Lightning Mini 10-2

User Manual

Version: 1.0

Original Manual

Contents

1 Introduction

1.1 Foreword

This manual is intended for users of Vision Hardware Partner products only. Any publication of this document or parts thereof requires written permission by Vision Hardware Partner.

This documentation has been prepared with the most possible care. However, Vision Hardware Partner does not take any liability for possible errors in the documentation.

Please notify Vision Hardware Partner (support@VisionHardwarePartner.nl) if you become aware of any errors in this manual or if a certain topic requires more detailed documentation.

1.2 Disclaimer

In the interest of progress, Vision Hardware Partner reserves the right to perform technical changes without further notice.

1.3 Used symbols

The following symbols are used in this manual:

This symbol provides insight or offers tips to help facilitate certain actions.

This symbol warns for situations that may lead to malfunction or even damage to the device.

This symbol warns for dangerous situations that may lead to damage to the device or personal injury.

1.4 Please provide feedback

Dear user,

Vision Hardware Partner has a rich experience of using machine vision products in industrial environments. We try to use this experience to create products which are robust, easy to use and suit your requirements while still being affordable.

However, not all applications are the same and not all users have the same requirements. In order to make sure that the needs of as many as possible customers are served it is important to keep in touch with them. So if you can spare a minute please tell us what you do and do not like about

our product. This way you will help us to keep on improving our solutions for your machine vision challenges.

Please, send your feedback by e-mail to feedback@VisionHardwarePartner.nl.

2 About Lightning mini 10-2

Lightning mini 10-2 is a low-cost power supply designed to pulse-drive LED-lamps at currents up to 12.5 A.

The current pulses are supplied from an internal charge buffer, which is recharged at a lower current. Because of this the Lightning mini 10-2 can supply pulse currents up to 12.5 A, while drawing no more than 3 A supply current.

Lightning mini 10-2 also supports triggering a camera.

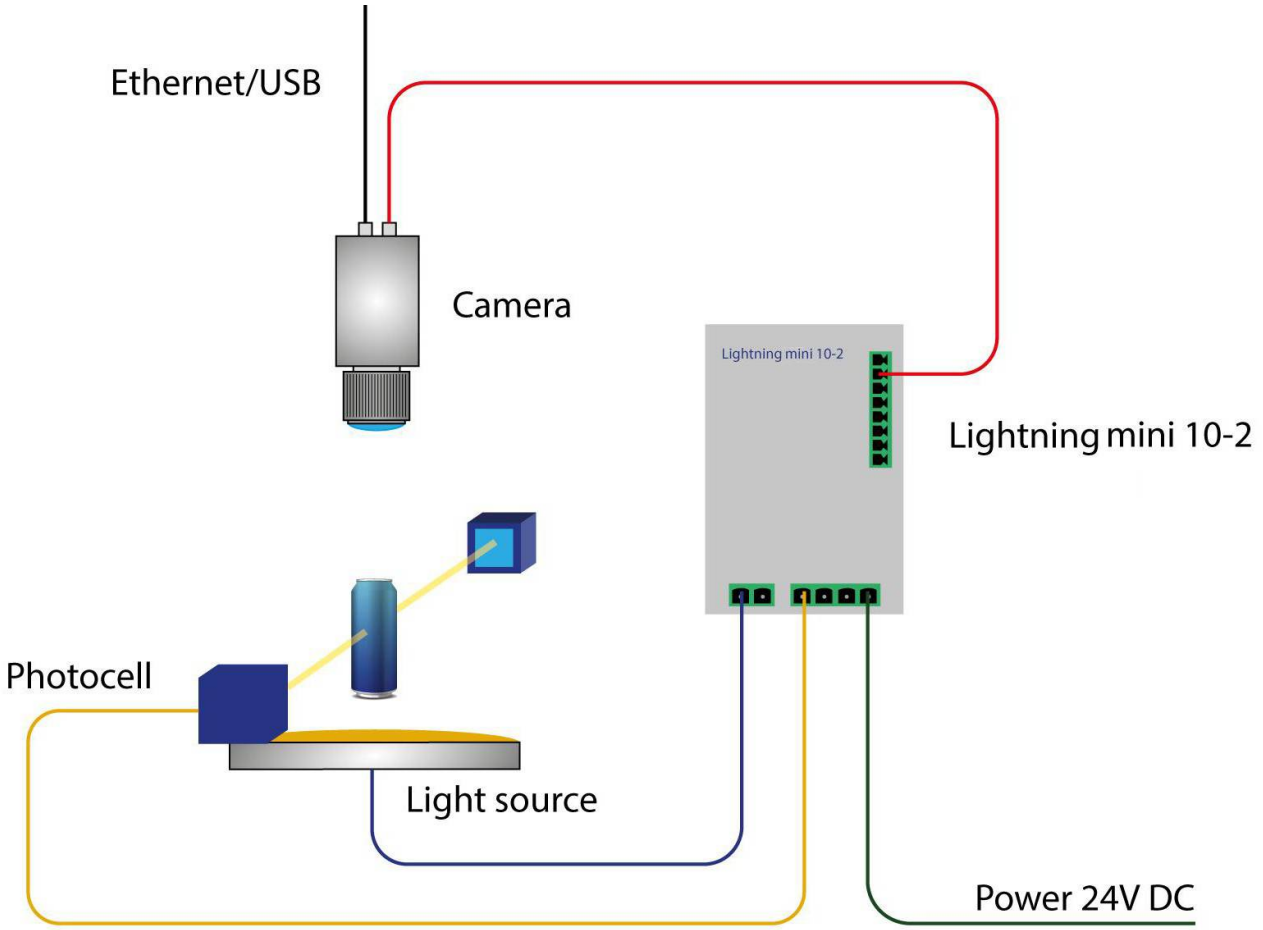


Figure 1: Lightning mini 10-2 system overview

The DIN-rail housing and the broad input supply range make this product well suitable for industrial applications.

2.1 Functional overview

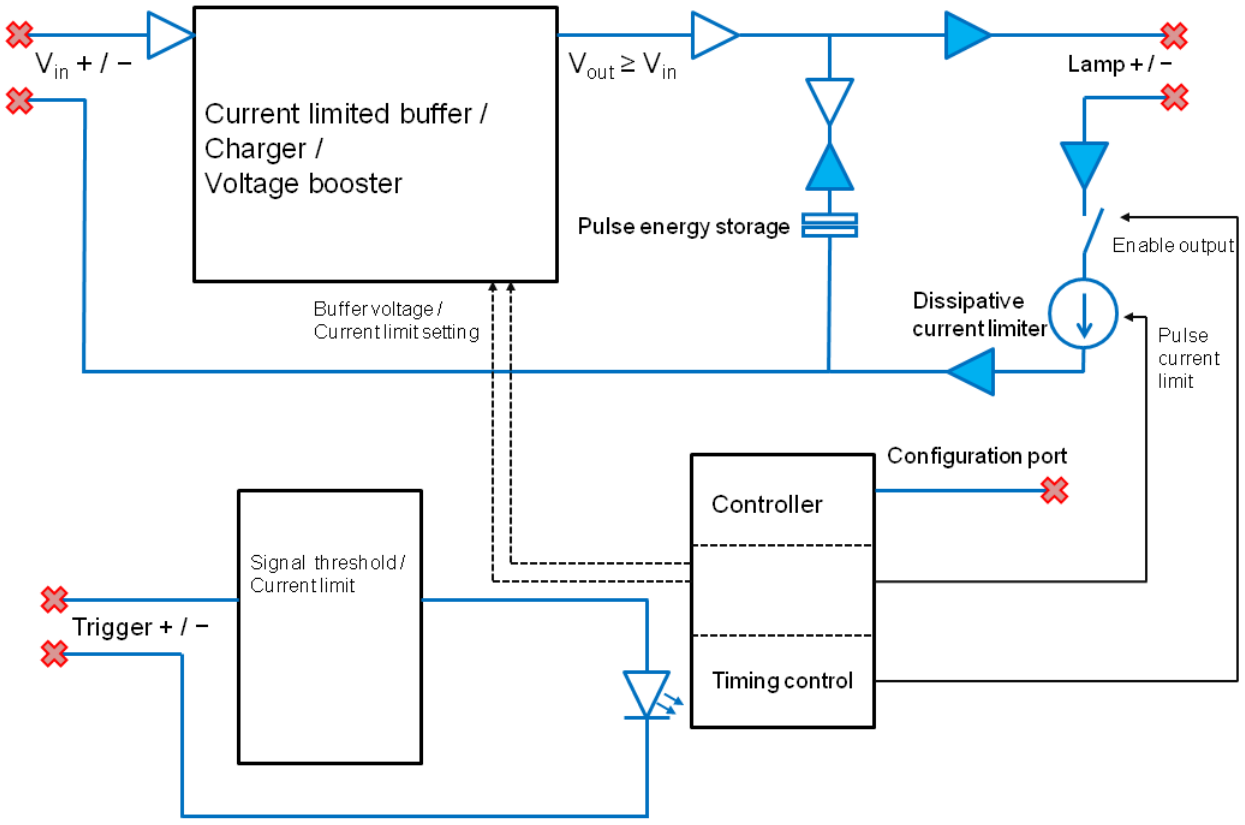


Figure 2: Functional overview

Pulsing principle

The driver sends current pulses to the LED from a buffer. The buffer can therefore deliver more output current than its own input current. Because the buffer is drained during the pulse it has to recharge during the “LED off-time”. At the end of the pulse the buffer voltage has therefore dropped a certain amount.

In order for the device to function properly, the minimum buffer voltage must be equal to the voltage the LED requires plus the voltage lost during the pulse ($V_{buffer} = V_{lamp} + V_{drop}$).

The pulse current limiter (see *Figure 2: Functional overview* on page 7) regulates the lamp current to a set limit during the flash. The pulse current limiter is a fast linear regulator that converts the voltage difference between the buffer voltage and the required lamp voltage into heat. The greater the voltage difference between the buffer and the LED’s required voltage, the more heat the pulse current limiter dissipates. The user must keep track of the heat dissipation.

> If the pulse frequency is around 20 Hz or higher and the LED current is around 5 A or higher the user must always calculate if the heat dissipation is within safe limits. Never exceed the maximum Pulse driver dissipation (see *Electrical specifications* on page 28).

The pulse current limiter is not suitable for use in continuous mode.

Pulse energy storage

The buffer allows for pulse currents up to 12.5 A to be supplied to the lamp while drawing a considerably lower current from the Power + terminal.

Buffer charger / voltage booster

The buffer charger is used to recharge the energy storage at a controlled rate. It is also able to generate voltages up to 45 V.

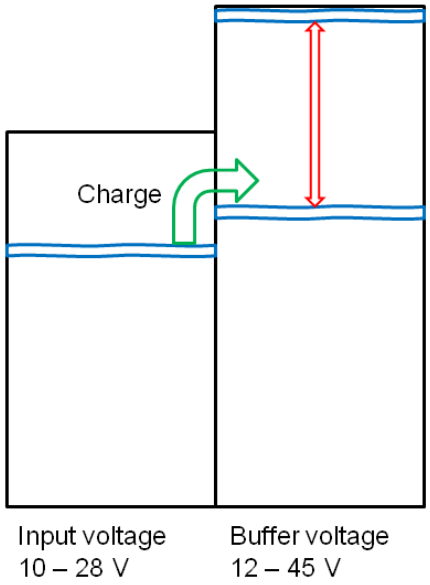


Figure 3: buffer principle

The buffer voltage can never be lower than the input (supply) voltage. So when the Buffer voltage is set at 12V while the Input (supply) voltage is 24V, the Buffer voltage will become 24V and not 12V!

The input current limiter only works when the Buffer voltage is higher than the Input (supply) voltage.

Controller

The device is intended to be used fully autonomously. The controller is used to set the operating values of the internal components and to control the lamp output switch (including timing).

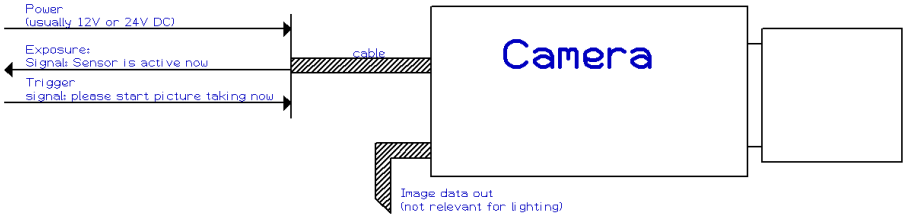
The configuration port (USB) is used to apply settings before the device is used. It is not intended as an “always on” connection.

Enable input

The digital enable input works at all signal levels from LVTTL to 24 V. It requires at least 5 mA to detect an “on-level”. The pulse mode provides multiple options.

2.2 Camera Interface Connectors

Most cameras are equipped with two interface connectors.



1. Data cable to send images to the computer (not relevant for lightning).
2. Power/IO cable. This cable supplies power and trigger signals to the camera and receives exposure signals from the camera.

Synchronization works as follows:

Trigger

An external trigger signal starts the recording of the camera. The image recording is thus synchronized with the pulse.

> A typical use case is an external signal that indicates that the object that has to be photographed, is in the correct position. For example, the moment the product interrupts the beam of a light barrier, or a signal from a PLC showing that a container is in position.

Exposure

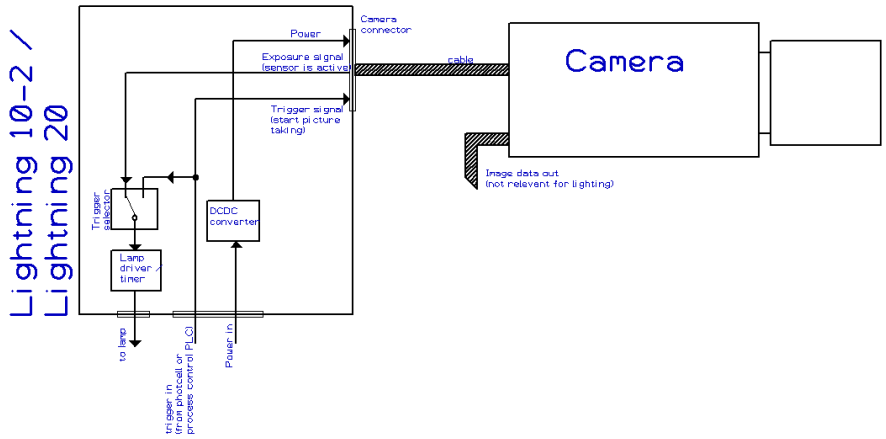
After a delay (propagation delay), the camera gives a signal that the sensor is active (exposure). The exposure signal of the camera is thus used as a trigger to light the lamp.

> A typical use case is the exposure signal triggering the Lamp.

Example of the **Trigger** and **Exposure** signals:

2.3 Camera Interface Block schematics

Block schematics describe how the LED lamp driver uses the Power/IO cable of the camera.



Power: The power supplying the LED lamp driver (usually 24V) is supplied at **Power in** and routed to the power of the camera. Depending on the type of camera, the power is sent unconverted, or it is converted by the **DCDC converter** to 12V.

Trigger: The trigger signal offered by the photocell or PLC at **Trigger in** will be directed to the camera's **trigger in**.

Exposure: The **exposure** signal of the camera is used by the LED lamp driver as a trigger for the flash. This signal is available through the **Lamp driver/timer** driver at **to lamp**.

> Alternatively, the **trigger in** signal may be used to trigger the lamp directly. The advantage is that, in some cases, a cable to the camera is not needed. However, the advantage of the situation described above, is that the camera can also trigger the lamp without receiving an external trigger signal. This occurs when the camera shows live (continuously) video, or if it is triggered via the data cable.

The choice between triggering from trigger in or exposure is made by the trigger selector. In the setup software, this control is set with the **trigger from** menu, where you can choose between **enable input** and **CAM exposure**. See *Configuration tool* on page 21 for more information.

2.4 Pulse mode (overdrive mode)

Pulse mode is designed for when the used lamp current is actually higher than the rated continuous current. This gives extra brightness during camera exposure, but it also introduces the risk of overheating the lamp.

Therefore the average power to the lamp has to be kept within specified ratings.

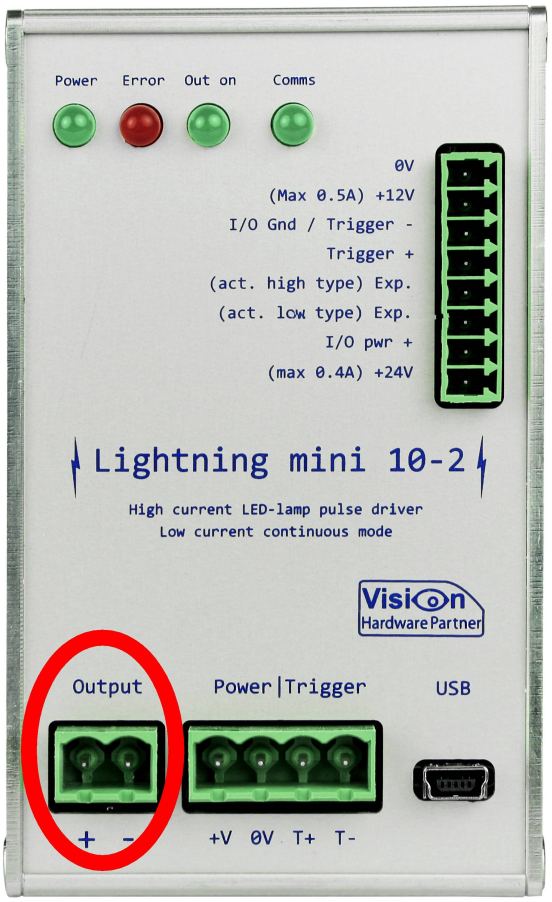
To achieve this in pulse mode the lamp on-time is limited to a set value. After the lamp is switched off the controller will not allow the lamp to be switched on for a set time. This time is referred to as the “cool down time”. Not only the lamps safety relies on this cool down time. It is also used to recharge the energy storage buffer to the set level, and to let the pulse current limiter cool down.

3 Getting started

3.1 Connecting the device

3.1.1 Lamp output connector

Connect the LED-lamp to connector J2 (Output)



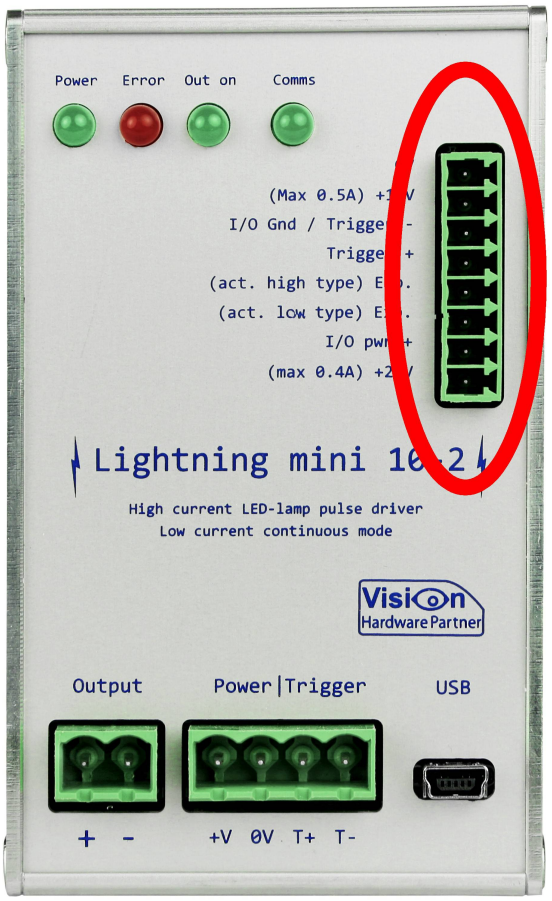
Pin	Function
1	Lamp +
2	Lamp -

Do not connect the LED-lamp to any other terminal!

Connecting the lamp to 0V will bypass the current regulation and damage the lamp and possible the driver!

3.1.2 Camera connector

Connect the camera to connector J3.



Pin	Name	Function
1	0V	0 V for powering the camera
2	+12V	+12 V for powering the camera
3	Trigger -	Connect to the camera's I/O GND
4	Trigger +	Trigger signal to the camera. The trigger signal received on J1 will be forwarded to this pin.
5	Exp. (act. high type)	If the camera has an active high (PNP) exposure output then connect this pin to the camera's exposure output and leave pin 6 unconnected.
6	Exp. (act. low type)	If the camera has an active low (NPN) exposure output then connect this pin to the camera's exposure output and leave pin 5 unconnected.
7	I/O pwr +	Connect to the cameras I/O pwr. If the camera has an active low (NPN) outputs it might not have this connection. In that case it can be left open.

Pin	Name	Function
8	+24V	+24 V for powering the camera.

Refer to the camera's user manual for the proper wiring of your camera. Most cameras will take either 12 V or 24 V power. Check first before connecting it.

3.1.3 Power | Trigger connector

Connector J1 is used to connect the supply power and the trigger signal input.

Pin	Function
1	Power +V
2	Power 0V
3	Trigger T+
4	Trigger T-

Power input

The power input features both reverse polarity and overvoltage protection. However, activating one of these protections results in blowing a fuse. Replacing the fuse requires opening the housing.

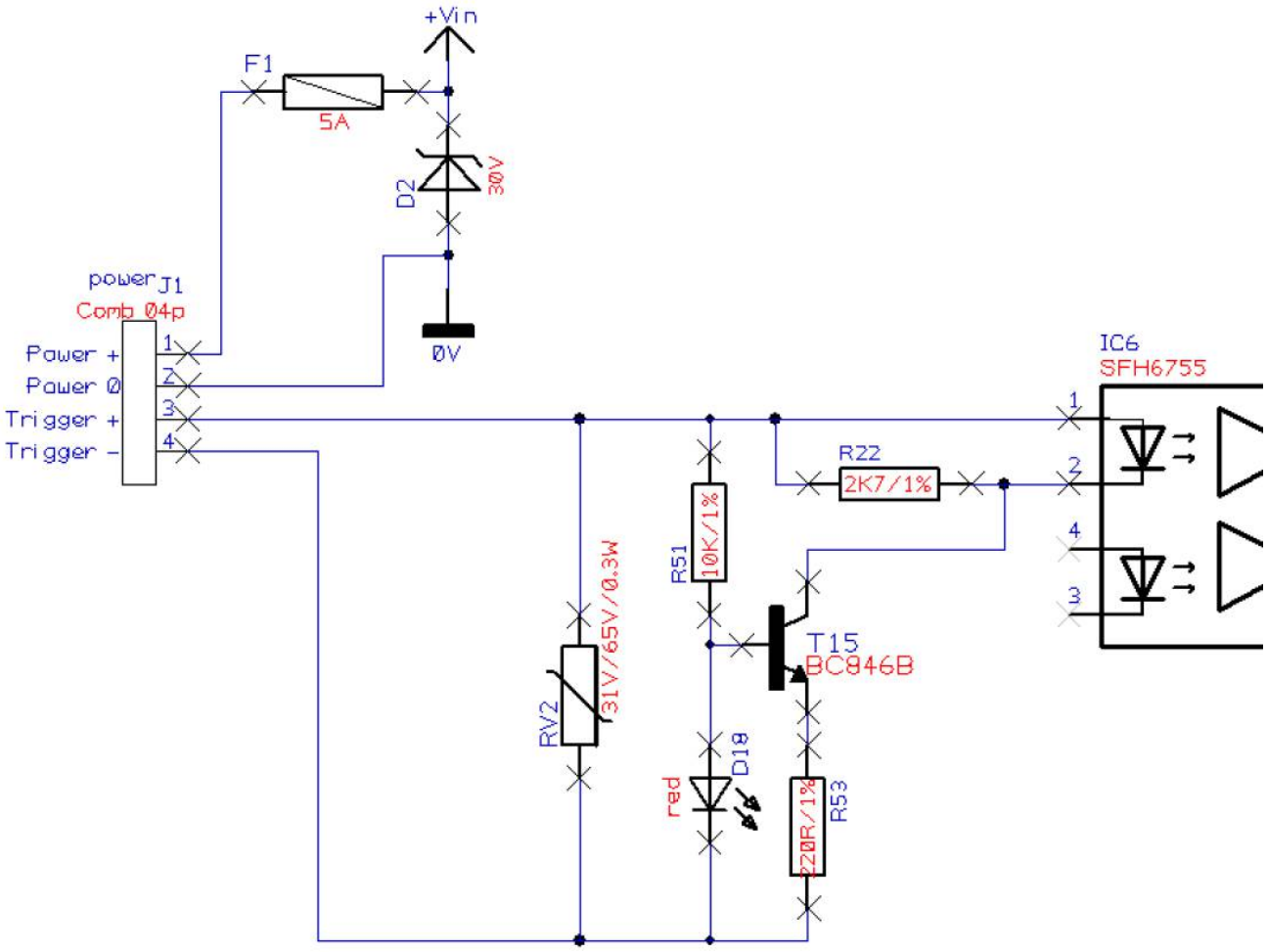
Trigger input

The trigger input has galvanic separation. Both terminals need to be connected .

The input is compatible with both 5 V TTL and 24 V I/O standards.

The signal threshold is approximately 2.5 V at a current consumption of 5 mA.

This means that any voltage higher than 2.5 V will generate a logic high.

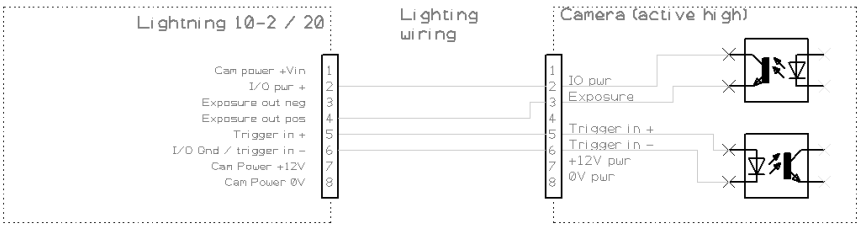


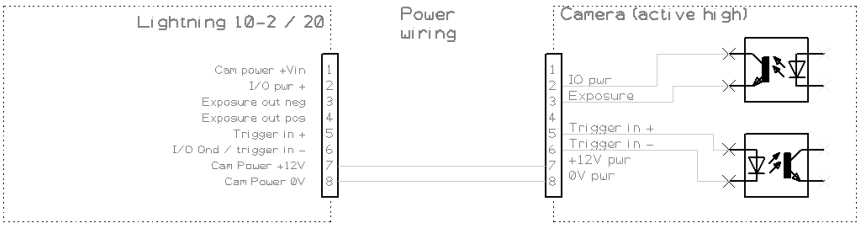
3.1.4 Connecting the Camera Interface Connector

The interface connector is designed to work with a wide range of brands and types of camera. Generally, camera manufacturers design their own interface.

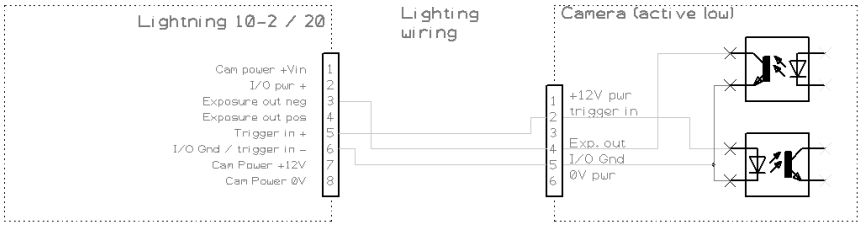
Roughly, there are two classes: active high and active low. These are electrically different.

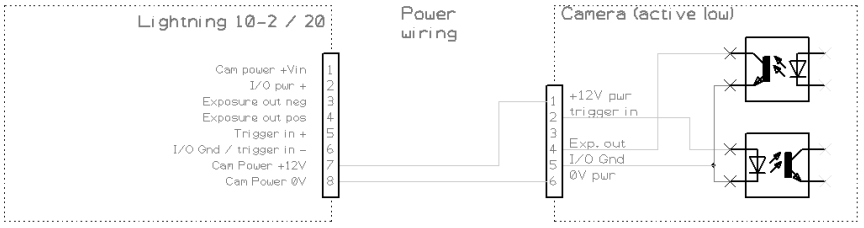
Camera interface pin-out handling **Active High** signals:





Camera interface pin-out handling **Active Low** signals:





If you are not sure how to connect your camera, please contact Vision Hardware Partner. We will provide instructions and add the information to the manual.

3.2 Indicators

The Lightning mini 10-2 is equipped with four LED indicators.

Indicator	Function
Power	Indicates that power is supplied correctly.
Error	Indicates a system error. This can either be an overheat condition, or a hardware failure.
Out on	Indicates that a lamp pulse cycle is active (lamp on, or in cool down).
Comms	Lights when data is received through the configuration port.

4 Configuring Lightning mini 10-2

4.1 Adjusting settings

Settings can be adjusted over the configuration port (USB).

> The configuration port is a standard USB port which does not provide for extra industrial ruggedness like galvanic separation or additional transient protection. Therefore it is highly recommended to only connect the cable while applying the settings. As the Lightning mini 10-2 is a stand-alone unit which can function fully independently of the USB port the cable only needs to be connected during configuration. In case that the USB connection is used permanently, it is highly recommended to keep the cable as short as possible.

Configuration changes can be made using the Lighting Config software.

4.2 Possible settings

Both a maximum current and a maximum voltage can be set. The power supply limits the supplied energy according to the first reached maximum.

- In case the maximum voltage is reached first, the setting for current will not be reached.
- In case the current limit is reached first, the set voltage will not be reached.

4.3 Output voltage considerations

When the supply is used for driving LEDs it will be in current mode.

The pulse buffer will be charged up to the set voltage. During the pulse the buffer will discharge and the voltage will drop.

Higher buffer voltages mean more stored energy, so the pulse can be sustained for longer.

They might also mean higher dissipation while pulsing.

If the maximum current is set correctly, the setting for maximum voltage will never lead to damage to the LEDs.

4.3.1 Lamp considerations

The lamp is regulated by the current. The voltage is a means to reach the right amount of current.

> The lamp can be damaged by setting the current to a wrong value.

> The lamp cannot be damaged by setting the voltage to a wrong value.

By setting the buffer voltage to a value that is too low, it is possible that the set current will not be reached. The driver is thus set out of its working range.

4.3.2 Driver considerations

Setting the voltage to a value that is too low, the set current will not be reached.

Setting the voltage to a value that is too high, the driver will become too hot.

The buffer voltage must not be set too low and neither too high.

There is a certain margin between too high and too low.

4.3.3 Lower limit buffer voltage

The minimum value of the buffer voltage is determined by a combination of several factors.

1. The lamp’s requirements (depends on the type of lamp used and the set current).
2. Voltage drop due to the buffer’s emptying during the pulse (depends on the pulse duration and the set current).
3. Internal system loss (set to a fixed value of 2 V).

4.4 User types

Lightning 10-2 is a generic pulse current supply which can be configured to drive both smaller and larger lamps. Not all lamps will be able to handle the amount of power that can be supplied by Lightning mini 10-2. Therefore it is of great importance that the device is only configured by users with in-depth knowledge of the connected lamp’s limits.

It is assumed that the Lightning mini 10-2's power supply must also be able to be operated by persons without detailed knowledge of electronics and / or pulsing LEDs.

To make sure that the non-expert users will not damage the lamp or the device, settings are divided into two user groups: **end users** and **expert users**.

End users will be able to change the lamp's brightness without the risk of damaging the LEDs. Experts can do all necessary settings, including the ones that will do damage when made improperly.

User type	Permissions
End users	Are allowed to changed all parameters marked with "user: all".
Expert users	Are allowed to set all parameters. This means experts must have proper knowledge and understanding of the ratings of the connected hardware. They can set the limits for voltage and currents in such a way that end users can safely control their set of parameters.

None of the settings are password protected. It is the user's responsibility to use the settings wisely. Do not make any changes without reading the manual on that particular item.

4.5 Setting parameters

Parameters can be set by sending the following command over the configuration port:

setvar <parameter name> <value><enter>

Example:

setvar vout_mv 10000<enter>

will set the buffer voltage to 10 V (= 10,000 mV).

Parameters which are out of range will not be accepted. When possible the nearest acceptable value will be assumed instead.

The command

print<enter>

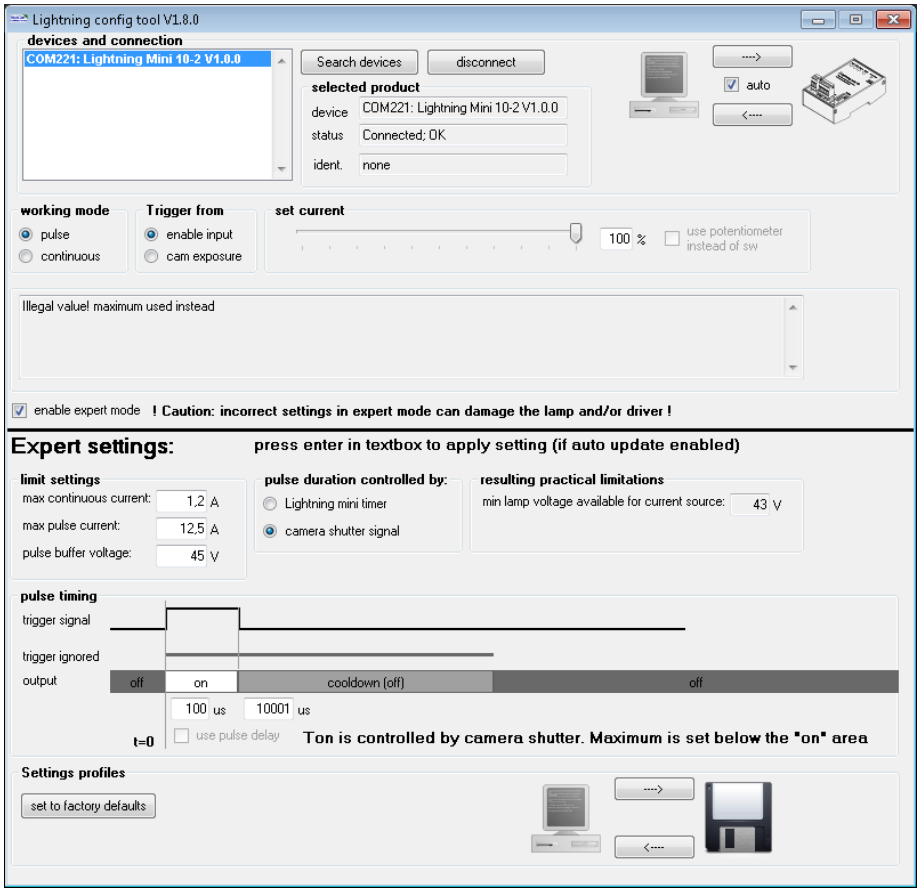
will print a list of all settings and their values.

4.5.1 Configuration tool

The configuration tool is used to make specific settings for devices. These settings can then be written to various devices. Also settings of a device can be read into the configuration tool.

The upper part of the menu represents the End user menu.

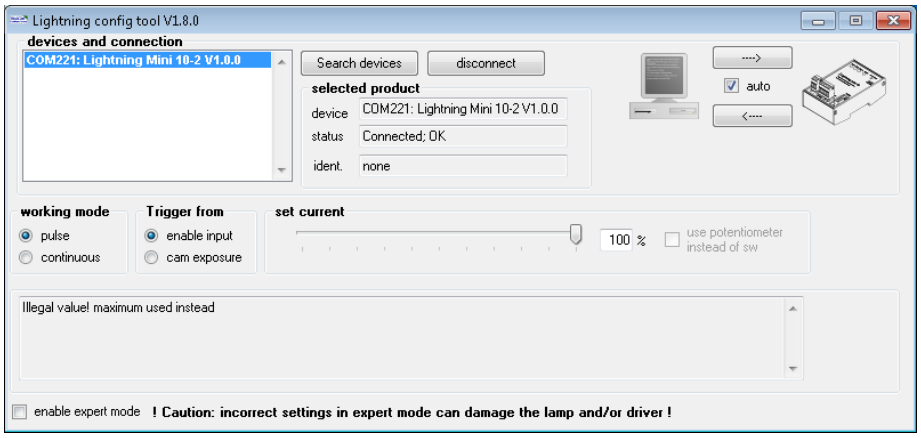
The lower part of the menu represents the Expert menu.



Expert settings are only visible when the check box **enable expert mode** is checked.

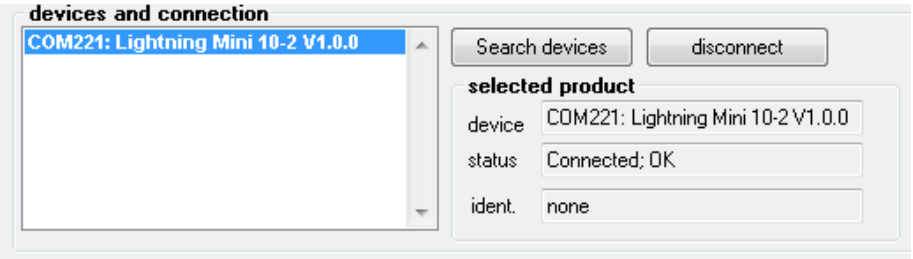
4.5.1.1 Configuration tool for end users

End users are only allowed to change a limited set of "safe" parameters.



devices and connection

The **devices and connection** menu is used to select devices and connect/disconnect them.



Devices are listed in the left box. To connect to a device, highlight it in the menu and press the **connect** button.

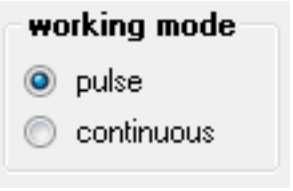
To disconnect, highlight the device and press the **disconnect** button.

Detailed information about the device is shown under **selected product**. This shows the device name, status and identity. When a new device is connected, it will not appear in the list until the **search device** button is pressed.

> If a device is removed, it will remain in the list until the **search device** button is pressed.

working mode

The working mode of the lamp can be in this menu.



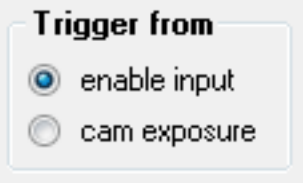
pulse: the lamp will light when the input trigger signal is present. The lamp will light at high intensity. The lamp stays on as long as the trigger signal is present, but goes out when the maximum light time is exceeded, preventing damage to the lamp.

continuous: the lamp will light Continuously when the input trigger signal is present. The lamp will light at low intensity. The lamp stays on as long as the trigger signal is present.

> Some devices, like the mini 10-2, do not have a continuous mode. The **continuous** option cannot be selected (grayed out)!

trigger from

The source of the trigger signal can be set in this menu.

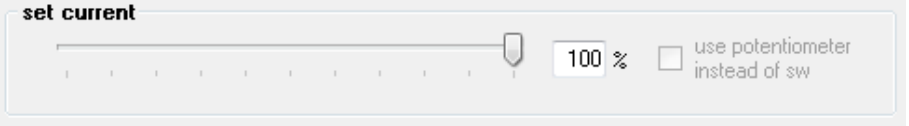


cam exposure: the device is triggered by a pulse signal from a camera. Camera trigger signal is connected to pin 3 and 4 on connector J3.

enable input: the device is triggered from an external source like a photocell. An external trigger signal is connected to pin 3 and 4 on connector J1.

set current

The relative current to the lamp is set here.



A percentage of the maximum current can be set here. A higher percentage means a brighter lamp. This setting applies to pulse and continuous mode.

> The maximum current for pulse and continuous mode can be set in the "expert menu".

save and read settings

Settings made in the configuration tool can be saved to the device or read from the device.

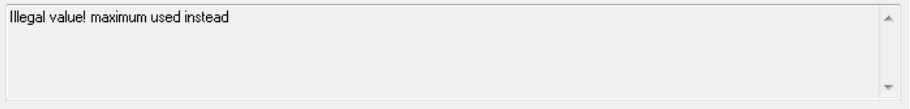
Any settings made in the configuration tool, can be written to the device using the **---->** button.

When the auto check box is enabled, all settings that are made in the configuration tool are automatically saved to the device. Value boxes are synchronised when the cursor leaves the value box, or when enter is Pressed. Selection buttons are synchronised instantly. The **---->** is not needed to save settings.

Use the **<----** button to read settings from the device into the configuration tool.

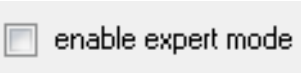
Message display

Error messages are displayed here.



This display shows when a incorrect value is entered somewhere in the configuration tool.

Expert mode

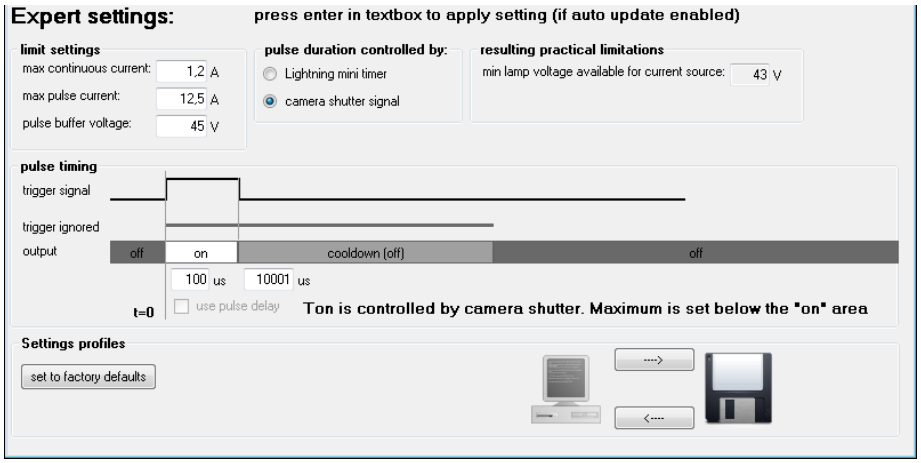


By enabling the **enable expert mode** check box; the parameters for expert users are shown.

> Incorrect settings in the expert mode can damage the lamp and/or the driver!

4.5.1.2 Configuration tool for expert users

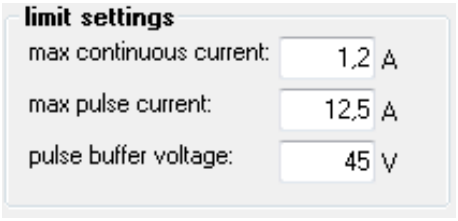
Expert users can set all parameters, such as the maximum pulse current and the maximum pulse buffer voltage.



Incorrect settings in the expert mode can damage the lamp and/or the driver!

limit settings

The maximum voltage and current can be set for the lamp.



max continuous current: set the maximum current for the lamp when **working mode** is set to continuous.

max pulse current: set the maximum current for the lamp when **working mode** is set to pulse.

pulse buffer voltage: set the maximum charge voltage for the buffer capacitor.

pulse duration controller

Lightning mini timer: the built in timer controls when and how long the lamp is lit. This allows the lamp to light with a certain delay. As soon as the shutter signal rises from low the high (rising edge) the Lightning min timer takes over and controls the lamp.

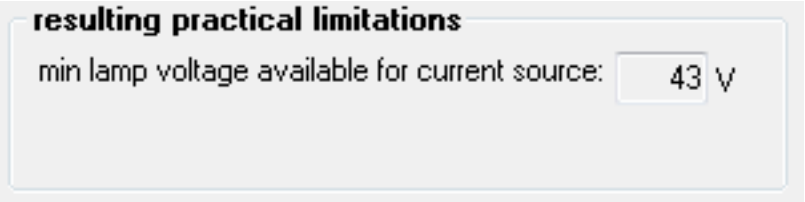
this mode needs to be chosen when:

1. The camera gives an exposure/strobe signal of fixed length (not related to the actual shutter duration)
2. The camera has no strobe output and the Lighting controller is triggered by the same signal that goes to the camera to trigger image acquisition.

camera shutter signal: the shutter signal of the camera controls how long the lamp is lit. When this time exceeds the maximum on time of the lamp (set in the menu below), the lamp goes out.

resulting practical limitations

This menu shows the minimum lamp voltage available for the current source. This is calculated as a function of the settings for buffer voltage, pulse current and pulse duration.



pulse timing

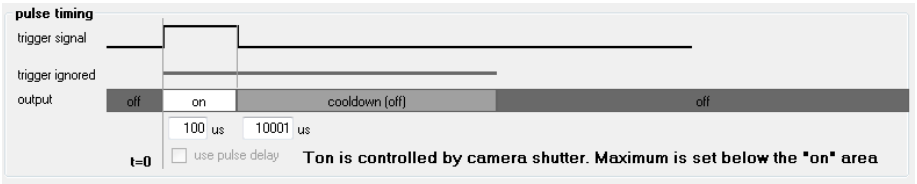
The figures below show several examples of how to set the pulse timing.

1. Pulse duration is controlled by the **camera shutter signal**

   The lamp on time equals the duration of the trigger signal. The rising edge of the trigger starts the pulse cycle. The lowering of the trigger signal stops the pulse cycle. If the maximum on time is reached first, the lamp switches off.

   Set the duration for **on** and **cooldown (off)** of the lamp.

   The check box **use pulse delay** is unavailable (grayed out)



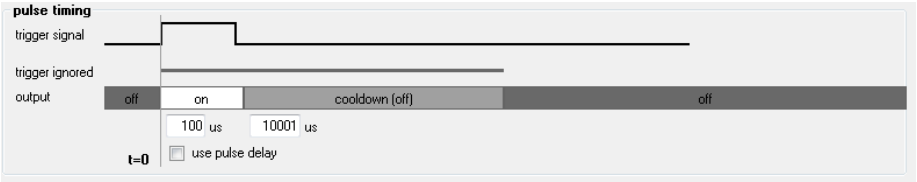
2. Pulse duration is controlled by the **Lightning mini timer**:

   The lamp on time equals the set on-time. It has no relation to the duration of the trigger signal. The rising edge of the trigger starts the pulse cycle. The rest is determined by the timer settings. When the user enables 'pulse delay' the lamp will switch on the set no of us after the rising edge of the trigger signal

   a. **Pulse delay disabled:**

      The duration for **on** and **cooldown (off)** are set.

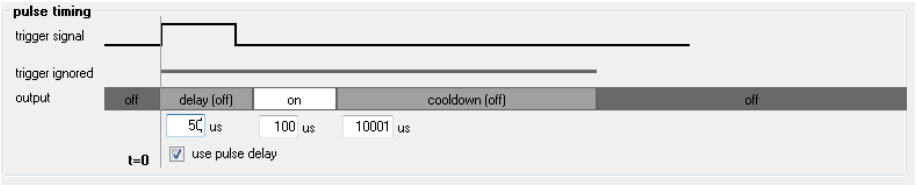
      The check box **use pulse delay** is unchecked.



b. Pulse delay enabled:

The duration for **delay (off)**, **on** and **cooldown (off)** are set.

The check box **use pulse delay** is checked.



Saving and loading configurations

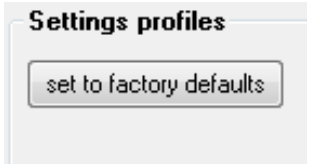
Settings can be saved to the computer for later reference or adaptation.

Press the **---->** to save settings.

Press the **<----** to load/open settings.

For both actions, a dialogue screen appears asking where to save the settings to or load the settings from.

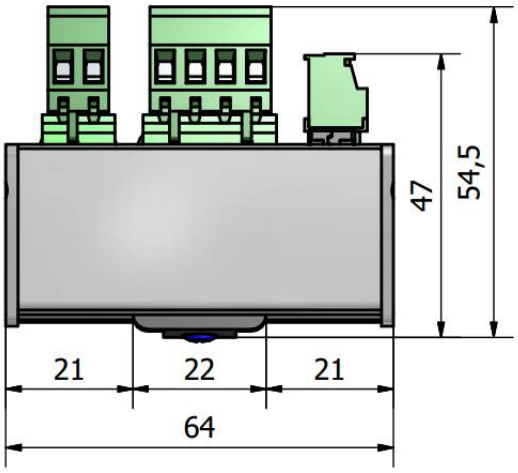
Restore default settings

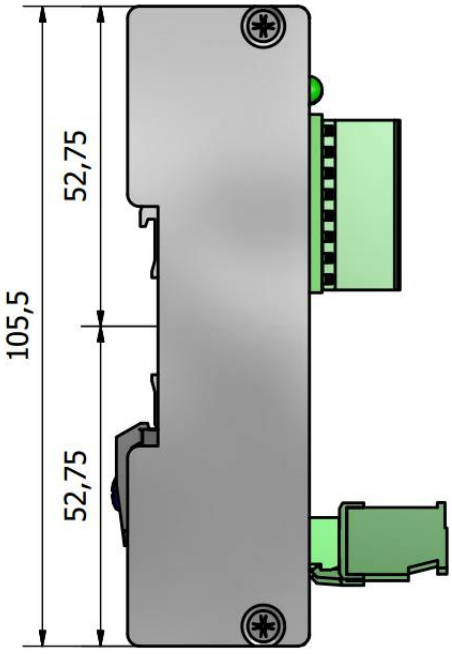


Press the **set to factory default** button to reset the device to its factory default settings.

5 Specifications

5.1 Dimensions





All dimensions are in mm.

5.2 Electrical specifications

Item	Minimum	Typical	Maximum
Supply voltage	10 V	12 - 24 V	28 V
Enable input voltage	3.0 V	- - -	30 V
Enable signal high threshold	2.0 V	3.0 V	4.0 V

Item	Minimum	Typical	Maximum
Enable high input current	- - -	8 mA	11 mA
Pulse driver dissipation *)	- - -	2 W (recommended)	3 W (absolute maximum)

*) The recommend pulse driver power dissipation is 2 W. The absolute maximum pulse driver power dissipation is 3 W. Exceeding this value will damage the device.

5.3 Timing

Item	Minimum	Typical	Maximum
Response time enable signal *)	- - -	- - -	10 µs
Current stable (pulse mode)	- - -	- - -	3 µs

*) Set pulse must be > 100 mA.

5.4 Range / resolution

Item	Minimum	Maximum	Resolution
Output voltage range	12 V	45 V	0.01 V
Pulse mode output current	0 A	12.5 A	0.02 A
Pre-pulse delay time	0 µs	30,000 µs	1 µs
Pulse duration time	10 µs	10,000 µs	1 µs
cool down duration time	100 µs	30,000 µs	20 µs

5.5 Operating temperature range

Item	Minimum	Typical	Maximum
Operating temperature range	0 °C	- - -	45 °C

6 Appendices

6.1 Calculations

6.1.1 Pulse driver dissipation

The driver dissipation is calculated with the following formula:

$$P_d = (V_{out} - 0.2 * I_{set} - V_{lamp}) * I_{set} * T_{pulse} * F_{pulse}$$

In which

Symbol	Meaning
P_d	The dissipated power in Watts
V_{out}	The set buffer voltage in Volts (VOUT_MV / 1000)
I_{set}	The output current set in Amperes (IOUT_MAX_PULSE_MA / 1000)
V_{lamp}	The estimated lamp voltage at the set current in Volts
T_{pulse}	The pulse duration set in Seconds (PULSE_DURATION_US / 1000000)
F_{pulse}	The maximum pulse frequency in Hz

> The values T_{pulse} and F_{pulse} have a large influence on the dissipated power.

The formula can be simplified in order to do a quick check if the dissipation is in a dangerous region.

> The recommend pulse driver power dissipation is 2 W. The absolute maximum pulse driver power dissipation is 3 W. Exceeding this value will damage the device.

$$P_d = V_{out} * I_{set} * I_{set} * T_{pulse} * F_{pulse}$$

This formula assumes that the lamp voltage = 0 V. If P_d is OK according to this formula, ratings will never be exceeded. If it is not you can still use the first formula to check if the more realistic model checks out OK.

6.1.2 Voltage drop due to buffer drain

As mentioned before, the high pulse current is achieved by using a power buffer. The buffer will drain during the pulse. Due to this the useful pulse duration and current are limited. The device will calculate the expected voltage drop when applying settings and notify the user.

> This is an estimated voltage drop. It is recommend to make sure that the minimum pulse voltage is at least 2 V higher than the required minimum lamp voltage.

$V_{drop} = 0.2 * I_{set} + (I_{set} * T_{pulse}) / 990$

In which

Symbol	Meaning
V_{drop}	The voltage drop over a single pulse
I_{set}	The output current set in Amperes (IOUT_MAX_PULSE_MA / 1000)
T_{pulse}	The pulse duration set in microseconds (PULSE_DURATION_US)

In order to keep the output current regulated the output voltage must be set to a value which includes both the buffer voltage drop and the lamp voltage. The formula for meeting this condition is:

$V_{out} \geq V_{drop} + V_{lamp}$

Symbol	Meaning
V_{out}	The output voltage that needs to be set in order to remain within regulation
V_{drop}	The voltage drop over a single pulse as calculated above
V_{lamp}	The estimated lamp voltage at the set current

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