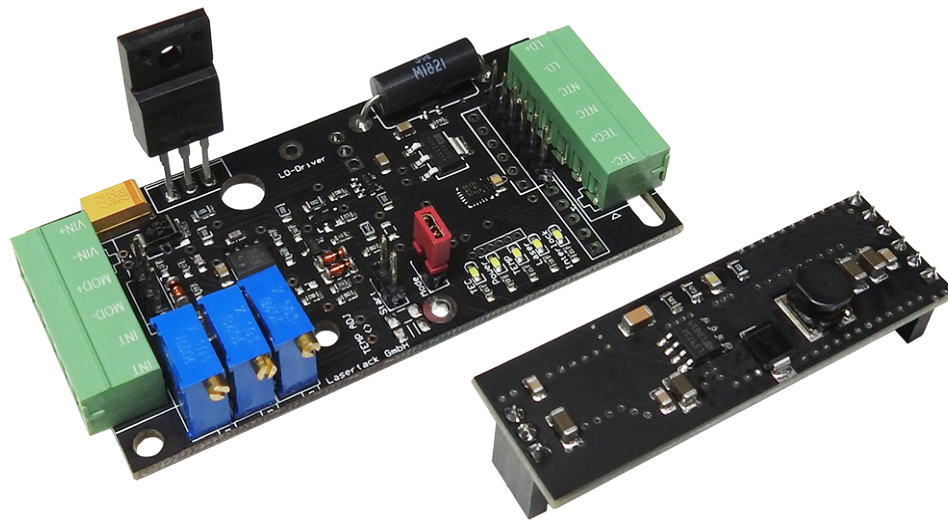# Lasertack GmbH

**High power Laser Diode Driver
with TEC Controller (optional)**

iLD Serie

User´s Manual

Download the PDF User´s Manual to use dynamic contents

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Content

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We, Lasertack GmbH, strive to develop and produce highly reliable and versatile devices. In order to be able to do our best, we are reliant on your feedback and ideas.
Feel free to contact us at any time. We are looking for feedback and ideas!

Warning   Sections with safety relevant information regarding injury or death and damage of the device and periphery. It is highly important to read and fully understand this information.

Attention   Sections describing risk of malfunctions which can lead in damaged driver or laser or measurement equipment.

Note   Sections with information which are to be understood and followed.

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1. General information and features

Note   The iLD driver series is available with an optional TEC controller. This can be purchased separately or along with the driver board.

ESD Note   During operation and storage ESD safety precautions need to be taken.
The power supply must have a galvanically isolated GND channel from the earth wire.

Attention   All statements regarding safety and technical specifications are only valid when the operation is followed step by step and no changes to the hard or firmware are made.
Before connecting the laser to the driver, make sure that the power supply is disconnected from the driver.

The temperature monitoring and thermal shutdown feature is active with the NTC connected only.

The driver is equipped with an overvoltage protection but is not protected against reverse polarity.

Only with written approvement modifications are allowed do be made. Not approved modifications will void the warranty.

Warning   Laser light is dangerous to the eyes, skin and flammable materials.
Use an appropriate shield to keep the environment safe from laser light.

ATTENTION

ELECTROSTATIC SENSITIVE DEVICES

OBSERVE PRECAUTIONS FOR HANDLING

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Features

- Linear controller with high output current.

- Modulation up to 500 kHz

- Temperature monitoring at thermal shutdown

- Optional unidirectional TEC controller

- Interlock safety shutdown

- Wide diode range.

- Small footprint

- Stand by beam suppression

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2. Description

This driver is based on our well known linear regulator for laser diodes in a new design with a higher functionality.

The laser diode driver operates as an analog driver which is superordinate a control unit. This structure permits a reliable laser current control in unison with an equally reliable temperature and interlock monitoring. Arising thereby the laser output will be disabled within microseconds if an overtemperature or interlock failure occurres.

The temperature monitoring part measures the temperature with a small sized and easy to use NTC directly next to the laser diode. With the additional plug-on TEC controller (Part# PD-01360) the temperature monitoring can be enhanced to a temperature control on the same board without other sensors or increasing the footprint.
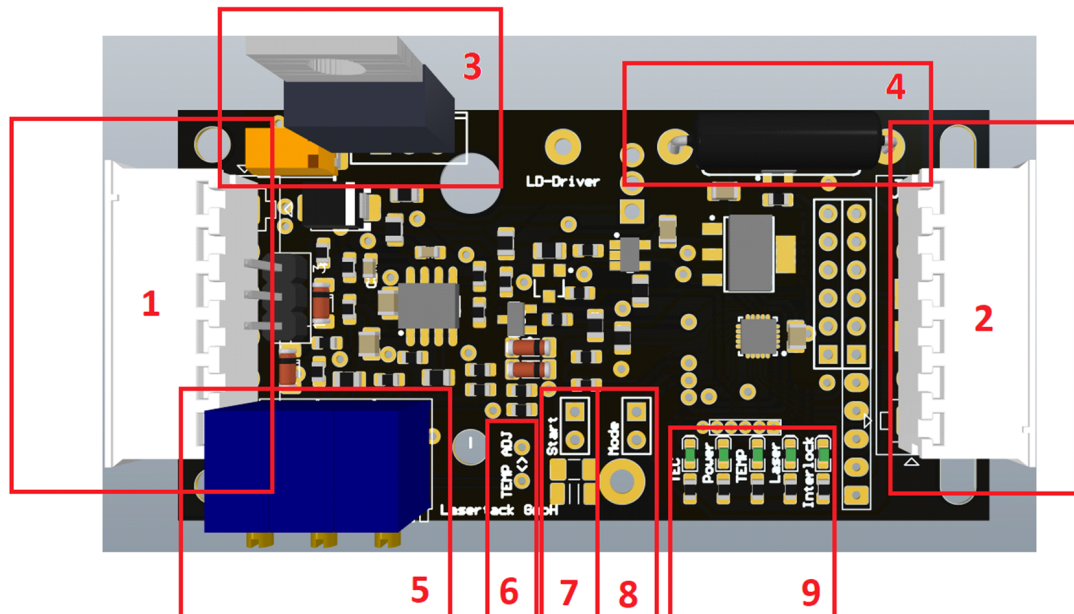
The interlock feature triggers a safety shutdown or can be used easily as a redundant shutdown system for external interlock systems.

Depending on the final application, the driver can be started by a separate start signal e.g. key switch or directly. Selectable by a simple switch which can be also executed by a simple shorting jumper with 2,54mm pitch.

The revised connection terminals enhance the connecting of the laser diode, the supply voltage and the remaining periphery.
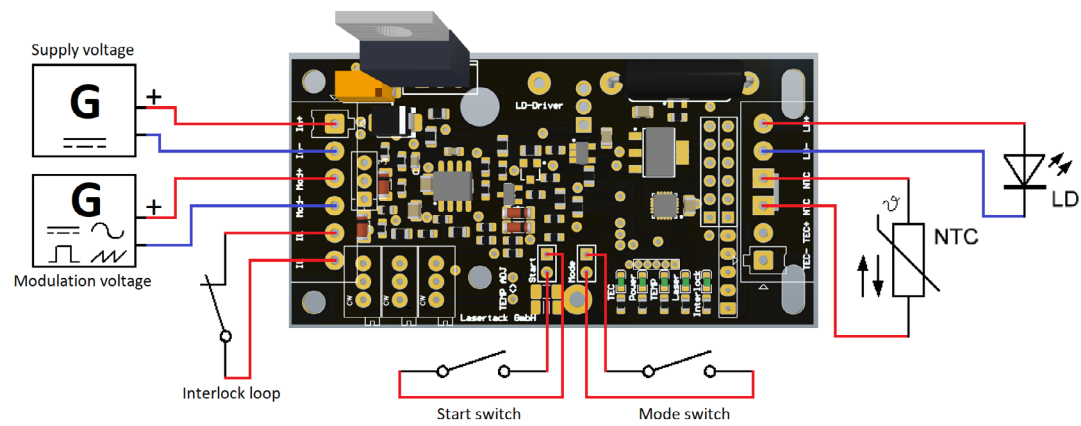
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2.1 Control elements

| Number	Description
1	Input connector
2	Output connector
3	Power transistor
4	Shunt resistor
5	Potentiometer for BIAS and GAIN current, temperature setpoint
6	Measuring points for temperature setup
7	Connector with 2.54 mm grid for a key switch
8	Connector with a 2.54 mm grid for the „*MODE*" mode jumper or a switch
9	LED indicators

Connection scheme

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Symbol	Parameter	Condition	Min.	Typ.	Max.	Value
V_{IN}	Supply voltage		+5	$V_{LD}+V_{Drop}$	+24	V
V_{DROP}	Voltage drop		+1	-	+2	V
P_D	Power losses		-	-	33	W
I_{OUT}	Output current	iLD500	0,01	-	0,5	A
		iLD2500	0,07	-	2,5	A
		iLD4500	0,14	-	4,5	A
I_{OUT_RIPPLE}	Output current ripple	$I_{OUT=500mA}$	-	<0,5		mA_{RMS}
		$I_{OUT=2500mA}$	-	0,7		mA_{RMS}
		$I_{OUT=4500mA}$	-	3,1		mA_{RMS}
I_{DRIVER}	Current consumption		20	-	60	mA
V_{MOD}	Modulation voltage		0,3	-	5	V
V_{MOD_TH}	Modulation voltage threshold		0,2	-	0,3	V
f_{MOD}	Modulation frequency	Sinus	DC	-	500	kHz
		TTL	DC	-	100	kHz
R_{MOD_IN}	Modulation input impedance		-	20	-	kΩ
t_{RISE}	Rise time		-	1,4	-	µs
t_{FALL}	Fall time		-	1,6	-	µs
t_{PD}	Jitter		-	1,5	-	µs
t_{START}	Turn-on delay		-	5	-	s
V_{IL_HIGH}	Interlock High level		4	-	5	V
V_{IL_LOW}	Interlock Low level	@25°C B25/85=3960	0	-	1	V
R_{TEMP_SENSE}	NTC resistance		-	10	-	kΩ
Weight	–	-	-	10	-	g
Compliance	CE EMC Directive 2004/108/EC	-	-	-	-	-

3. Operating modes

3.1 ARM (*Automatic Recovery Mode*)
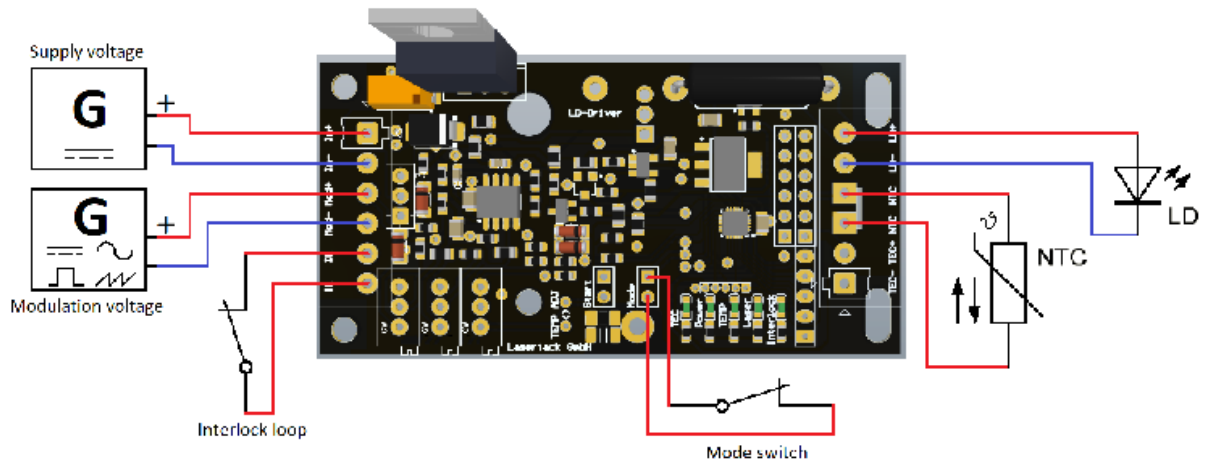
In this mode the driver starts automatically after a power-up delay, if the start conditions are fulfilled.

The start conditions are a modulation voltage higher the threshold voltage, a closed interlock loop and, if a temperature sensor is connected, a temperature below the adjusted temperature threshold. If no temperature sensor is connected, the driver will ignore the temperature conditions.

If the interlock loop is open, the driver will disable the laser and indicate the interlock failure with a flashing **Interlock** LED. The driver will remain in this state until the interlock loop is closed. When the interlock loop is closed, the laser will be enabled after a five seconds delay.

The Interlock loop can also be used as an enable signal.

When the detected temperature at the sensor reaches the temperature threshold, the driver will disable the laser and indicate the temperature failure with a flashing **TEMP** LED. The driver will remain in this state until the temperature decreases below the hysteresis threshold. When the temperature decreased below the hysteresis threshold, the laser will be enabled after a five seconds delay.

If the modulation voltage is below the threshold voltage (0,2-0,3V), the **Laser** LED will be on but the laser will not emit until the modulation voltage will rise above the threshold voltage.

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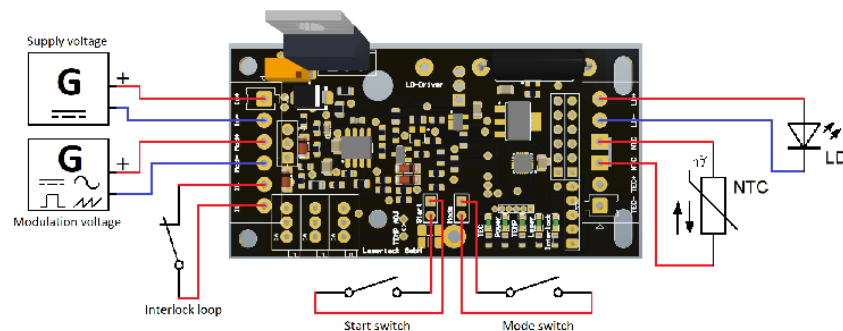
Activating ARM mode

Instructions:

• Disconnect or switch off the power supply.
• Set *Mode* jumper.
• As long as the jumper is set, the driver will start in this mode.
• Connect or switch on the power supply.

Warning   The laser will emit if the start conditions are fulfilled after a five seconds power-up delay.

Note   The start switch is out of function.

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3.2 Standard Mode (*start signal required*)

In this mode the driver starts with a power-up delay and will wait for a start signal afterwards, if the remaining start conditions are fulfilled.

The start conditions are a modulation voltage higher the threshold voltage, a closed interlock loop and, if a temperature sensor is connected, a temperature below the adjusted temperature threshold. If no temperature sensor is connected, the driver will ignore the temperature conditions.

After the start signal was set, the driver will enable the laser output after a further power-up delay. The laser will emit, if the modulation voltage is higher than the threshold voltage.

The driver monitors two separate parameters:

1. Interlock lopp
2. Temperature.

The interlock failure occurs when the interlock loop is open. The temperature failure occurs when the temperature at the sensor reaches the temperature threshold.

If one or both failures occur, the driver will disable the laser output and indicate the failure with a flashing **Interlock** LED or **TEMP** LED. The driver will remain in this state even when the fault is rectified until the start signal is reset.

When the start signal is reset and the failure is still present, the **Interlock** or **Temp** LED will keep flashing. Is the fault rectified, the flashing LEDs will stop flashing when the start signal was reset.

To rectify the Interlock fault, close the open interlock loop. To rectify the temperature fault the temperature at the sensor has to drop below the hysteresis threshold.

Are all faults rectified and the start signal is reset, the driver will start after a five seconds delay.

If the modulation voltage is below the threshold voltage (0,2-0,3V), the **Laser** LED will be on but the laser will not emit until the modulation voltage rises above the threshold voltage.

If an input voltage interruption or an unwanted shut down occur and the start signal is set, the driver won't start automatically. The driver stays in the power-up delay mode and the **Laser** LED, the **Interlock** LED and the **Temp** LED will flash at the same time. To start the driver, the start signal has to be reset and set again.

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Activating Standard mode

Instructions:

1. Disconnect or switch off the power supply.
2. Remove the **Mode** jumper.
3. As long as the jumper is removed, the driver will start in this mode.
4. Connect or switch on the power supply.

Warning The laser will emit when the start conditions are fulfilled and the start signal is set after a five seconds power-up delay.

Note The driver enable the laser only when the start signal was set.

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4. Safety shutdown

The driver monitors two parameters which trigger the shutdown event:
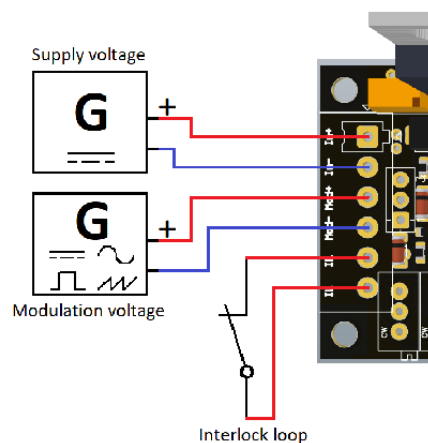1. Interlock loop.
2. Operating temperature.

When the safety shutdown was triggered, the laser is disabled within a few microseconds.

4.1 Passive Interlock Systems

The driver generates a low voltage signal for passive interlock systems. In these systems the interlock loop is realized with an ordinary breaker switch.
The breaker switches (if more than one) must be connected in series as single loop. Each end of the loop has to be connected to one of the interlock ports on the driver as shown in the figure below.


Note   The low voltage signal is intended for the interlock loop only and not for signal lights or other active components and devices. Make sure that all switching contacts are potential-free and no parasitic current can influence the interlock loop.

4.2 Active Interlock Systems

The driver can handle active interlock signals. For usage with active Interlock signals make sure that the signal is active low and limited up to 5 V. Active low means, the interlock will be activated, and laser will be disabled when the interlock signal is low (0 V). When the interlock signal is high (5 V), the driver will interpret this signal as error-free, as usual for fail-safety signals.
Connect the signal like it is shown in the figure below. Make sure that reference potential for the interlock signal is the same as it is for the modulation voltage.
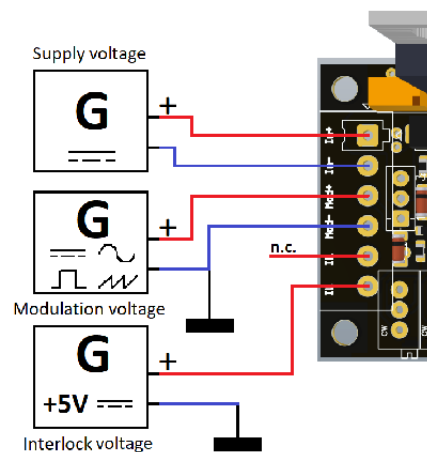
Note   While using active interlock systems with possible voltage levels higher than 5 V it is recommended to use relays or optical couplers, i.e. galvanically isolated switches, in combination with the interlock application for passive interlock systems.

Warning   Interlock signals with voltage levels higher than 5V may cause unknown errors or damage the whole driver. At its worst, the laser can emit uncontrolled and with the maximum power which is usually higher that rated power.

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4.3 Overtemperature protection

The overtemperature protection is design to protect the laser diode from overheating.
In order to allow an easy operation and integration, the overtemperature shutdown is bound to the operating temperature and cannot be set independently.
Changing the operating temperature will change the shutdown temperature as well.

The table below shows shutdown temperature examples („Threshold temperature") depending on the set operating temperature.

The „Temperature hysteresis" values show the temperature to which the laser needs to cool down before leaving the failure mode.

Threshold Temperature °C	Hysteresis Temperature °C	R_{POT} kOhm
15	6	41,5492
20	12	32,9716
25	18	26,352
30	23	21,2049
35	29	17,1752
40	34	13,9995
45	39	11,4805
50	44	9,4699
55	49	7,8555
60	54	6,5516
65	58	5,4925
70	63	4,6279
75	67	3,9183
80	71	3,3327
85	75	2,8476
90	79	2,4434
95	83	2,1054
100	87	1,8213

Note The resistor values shown in the table are only valid for the included 10k foil NTC. If you want to use another 10k NTC you need to adapt the values. Please follow the instructions in the section „**6.2 Settings with other NTCs**".

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5. LED Indicators

5.1 Description

The LED array shows the current state of the driver and all implemented failure states. Every LED has their own states, which are shown by illuminated, extinguished or flashing.

View	LED	Mode	Description
	TEC	off	No TEC-Board mounted / TEC is not cooling.
		on	TEC is cooling
	Power	off	Power supply not connected.
		on	Power supply connected.
	TEMP	off	No temperature sensor is connected / a wire break is detected.
		on	A temperature sensor is connected and the temperature is below the threshold.
		flashing	The temperature at the sensor exceeded the threshold value. A temperature failure is accrued.
	Laser	off	The Laser is disabled.
		on	The Laser is enabled.
		flashing	A power-up delay is running.
	Interlock	off	The Interlock loop is intact.
		flashing	The Interlock loop was opened. An Interlock failure is accrued.

5.2 States

State	TEC	Power	TEMP	Laser	Interlock	Description
Power-up delay	*n*	*i*	*f*	*f*	*f*	A power-up delay is running or the driver is waiting for start signal reset.
Failure mode (interlock and temperature)	*n*	*i*	*f*	*e*	*f*	The driver detected an Interlock and a temperature failure. The Laser is disabled.
Failure mode (interlock)	*n*	*i*	*e*	*e*	*f*	The driver detected an Interlock failure. The temperature sensor is not connected, or the wire is broken. The Laser is disabled.
Failure mode (temperature)	*n*	*i*	*f*	*e*	*e*	The driver detected an over temperature failure. The Laser is disabled.
Laser power-up delay	*n*	*e*	*i/e*	*f*	*e*	A power-up delay is running. The driver will start after 5 seconds. The TEMP LED is illuminated if a temperature sensor is connected. In case of a not connected temperature sensor or a broken wire, the TEMP LED is extinguished.
Laser enabled	*n*	*i*	*i/e*	*i*	*e*	The Laser Output is enabled. The TEMP LED is illuminated if a temperature sensor is connected. In case of a not connected temperature sensor or a broken wire, the TEMP LED is extinguished.
Waiting for start signal / Laser disabled	*n*	*i*	*i/e*	*e*	*e*	The Laser Output is disabled. The driver is waiting for a start signal. The TEMP LED is illuminated if a temperature sensor is connected. In case of a not connected temperature sensor or a broken wire, the TEMP LED is extinguished.

f=flashing; e= extinguished; i= illuminated; n=not relevant

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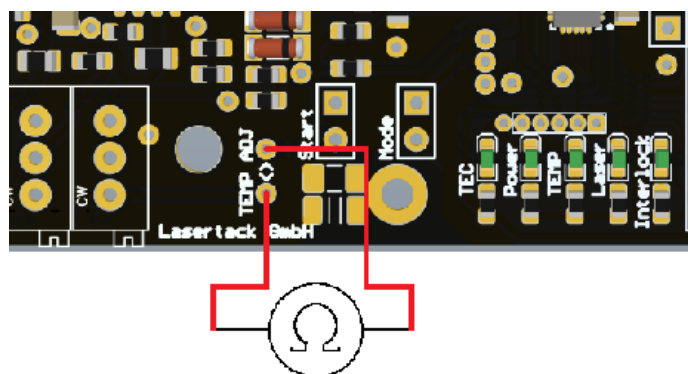
6. Temperature monitoring

The driver has an on-board temperature monitoring which can be used for temperature control in combination with the optional TEC controller (product# PD-01360). The Temperature monitoring is designed for the 10 kOhm NTC NTCAFLEX05103HH but can be used with other NTCs as well.

6.1 Settings with NTCAFLEX05103HH

- Disconnect the power supply to the driver.
- The setting of the temperature is done by turning the screw of the potentiometer "TEMP".
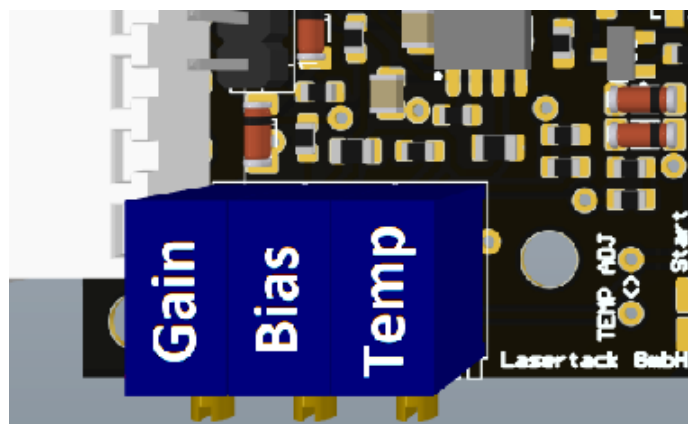
- To set the right temperature, please use the resistance values shown in the R/T table below.
- Measure the resistance at the points "TEMP ADJ" and set the resistance value shown in the R/T table. The testing points are two holes next to the "TEMP" potentiometer

- Solder the 10 kOhm foil NTC to the connecting cables. The polarity of the cables is not relevant for the NTC.
- Connect the soldered NTC to the connector "NTC" on the board.
- The temperature monitoring is set now.
- Connect the power supply to the driver.

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R/T values for NTCAFLEX05103HH

| Temperature Nominal	Temperture Hysteresis	Temperature Threshold	R Pot
5	6	11	46,2085
10	13	17	36,1246
15	19	23	28,4575
20	25	29	22,5826
25	31	35	18,0488
30	36	41	14,5235
35	42	46	11,7635
40	47	51	9,5884
45	52	56	7,8631
50	57	61	6,4860
55	62	66	5,3803
60	67	71	4,4873
65	71	76	3,7619
70	76	80	3,1697
75	80	84	2,6837
80	84	88	2,2826
85	88	93	1,9504
90	92	96	1,6735
95	96	100	1,4420
100	100	104	1,2475

Note   The resistor values shown in the table are only valid for the included 10k foil NTC. If you want to use another 10k NTC you need to adapt the values. Please follow the instructions on next chapter.

The distance between the laser diode, the NTC and the TEC needs to be chosen as short as possible. Otherwise the driver will not be able to keep the temperature stable at the needed value and may oscillate.
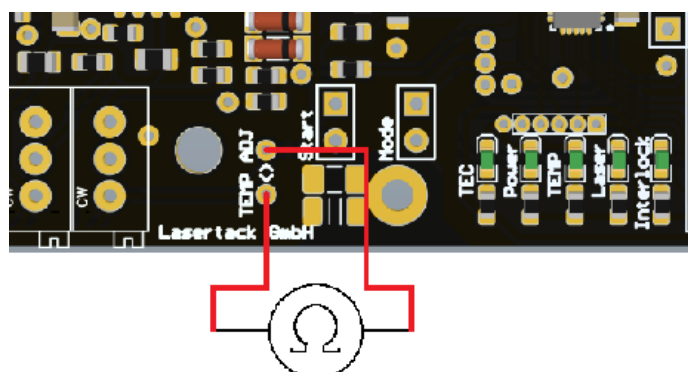
6.2 Settings with other NTCs

- Disconnect the power supply to the driver.
- The setting of the temperature is done by turning the screw of the potentiometer „TEMP".
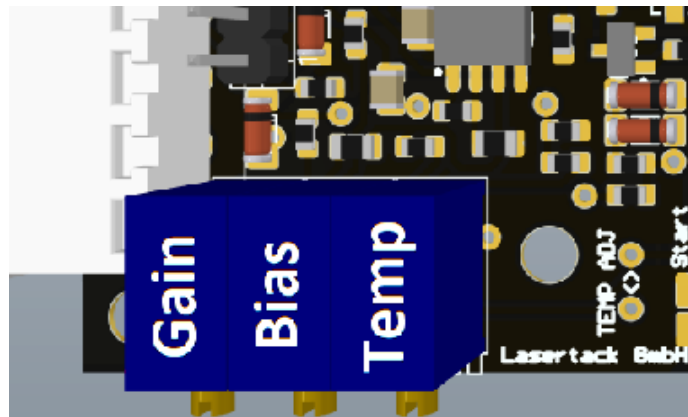
To calculate the needed resistance value for temperature threshold, determine the resistance of the NTC at the threshold temperature in the NTC datasheet. Calculate the needed resistance by multiply the NTC resistance at the threshold temperature by 2,3791.

$$R_{POT}=R_{(NTC@TEMP)} \cdot 2,3791$$

Measure the resistance at the points „TEMP ADJ" and set the resistance as calculated previously. The testing points are two holes next the "TEMP" potentiometer.

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To calculate the hysteresis threshold temperature, divide the previously calculated resistance by 1,7034. This is the Value for the NTC resistance at the hysteresis threshold temperature. Now determine the hysteresis temperature with the calculated resistance and the NTC datasheet.
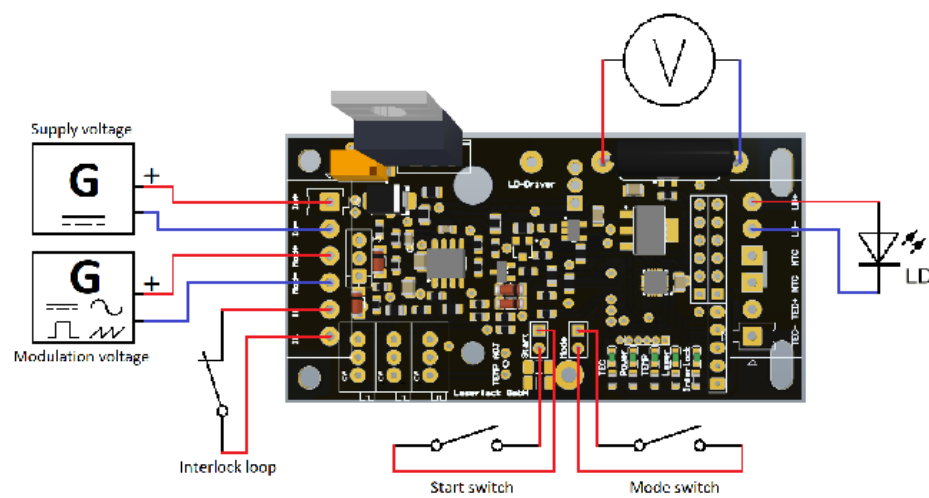
$$R_{(NTC@TEMP)}=R_{POT}/2,004$$

- The temperature difference between the two temperature points are set by the used NTC.
- Solder the NTC to the connecting cables. The polarity of the cables is irrelevant for the NTC.
- Connect the soldered NTC to the connector „NTC" on the board.
- The temperature monitoring is set now.
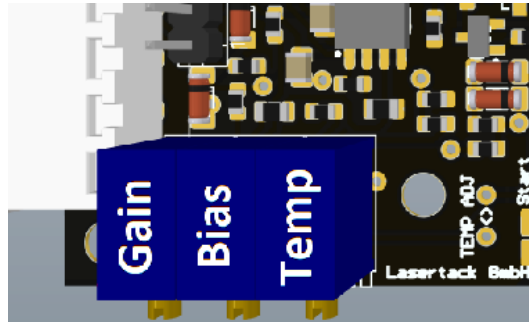- Connect the power supply to the driver.

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7. Diode current

7.1 Setting the LD current

Attention For safety reasons it is recommended to proceed the following steps while the driver operates in *Standard* mode, where the start signal has to be set manually.

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1. Set the potentiometers BIAS and GAIN by turning the screws counterclockwise (25 turns) to zero.
2. Connect the laser diode to the Output terminal on the board.
3. Set the supply voltage to 5~24VDC. Choose a supply voltage ~2VDC above the forward voltage of the laser diode.
4. Connect the main power supply to the Input terminal.
5. Connect the modulation source to the Input terminal.
6. Make sure that the Interlock loop is closed. Turn On the main supply voltage and reset the start signal.
7. Set the start signal to enable the Laser output after the power-up delay is run.
6. Set the modulation voltage to 0,2~0,3VDC.
9. Now adjust the BIAS (lower limit) current by turning the screw of the BIAS potentiometer clockwise until the threshold current of the laser diode is reached and it starts to lase.
10. Set the modulation voltage to 5VDC.
11. Now adjust the GAIN (upper limit) current by turning the screw of the GAIN potentiometer clockwise until the max. working current is reached.
12. Set the modulation voltage again to 0,2~0,3VDC and check the BIAS current. If it has changed, turn the screw of the BIAS counterclockwise to the value you set in step 9.
13. Set the modulation voltage again to 5VDC and check the GAIN current. If it has changed, turn the screw of the GAIN clockwise to the value you set in step 11.
14. The laser diode driver is set now.

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7.2 Measuring the LD current

The measurement of the laser diode current can be done by measuring the reference voltage at the points above the shunt resistor while the laser diode is connected.

Measure the reference voltage at measuring points as shown in the figure above.

The ratio between measured voltage and current is model dependent.

1.0 V / A or 1:1 for 10 - 500mA version
0.2 V / A or 1:5 for 70 - 2500mA version
0.1 V / A or 1:10 for 140 - 4500mA version.

Example:

The measured reference voltage is 0.04V. By applying the formula above, the current calculation is as following:
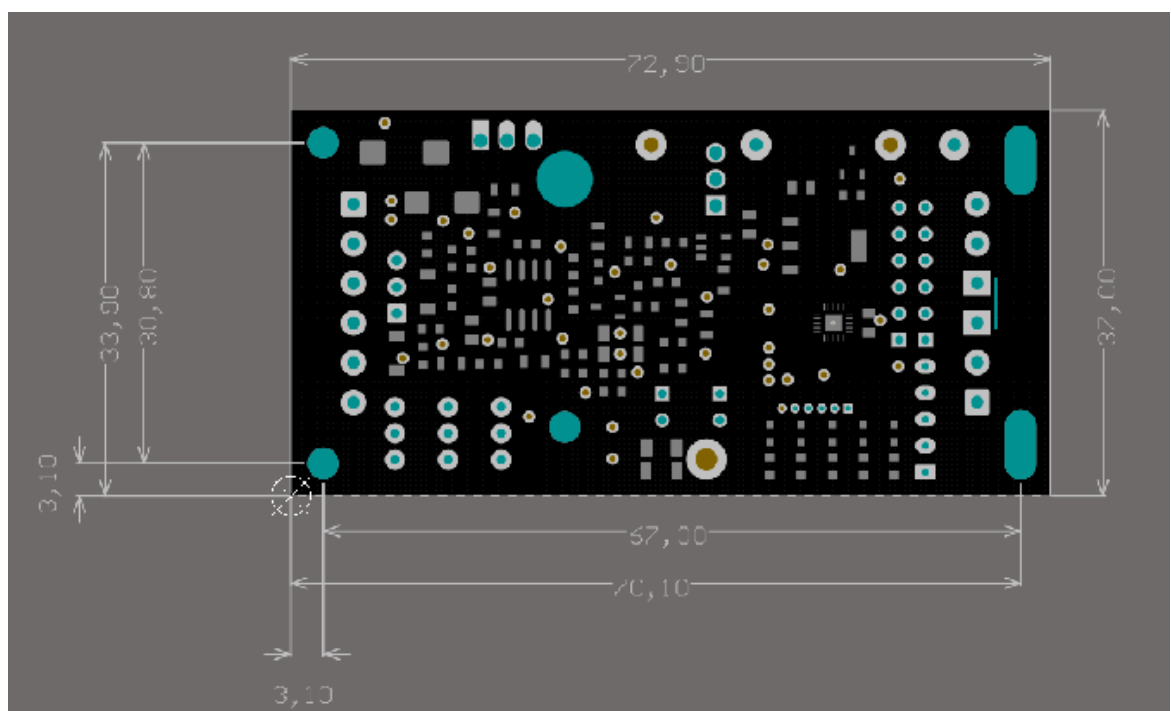0.5A version   0.04V * 1   = 0.04 A
2.5A version   0.04V * 5   = 0.20 A
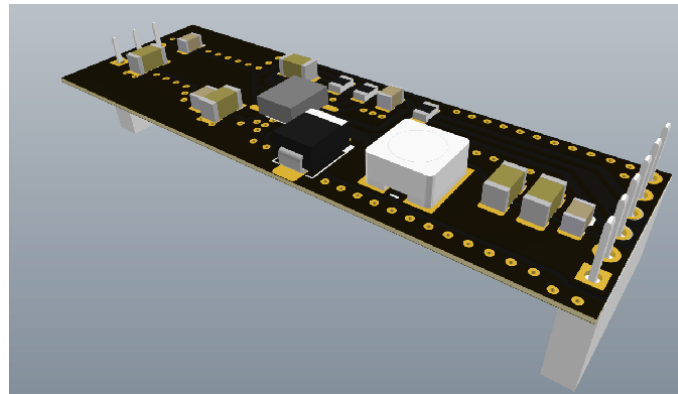4.5A version   0.04V * 10 = 0.40 A

Warning   Connect the laser diode to the driver prior connecting the driver to the power supply. Otherwise the laser diode can get damaged due to the open circuit voltage. For working current of >300mA it is necessary to mount the driver on a heat sink.

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8. TEC Controller

Note This chapter relates to the additional TEC controller (product# PD-01360). With this TEC controller, the temperature monitoring of the driver can be used as a temperature control for an external TEC. Without the TEC controller, the TEC ports at the output terminal are out of function.

The temperature monitoring of the LD driver board can be used easily as a temperature controller with the addition plug-on TEC controller board. The controller is unidirectional and especially designed for this driver board. Every of our LD driver of this generation can be upgraded with one of these TEC controllers without further updates or modifications.

Note The nominal temperature of the TEC controller is a different one than the threshold temperature of the temperature monitoring.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Value
V_{OUT}	Output voltage		-	-	V_{IN}	V
P_D	Power losses	TA ≤ 60 °C	-	-	2,25	W
I_{OUT}	Output current		-	-	2	A

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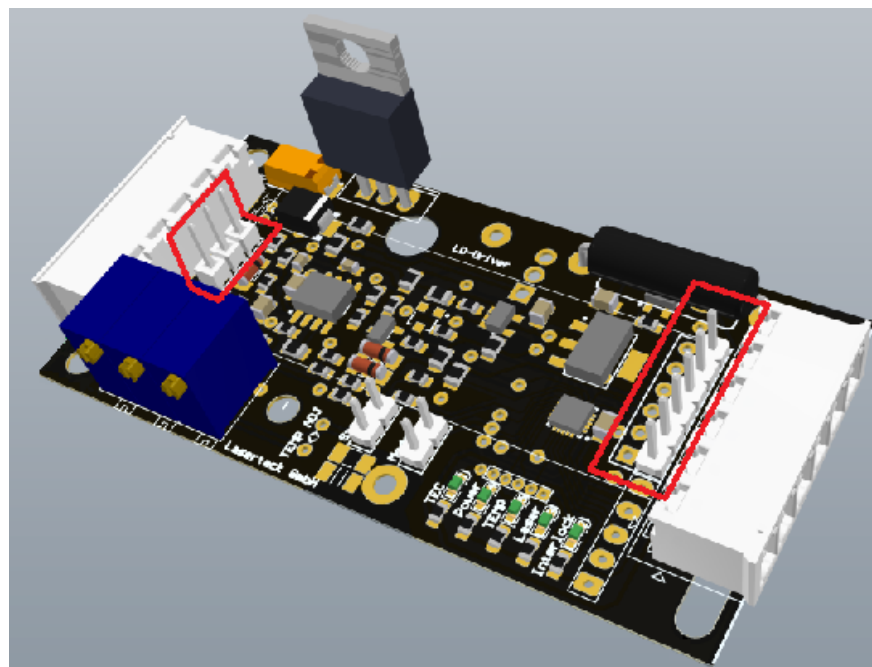
8.1 Connecting to the mainboard

Warning   Before mounting the TEC controller, the driver must be disconnected from the power supply. Mounting the driver while the supply voltage is still connected will may damage the laser which can also emit output power that is much higher than the rated power.

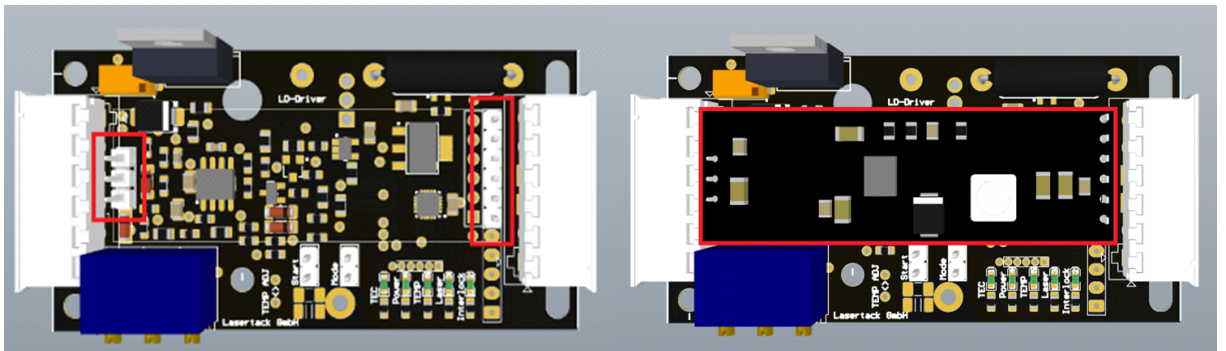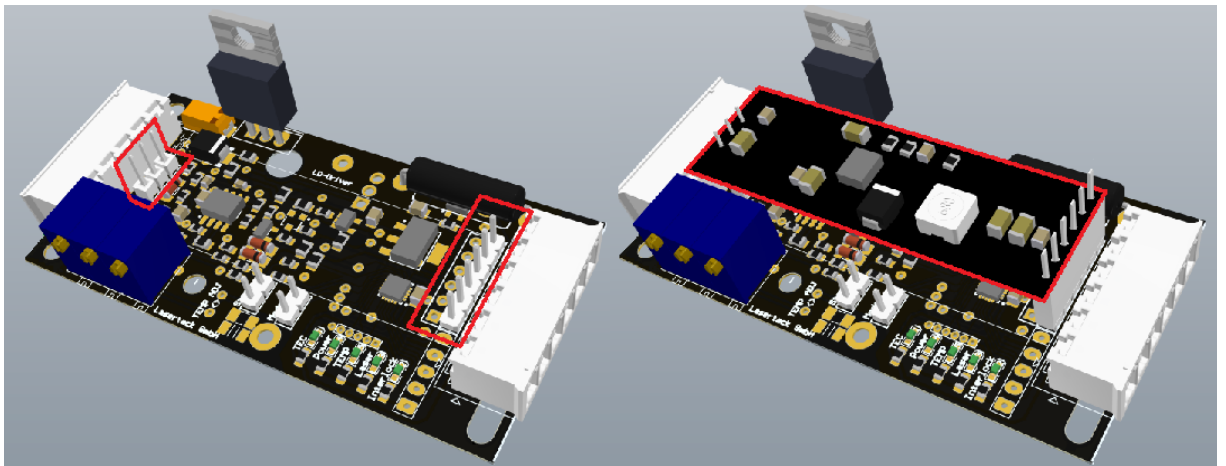The TEC controller has two different sockets on the bottom as shown in the figure below.
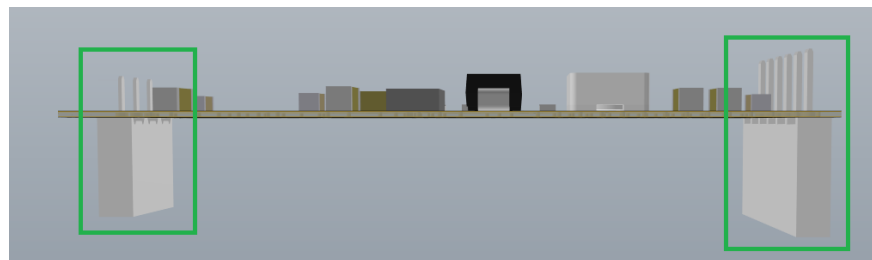
These sockets fit the marked pin strips on the driver board.

Plug the connectors of the TEC board into the corresponding connectors on the mainboard. Pay attention on not to reverse connection. Plug the short socket onto the short pin strip and the long socket onto the long pin strip.

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The following figures show the driver with and without TEC controller.

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8.2 Function of the TEC controller

The TEC controller regulates zhe output current depending on the value of the connected NTC and the setting of the **TEMP** potentiometer. The TEC driver output is active when the set nominal temperature is about to exceed. If the threshold temperature is reached and the laser is disabled, the TEC controller output will remain activate until the temperature is equal to the nominal temperature. The threshold temperature and the hysteresis temperature depend on the nominal temperature for the TEC controller and cannnot be adjusted separately.

8.3 Setting temperature with NTCAFLEX05103HH

• Disconnect the power supply from the driver.
• The setting of the temperature is done by turning the screw of the potentiometer "**TEMP**".
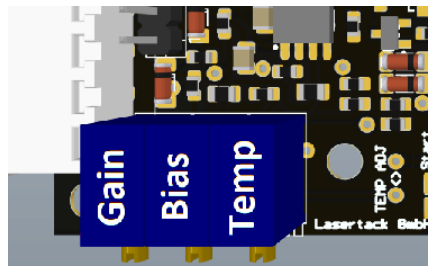
• To set the right temperature, please use the resistance values shown in the R/T table below.
• Measure the resistance at the points "**TEMP ADJ**" and set the resistance value shown in the R/T table. The testing points are two holes next to the "TEMP" potentiometer.
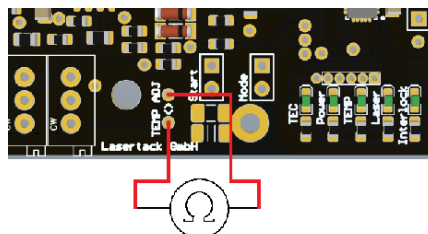
• Connect the power supply to the driver.

Attention   Diconnect the NTC from the driver before setting the temperature values. Setting the values with NTC connecte will lead in wrong setting.

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R/T values

| Temperature Nominal	Temperture Hysteresis	Temperature Threshold	R Pot
5	6	11	46,2085
10	13	17	36,1246
15	19	23	28,4575
20	25	29	22,5826
25	31	35	18,0488
30	36	41	14,5235
35	42	46	11,7635
40	47	51	9,5884
45	52	56	7,8631
50	57	61	6,4860
55	62	66	5,3803
60	67	71	4,4873
65	71	76	3,7619
70	76	80	3,1697
75	80	84	2,6837
80	84	88	2,2826
85	88	93	1,9504
90	92	96	1,6735
95	96	100	1,4420
100	100	104	1,2475

Note The resistor values shown in the table are only valid for the included 10k foil NTC. If you want to use a different 10k NTC the values need to adapted. Please follow the instructions in next chapter.
The distance between the laser diode, the NTC and the TEC needs to be chosen as short as possible. Otherwise the driver will not be able to keep the temperature stable and may oscillate.

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8.4 Setting temperature with other NTCs

- Disconnect the power supply.
- The setting of the temperature is done by turning the screw of the potentiometer „TEMP".
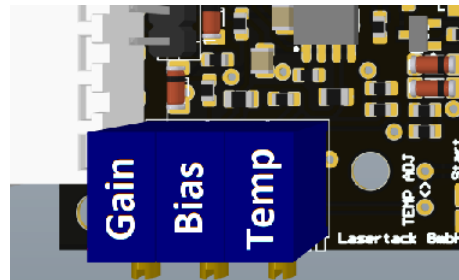
To calculate the needed resistance value for temperature threshold, determine the resistance of the NTC at the threshold temperature in the NTC datasheet. Calculate the required resistance by multiplying the NTC resistance at the threshold temperature by 2,3791.

$$R_{POT}=R_{(NTC@TEMP)}\cdot2,3791$$

- Measure the resistance at the points „**TEMP ADJ**" and set the resistance as calculated previously. The testing points are two throuh hole contacts next the "**TEMP**" potentiometer.
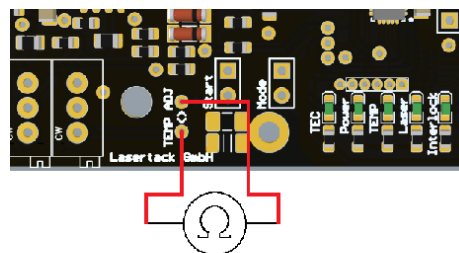
To calculate the hysteresis threshold temperature, divide the previously calculated resistance by 1,7034. This is the Value for the NTC resistance at the hysteresis threshold temperature. The hysteresis temperature is determined with the calculated resistance from the NTC datasheet.

$$R_{(NTC@TEMP)}=R_{POT}/2,004$$

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- The temperature difference between the two temperature points is set by the used NTC.
- Solder the NTC to the connecting cables. The polarity of the cables is not relevant.
- Connect the soldered NTC to the connecting port „**NTC**" on the board.
- The temperature control is set now.
- Connect the power supply to the driver.

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9 Appendix

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