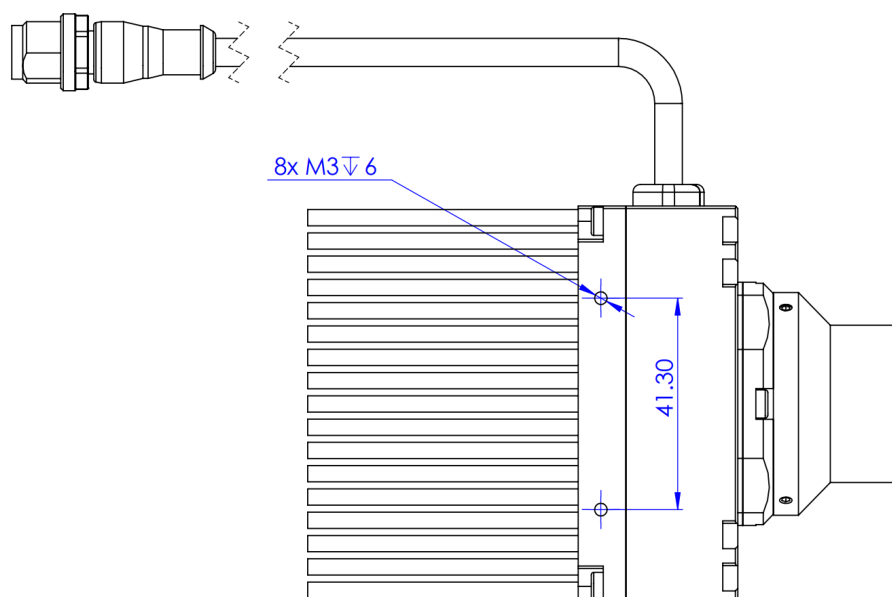


Figure 5: Schematic drawing of LT2PRUP device with the M3 threaded holes highlighted.

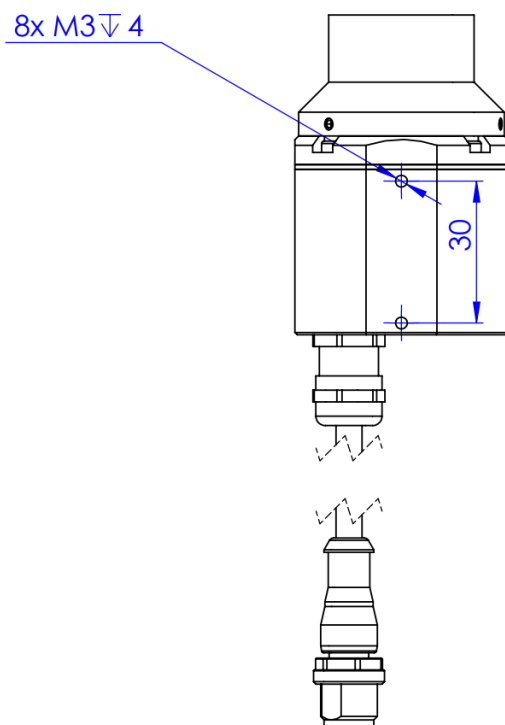


Figure 6: Schematic drawing of the -C variant device with the M3 threaded holes highlighted.



### 4.3 Pattern and stop replacement

In order to change the pattern, first you have to remove the mount by unscrewing the set screws (Figure 7). Then, with a locknut you release the mount ring (Figure 8), freeing the pattern and the stop underneath. The latter two elements can then be taken out, changed, and repositioned to the initial configuration. Then, proceed to reassemble the product by following these steps backwards (Figure 9).



Figure 7: First step: disassemble the mount by unscrewing the set screws.



Figure 8: Second step: release the mount ring.



Figure 9: From left to right: mount, stop, pattern, ring. When replacing the pattern, the elements must be placed in the order shown.

## 4.4 Lens installation

The product is compatible with lenses with image circle up to 1.1 inches (17.6 mm).

In order to ensure better homogeneity for lenses with smaller image circle, it is necessary to substitute the stop of the optical assembly by following the same procedure of Section 4.3. In fact, 3 different stops, for image circle 1.1 inches (17.6 mm), 1 inches (16 mm) and 2/3 inches (11 mm) respectively, are provided with the product.

## 4.5 Spacer adjustment

The projector should be compatible with all the fixed focal lenses, but in some cases it may prove necessary to intervene on the spacer so to obtain the desired degree of homogeneity of illumination.

In order to adjust or add the spacers, first disassemble the mount by unscrewing the set screws (Figure 7). Using a spanner wrench, remove the phase adjust ring (Figure 10). Then, unscrew the 4 M3 T10 screws so as to remove the corresponding part of the assembly, thus leaving the spacer free (Figure 11). The latter can then be changed or combined with other spacers. In particular, two spacers are provided with the product (Figure 12): one is already mounted, the other is additional. Finally, proceed to reassemble the product by following these steps backwards.



**CAUTION:** It is important to operate in a clean environment. Please, do not touch the optics with bare hands.



**CAUTION:** It is strongly recommended to handle electronics with ESD protection devices.



Figure 10: After removing the mount, remove the Inox steel ring.



Figure 11: Unscrew the screws so to free the spacer.



Figure 12: Two spacers are provided with the product.

## 5 TECHNICAL SPECIFICATIONS

### 5.1 Hardware dimension

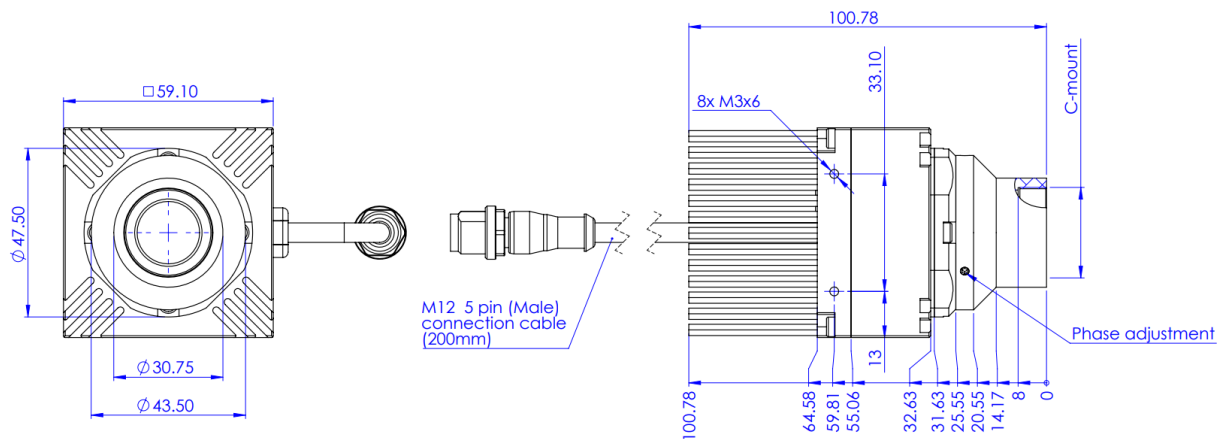


Figure 13: Linear dimensions of the device hardware for LT2PRXP.

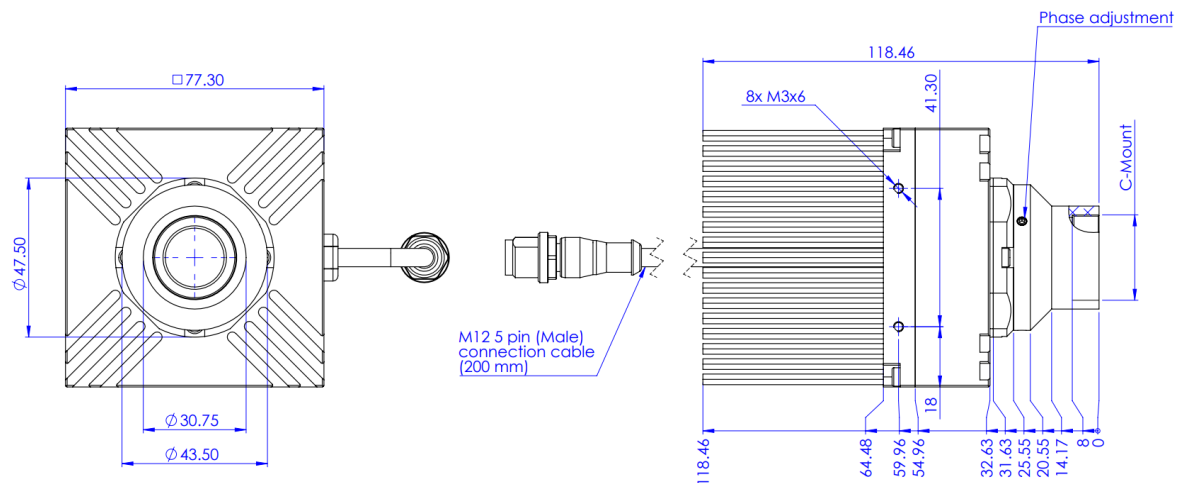


Figure 14: Linear dimensions of the device hardware for LT2PRUP.

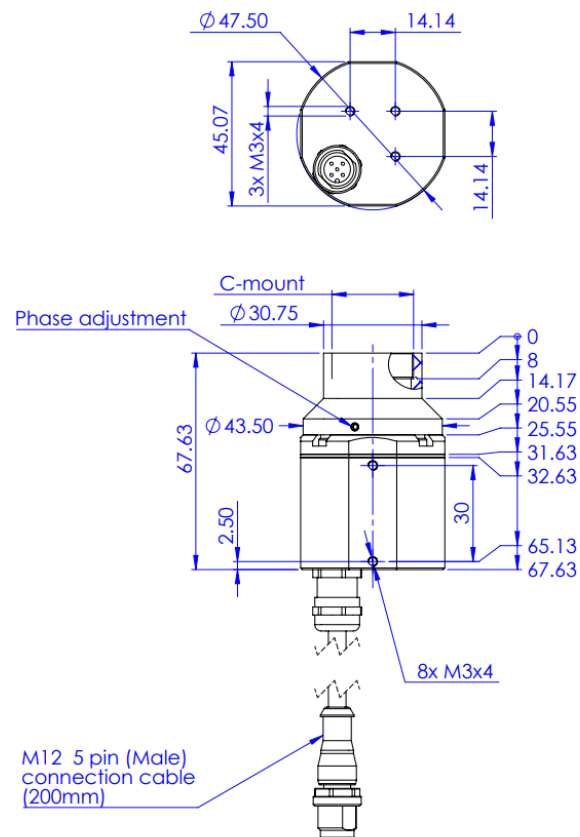


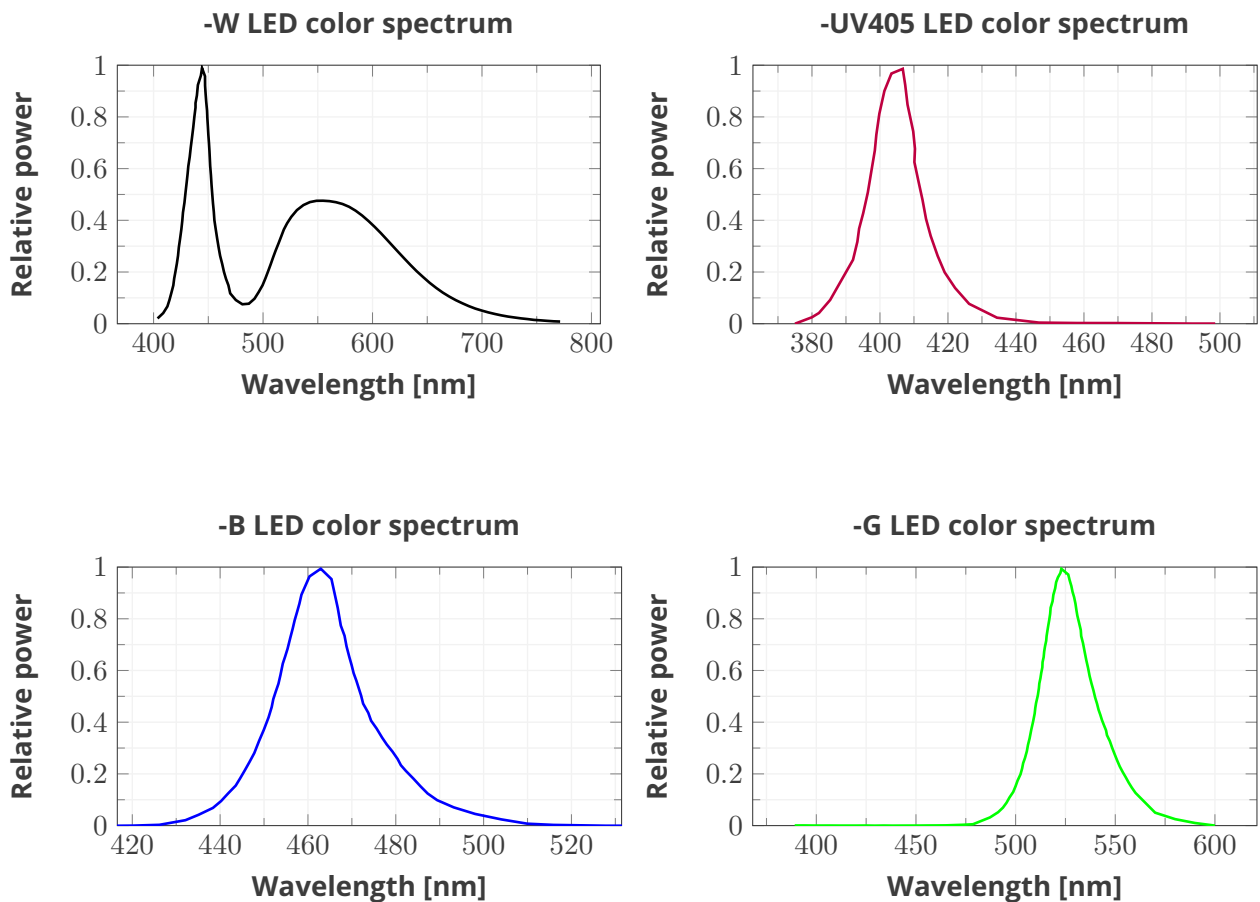
Figure 15: Linear dimensions of the device hardware for the -C variant device.

## 5.2 LED color

The product is available with different LED color options depending on the specific model. In Table 6 you will find the correspondence between the model suffix and the color with its peak wavelength. The spectra of the available models are presented in Figure 16.

Model suffix	Color
-W	White, 5700 K
-UV405	UV, 405 nm
-B	Blue, 465 nm
-G	Green, 525 nm
-R	Red, 625 nm
-IR850	IR, 850 nm
-CG (only UP)	Conversion green

Table 6: Model suffix and corresponding colors.





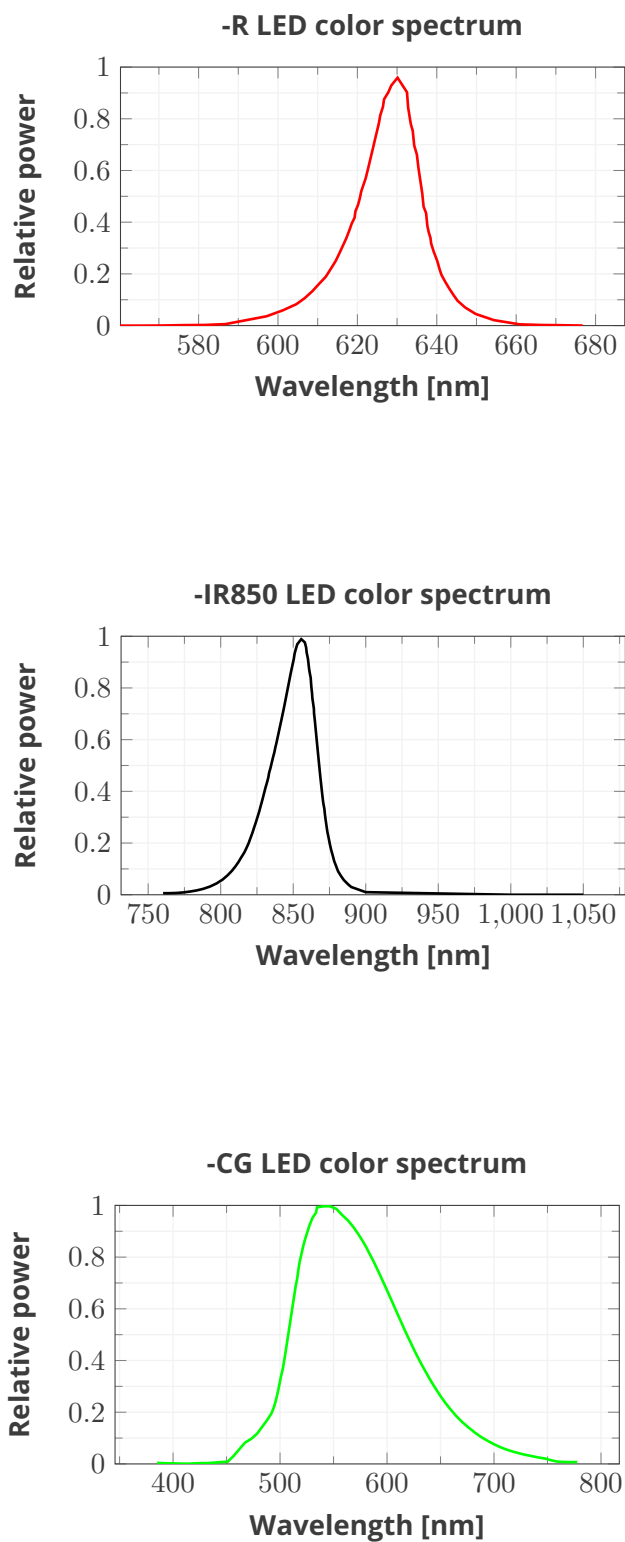


Figure 16: LED's emission spectrum of each color model.

### 5.3 Connectors and pinout

The M12 straight plug male connector is schematized in Figure 17 in order to show the 5 pins. The functionality of the pins both for standard and for the -C variants are shown in Table 7. The 5 wires used are 0.35 mm<sup>2</sup>, 5 m, black PVC wires.

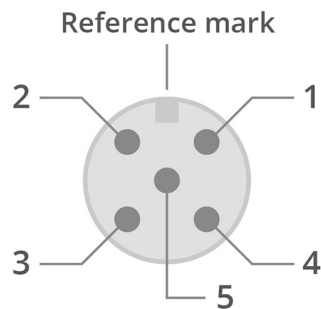


Figure 17: Scheme of the connector pinout (device side).

Pin	Standard	-C variant
1	Power +24 V <sub>dc</sub>	LED anode
2	NPN	LED cathode
3	GND	NTC terminal 1
4	PNP	NTC terminal 2
5	Analog dimming	Not connected

Table 7: Connector pinout for standard device and the C-variant.



**CAUTION:** The device can be damaged if the wrong connections are made.

## 5.4 Electrical specifications

The voltage supported by the pins in Figure 17 for the standard variant device are:

Pin	Voltage
1: Power	+26 V (Maximum Working voltage), +30 V (Absolute Maximum Ratings)
2: NPN	±9 V (Absolute Maximum Ratings)
3: GND	Ground
4: PNP	±27 V (Absolute Maximum Ratings)
5: Analog	±27 V (Absolute Maximum Ratings)

Table 8: Voltage supported by the connector pins.



**HAZARD:** Do not exceed the recommended voltages! Risk of damage to the device and danger for the operator.

Instead the -C variant device must be current controlled with a constant current source. The maximum LED forward current is  $i_{LED}^{max} = 3$  A.

## 5.5 Electrical protections

All the signal inputs (Pin 2,4,5) feature ESD protection. Furthermore, the power supply input (Pin 1 in Table 7) exhibits reverse polarity protection and surge protection.

## 5.6 Thermal protection

The temperature of the device is continuously monitored by a temperature sensor placed near the LEDs. If the maximum temperature  $T_{max} = 110^{\circ}$  C is reached, then the thermal shutdown occurs. The system reactivates when the temperature decreases by the amount given by the hysteresis temperature  $\Delta T_{hyst} = 10^{\circ}$  C.

In the case of the -C variant, a 10 k $\Omega$  2% SMD NTC thermistor from Vishay/BC Components, part number: NTC50603E3103GMT is used. The temperature of the device can be obtained by the user from the known relationship between the thermistor resistance as a function of the temperature characterized by the parameter  $B_{25/85} = 3610$  K.

## 5.7 Operating modes

For the standard variant device, the LEDs can operate in two different modes: the *continuous mode* and the *strobe mode*, while the -C variant device works only in strobe mode. The two modes are described in the following sections.

The behavior of the electrical power delivered on the LED as a function of the analog input voltage is depicted in Figure 18 and it is schematized as follows:

- 0 – 1 V: LED off
- 1 – 10V: LED power modulation 10-100%
- 10 – 24 V: LED power 100%
- Not connected: LED off

The previous percentages are referred to the maximum power delivered in the corresponding selected mode.

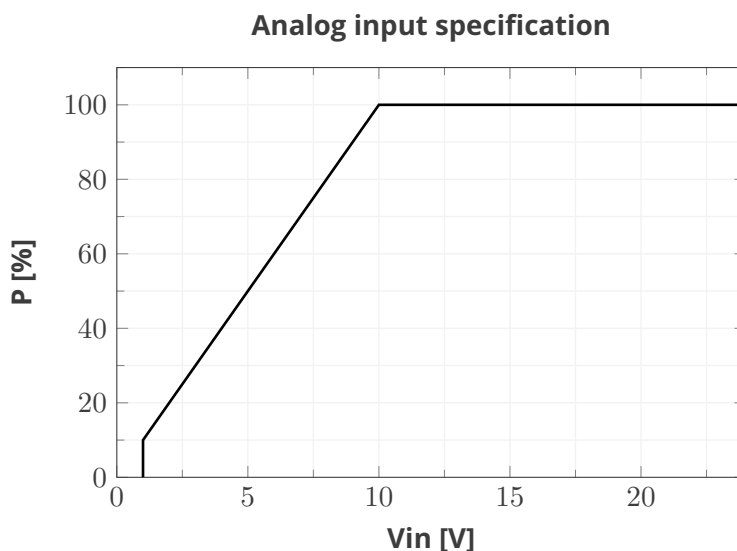


Figure 18: Percentage LED power as a function of the input voltage. The percentages are referred to the maximum power delivered on the LED for the corresponding selected mode, continuous or strobe.

### 5.7.1 Continuous mode

Continuous operations are available with the possibility of delivering continuous electrical power on the LED.

In order to select the continuous mode, there are two different options:

1. When turning on the device, the pin NPN must be kept at  $V_{NPN} \leq 1$  V for at least 100 ms
2. When turning on the device, the pin PNP must be kept at  $V_{PNP} > 3$  V for at least 100 ms

Then, the NPN and PNP pins are no more sampled during continuous mode use, while the analog input is sampled every 10 ms (100 Hz).

### 5.7.2 Strobe mode

Operations in strobe mode are available with the possibility of delivering pulsed electrical power on the LED.

In this case, differently from the continuous mode, in order to select the strobe mode there is no need to connect the device when it starts up. When  $V_{NPN} \leq 1\text{ V}$  or  $V_{PNP} > 3\text{ V}$ , the LEDs are turned on for a time duration that corresponds to the trigger impulse duration. At the end of the trigger pulse, the minimum  $T_{off}$  timer is automatically modulated based on the duty cycle values to comply with the maximum limits set (Section 5.7.3). Therefore, each successive pulse that is sent to the device before this  $T_{off}$  has elapsed since the end of the previous one will be ignored.

### 5.7.3 Signal timing

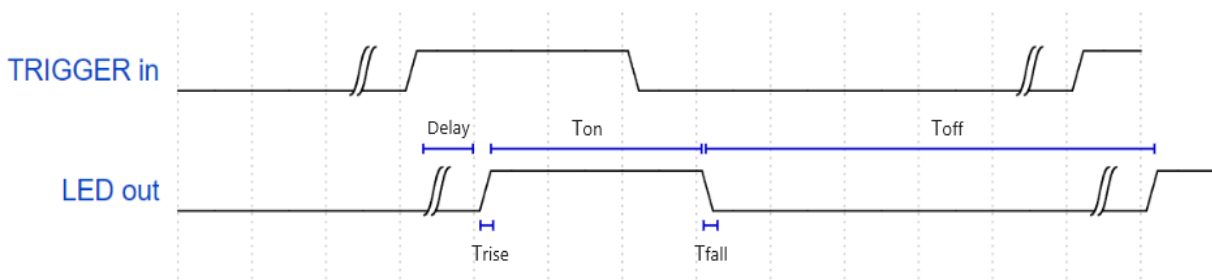


Figure 19: Scheme of the input trigger signal and of the corresponding LED output.

For strobe mode, let's refer to Figure 19 for the definitions of  $T_{on}$  and  $T_{off}$ . The period is  $T = T_{on} + T_{off}$ . The duty cycle is:  $\text{Duty Cycle} = T_{on}/T$ .

In Figure 19 it is also possible to see the schematization of the time delay of the LED output response with respect to the trigger signal, the time  $T_{rise}$  needed for the LED output to reach the maximum voltage value and the time  $T_{fall}$  needed for the output to drop to zero.

The timer resolution is smaller than  $1\mu\text{s}$ , while the delay jitter, i.e. the repetition uncertainty on the time delay, is guaranteed to be less than 100 ns.

All the aforementioned parameters are summed in Table 9.

Parameters	Value
$T_{on}^{min}$	$2 \mu s$
$T_{on}^{max}$	10 ms
Timer resolution	$\leq 1 \mu s$
Duty cycle max	10%
$T_{rise} + \text{Delay}$	$< 500 \text{ ns}$
$T_{fall}$	$< 200 \text{ ns}$
Delay jitter	$< 100 \text{ ns}$

Table 9: Signal timing parameters for strobe mode.

## 5.8 Status LED

A RGB-LED, placed on the outer surface of the device, indicates the system status with the following color legend, which depends on the selected mode of use.

In continuous mode:

Color	Status
● Green	Enabled (Analog input voltage $\geq 1 \text{ V}$ )
● Orange	Disabled (Analog input voltage $< 1 \text{ V}$ )
● Red	Generic error (MCU error, drivers, ...)
● Red blink	Over temperature

Table 10: Color legend for continuous mode of the status RGB-LED.

In strobe mode:

Color	Status
● Blue	Enabled (Analog input voltage $\geq 1 \text{ V}$ , but no trigger pulse)
● Orange	Disabled (Analog input voltage $< 1 \text{ V}$ )
● Green	Trigger pulse
● Red	Generic error (MCU error, drivers, ...)
● Red blink	Over temperature

Table 11: Color legend for strobe mode of the status RGB-LED.

## 5.9 I/O circuitry

### 5.9.1 NPN input

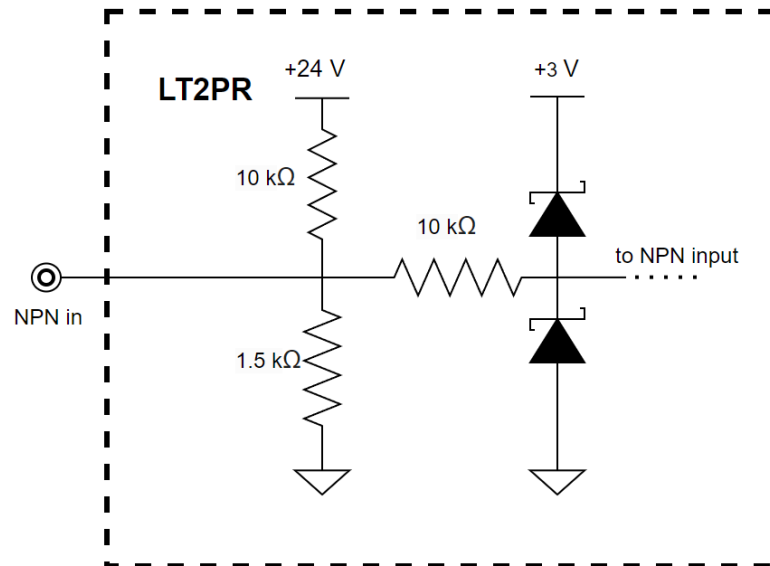


Figure 20: Scheme of the NPN input.

The NPN logic input scheme is depicted in Figure 20. Please note that the NPN input is in pull-up configuration. Thus, it could be a current source with respect to the controller connected.

### 5.9.2 PNP input

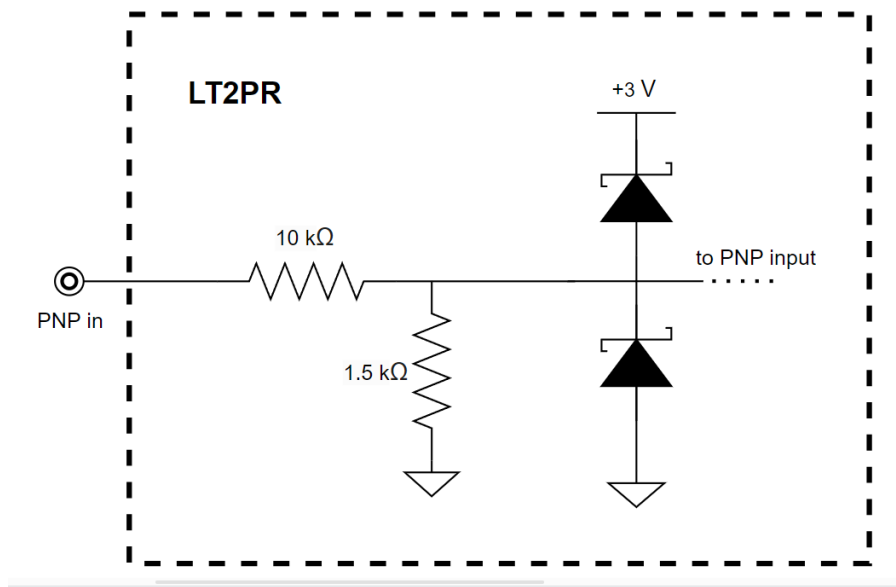


Figure 21: Scheme of the PNP input.

The PNP logic input scheme is depicted in Figure 21. Please note that the PNP input is a current sink with respect to the controller connected.



### 5.9.3 Analog dimming input

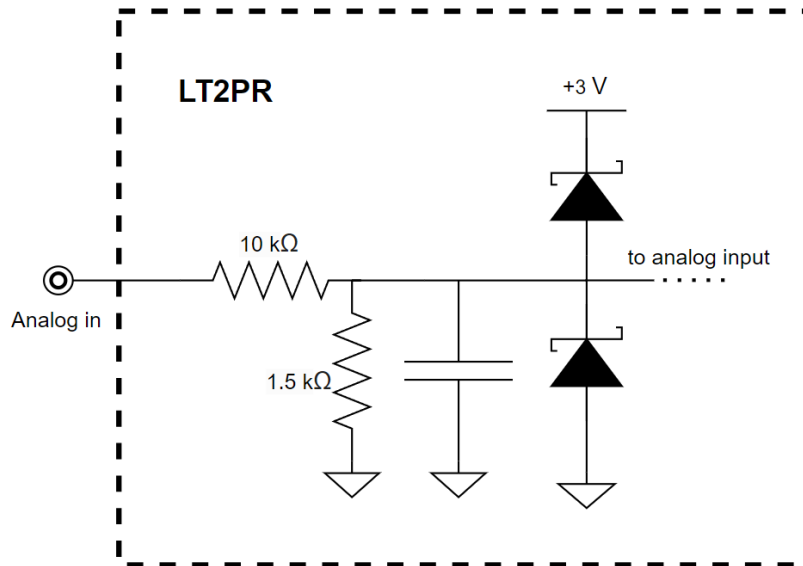
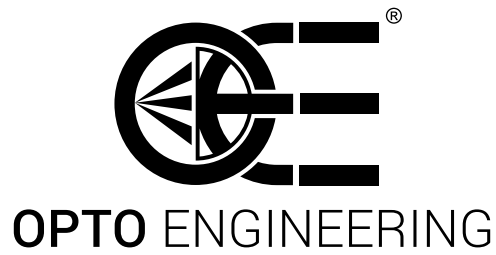


Figure 22: Scheme of the analog dimming input.

The analog dimming input scheme is depicted in Figure 22. The DC input impedance is  $Z_{In} = 11.5 \text{ k}\Omega$ . A low-pass filter (cut-off frequency  $f_c \approx 2.34 \text{ kHz}$ ) cuts high-frequency input signals.



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