(Image for illustrative purposes only)

User manual

Lightning 20

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Foreword / disclaimer

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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.

You can do this by sending a e-mail to feedback@VisionHardwarePartner.nl.

Thanks in advance.

1 About Lightning 20

Lightning 20 is a versatile power supply designed to pulse-drive LED-lamps at currents up to 20A and voltages up to 55V

The current pulses are supplied from an internal charge buffer, which is recharged at a lower current. Because of his the Lightning 20 can supply pulse currents up to 20A, while drawing no more than 4A supply current.

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

1.1 Functional overview

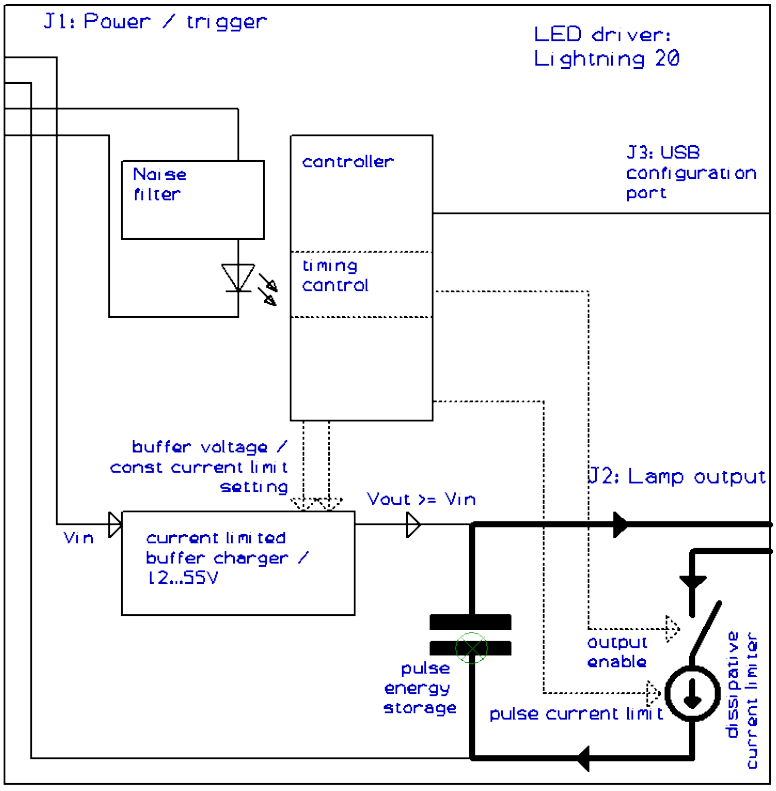


Figure 1: Simplified functional diagram

Pulse current limiter:
The pulse current limiter (shown at the lower right corner of figure 1) regulates the lamp current to a set limit during the the flash. The pulse current limiter is a fast linear regulator where the voltage difference between the buffer voltage and the required lamp voltage, is converted to heat.

Pulse energy storage:
The lamp is powered from a local energy buffer. This buffer allows for pulse currents up to 20A to be supplied to the lamp while drawing a considerably lower current from the supply power.

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 55V

Controller:
The controller is used to control the lamp output switch (including timing) and to set the operating values to the internal components.
The controller is designed to function fully autonomously. The USB port can be used to apply settings before the device

is used. It is not intended to be an “always on” connection.

Enable input:
The digital enable input works at all signal levels from LVTTL to 24V. It requires at least 5mA to detect an “on-level”.
In continuous mode the enable works as a direct switch input. If the enable is set to on, the lamp is also set to on.
In pulse mode there are multiple options.

1.2 About pulse mode

Pulse mode is designed for when the used lamp current is actually higher than its 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 the ratings.

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

2 Getting started

Figure 2: Connectors and indicators

2.1 Connecting the device

2.1.1 Connector J1: Power | Trigger

This connector connects both the supply power and the trigger signal input.

Pin	Name	description
1	Power +	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.
2	Power 0V	
3	Trigger+	The trigger input has galvanic separation. Both terminals need to be connected . The input is compatible with 3.3V/5V TTL and 24V I/O standards. The signal threshold is approximately 2.5V at a current consumption of 5mA. This means that any voltage higher than 2.5V will generate a logic high, provided that the current is at least 5mA At 24V the current draw will be no more than 8mA.
4	Trigger-	

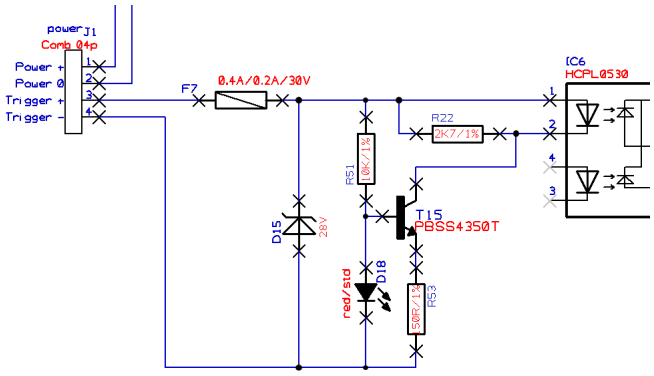


Figure 3: Trigger input circuit

2.1.2 Connector J2: lamp output

Pin	Name	description
1	Lamp+	Connect the LED-lamp + and – terminals here. ***Do not connect the LED-lamp to any of the terminals of J1!***
2	Lamp-	

2.1.3 Connector J3: USB

Connector for configuring the device through USB.

2.1.4 Connector J4: Camera interface

This connector can be used to connect to the power/interface cable of many types of cameras.

It will provide power to the camera as well as trigger signals

Pin	Name	description
1	Power 0V	0V for powering the camera
2	Power +12V	+12V for powering the camera
3	I/O GND / Trigger -	Connect to the cameras I/O GND
4	Trigger +	Trigger signal to the camera. The trigger signal received on J1 will be forwarded to this pin
5	Exposure act. High	If the camera has an active high (PNP) exposure output then connect this pin to the camera's exposure output and leave J4 pin 6 unconnected
6	Exposure act. low	If the camera has an active low (NPN) exposure output then connect this pin to the camera's exposure output and leave J4 pin 5 unconnected
7	I/O power +	Connect to the cameras I/O pwr. If the camera has active low (NPN) outputs it might not have this connection. In that case it can be left open.
8	Power +24V	+24V for powering the camera. Most camera's will take either 12V or 24V power. Check first before connecting it.

2.2 Indicators

Ind.	Name	description
I1	Error	Indicates a system error. This can either be an overheat condition, or a hardware failure.
I2	Comms	Lights when data is received through USB
I3	Out on	Indicates that the lamp is currently switched on (or in cool down)
I4	Trig from cam	Indicates that the device will (only) pulse on triggers received through the camera I/O connector. If the LED is off it the trigger input on J1 will be used
I5	Power	Indicates that power supply is present
I6	USB OK	Indicates that the USB port is connected and the drivers are installed OK

3 Configuring Lightning 20

3.1 connecting the device

Settings can be adjusted over a USB connection.

> **!! Important !!**
>
> *The configuration port is a standard USB port which does not provide for extra industrial ruggedness like galvanical separation or additional transient protection. Therefore it is highly recommended to only connect the cable while applying the settings. As the Lightning 20 is a stand alone unit which can function fully independently of the USB port the cable only needs to be connected during communication.*
> *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.

3.2 Setting the buffer voltage

The buffer voltage setting will never lead to damage to the LEDs. For the LEDs only the set current and duration are relevant. However, there are other reasons for correctly setting the buffer voltage.

The current regulation in pulse mode is done completely by a linear current regulator. The driver will convert the difference between the buffer voltage and the needed lamp voltage to heat. Because of this it makes sense to adjust the buffer voltage to the requirements of the connected lamp. This is especially important when pulsing at (relatively) long durations / high frequencies.

The minimum buffer voltage is determined by the lamp pulse voltage (depends on the number of LEDs in series and the set pulse current) and the buffer voltage drop during the pulse. The buffer voltage will drop a certain amount as the buffer drains.
Please note: If the buffer voltage will fall below the required lamp voltage, the set current will not be achieved.

During the pulse, the buffer will discharge and the voltage will drop. The total voltage drop depends on the pulse current and its duration. Higher buffer voltage mean more stored energy, so the pulse can be sustained for longer. It also means higher dissipation while pulsing. This in turn may overheat the device. To limit the dissipation there is a maximum to the buffer voltage.

For the maximum voltage it is important to take into account the driver power dissipation. For reliable operation over the whole temperature range it is recommended to limit the dissipation to a maximum of 3W.

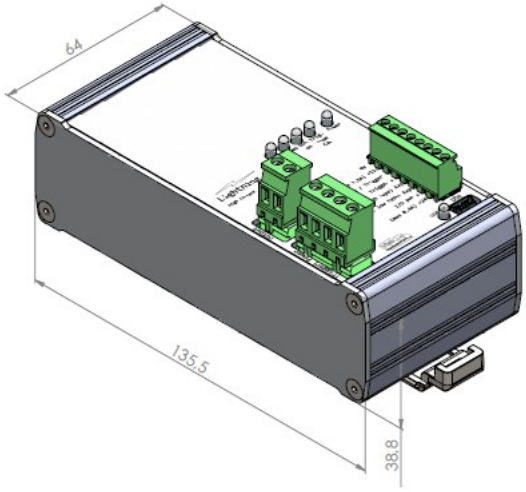
Appendix A provides the necessary formulas for calculating the buffer voltage drop during pulsing and the pulse driver power dissipation.

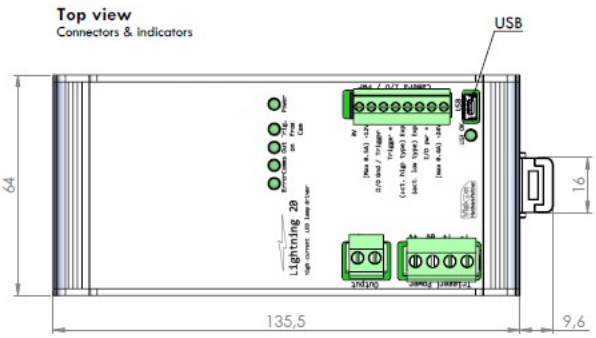
Lightning 20's firmware will also give an estimation of the voltage which will be available to the lamp at the end of the pulse. The method used for this is explained in appendix A.
Whenever the user changes a pulse setting, the unit will report the calculated available voltage like shown below.

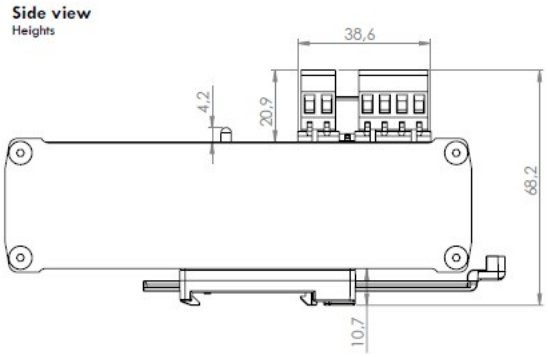
min pulse voltage will be: 25.5

4 Specifications

4.1 Dimensions







4.2 Electrical characteristics

Item	min	typ	max	unit
Supply voltage	20	24	28	V
Trigger, exposure input voltage	3.0		30	V
Enable signal high treshold	2.0	3.0	4.0	V
enable high input current		8	11	mA
Pulse driver dissipation (absolute max)			5	W
Pulse driver dissipation (recommended)		3		W

4.3 Timing

Item	min	typ	max	unit
Response time enable signal*			10	µS
Current stable (pulse mode)			3	µS

set pulse current needs to be > 100mA

4.4 Range / resolution

Item	min	max	res	unit
Output voltage range	12	55	0.05	V
Pulse mode output current	0	20		A
Pre pulse delay	0	30000	1	µS
Pulse duration	10	10000	1	µS
Cooldown duration	100	30000	20	µS

4.5

Item	min	max		unit
operating temperature	0	45		ºC

5 Appendix A: calculations

5.1 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:

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

Note that 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:

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

This formula assumes lamp voltage = 0V. 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.

5.2 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.

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

$V_{drop} = 0.2*I_{set} + (I_{set} * T_{pulse}) / 6600$

In which:

V_{drop}	is the voltage drop over a single pulse
I_{set}	is the output current set in amperes (IOUT_MAX_PULSE_MA / 1000)
T_{pulse}	is 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:

$V_{out} >= V_{drop} + V_{lamp}$

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