LDD-1321 Laser Diode Driver with optional TEC Controller

Overview

The LDD-1321 is a current driver designed to precision-drive low-current laser diodes or other loads in continuous wave applications.
The LDD-1321 offers various safety features, including two inputs for laser diode temperature monitoring.
The PWR-1191 expansion board can be attached on top to enable the TEC Controller feature of the device, turning it into a full-fledged Laser and TEC Controller (LTC).
The device can be fully digitally controlled, the firmware can be upgraded, and various digital and analog interfaces are available.

Documentation

- For additional information, please consult the User Manual and the Communication Protocol of the device.

Features

Input Characteristics

- DC input voltage: 12 to 24 V

Laser Diode Driver

- Output Voltage: 0 to 14 V (nominal)
- Output Current: 0 to 1.5 A (nominal)
- Target application: low current CW

Main Features

- Digital control
- Easy configuration via provided GUI software
- Can be integrated in a system via a variety of interfaces or used as a stand-alone driver (set and forget)

Communication interfaces

- USB (isolated)
- RS485
- RS232 TTL
- CAN

Digital I/O

- Assortment of configurable functions
- Interlock input

Analog interfaces

- 2 temperature inputs
- Optional photodiode input

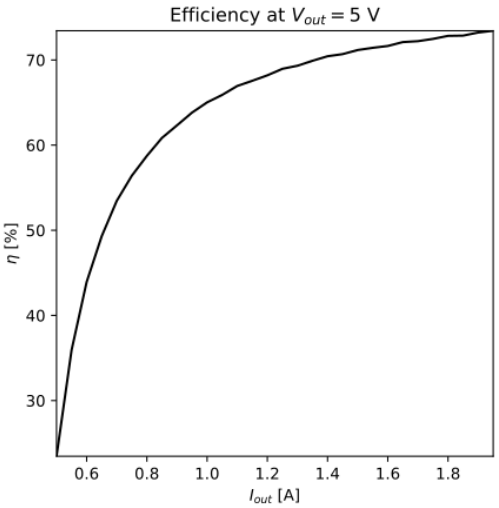
TEC controller (optional feature)

- Supports TECs and resistive heaters.
- Output voltage: 0 to ±20 V (dependent on input voltage)
- Output current: 0 to ±4 A
- Autotuning
- Can be used to stabilize your laser's temperature

Absolute Maximum Ratings

Supply voltage (DC)	27 V
Supply current (DC)	7 A (fused)
Temperature	–40 – 90°C
Humidity	5 – 95%, non-condensing

Thermal Information

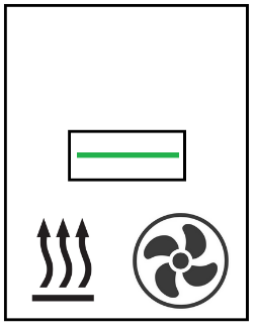


Operating temperature range (board temperature, upper limit enforced by overtemperature protection)	0–70 °C

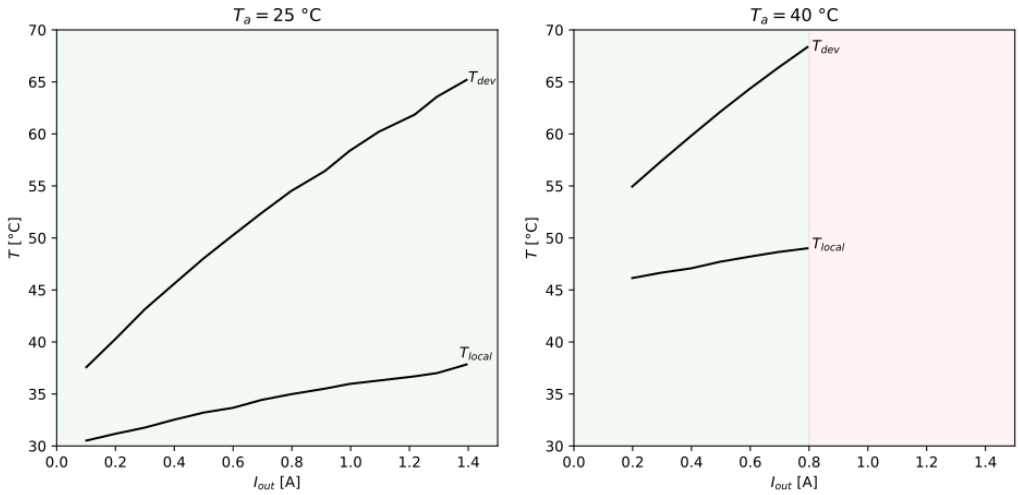
Note on heat sinking

Depending on your setup, additional cooling might be needed to avoid an overtemperature error during operation of the LDD.

This note shows a possible application scenario. The LDD-1321 was placed in a closed aluminum case with one perforation, which was then placed inside a ventilated climatic chamber. The device was driving a constant voltage load of 5 V with the following settings: forward voltage 5 V, differential resistance 0 Ω, maximum current 1.5 A. The power supply voltage chosen was 12 V.



Three temperatures were measured. T_a is the ambient temperature inside the chamber, T_{local} is the air temperature inside the case, and T_{dev} is the PCB temperature of the device. In the operating area marked in red, the heatsinking (or lack thereof) of this setup becomes insufficient for continuous use over several minutes.



Power Input Characteristics

Unless otherwise noted: T_A = 25 °C.

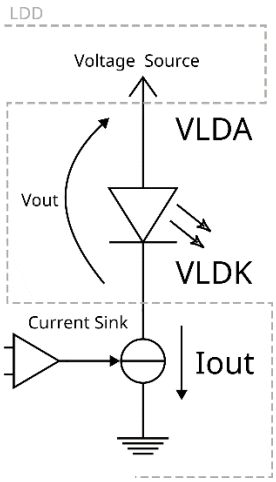
Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
U_{in}	Supply voltage	Nominal	11.5		25.5	V
$U_{in_{ripple}}$	Tolerated ripple voltage	U_{in} always in range specified above		300		$\mathrm{mV_{pp}}$

LDD Output Characteristics

Unless otherwise noted: T_A = 25 °C.

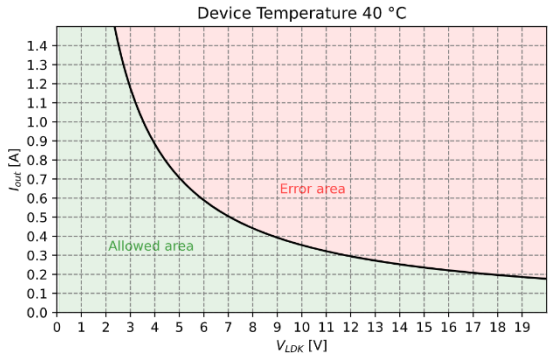
Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
Static						
$I_{out_{max}}$	Maximum nominal output current	Operating area limitations apply separately.	1.5			A
$I_{out_{leak}}$	Leakage output current Applies with current output disabled but anode supply enabled (use case: current modulation down to zero). Disabling the anode power supply turns off this current (use case: static on or off use of the current source).	$V_{LDA} > 1$ V, $R_{load} \cong 0\ \Omega$	$0.84 \cdot \mathrm{V_{LDA}}$			mA
$I_{out_{min}}$	Zero-setpoint output current Due to calibration. Can be reduced to the specification above by applying a user calibration offset (reduces current accuracy).	$V_{LDA} = 6$ V, $R_{load} \cong 0\ \Omega$	4			
		$V_{LDA} = 15$ V, $R_{load} \cong 0\ \Omega$	5			
$\Delta_{I_{out}}$	Set current resolution			0.1		mA
$V_{LDA_{max}}$	Maximum anode voltage	Whichever is lower		$V_{in} - 1$ or 20		V
$V_{out_{max}}$	Maximum output voltage (on load)	Corresponding anode voltage must be reachable		14		V
$\alpha_{T_{drive}}$	Output current temperature coefficient/drift (relative to device temperature)	$I_{out} = 0.5$ A, $T_0 = 15$ °C, $T_1 = 40$ °C		±125		ppm/K
$\alpha_{T_{meas}}$	Output current temperature measurement coefficient/drift (relative to device temperature)	$I_{out} = 0.5$ A, $T_0 = 15$ °C, $T_1 = 40$ °C		±80		ppm/K
Dynamic						
f_{BW}	Analog bandwidth	1.5 A on 1 Ω resistor. 50% sine amplitude. This specification is relevant to changing load characteristics. Applies independently of the refresh rate.		190		kHz
t_{rise}	Analog rise time	1.5 A on 1 Ω resistor. This specification is relevant to step changes in the load and applies independently of the modulation rise time. Pulsing not supported at time of publication.		6		µs
f_s	Setpoint refresh rate	Applies to internally generated current ramping. Current modulation not supported at time of publication.		1562.5		Hz

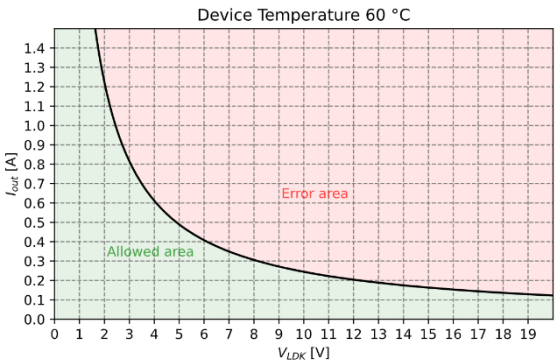
Operating area



This device features a linear-mode laser diode driver, which uses a transistor (pictured as a current source) to control the current in the laser. This topology requires to consider the power dissipated on the current sink, as the portion of the voltage that does not fall on the load will fall on it. To enable simple and safe use, this device automatically shuts down if the safe operating area of the current sink is not respected. The shutdown limit is shown in the charts below, at a typical device temperature and at the limit device temperature (worst-case). The voltage of the voltage source, V_{LDA} (laser diode anode voltage), is automatically set by the device based on the laser characteristics and maximum current set by the user.

Note: these points are not all thermally stable without additional cooling. See User Manual for details on how to use this curve to see if your load is compatible with the LDD-1321.





Safety Characteristics

Unless otherwise noted: T_A = 25 °C.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
Current shut-off time (current < TBD)						
$t_{off_{overcurrent}}$	Overcurrent (against set threshold)			TBD		µs
$t_{off_{overcurrent}}$	Fast overcurrent (fixed threshold)			TBD		µs
$t_{off_{PIDover}}$	PID upper saturation			TBD		µs
$t_{off_{interlock}}$	Interlock signal low			TBD		µs
$t_{off_{error}}$	Generic software-initiated error			TBD		µs

External Temperature Measurement (NTC only)

T_A = 25 °C, measurement configuration: 12 bit / 2-wire / unshielded cable < 50 mm, temperature probe: NTC $B_{25/100}$ 3988K R_{25} 10k.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
$R_{LR\ range}$	Measurement range		295		106400	Ω
		Corresponding temperature range	130 to -21			°C

General Purpose Digital I/O Characteristics (GPIO1 … GPIO10)

Unless otherwise noted: T_A = 25 °C.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
Input Characteristics						
U_{IH}	Logic high input threshold		2			V

U_{IL}	Logic low input threshold				1	V
$U_{I_{MAX}}$	Maximum input voltage		-0.3		5.5	V
Output Characteristics						
U_{OH}	Logic high output voltage	Output current 8mA	2.8		3.3	V
U_{OL}	Logic low output voltage	Input current 8mA			0.4	V
Z_{OUT}	Output Impedance		110	120	150	Ω
I_{OUT}	Output Sink or Source Current			±8	±20	mA
ESD Protection						
U_{PP}	ESD discharge	IEC61000-4-2		18		kV

Analog Input Characteristics

Unless otherwise noted: T_A = 25 °C. Voltages referenced to AGND.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
Input Characteristics						
U_{I+}	AIN+ voltage		–1		11	V
U_{I-}	AIN– voltage		–1		11	V
U_{IN}	Nominal differential input voltage range		0		10	V

Interlock Input Characteristics

Unless otherwise noted: T_A = 25 °C. The interlock can be deactivated by using the dipswitch S1.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
Input Characteristics						
V_{IACT}	Interlock active input voltage range	Voltage range which is detected as active input	3		30	V
V_{IORM}	Maximum working insulation voltage				120	V

Photodiode Input Characteristics (optional)

Unless otherwise noted: T_A = 25 °C.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
Input Characteristics						
I_{in}	Photodiode current measurement nominal limits	-PD0.5	0		4	mA
		-PD1	0		2	
		-PD2	0		1	
		-PD4	0		0.5	

TEC Controller (PWR-1191 expansion board required)

HW v1.10

This board features a bidirectional current driver, which enables the TEC Controller functionality of the device.

Operating range

Operating temperature range (board temperature, upper limit enforced by overtemperature protection)	0–90 °C

Electrical characteristics

Unless otherwise noted: 25 °C, U_{in} = 24 V, R_{load} = 3.75 Ω.

Symbol	Parameter	Test Conditions/Notes	Min	Typ	Max	Unit
I_{out}	Bipolar output current swing				±4	A
U_{out}	Bipolar output voltage swing	U_{out} maximum ~$0.85 \cdot U_{in}$		±20		V
η	Power efficiency			90		%

Output Monitoring (IOUT Resolution is 1.46 mA; UOUT Resolution is 6.1 mV)						
IOUT Read	Precision	@ 3.8 A		1	5	%
UOUT Read	Precision	@ 15.0 V		1	3	%

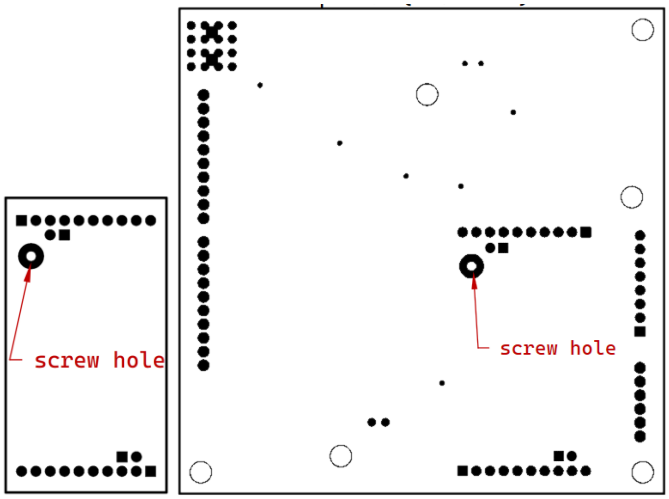
Attaching the device to the LDD-1321

This step is necessary if you buy the PWR-1191 separately from the LDD-1321.

⚠ *Always perform this operation with the LDD-1321 disconnected from the power supply.*

The board must be inserted with the correct orientation. The screw holes shown in the picture provide a reference and can optionally be used to secure the two boards together (not required for static applications).

⚠ *An incorrect orientation of the PWR-1191 can damage the devices upon turning on the power. Damage due to incorrect assembly is not covered by warranty. In case of doubt, please refer to support before proceeding.*

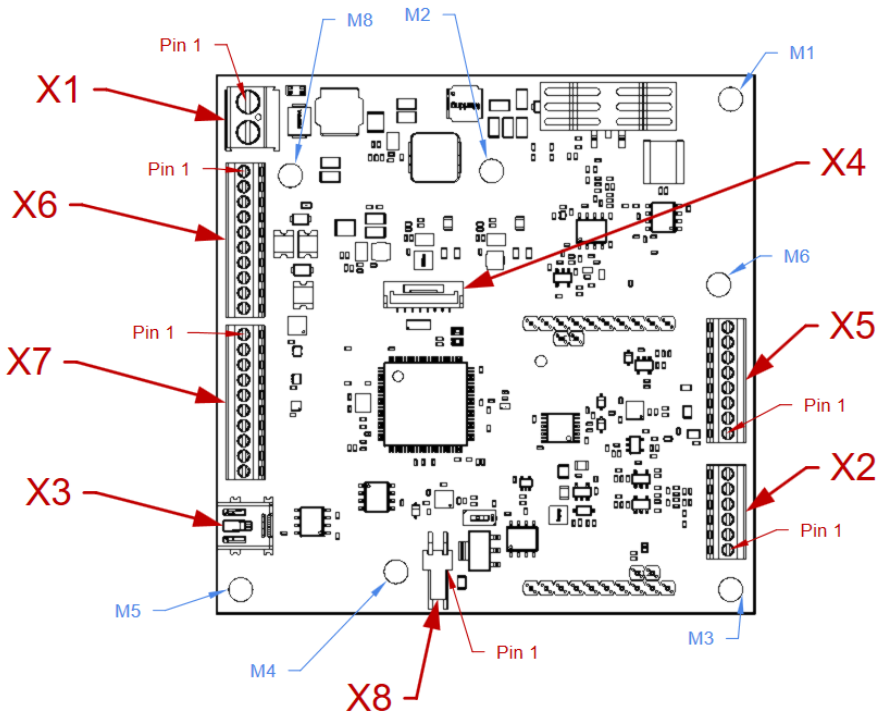


Device Connectors

Connector configurations

-SCREW: X1, X6, X7, X5, X2 are populated with screw headers and X8 is populated with a connector. See connector details below.
-PIN: X1, X6, X7, X5, X2 and X8 are populated with 2.54 mm pin headers on the bottom side of the board.
-NC: X1, X6, X7, X5, X2 and X8 are not populated.
Customized configurations available on request.

Connector Overview



-SCREW version pictured for reference, top view. Connector locations analogous in other versions.

X1

Screw terminal: stripping length 6.5 mm, wire section $0.05 \div 2.5\ \mathrm{mm}^2$.
No connector or pin: 2.54 mm pitch pads/pins.

Pin	Name	Description
1	VIN	Power Input +
2	GND	Power Input –

X6

Screw terminal: stripping length 5 mm, wire section $0.05 \div 1\ \mathrm{mm}^2$.
No connector or pin: 2.54 mm pitch pads/pins.

Pin	Name	Description
1	5V	5V supply for ancillary circuits
2	GND	GND connection for ancillary circuits
3	3.3V	3.3V supply for ancillary circuits
4	RS485 1 A/D+	RS485 communication interface.
5	RS485 1 B/D–	
6	RS232 TTL RX	RS232 TTL communication interface.
7	RS232 TTL TX	
8	GND	GND connection for communication interfaces. Internally shorted to pin 2.

9	CAN1 H	CAN communication interface. Firmware feature available from FWv1.10.
10	CAN1 L	

X7

Screw terminal: stripping length 5 mm, wire section $0.05 \div 1\ \mathrm{mm}^2$. No connector or pin: 2.54 mm pitch pads/pins.

Pin	Name	Description
1	GPIO1	Configurable digital input/output pins.
2	GPIO2	
3	GPIO3	
4	GPIO4	
5	GPIO5	
6	GPIO6	
7	GPIO7	
8	GPIO8	
9	GPIO9	
10	GPIO10	

X3

Mini USB type B. ID pin not connected.

X4

Reserved. Do not connect.

X5

Screw terminal: stripping length 5 mm, wire section $0.05 \div 1\ \mathrm{mm}^2$.
No connector or pin: 2.54 mm pitch pads/pins.

Pin	Name	Description
1	SYNC OUT	Reserved. Do not connect.
2	AIN–	Differential analog input, negative terminal.
3	AIN+	Differential analog input, positive terminal.
4	AGND	Ground connection for ancillary analog circuits.
5	PDC	Photodiode cathode terminal. Must be independent from GND (floating).
6	PDA	Photodiode anode terminal. Internally connected to GND.
7	LDC	Laser diode cathode terminal. Must be independent from GND (floating).
8	LDA	Laser diode anode terminal. Must be independent from GND (floating).

X2

Screw terminal: stripping length 5 mm, wire section $0.05 \div 1\ \mathrm{mm}^2$.
No connector or pin: 2.54 mm pitch pads/pins.

Pin	Name	Description
1	TEC–	TEC negative output, only available with PWR-1191 expansion board.
2	TEC+	TEC positive output, only available with PWR-1191 expansion board.
3	T2B	Resistive temperature sensor input 2 terminal B. Internally connected to GND.
4	T2A	Resistive temperature sensor input 2 terminal A. Must be independent from GND (floating).
5	T1B	Resistive temperature sensor input 1 terminal B. Internally connected to GND.
6	T1A	Resistive temperature sensor input 1 terminal A. Must be independent from GND (floating).

X8

Populated with connector in -SCREW version of the device, compatible mating part: Molex 0022013027 with pre-crimped leads 0797580015.
No connector or pin: 2.54 mm pitch pads/pins.

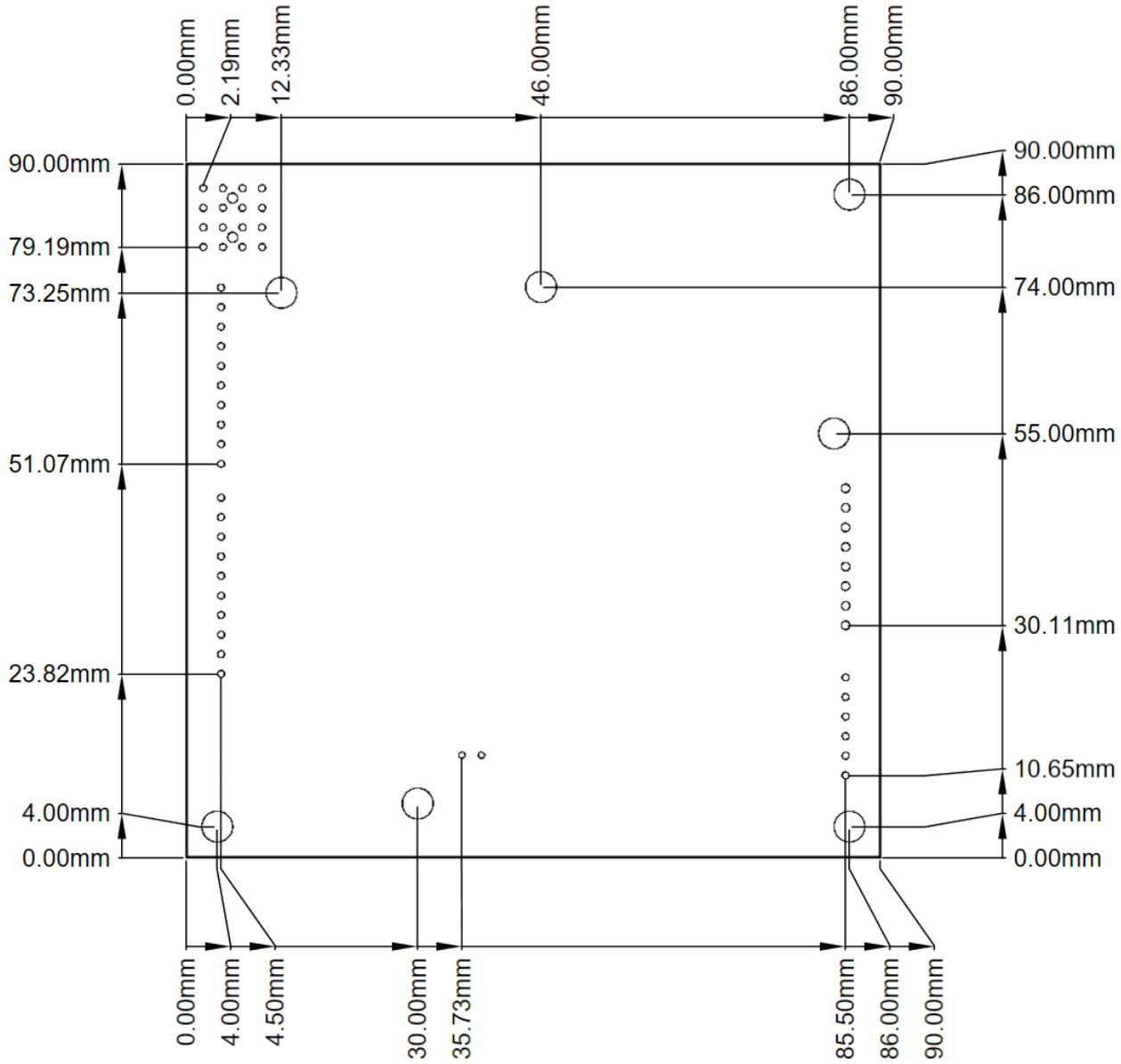
Pin	Name	Description
1	Interlock+	Interlock positive input
2	Interlock–	Interlock negative input

If the connector is not used, the interlock can be deactivated via the DIP switch.

M1-M6 & M8

Mounting holes. Internal capacitive connection to GND. M1 and M4: 1 MΩ connection to GND.

Mechanical Information



All dimensions nominal.

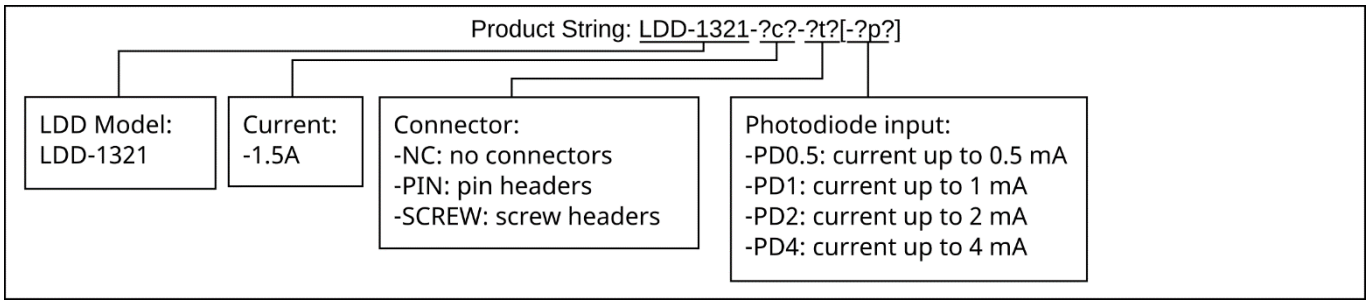
Connector pads: 2.54 mm pitch, compatible with 2.54mm pin headers.

Mounting holes nominal diameter: 3.05 mm (compatible with M3 screws).

3.17 mm spacer on the bottom side.

3D models of the device are available on our website or on request.

Ordering Information



The PWR-1191 module is sold as a separate item.

Laser diode, temperature probes, power supply and mating connectors not included.

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