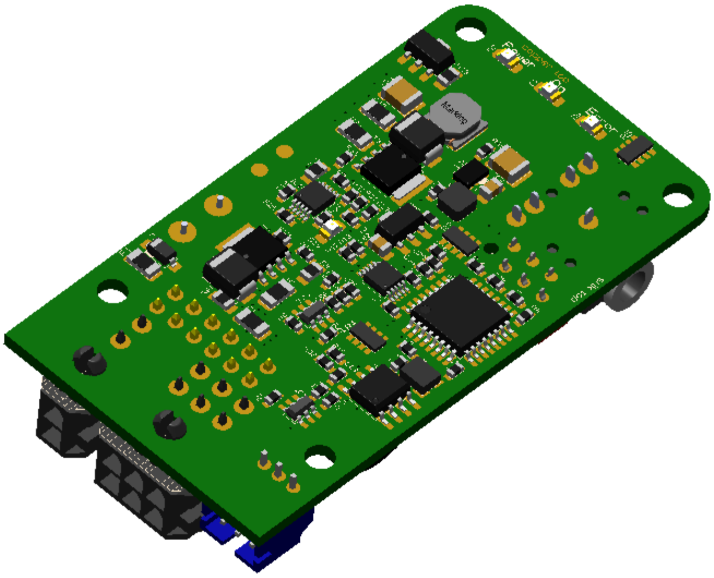
# User manual



# Lightning OEM10-3

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|---|---|
| Product no: | 10440904 |
| Versions: | V1.0 |
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| Product no: | 10440904 |
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## Foreword / disclaimer

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.

In the interest of progress, Vision Hardware Partner reserves the right to perform technical changes

without further notice.

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.



## 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.

# About Lightning OEM 10-3

Lightning OEM 10-3 is a low-cost power supply designed to pulse-drive LED-lamps at currents up to 10A.

The current pulses are supplied from an internal charge buffer, which is recharged at a lower current. Because of his the Lightning OEM 10-3 can supply pulse currents up to 10A, while typically drawing no more than 0,5A supply current. The buffer charger can also boost the buffer voltage up to 55V

This OEM version is designed specifically for easy integration with a custom made LED lamp. The driver is configured by setting a number of digital.

## *About pulsing*

Pulsing LEDs is a good solution to avoid heat problems. If the pulse is short enough, and sufficient time is provided for the lamp to cool down, the lamp can be pulsed at currents higher than rated for continuous use. Even if the lamp would run at its rated current a heatsink might be necessary, which can be omitted when in pulse mode. The basic assumption with pulse mode is that the average power to the lamp (average over on-time and off-time) does not exceed the rated power for continuous mode.

To assert this assumption the lamp on-time is limited to a configurable value, after which the lamp is disabled for a certain configurable duration ( the so called cooldown time). During the cooldown time the controller will not allow the lamp to be switched on. Any incoming trigger during the cooldown cycle will be ignored.

Not only the lamps safety relies on this safety mechanism. It is also used to recharge the energy storage to the set level, and to let the pulse current limiter cool down.

## *Functional overview*

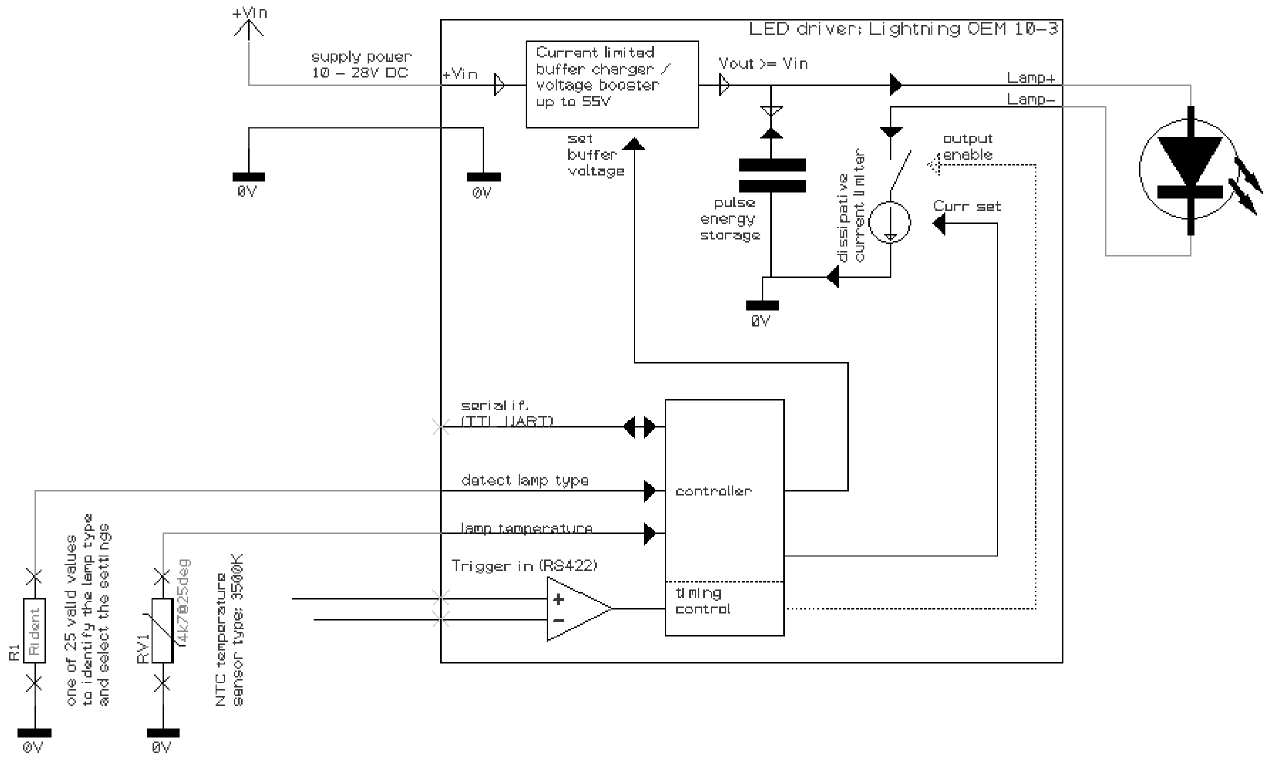



*Figure 1: Block diagram*

**Controller:**
The controller is used to set all operating values like the duration of the pulse and the cooldown time, the pulse current, buffer voltage etc. These are set by selecting settings profiles, which are defined through the serial interface.

**Lamp type detection:**
Each connected lamp must have a resistor that will be used to identify the type of lamp connected. 25 different types can be recognized. Each type has its own profile of settings that can be automatically activated when connecting the lamp.

**Lamp temperature sensor:**
Connect an MTC temperature sensor here to monitor the lamps temperature. If the lamp temperature exceeds a set limit the driver will be disabled and an error will be signalled. If the lamp does not have a temperature sensor a fixed 4.7k resistor can be connected instead.

**Serial interface:**
The user can connect to the serial interface using the USB to UART conversion cable (to be ordered separately).
Using this interface the different settings profiles can be defined. Also the limiting values for the lamp temperature can be set.

**Pulse current limiter:**
The pulse current limiter (shown at the upper right corner of figure 1) regulates the lamp current to a set limit during the the pulse. The limiter is a fast linear regulator in which the voltage difference between the buffer voltage and the required lamp voltage, is converted to heat.
The pulse current limiter is not suitable for use in continuous mode.

**Pulse energy storage:**
The lamp is powered from a local energy buffer. This buffer allows for pulse currents up to 10A to be supplied to the

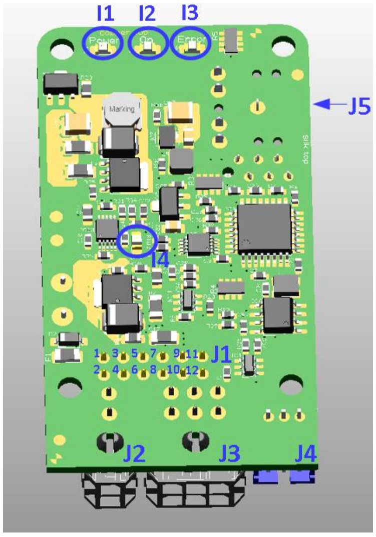
lamp while drawing a considerably lower current from the Power + terminal.

**Buffer charger:**
The buffer charger is used to recharge the energy storage at a controlled rate. It is also able to boost the input voltage to voltages up to 55 V.

**Trigger input:**
The digital trigger input works with the RS-422 differential signal standard.

# Getting started

## Connecting the device





The lightning OEM 10-3 is designed for being used in 2 different scenarios.

1. **As an add on module to the lamp**. In that case all operational signals are wired through connector J1
2. **As a separate driver**. In that case the driver is supplied with power (J2) and a trigger signal (J4) and connected to the lamp using J3.

An in between scenario is also possible. For example, the lamp can be connected to the driver using J1 while the driver gets power and trigger through J2 and J4.

## Add on (all in one connector) J1

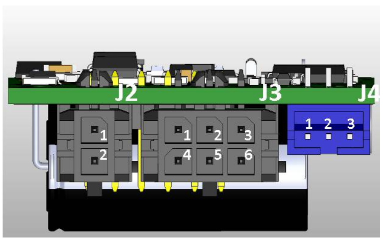
| J1: All in one connector | | |
|---|---|---|
| **Pin** | **Function** | **description** |
| 1 | Power +V | Connect to supply power. |
| 2 | Power 0V | |
| 3,4 | Lamp + | Connect to the lamp.<br><br>*!!! Important note !!!*<br>*Lamp + does **not** equal Power +.*<br>*Lamp – does **not** equal Power 0V*<br>*Connect the lamp **only to the designated pins***<br><br>10A is high current. Use wide PCB traces wires with a matching cross section and keep them short to minimize voltage drops over the wires. |
| 5,6 | Lamp - | |
| 7 | Lamp ident | Connect a resistor with a correct value for the desired profile. See table 1 for possible values. Connect between this pin and the signal 0V |
| 8 | Signal 0V | Reference 0V for the lamp-ident, lamp temperature and trigger input. |

| J1: All in one connector | | |
|---|---|---|
| 9 | Lamp temperature | Connect and NTC resistor (see specifications for value) between this pin and signal 0V for sensing the lamp temperature. |
| 10 | Trigger - | Trigger signal.<br><br>The trigger input is designed for differential signals. For best noise immunity connect through a twisted pair cable with a characteristic impedance of 120R.<br><br>If there the OEM10-3 is connected to the end of the cable (likely setup if there is only one unit connected) then the line must be terminated. This can be done by shorting pin 11 to pin 12. |
| 12 | Trigger+ | |
| 11 | Trigger termination. | |

| Profile no | Resistor value | | Profile no | Resistor value |
|---|---|---|---|---|
| 0* | > 100K | | 13 | 5,6K |
| 1 | 100K | | 14 | 4,7K |
| 2 | 56K | | 15 | 3,9K |
| 3 | 39K | | 16 | 3,3K |
| 4 | 27K | | 17 | 2,7K |
| 5 | 22K | | 18 | 2,2K |
| 6 | 18K | | 19 | 1,8K |
| 7 | 15K | | 20 | 1,5K |
| 8 | 12K | | 21 | 1K |
| 9 | 10K | | 22 | 680R |
| 10 | 8,2K | | 23 | 390R |
| 11 | 6,8K | | 24 | 180R |
| 12 | 6,2K | | 25 | < 180R |

*** Profile 0 is detected when no resistor is connected. In this case it is assumed that no lamp is connected. This profile is therefore invalid.**

## *External connectors J2, J3, J4*




*Connectors and their pinout*

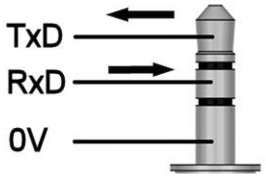
All of the signals on these connectors are also available on the all in one connector J1. For all the additional information please also read the above section about this connector.

| J2: Power | |
|---|---|
| **Pin** | **Function** |
| 1 | Power +V |
| 2 | Power 0V |

| J3: Lamp | |
|---|---|
| **Pin** | **Function** |
| 1 | Lamp + |
| 2 | Lamp ident |
| 3 | Temperature sensor |
| 4 | Lamp - |
| 5 | 0V |
| 6 | 0V |

| J4: trigger | |
|---|---|
| **Pin** | **Function** |
| 1 | Trigger+ |
| 2 | Trigger- |
| 3 | 0V |

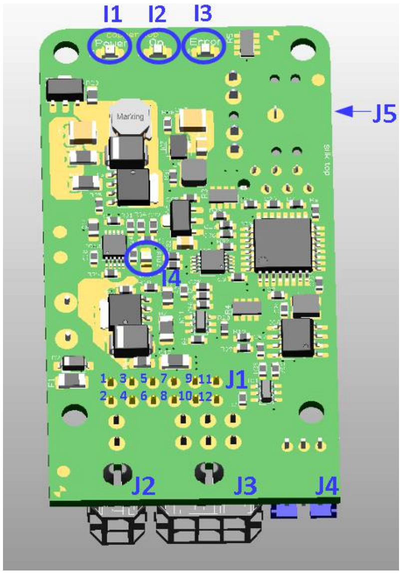
### *Communication connector J5*




The communications connector interfaces directly to the microcontroller. It is intended for configuring the device before in a production environment before it is installed. Voltage levels are 0-5V. There is no industrial grade port protection.

Using FTDIs TTL-232R-5V-AJ interface cable the unit can be directly connected to a USB2 port. The interface is also compatible to the TTL-232R-3V3-AJ cable.

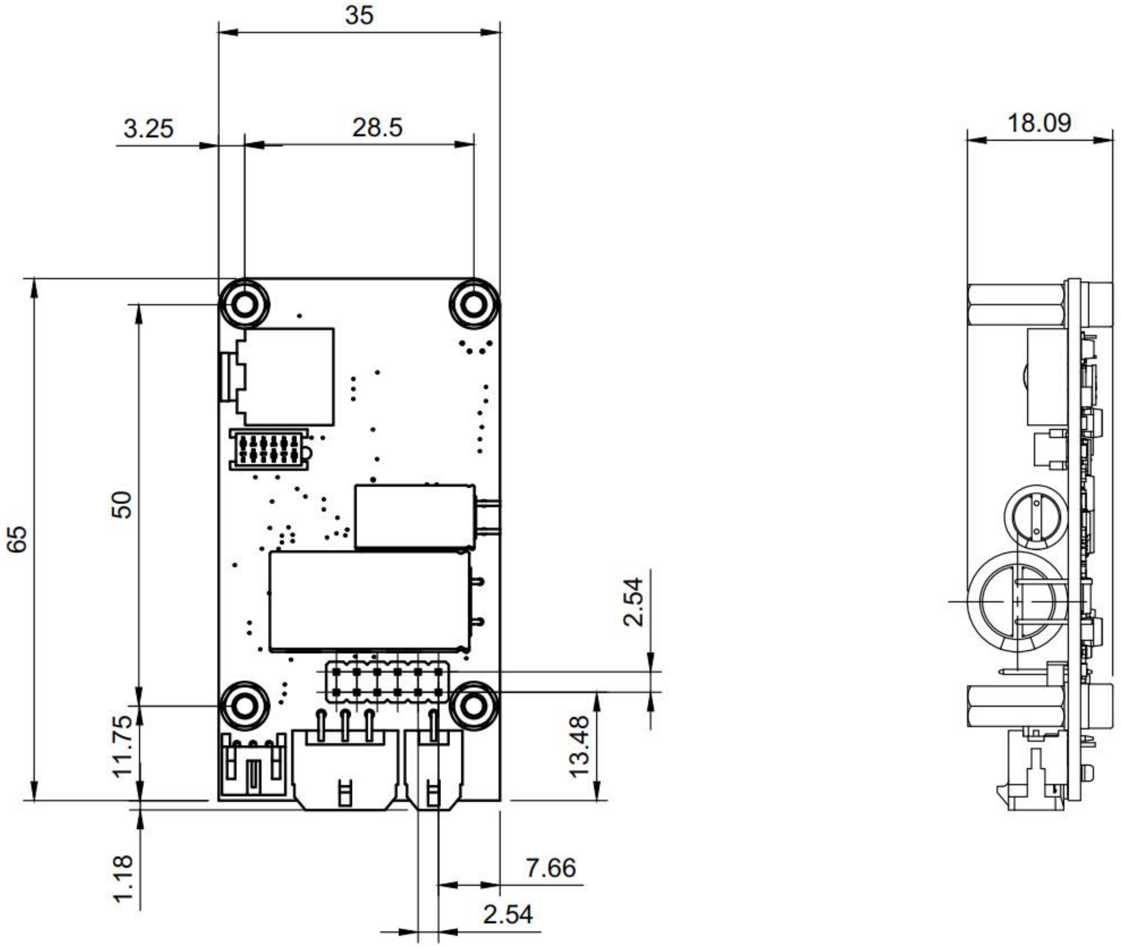
### *Indicators*




| indicator | Function | description |
|---|---|---|
| I1 | Power OK | Lights when power is applied |
| I2 | Pulse | Lights when a trigger is received and a pulse cycle is active. When the LED is on any incoming triggers will be ignored. |
| I3 | Error | Lights in case of an error. In that case the communication cable can be connected to see when error is reported. |
| I4 | Buffer voltage error | Lights when the buffer voltage exceeds the set value. This would usually happen if the set buffer voltage is lower than the supply voltage. Or in rare cases when the buffer charger malfunctions. |

# Specifications

## *Dimensions*



## *Electrical characteristics*

| Item | min | typ | max | unit |
|---|---|---|---|---|
| Supply voltage | 10 | 24 | 28 | V |
| Pulse driver dissipation (absolute max) | | | 1* | W |
| Pulse driver dissipation (recommended) | | 0,75* | | W |

*** Please read Appenix A for the details on power dissipation.**

## *Timing*

| Item | min | typ | max | unit |
|---|---|---|---|---|
| Response time enable signal* | | | 10 | µS |
| Current stable | | | 2 | µS |

set pulse current needs to be > 100mA

## *Range / resolution*

| Item | min | max | res | unit |
|---|---|---|---|---|
| Pulse mode output current | 0 | 10 | 0.01 | A |
| Pulse duration | 10 | 1000 | 1 | µS |
| Cooldown duration | 10 | 40 | 10 | mS |
| Buffer voltage | 12 | 55 | 0.008 | V |

## *Temperature*

| Item | min | typ | max | unit |
|---|---|---|---|---|
| operating temperature fully functional | 0 | | 45 | ºC |
| operating temperature with derated driver power | 0 | | 80* | ºC |

The driver will automatically be disabled if the sensor temperature next to the driver exceeds 80ºC

# Appendix A: heat dissipation

### context

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.
The heat is dissipated by airflow around the driver. As the driver is rather small the heatsinking capability is limited.
The ratings assume an environment temperature of maximally 45ºC and free air flow around the driver.

The heatsinking can be improved by mechanically connecting the driver to the housing of the users product, or a larger heatsink. In the following situations additional heatsinking might be required:

- When there is no free air flow around the driver
- When the environment temperature might exceed 45ºC
- When the average power in the driver exceeds 1W.

***Note: Vision Hardware Partner will only commit to the specifications in this manual. The user can contact us for advice and we will help him best as we can, but without any warranty on any use exceeding the herewith provided specifications***

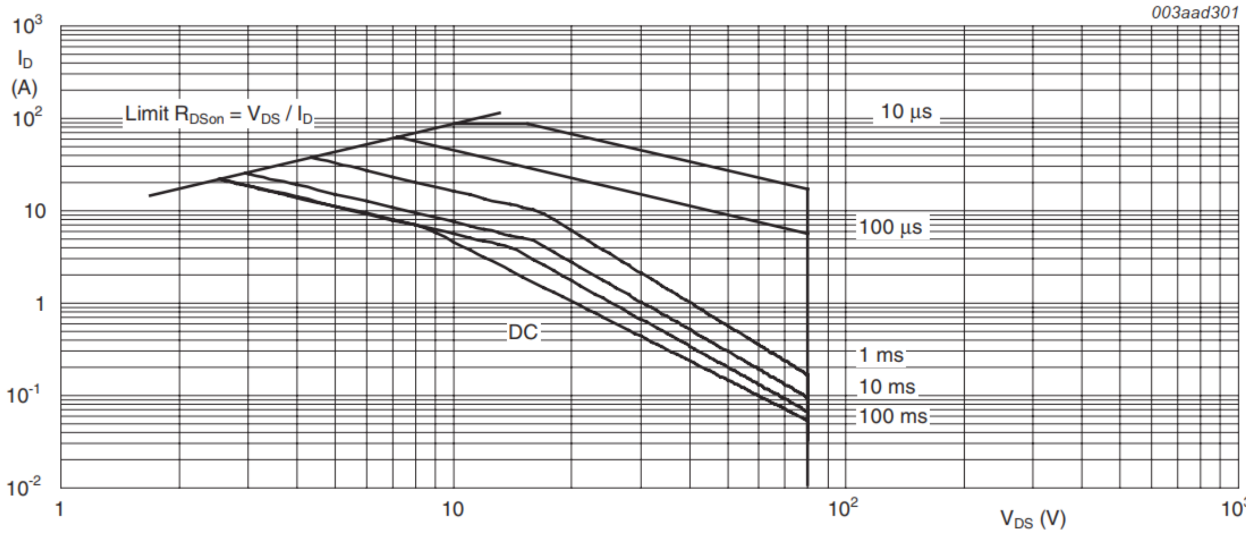
### Pulse driver dissipation

It is essential to keep the power dissipation in the driver within safe limits. If the generated heat exceeds the devices cooling capacity the driver will overheat, resulting in damage to the device.
There is 2 things to take into account.

1. the maximum heat energy per pulse
2. the maximum average power dissipated

The smallest of both limits must not be exceeded.

**energy per pulse**
The energy per pulse is the product of the voltage over the driver, the pulse current and the pulse duration. The voltage over the driver is the buffer voltage - the voltage needed by the lamp.




The above graph shows which combinations of voltage, current and duration are safe. Each line shows a limit for the given pulse duration. The chosen values needs to be below the line.

**Average driver dissipation**
As a rule of thumb pulsing at frequencies <= 10Hz and pulse durations of <= 500uS is generally safe. When exceeding one of these limits it is important to calculate the drivers average dissipation and make sure that it is within the limit

The momentary power dissipated in the driver equals the driver voltage * the set current. Where driver voltage = buffer voltage – output voltage.

The output voltage will equal the lamp pulse voltage (depends on the number of LEDs in series and the set pulse current).

The buffer voltage will drop during the pulse 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.*

The average driver dissipation is calculated with the following simplified formula:

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

In which:
$P_d$ is the average dissipated power in Watts
$V_{buf}$ is the buffer voltage in Volts at the start of the pulse
$I_{set}$ is the output current set in Amperes
$V_{lamp}$ is the estimated lamp voltage at the set current in Volts
$T_{pulse}$ is the pulse duration set in Seconds
$F_{pulse}$ is the maximum pulse frequency in Hz

This formula assumes that the buffer voltage will be the same during the whole pulse. This is a pessimistic (safe) approach. If the result of this formula is a safe value then these are guaranteed safe settings.

Note that the values $T_{pulse}$ and $F_{pulse}$ have a large influence on the dissipated power.

If the resulting value is near the maximum the below mentioned more accurate formula can be calculated to check if it is still on the safe side.

$P_d = (V_{buf} - 0.5*V_{drop} – 0.1*I_{set} – V_{lamp}) * I_{set} * T_{pulse} * F_{pulse}$

In which:
$V_{drop}$ is the buffer voltage drop during the pulse (explained later)

## 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.

***Note: the below mentioned values are an estimated voltage drop. It is recommend to make settings such that the minimum pulse voltage is at least 2V higher than the required minimum lamp voltage.***

$V_{drop} = 0.1*I_{set} + (I_{set} * T_{pulse}) / 470$

In which:

$V_{drop}$ is the voltage drop during a single pulse
$I_{set}$ is the output current set in amperes
$T_{pulse}$ is the pulse duration set in Microseconds (µS)

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 |