Warning!
Risk of exposure of hazardous laser radiation
in combination with laser light emitting devices!

Content

General Description

The **L**ow **P**ower **D**river LDP-2023 is a linear current source with excellent properties for driving low power laser diodes with arbitrary current wave forms. Waveforms can be

- CW current
- pulsed current
- modulated or mixed current

with frequencies up to 50 kHz (square wave) or 165 kHz (sine wave, -3dB).

The maximum diode current is 2 A.

LDP-2023 has a short rise and fall time, no overshot and no ripple.

It has two dedicated control inputs:

- analog modulation input
- digital enable / trigger input for fast and clean pulses

There is one potentiometer built in for current set point or BIAS current adjustment. The settings of the potentiometer and the modulation input are both internally combined and added to the final current set point.

LDP-2023 is small and compact and can be operated without heatsink up to a power dissipation of 3.8W; with a heatsink up to a power dissipation of 15.6 W.

LDP-2023 works with just one DC supply voltage.

The user has to make sure that the maximum power dissipation will not be exceeded!

Power Dissipation

LDP-2023 can be operated **without heatsink** until a limit of the power dissipation P_D of **P_{Dmax} = 3.8 W.**
Larger power dissipation values can be handled, if an appropriate heat sink is used. LDP-2023 can be operated **with heatsink** until a limit of the power dissipation P_D of **P_{Dmax} = 15.6 W.**

For a safe operation of the LDP-2023 the power dissipation P_D must be considered according to the following descriptions and calculations.

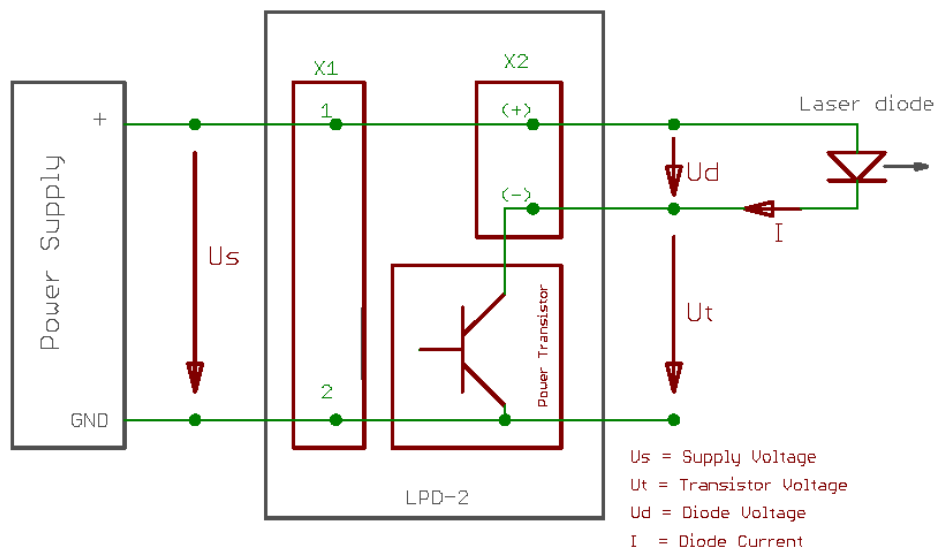Fig. 1: Block diagram – Power Dissipation P_D

U_s Supply Voltage (V)
U_d Diode Voltage (V)
I   Diode Current (A)
tp   Pulse Duration (s)
f   Pulse Frequency (Hz)
D   Duty Cycle, D = tp x f
P_D Power Dissipation (W)

For operating with CW current:
$P_D = (U_S - U_d) \times I$

For pulse frequencies >1000 Hz and pulse width <500µs the power dissipation P_D is for operating with rectangle current:

$P_D = (U_S - U_d) \times I \times D = (Us - Ud) \times I \times tp \times f$

For operating with sinusoidal current:

$P_D = (U_S - U_d) \times I \times 0{,}5$

1. CW Operation without heatsink

The maximum power dissipation without heatsink is $P_{Dmax} = 3.8$ W

This leads to the following equation: $I = 3.8 / (U_s - U_d)$

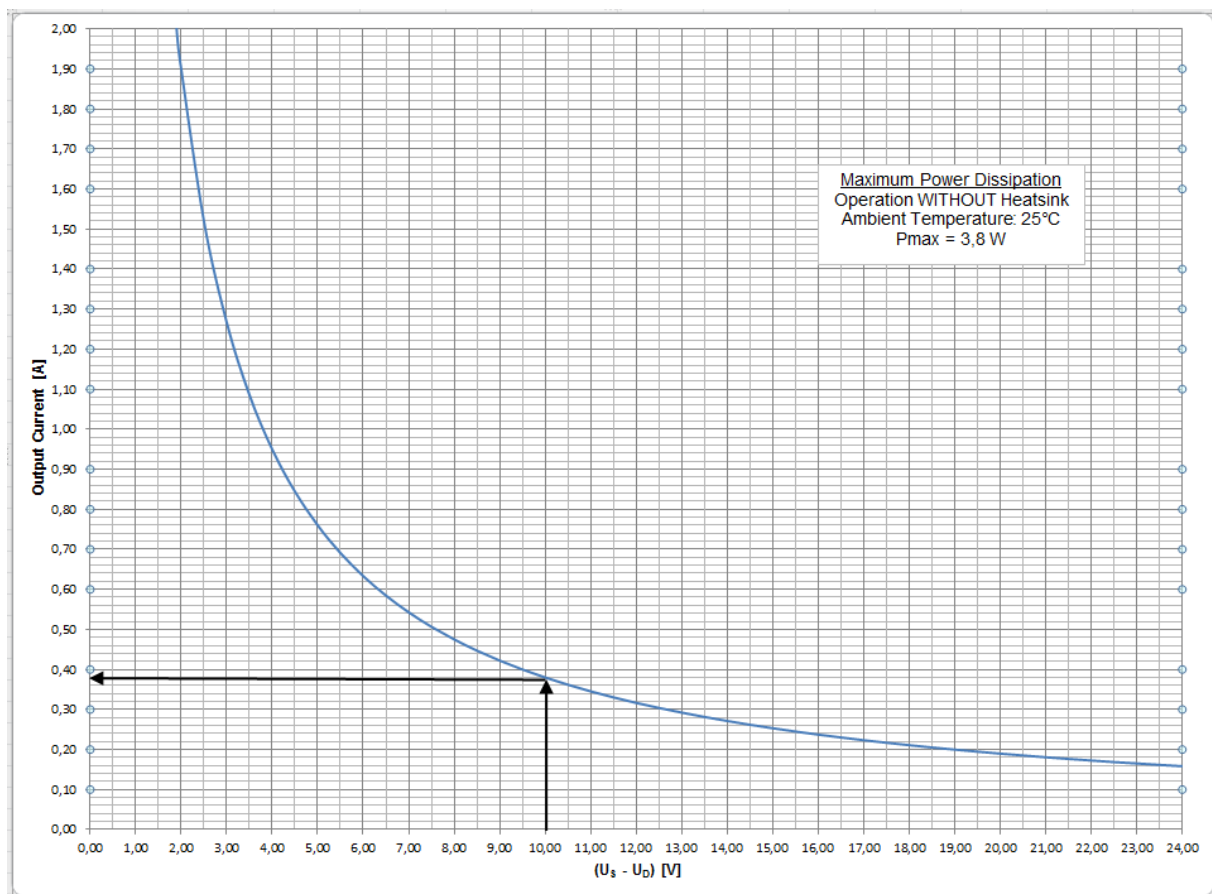This relationship is shown in the following diagram, figure 2.

Fig. 2: maximum power dissipation, CW operation – no heatsink

Example:
Supply Voltage: 12 V
Laser Diode Voltage: 2 V

What is the maximum diode current, operating in CW without heatsink?
It follows from above: U_s - U_d = 12 V – 2 V = 10 V

In the diagram figure 2 start at 10 V and go up vertically to the power-hyperbola.
From the point of intersection go on horizontally to the left.
On the y-axis you get a current of 0.38 A.
This is the maximum CW current **without** heatsink.

Vice versa the maximum allowed voltage difference can be calculated:
- The laser diode can be operated with 1 A, when U_s - U_d is less than 3.8 V.
- The laser diode can be operated with 2 A, when U_s - U_d is less than 1.9 V.

2. Pulsed Operation without heatsink

When LDP-2023 is driven with square wave pulse-signals, the maximum power dissipation is also dependent from the duty cycle of the control signal. The lower the duty cycle the lower is the generated power dissipation. This is valid for a pulse frequency >1000 Hz and a pulse width <500µs.

The duty cycle is defined as $D = t_p \times f$
t_p: pulse duration
f: frequency

The maximum power dissipation $P_{Dmax\text{-}puls}$ in pulsed operation is:
$P_{Dmax\text{-}puls} = P_{Dmax\text{-}CW}$ / D

The duty cycle has an inversely proportional impact on the power dissipation. If, for example, the duty cycle is 0.5 (50%), the maximum acceptable power dissipation will be doubled.

In the following diagram (figure 3) the conditions are presented under various duty cycles D without heatsink.
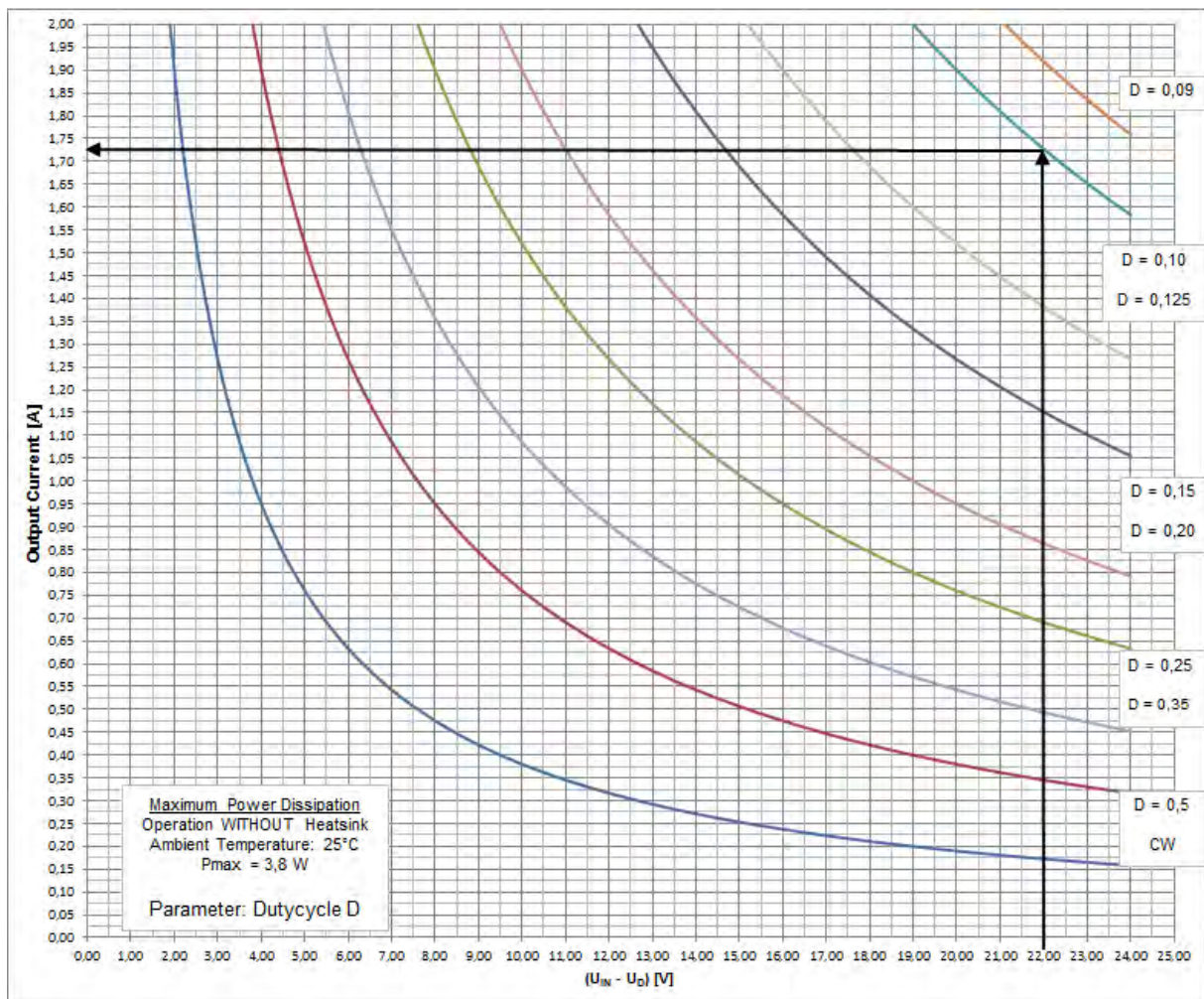
Fig. 3: maximum power dissipation, parameter D – no heatsink

Example:

A laser diode has to be operated at 5 kHz and a pulse width of 20 µs. The supply voltage of LDP-2023 is 24 V, the voltage of the diode is 2 V.

What is the maximum output current, when the LDP-2023 is operated without heatsink?

It follows from above: $U_s - U_d$ = 24 V – 2 V = 22 V

Calculate duty cycle: D = tp x f = 20 µs x 5 kHz = 0.1 (10%)

In the diagram start at 22 V (x-axis) and go up (arrow) to the power-hyperbola with a parameter of D = 0.1. From the point of intersection go on horizontally to the left. On the y-axis you get a current of 1.725 A.

This is the maximum (pulsed) current for LDP-2023 when operated without heatsink.

This value also can be calculated with the formula:

$I = 3.8 / ((U_s - U_d) \times D)$

Vice versa the maximum allowed voltage difference at a Duty Cycle of 10% can be calculated:

The laser diode can be operated with 2 A, when $U_s - U_d$ is less than 19 V.

3. CW and Pulsed Operation with heatsink

When LDP-2023 is operated with a heatsink, the maximum possible power dissipation increases significantly to P_{Dmax} = 15.6 W

This leads to the following equation for CW operation: $I = 15.6 / (U_s - U_d)$

For pulsed operation, the following equation is valid: $I = 15.6 / ((U_s - U_d) \times D)$

In the following diagram figure 4 the conditions are presented for CW and various duty cycles (with heatsink).
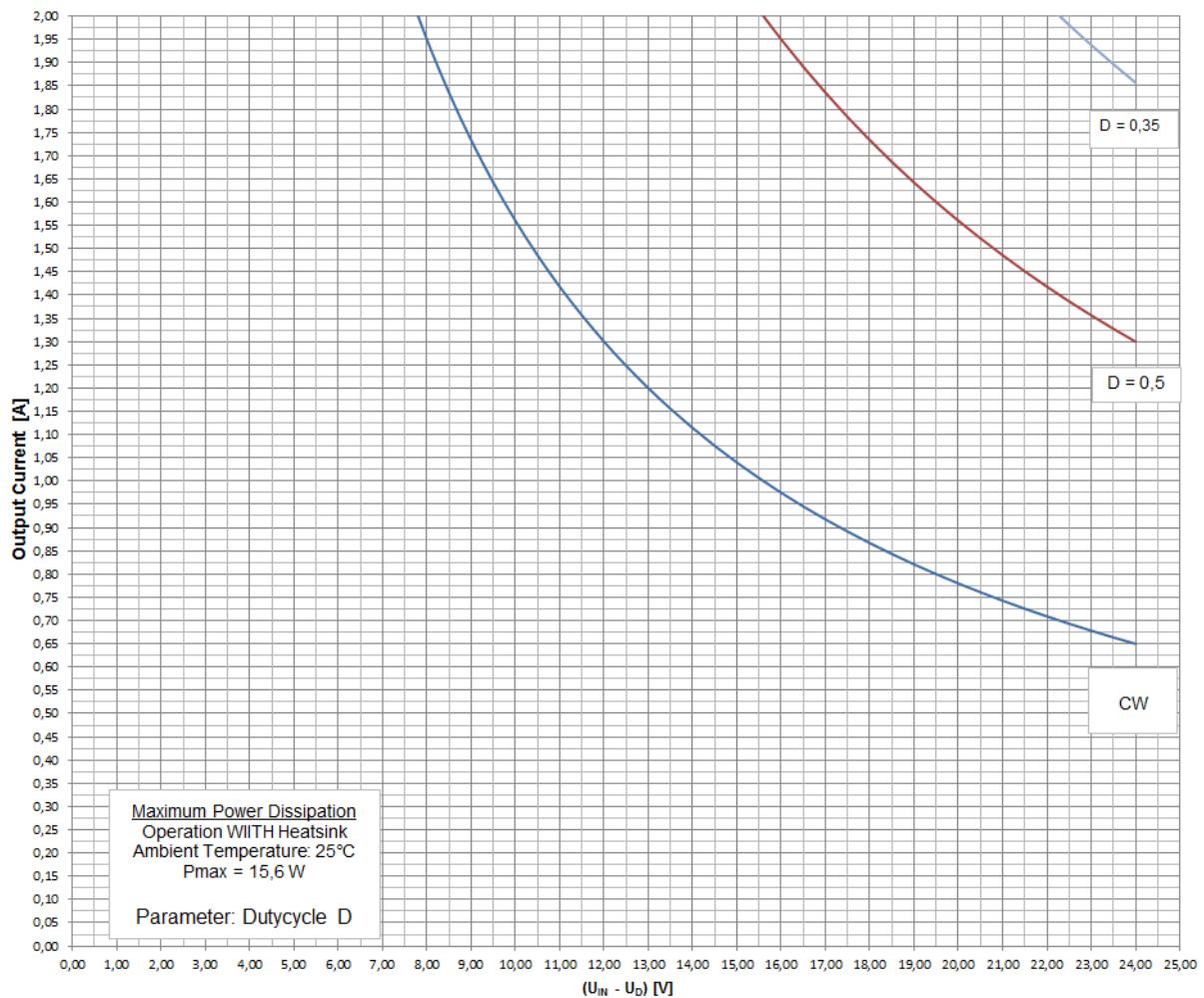

Fig. 04: maximum power dissipation for CW and pulsed operation with heatsink

Operation Modes and Wiring Diagrams

The wirings between the power supply, the LDP-2023 and the laser diode should be as short as possible.

The laser diode has to be mounted and operated electrically floating. Neither the cathode nor the anode must be connected to ground!

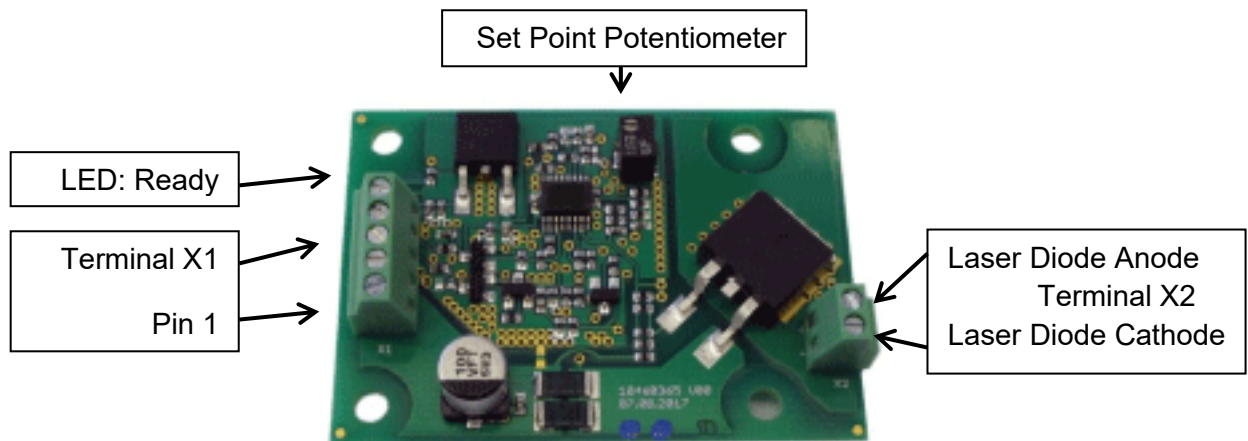Power GND and Signal GND are connected internally.
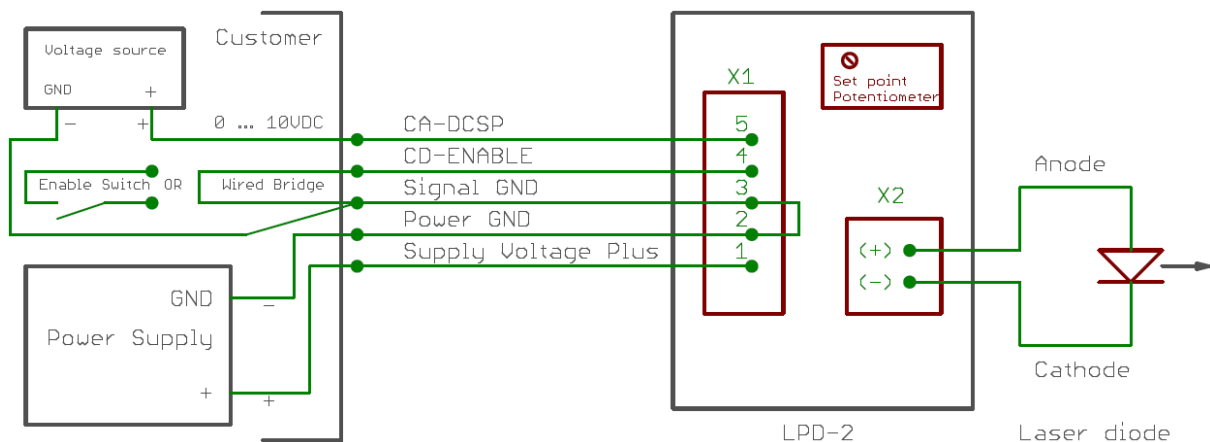

Fig. 5 LDP-2023

1. <u>CW Operation</u>

Fig. 6: Wiring diagram with LDP-2023 operating in CW mode.

There are two alternatives to enable (switching ON) the driver:
- A wire bridge between Signal GND (X1-3) and CD-ENABLE (X1-4).
  The driver is continuously ON.
- An enable switch between Signal GND (X1-3) and CD-ENABLE (X1-4).
  The driver is ON when the switch is closed.

There are three alternatives to control the set-point of the CW output current:
- Internal set-point potentiometer on the PCB between 0A and 2A by turning the set-point potentiometer (max. 11 turns) accordingly.
- External DC voltage on the analog input CA-DCSP (X1-5) in the range of 0…10VDC which corresponds to an output current between 0A and 2A.
- Combination of both (set-points of potentiometer and analog input are added).

Warning: **Max power dissipation and max diode current must be considered! It is recommended to monitor the diode current (Multimeter), while altering the potentiometer adjustment.**

A typical characteristic curve - input voltage versus output current - is shown in fig. 7.
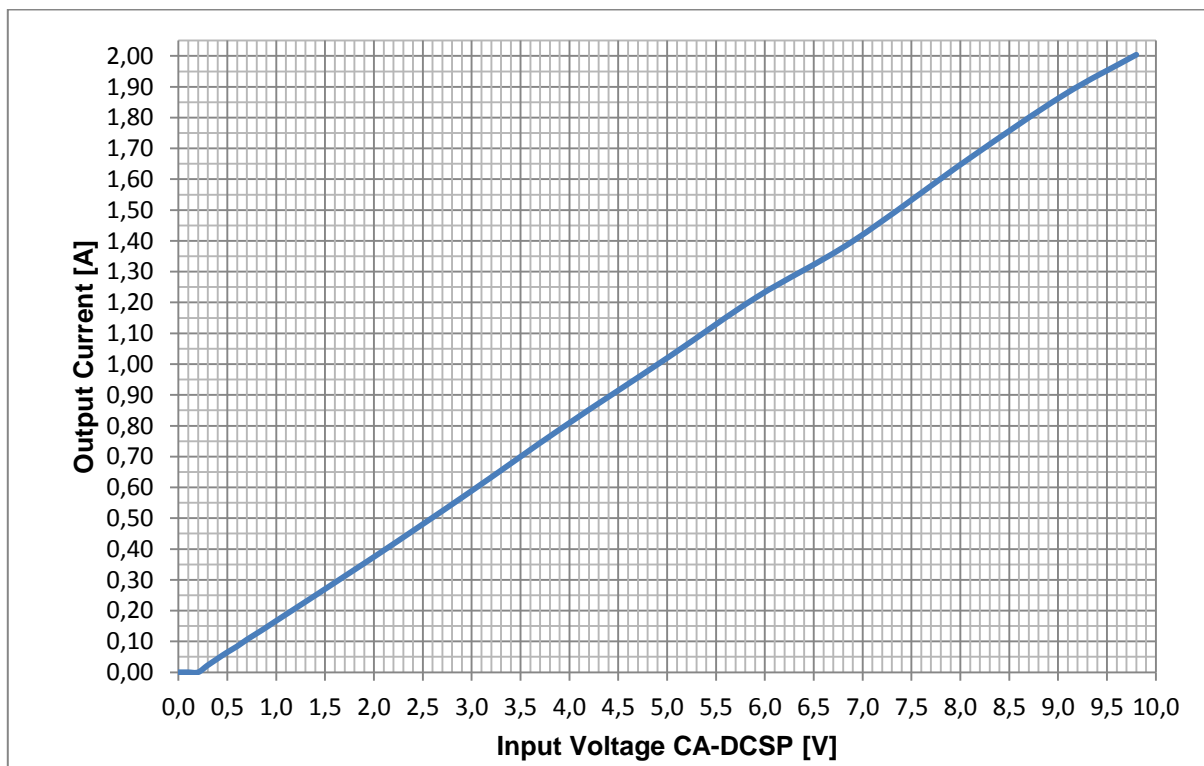

Fig. 7: Input voltage (set-point CA-DCSP at X1-5) versus output current

The following formula describes the relationship between input voltage and output current: $I_{OUTPUT} = (U_{INPUT} \times 0.210) - 0.035$.
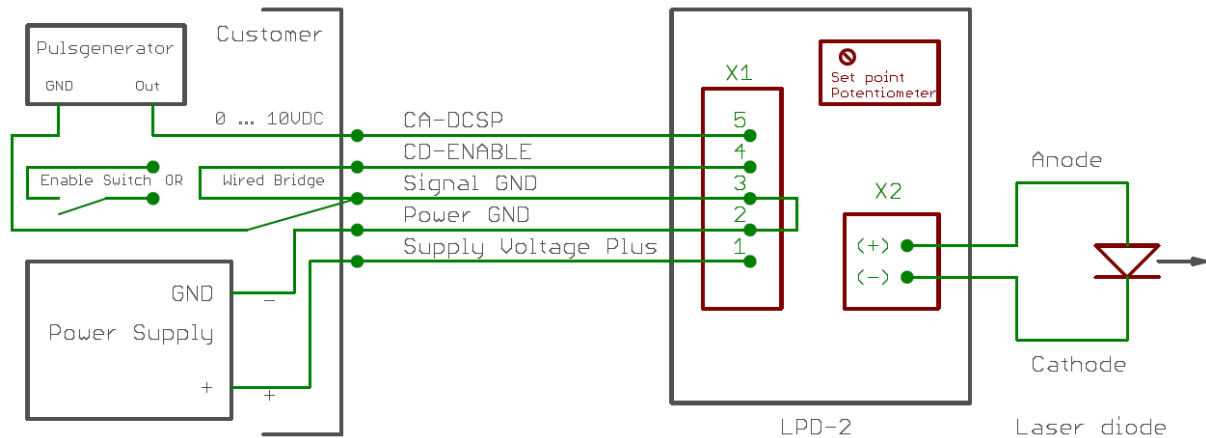
2. Pulsed and Burst Operation

Fig. 8: Wiring diagram pulsed operation

Figure 8 shows the wiring diagram with LDP-2023 operating in pulsed mode. The output voltage of the pulse generator should be in a range between 0V and 10V which corresponds to an output current between 0A and 2A.

Example:
Pulse generator settings: square wave; T_{PULSE} = 1 ms; t_{PULSE} = 100 µs; U_{PULSE} = 2 V_{SS}
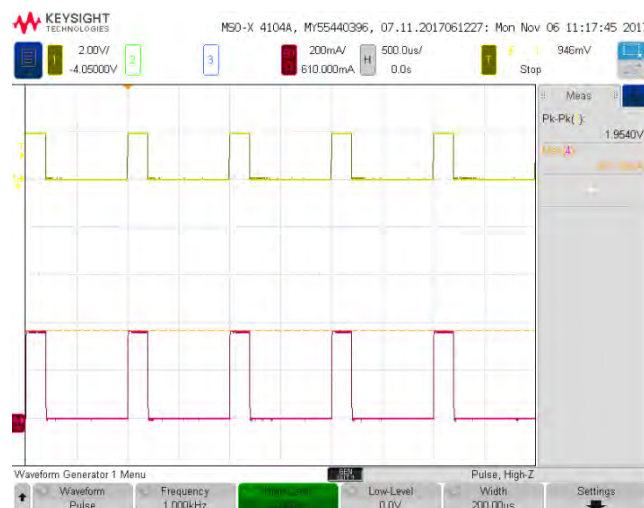

Fig. 9: Pulsed operation
yellow/upper trace: Input voltage CA-DCSP; red/lower trace: Output current

The screen-shot (oscilloscope) shows the modulator input voltage (CA-DCSP) and the output current. The duty cycle is 10%.

It is also possible to replace the wired bridge by a switch (input CD-ENABLE). Then the square-wave-pulse-current can be switched on or off.

In addition it is possible to add a continuous BIAS current by turning the set point potentiometer accordingly. This case is depicted in the next screen-shot (fig. 10), where an offset current of 200mA is added.
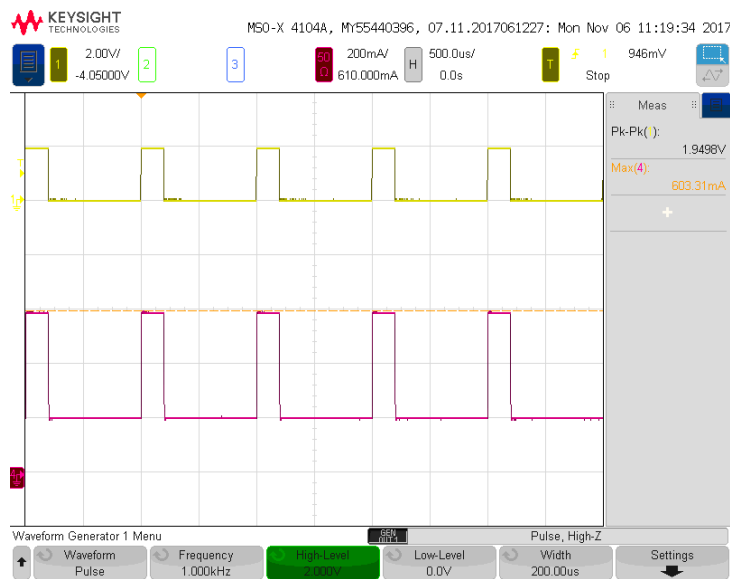

Fig. 10: Pulsed operation with offset;
yellow/upper trace: Input voltage CA-DCSP; red/lower trace: Output current

In the next example, the enable input is connected to a second pulse generator output (see figure 11 and 12). In this way it is possible to generate user defined burst pulses in the output circuit.
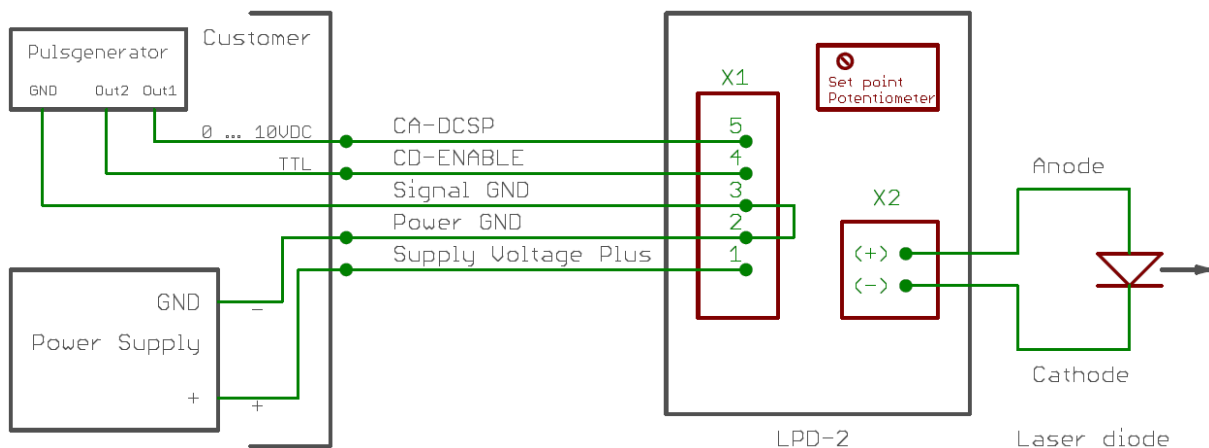

Fig. 11: Wiring diagram for burst operation

Figure 12:

Pulse generator 1: square wave; T_{PULSE} = 1 ms; t_{PULSE} = 100 µs; U_{PULSE} = 2 V_{SS}

Pulse generator 2: square wave; T_{PULSE} = 16 ms; t_{PULSE} = 10 ms; U_{PULSE} = 5 V_{SS}

Fig. 12: Burst operation; yellow/upper trace: Input voltage CA-DCSP;
green/medium trace: Input voltage CD-ENABLE; red/lower trace: Output current

3. Arbitrary Curves

The signal at the modulator input CA-DCSP (analog input) can be arbitrary in its form
In the same way as described above ramp signals, triangle signals and any arbitrary
curves, etc. can be generated.

Adjustment elements

11 turn potentiometer for a CW current set point

The potentiometer covers the current range between 0 A and 2 A.

Turn clockwise for increasing current.

Indicator elements

Green LED for indicating status Ready. Internal supply voltage is present.

Connectors

X1   5-pole single row screw terminal. Input for control signals and supply voltage.

X2   2-pole single row screw terminal. Output for laser diode connection.

Conductor cross-section min   0.14mm², AWG 26

Conductor cross-section max   0.5 mm², AWG 20

Signal Description Control Port X1

CA = Control Analog

CD = Control Digital

Inputs - Supply and Control Port X1

Pin	Name	Function
1	SVI+	Supply Voltage plus
2	GND	Power Ground (supply voltage minus)
3	GNDA	Signal Ground
4	CD-ENABLE	Enable / Trigger
5	CA-DCSP	Diode Current Set Point

SVI+ (X1-1)

Supply voltage plus

Supply voltage: 6.0 V … 24 V DC (max. 26 V)

Supply current: max 2 A

Supply current internal: approx. 50 mA

Supply voltage must be minimum 1 V above diode voltage.

Make sure that the supply wiring (SVI+ and GND) is as short as possible.

GND (X1-2)

Power GND related to SVI+.

Connect to supply voltage minus.

GND (X1-2) and GNDA (X1-3) are connected internally.

GNDA (X1-3)
Signal GND related to control signal inputs.
GND (X1-2) and GNDA (X1-3) are connected internally.

CD-ENABLE / TRIGGER (X1-4)
Control Digital - Enable
Input resistance: 1 kΩ
Digital TTL (5V) input, High if left open.
A Low-Signal or pulling the input to GNDA enables diode current (low-active).
This input can also be used as a trigger input, to switch the total current set point On and Off.

CA-DCSP (X1-4)
Control Analog - Diode Current Set Point
Analog input 0 … 10 V
Input resistance: 2 kΩ
0 … 10 V corresponds to a diode current of 0 mA … 2000 mA.
Warning: Max power dissipation must be considered!

Signal Description Output Port X2

Pin	Name	Function
X2 +	Anode	Laser Diode anode connection
X2 -	Cathode	Laser Diode cathode connection

Anode (X2 +)
Connection of Laser Diode anode.

Cathode (X2 -)
Connection of Laser Diode cathode.

The output is short circuit proof.

Section Drawings

Fig. 12: PCB dimensions

Threaded holes (M3):
* – attaching the heatsink
** – mounting PCB on the heatsink
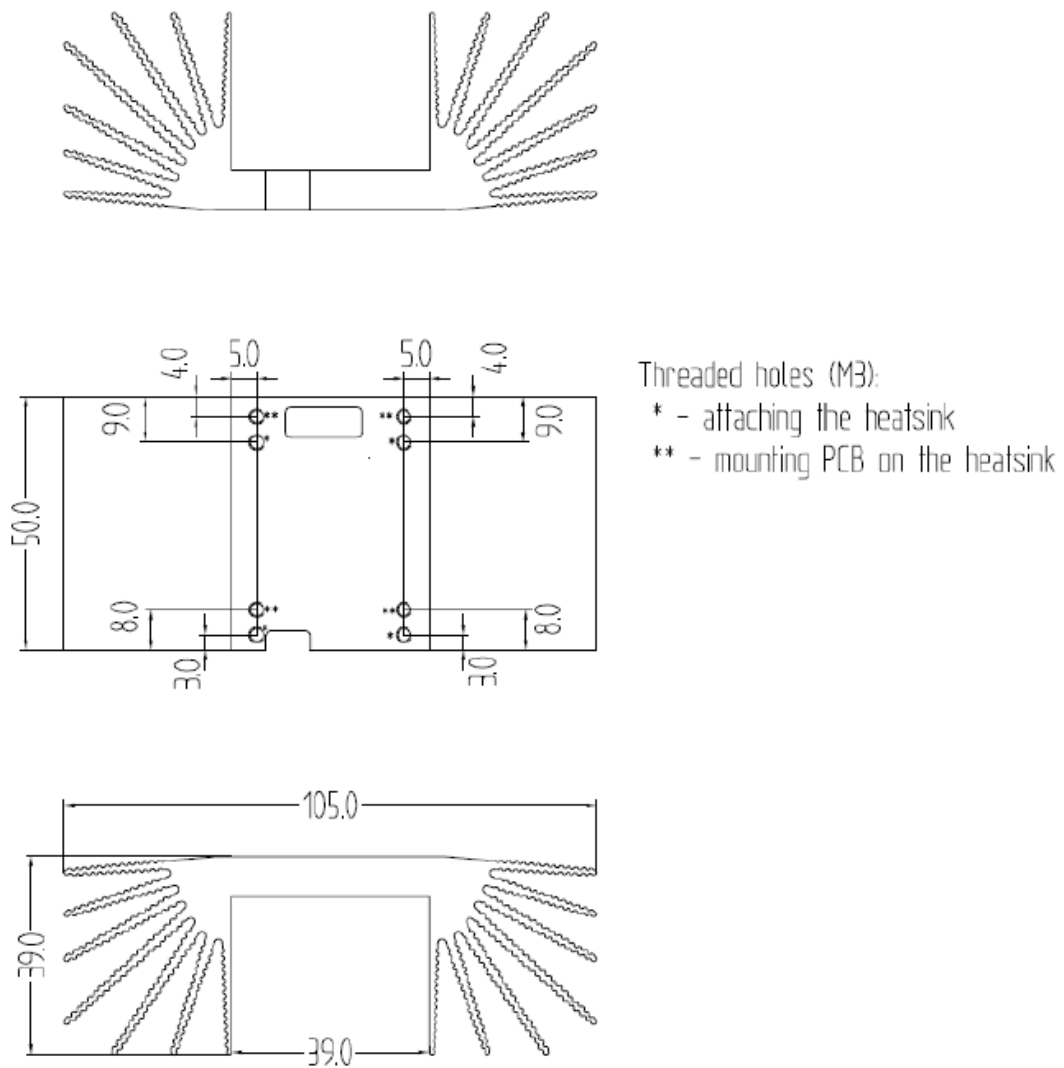
Fig. 13: Heatsink section drawing

Technical subjects to change without notice.

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