

THORLABS

OEM Laser Diode Controller

ITC1xx

Operation Manual



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We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and improve our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

Warning

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

Attention

Paragraphs preceded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

Note

This manual also contains "NOTES" and "HINTS" written in this form.

Please read these advices carefully!

1 General Information

The Thorlabs ITC1xx OEM Laser Controller is a compact combined laser current and temperature controller for OEM applications on a single Euro-board (100 x 160 mm).

- Combined Current and TEC Controllers
- Maximum laser currents of 200 mA, 1 A, or 3 A
- Constant Current (CC) and Constant Power (CP) Modes
- Full PID feedback loop with independent P, I, and D Settings
- Extensive protection against laser diode damage (softstart, interlock, temperature window for the laser diode, hardware limitation of TEC and laser current, interlock)
- Overtemperature protection of the ITC1xx
- Supports Many Standard Pin Configurations for Easy Integration into Systems

1.1 Safety

Attention

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.

The used with the ITC1xx mains power supply must provide a galvanical isolation between AC mains input and DC output in order to avoid electric shock resulting in damage to your health or even death!

The used power supply as well as the ITC1xx must be connected properly to the protective earth ground.

The ITC1xx must not be operated in explosion endangered environments!

Refer servicing to qualified personnel!

Only with written consent from *Thorlabs GmbH* may changes to single components be made or components not supplied by *Thorlabs GmbH* be used.

This precision device is only serviceable if properly packed into the complete original packaging. If necessary, ask for a replacement package prior to return.

Warning

Laser emission is dangerous to human eye. Do not stare into the emitting aperture, wear protective glasses and observe the safety instructions supplied with the laser diode.

Attention

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the accompanying documentation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Standard ICES-003 for digital apparatus. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Thorlabs GmbH is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and

equipment other than those specified by Thorlabs GmbH. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.

The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

Attention

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

1.2 Ordering Codes and Accessories

ITC102	OEM Laser Diode and Temperature Controller, ± 200 mA / 12 W
ITC110	OEM Laser Diode and Temperature Controller, ± 1 A / 12 W
ITC133	OEM Laser Diode and Temperature Controller, ± 3 A / 18 W
ITC100D	Control and Display Panel for the ITC100 Series; removable
ITC100F	Front Plate for ITC100D
ITC100P	Female 64pin DIN Connector
CAB430	Cable for a LD and TEC Controller with 15-Pin D-Sub Connector to a Laser Diode Mount, 1.5 m

2 Getting Started

2.1 Parts List

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the ITC1xx mechanically and electrically.

Verify that you have received the following items within the package:

1. ITC102/110/133 OEM Laser Diode and Temperature Controller
2. Operating Manual

2.2 Operating Principle

The ITC1xx is an 100 x 160 mm board level controller that combines a low-noise, low-drift current source with a precise TEC controller. Designed for easy integration into OEM applications, these euro-sized boards are ideal for products or systems where excellent laser emission stability is required. The analog interfaces offer easy access to parameter settings and readout.

These laser diode controllers support constant current (CC) and constant power (CP) modes, as well as all laser and monitor diode polarities (CG/AG). The connected laser interfaces with the controller through a 15-pin D-Sub connector. A fixed-ground-level design significantly improves noise, transient suppression, and output stability. The laser operating current can be modulated by an external control signal.

The built-in temperature controller includes a full PID feedback loop with independent P, I, and D settings, which can be individually optimized. A wide variety of temperature sensors (such as [thermistors](#) and the [AD590](#) temperature transducer) are supported. A standard 64-pin PCB connector provides access to output signals, analog control inputs, power supply connections, temperature sensors and thermoelectric cooler elements.

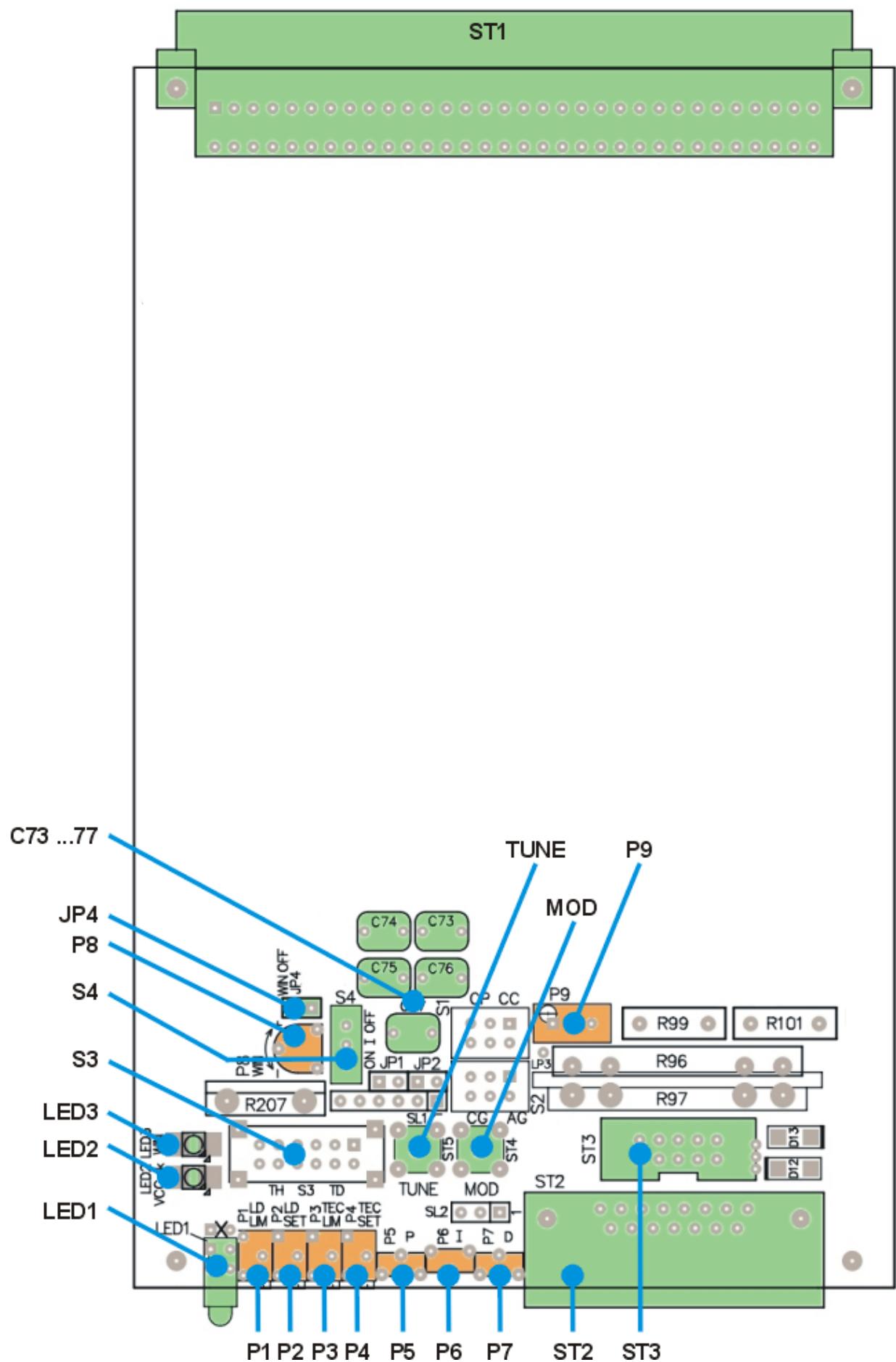
A variety of safety measures allows an easy and safe operation of semiconductor laser diodes.

- Softstart
- Interlock
- Hardware laser current limit
- Hardware TEC current limit
- Over temperature protection
- Temperature window for the laser diode
- Power supervision

Other features:

- Constant current or constant power mode
- Bipolar operation of laser diodes
- 2 mA floating photo current input
- Modulation input
- Individual TEC controller PID adjustment possible
- Thermistor or AD590/LM335 temperature sensor selectable
- Temperature tune input
- Analog control output for ILD, ILIM, IPD, TSET, TACT, ITLIM, ITEC

2.3 Operating Elements



Potentiometers

- P1 Sets the laser diode limit current
- P2 Adjusts the laser set current or power (depending on CC or CP Mode)
- P3 Sets the TEC current limit
- P4 Adjust the set temperature (transducer) or resistance (thermistor)
- P5 TEC P share
- P6 TEC I share
- P7 TEC D share
- P8 Define the TEC temperature window
- P9 For CMR adjustment. Should not be changed by the user.

Switches

- S1 Laser current controller mode
Switch to the left = constant power mode (CP)
Switch to the right = constant current mode (CC)
- S2 Laser diode polarity
Switch to the left = cathode grounded (CG)
Switch to the right = anode grounded (AG)
- S3 Temperature sensor selection
Switch to the left = thermistor
Switch to the right = transducer (AD590 etc.)
- S4 TEC I share ON/OFF
Switch towards ST2 = TEC I share ON
Switch towards ST1 = TEC I share OFF.

Jumper

- JP1 Bias+ Jumper closed: bias+ connected to ST2 Pin 12¹⁾
Jumper open: bias+ disconnected from ST2 Pin 12¹⁾
- JP2 Bias- Jumper closed: bias- connected to ST2 Pin 9¹⁾
Jumper open: bias- disconnected from ST2 Pin 9¹⁾
- JP4 TEC window Jumper closed: TEC window OFF
Jumper open: TEC window ON

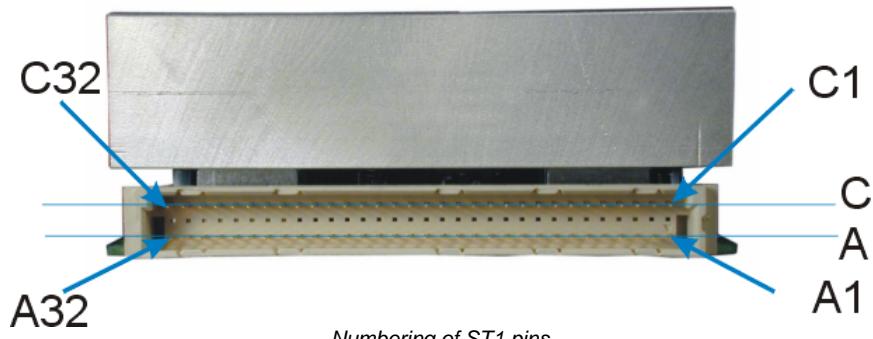
¹⁾ For compatibility with Thorlabs laser diode mounts

LEDs

- LED1a Laser ON (Upper LED)
- LED1b TEC ON (Lower LED, closest to the PCB)
- LED2 Power Supply OK
- LED3 TEC temperature out of window

3 Connecting Elements

3.1 ST1 I/O Connector 64 pin



C1	A1
C2	A2
C3	A3
C4	A4
TEC - (ground)	TEC - (ground)
TEC +	TEC +
AD 590+	AD 590-
Thermistor	Thermistor ground
GND	GND
ITEC	ITEC LIM
Tact/Ract	Delta T/R
Tset/Rset	T-Tune
TEMP ERR	TEC ON out
OTP	TEC ON in
Digital ground	GND
LD ON in	LD MOD
LD ON out	GND
INTERLOCK	GND
LIMIT LD	TTL MOD
ILD LIM	ILD
GND	GND
Bias +	Bias -
Mon. Diode Anode	Mon. Diode Cathode
LD Anode	LD Anode
LD Ground	LD Ground
LD Cathode	LD Cathode
Supply +	Supply +
Supply Ground	Supply Ground
Supply -	Supply -
C32	A32

Short Description of ST1 Pin Assignment

The following table lists the pin assignment of ST1 with respect to their functionality.

Power Supply

Pin	Function	Range / Coefficient		
		ITC102	ITC110	ITC133
A30,C30	Supply voltage +11.4 V to +15.8 V	2.4 A ¹⁾	3.2 A ¹⁾	3.2 A ¹⁾
A31,C31	Supply voltage ground			
A32,C32	Supply voltage -11.4 V to -15.8 V	2.4 A ¹⁾	3.2 A ¹⁾	3.2 A ¹⁾
A8, C8, A14, A16, A18, A21, C21		Analog measurement ground		

Analog Signals

Pin	Function	Range / Coefficient		
		ITC102	ITC110	ITC133
Temperature Controller				
A4,C4	TEC - (GND)		$\pm 2 \text{ A}$ max. $\pm 6 \text{ V}$	$\pm 2 \text{ A}$ max. $\pm 6 \text{ V}$
A5,C5	TEC +			$\pm 3 \text{ A}$ max. $\pm 6 \text{ V}$
C6	AD590 +		$-20 \text{ to } +80 \text{ }^\circ\text{C} / 253.2 \text{ to } 353.3 \mu\text{A}$ $1 \mu\text{A}/\text{ }^\circ\text{C}$	
A6	AD590 -			
A7	Thermistor (GND)		$100 \Omega \text{ to } 80 \text{ k}\Omega$	
C7	Thermistor			
C9	I_{TEC} (Measurement voltage; -5 to +5 V)	2.5 V/A	2.5 V/A	1.667 V/A
A9	$I_{\text{TEC, LIM}}$ (Measurement voltage; 0 to +5 V)	2.5 V/A	2.5 V/A	1.667 V/A
A10	$\Delta T / \Delta R$ (Measurement voltage; -5 to +5 V)	$0.5 \text{ V}/\text{ }^\circ\text{C}$ (transducer) $-0.5 \text{ V}/\Omega$ (thermistor)		
C10	$T_{\text{act}} / R_{\text{act}}^2$ (Measurement voltage)	$-1 \text{ to } +4 \text{ V} / 50 \text{ mV}/\text{ }^\circ\text{C}$ (transducer) $+5 \text{ mV} \text{ to } +4 \text{ V} / 50 \text{ mV}/\text{k}\Omega$ (thermistor)		
C11	$T_{\text{set}} / R_{\text{set}}$ (Measurement voltage)			
A11	T_{tune} (Control voltage; -5 to +5 V)	$20 \text{ }^\circ\text{C}/\text{V}$ (transducer) $16 \text{ k}\Omega/\text{V}$ (thermistor)		
Laser Diode Current Controller				
A15	LD Modulation Input (-5 to +5 V)	40 mA/V	200 mA/V	600 mA/V
A19	I_{PD}^2 (Measurement voltage; 0 to +5 V)	2.5 V/mA		
A20	I_{LD}^2 (Measurement voltage) 0 to +5 V (CG) / 0 to -5 V (AG)	25 V/A	5 V/A	1.667 V/A
C20	$I_{\text{LD, LIM}}$ (Measurement voltage; 0 to +5 V)	25 V/A	5 V/A	1.667 V/A
A22	Output PD Bias -	-5 V const.		
C22	Output PD Bias +	$+5 \text{ V const.}$		
A23	Monitor (Photo) Diode Cathode	0 to 2 mA (floating; differential input)		
C23	Monitor (Photo) Diode Anode			
A24,C24	Laser Diode Anode (CG)	+0.2 A max. 4 V	+1.0 A max. 4 V	+3.0 A max. 4 V
A25,C25	Laser Diode GND			
A26,C26	Laser Diode Cathode (AG)	-0.2 A max. 4 V	-1.0 A max. 4 V	-3.0 A max. 4 V

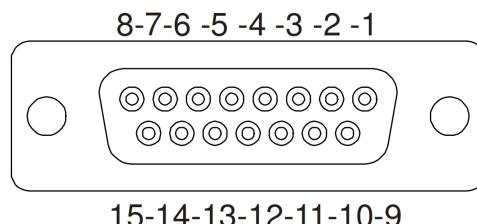
¹⁾ Without display module ITC100D

²⁾ If a long connection cable is attached to this output, a 1 kΩ resistor should be inserted in series as close as possible to the output pin.

Digital Signals

Pin	Function	Logical Level
Temperature Controller		
A13	TEC ON control input	H = TEC On
A12	TEC ON control output (open collector)	L = TEC on
C12	TEMP ERROR output (open collector)	L = Temperature window exceeded
C13	OTP output (open collector)	L = Heat sink over-temperature
C14	Digital GND (Common pin for all digital signals)	
Laser Diode Current Controller		
C15	LD ON control input	H = Laser on
A17	TTL MOD input	H = Laser on
C16	LD ON control output (open collector)	L = Laser on
C18	LIMIT LD control output (open collector)	L = Laser current limit reached
C17	Interlock	Interlock = CLOSED when connected to C17 ($R \leq 430 \Omega$)

3.2 ST2 I/O D-SUB Connector 15 pin



The following table lists the pin assignment of ST2 with respect to their functionality.

Pin	Function	Range		
		ITC102	ITC110	ITC133
Temperature Controller				
8	TEC - (GND)	± 2 A max. ± 6 V	± 2 A max. ± 6 V	± 3 A max. ± 6 V
7	TEC +			
6	AD590 +	-20 to $+80$ °C / 253.2 to 353.3 µA		
13	AD590 -			
14	Thermistor (GND)	100 Ω to 80 kΩ		
15	Thermistor			
Laser Diode Current Controller				
11	Laser Diode Anode (CG)	$+0.2$ A max. 4 V	$+1.0$ A max. 4 V	$+3.0$ A max. 4 V
3	Laser Diode GND			
10	Laser Diode Cathode (AG)	-0.2 A max. 4 V	-1.0 A max. 4 V	-3.0 A max. 4 V
2	Monitor (Photo) Diode Cathode	0 to 2 mA (floating; differential input)		
4	Monitor (Photo) Diode Anode			
9	Output PD Bias - (set with JP2)	-5 V const.		
12	Output PD Bias + (set with JP1)	$+5$ V const.		
1	Interlock	Interlock = CLOSED when connected to pin 5 ($R \leq 430$ Ω)		
5	Interlock GND			

3.3 ST3 Display Module Connector

Pin	Function
1	-9 V (not in use)
2	0 V Power supply for ITC100D
3	+5 V Power supply for ITC100D
4	Output IPD_DISP
5	Output ILD_DISP
6	Output ILDLim_DISP
7	Output TSET_DISP
8	Output TACT_DISP
9	Output ITECLim_DISP
10	Common ground for pin 4 to pin 9

3.4 ST4 and ST5 SMB Coaxial Connectors

	Function	Coefficient		
		ITC102	ITC110	ITC133
ST4	Laser Diode Modulation Input LD MOD (-5 V to +5 V)	40 mA/V	200 mA/V	600 mA/V
ST5	Temperature Tune Input T TUNE (-5 V to +5 V)	20 °C/V (transducer) 16 kΩ/V (thermistor)		

4 Operating Instruction

4.1 Connecting the Power Supply

The ITC1xx OEM board requires a supply voltage of \pm (12 ... 15) V for internal operation and for power supply of the laser diode and the TEC element.

The power supply must be regulated and free of ripple. The voltage must not exceed the range of \pm (11.4 ... 15.8) V. Lower voltages will cause the unit to operate improperly, higher voltages may damage the ITC1xx.

The power supply must be able to deliver the following current, both for the positive and negative supply voltage:

ITC102: 2.4 A

ITC110: 3.2 A

ITC133: 3.2 A

Note

Above current values are given without respect to power consumption of the ITC100D display module, if used.

Note

The total combined output current for the ITC133 is limited by the total thermal dissipation loss. With the standard heat sink, the total output current should be limited to 3 A ($I_{LD} + I_{TEC} \leq 3$ A). An optimized cooling, e.g. using a fan or a bigger heat sink, allows 3 A LD current and 3 A TEC current at the same time, provided that the power supply can deliver 6.1 A.

Note

With ± 15 V power supply and high output currents, the internal power dissipation of the ITC1xx increases significantly. This may cause a degradation of the specifications. In such cases the use of a ± 12 V supply is recommended.

The increase of the heat sink temperature for a vertically installed ITC1xx board without forced air cooling can be calculated as follows:

$$\Delta T = [(U_S - U_{LDC,out}) \times I_{LDC,out} + (U_S - U_{TEC,out}) \times I_{TEC,out} + 2.5W] \times 1.6 \frac{^{\circ}C}{W}$$

(U_S = Supply voltage)

Example:

$I_{TEC,out} = 2$ A; $U_{TEC,out} = 2.5$ V; $I_{LDCOUT} = 0.2$ A; $U_{LDCOUT} = 2$ V; $U_S = \pm 12$ V

This results in an temperature increase $T = 37.6$ K. At 25 °C ambient temperature the heat sink temperature reaches 62.6 °C.

Note

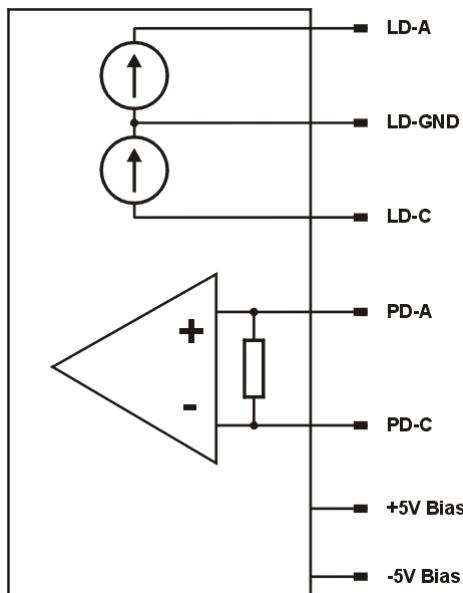
Using the ITC1xx with the display module ITC100D leads to an additional increase of the heat sink temperature for about 3 K.

The horizontal mounting of the ITC1xx board degrades the heat dissipation, so that the heat sink temperature increases! Forced air cooling may be required.

The maximum heat sink temperature is +85° C. When this limit is exceeded, the over-temperature protection activates and switches off the TEC and LDC outputs. The controller can be switched on again only after the temperature has dropped by about 10° C.

4.2 Connecting Laser Diode and Photo Diode

The ITC1xx OEM controllers are designed to drive laser diodes up to a maximum current of 0.2 A, 1 A or 3 A, depending on the type, either with laser diode anode or cathode grounded.



The laser diode is always sourced with respect to ground. Compared to a floating driver stage, this operation mode is advantageous with respect to laser diode protection and to the stability of the laser current.

The photodiode can be used either floating, or with anode or cathode grounded. Additionally, a bias voltage can be applied.

Connect the laser diode and the photodiode using shielded, twisted pair cables. The anode and cathode connection of each device should be twisted.

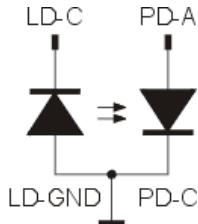
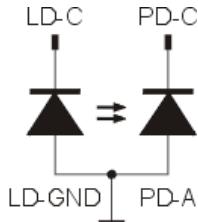
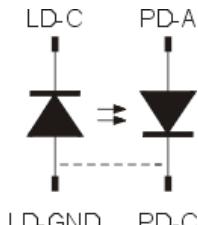
Warning

Disconnecting the laser diode during operation may destroy the laser diode!

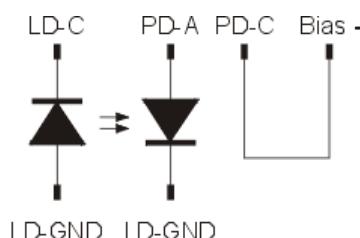
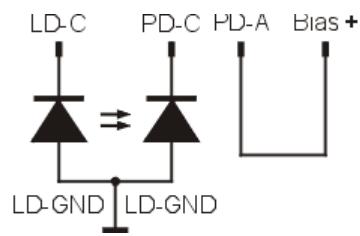
Below are shown possible configurations of the laser and monitor (photo) diode combination and the connection scheme to the output connectors ST2 or ST1.

AG = Anode Grounded

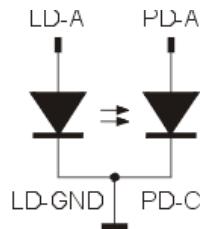
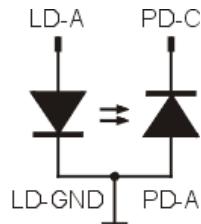
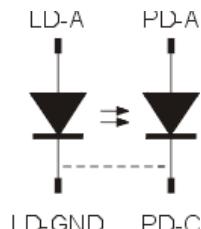
CG = Cathode Grounded

Laser diode AG, photo diode CG, no bias:**Laser diode AG, photo diode AG, no bias:****Laser diode AG, photo diode floating, no bias:**

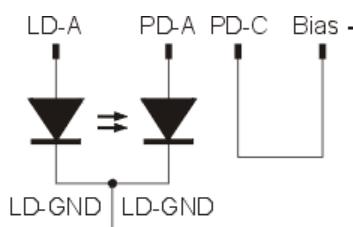
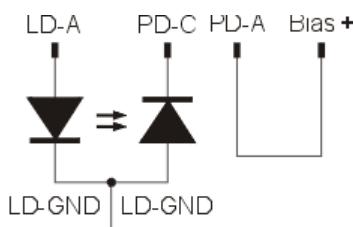
The connection, shown as dashed line, can be made either at the laser or at the ITC1xx connector.

Laser diode AG, photo diode CG, -5 V bias:**Laser diode AG, photo diode AG, +5 V bias:****Attention**

Reverse connection of the photo diode can permanently damage the photo diode when using a bias voltage. Check the control voltage output I_{PD} ([A19](#)) prior to enabling a bias voltage. The output voltage must be positive!

Laser diode CG, photo diode CG, no bias:**Laser diode CG, photo diode AG, no bias:****Laser diode CG, photo diode floating, no bias:**

The connection, shown as dashed line, can be made either at the laser or at the ITC1xx connector.

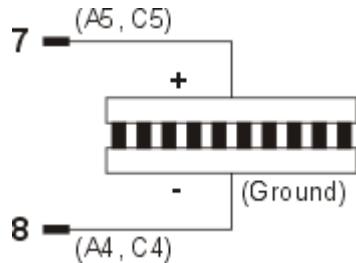
Laser diode CG, photo diode CG, -5 V bias:**Laser diode CG, photo diode AG, +5 V bias:****Attention**

Reverse connection of the photo diode can permanently damage the photo diode when using a bias voltage. Check the control voltage output I_{PD} ([A19](#)) prior to enabling a bias voltage. The output voltage must be positive!

4.3 Connecting TEC and Temperature Sensor

In the drawings below, the bold **pin numbers** correspond to the numbering of the 15 pin D-Sub [connector ST2](#), while pin numbers in (parantesis) correspond to the pin numbering of the 64 pin [connector ST1](#).

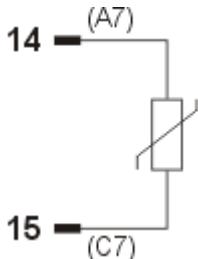
Connecting the TEC Element



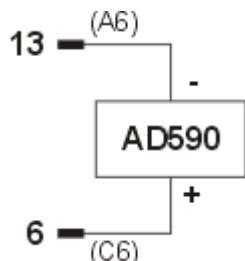
Attention

Make sure that the polarity of the TEC element (Peltier) is correct! Otherwise, the temperature will run into the wrong direction, this way leading to a thermal damage of the laser diode!

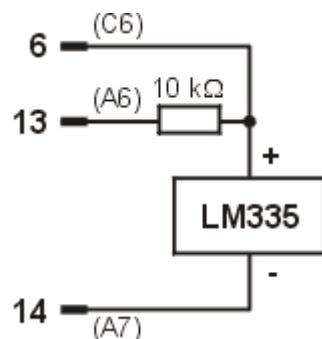
Connecting a thermistor (NTC temperature sensor)



Connecting an AD590 temperature sensor



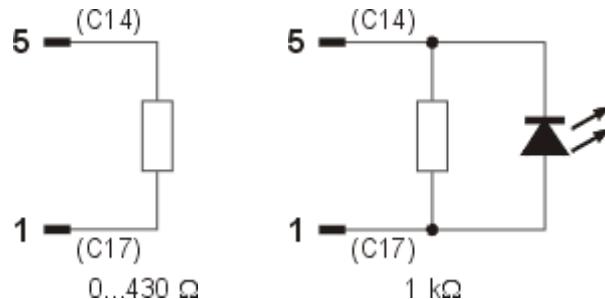
Connecting a LM335 temperature sensor



4.4 Connecting the Interlock

The interlock represents a current source (output pin 1 of ST2 resp. C17 of ST1), with the return pin 5 (ST2) or C14 (ST1). The voltage between pin 1 and 5 (or C14 and C17) is observed and used for enabling / disabling the output of the laser current controller.

Below are shown possible external connections to the interlock:



The voltage across the interlock pins must not exceed ~ 2.5 V, otherwise the interlock is considered as open. For this reason, the resistance of the external interlock circuit must be between 0 and $430\ \Omega$.

It is also possible to connect an LED (current through the LED is about 3.5 mA) as shown in the right diagram. In this case the LED serves as an additional signal that the laser current is switched on.

When the laser current is switched on, the interlock is checked - if it is open, the laser cannot be switched on. If the interlock is interrupted during laser operation, the laser is shut down immediately, so the interlock circuit can be used for emergency switch-off of the laser current as well.

When using the ITC1xx with Thorlabs laser diode mounts, the interlock function is provided by the mount. For details please see the Operation Manual of the used laser diode mount.

4.5 Polarity Check of the TEC

Preconditions

- Connect TEC element and temperature sensor (see section [Temperature Controller](#)). The sensor must have good thermal contact to the active surface of the TEC element.
- Switch on the ITC1xx.
- Select the correct type of sensor ([switch S3](#)).
- Set the appropriate value¹⁾ for $I_{TEC,LIM}$, using the potentiometer [P3](#) (measured at [pin A9 of ST1](#)).

Polarity check of the TEC element

- Adjust the temperature set point T_{SET} or R_{SET} using the potentiometer [P4](#) (measured at [pin C11 of ST1](#)) a few degrees away from the actual room temperature.
- Observe T_{ACT} or R_{ACT} ([ST1 pin C10](#)) and switch on the module.
- If T_{ACT} or R_{ACT} runs away from the set point, the TEC element is reverse poled. Change polarity and repeat the procedure.
- If T_{ACT} or R_{ACT} is oscillating around the set point, the TEC element is connected correctly, but the [P-, I- and D share](#) values of the control loop need to be adjusted.
- If T_{ACT} or R_{ACT} is settling properly to the set point, the TEC element has been connected correctly, however the values for the P-, I- and D share of the control loop might still need to be adjusted (Refer to section [PID Adjustment](#)).

¹⁾ The total combined current for the ITC133 is limited by the total thermal dissipation loss. When the standard heat sink is used, the total output current should be limited to 3 A ($I_{LD} + I_{TEC} \leq 3$ A). Optimized cooling by fan or bigger heat sink allows 3 A LD and 3 A TEC at the same time under the condition that the power supply provides 6.1 A.

4.6 Operation

Switch the ITC1xx module On/Off

The laser current and the temperature controller are switched on and off by logic signals. These signals are applied to the [64 pin connector ST1](#):

- pin C15: Laser current controller - H = On; L = Off
- pin A13: Temperature controller - H = On; L = Off

Voltage levels:

- $+2.0 \text{ V} \leq H \leq +25.0 \text{ V}$
- $L \leq +1.1 \text{ V}$

Either TTL or CMOS signals can be applied, as well as the positive supply voltage can be used. The input resistance is about $10 \text{ k}\Omega$.

Note

Please remember that the interlock circuit must be closed to enable the switch-on of the laser current.

Setting a Temperature Window

A temperature window can be enabled in order to protect the laser diode.

- The temperature controller must not be switched on!
- Keep your temperature sensor on a constant temperature.
- Adjust the temperature set point T_{SET} or R_{SET} using the potentiometer [P4](#) (measured at [pin C11 of ST1](#)) in such a way that the difference between actual and set temperature corresponds to the desired temperature window.
- Now remove [jumper JP4](#) and set potentiometer P8 fully clockwise (window = infinite).
- Rotate P8 slowly counter clockwise until LED3 lights up.
- The ITC1xx now is running in temperature protection mode.

4.7 PID Adjustment

A temperature control loop works comparably slow. Regulation oscillations have a period in the range of seconds.

The PID adjustment will optimize the dynamic behavior. The ITC1xx temperature controller allows the three control loop parameters P, I and D to be set independently from 5% to 100%.

Example of a PID adjustment

Pre-condition:

All limit values are set correctly, all polarities are correct, all set and relevant calibration values are entered, ambient temperature is about 20 °C.

- Switch off the I share ([switch S4](#) to OFF).
- Set the P, I and D share to minimum (turn P5, P6 and P7 fully counter clockwise).
- Observe the actual temperature T_{ACT} or the actual thermistor resistance R_{ACT} ([ST1 pin C10](#)) and switch on the temperature controller.

P share

- Change the set temperature repeatedly between about 18 °C and 22 °C while observing the settling behavior of the actual temperature.
- Increase the P share gradually. Higher values will increase the settling speed, too high values lead to regulation oscillations.
- The P share has been set correctly if after only 2-3 overshoots the actual temperature remains stable close to the set temperature.

D share

- Change the set temperature repeatedly between about 18 °C and 22 °C while observing the settling behavior of the actual temperature.
- Increase the D share gradually. Higher values will decrease the amplitude of the overshoots.
- The D share is set correctly when the actual temperature remains stable close to the set temperature after a minimum of overshoots.

I share

- Turn on the I share ([switch S4](#) to ON).
- Change the set temperature repeatedly between about 18 °C and 22 °C while observing the settling behavior of the actual temperature.
- Increase the I share gradually. Higher values will accelerate the settling to the set temperature.
- The I share is set correctly when the actual temperature reaches the set temperature in shortest time without overshoots.

Note

In case of a high thermal load, the adjustment ranges of the I and D shares might be insufficient. The adjustment range can be increased by using [additional foil capacitors](#): C73 for the D share and C75,C76 and C77 for the I share, typically 0.47 µF to 3.3 µF.

5 Connecting Scheme Examples

Below are given some examples of how to connect the ITC1xx.

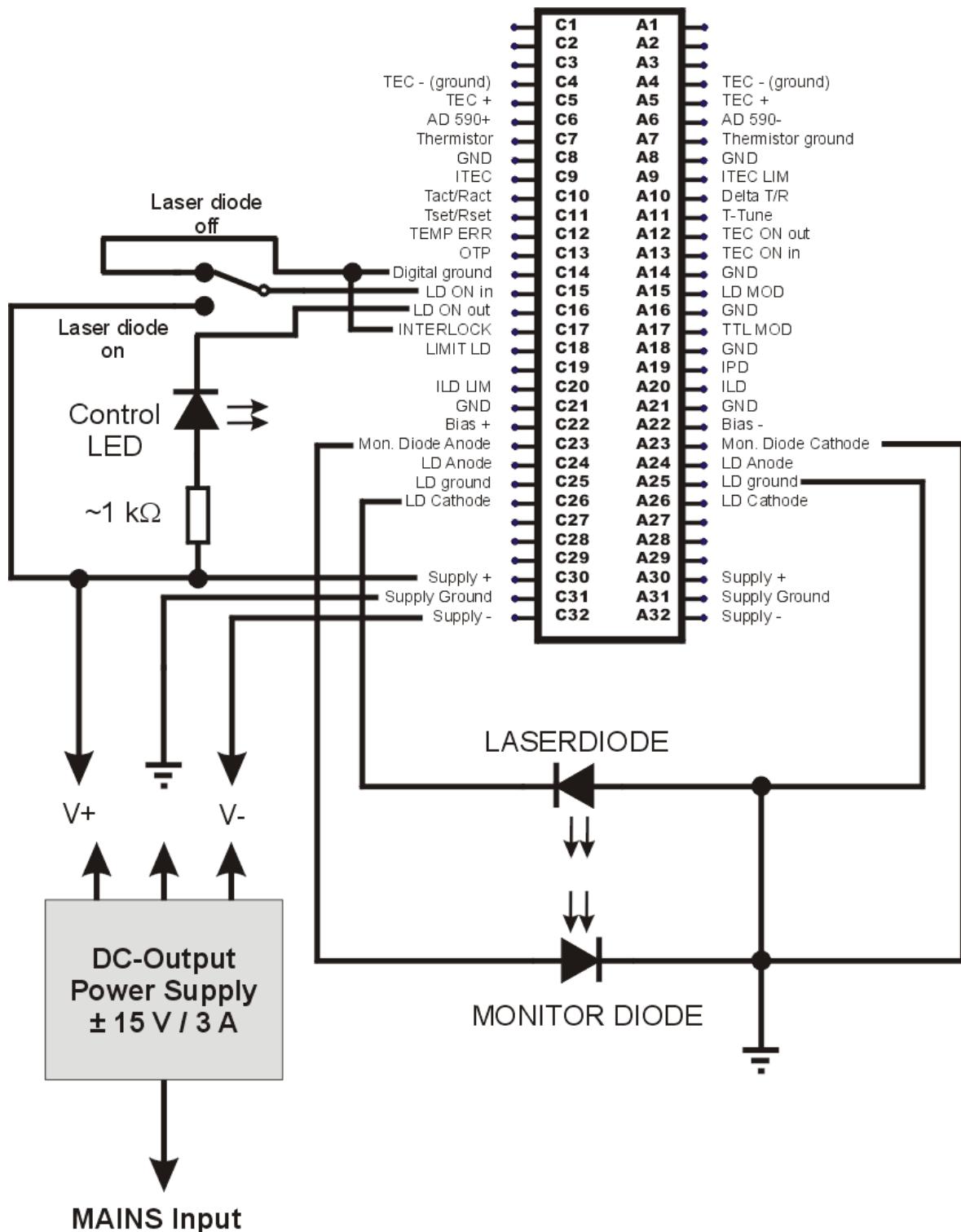
The 64 pin connector ST1 allows to establish all necessary connections. This is advantageous when using the ITC1xx in OEM applications.

Alternatively, the laser, the monitor diode, the temperature sensor, the TEC and the interlock connection can be made through the 15 pin DSUB connector ST2. This way, a Thorlabs laser diode mount can be connected directly using the CAB430 cable (to be ordered separately).

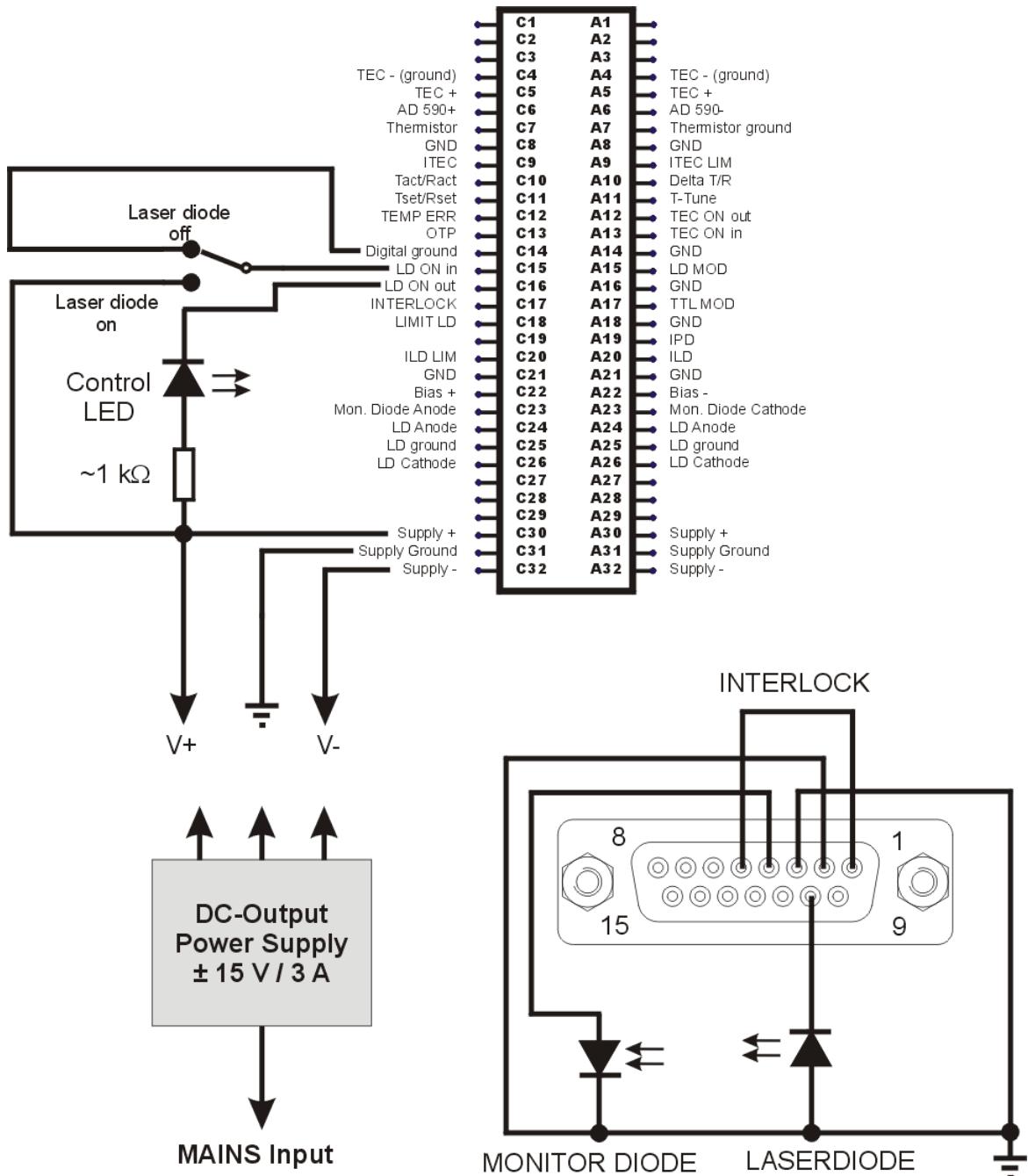
Below are given some schematic examples how to connect peripherals to the ITC1xx for the case of using ST1 only, and for the case using both the ST1 and ST2 connectors.

For clearness reasons, the connections of the the laser current controller and the temperature controller are separated.

5.1 Laser Diode Controller

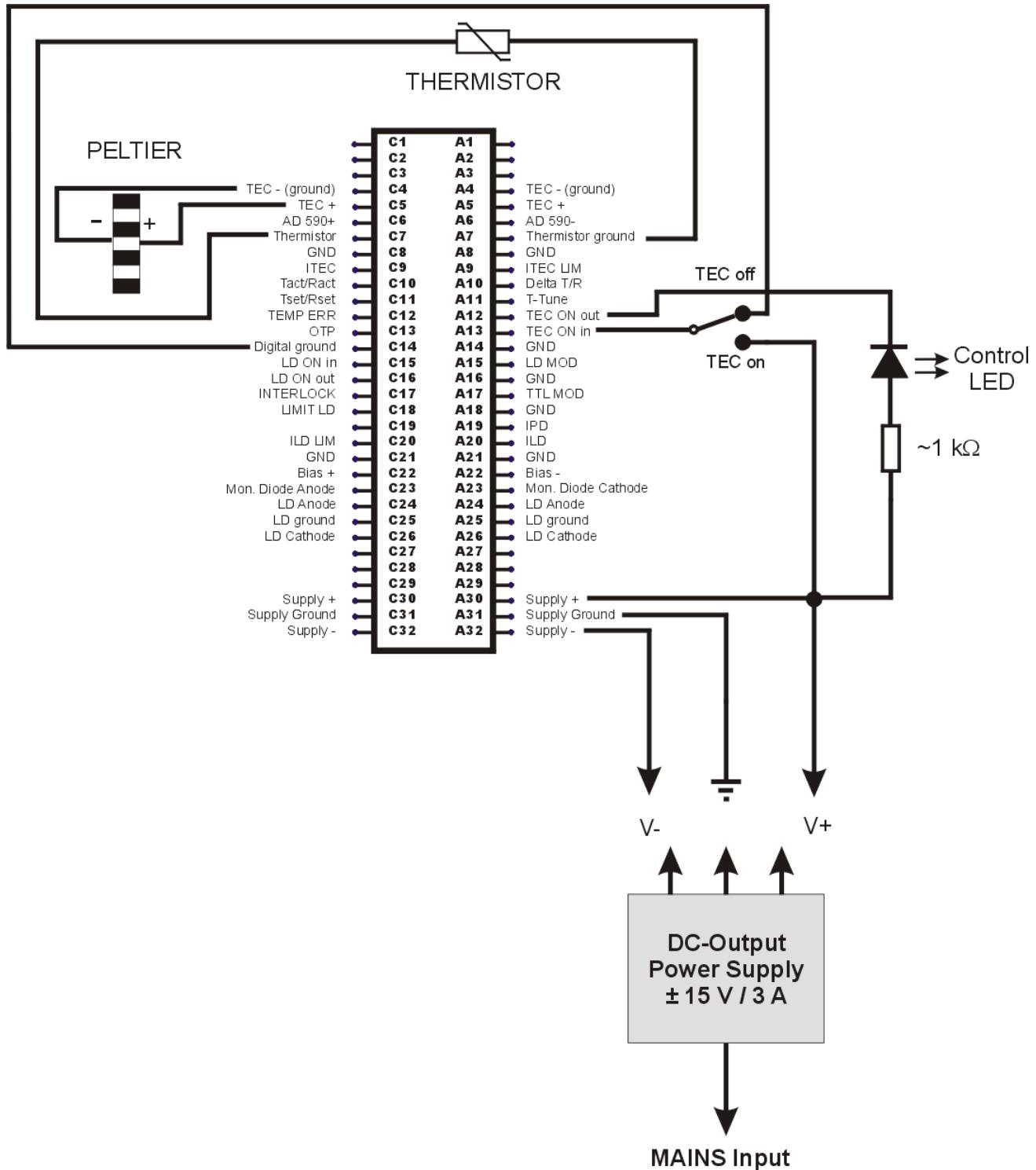


In the above schematic diagram a laser diode (AG - anode grounded) and a monitor (photo) diode (CG - cathode grounded) are connected to the 64 pin ST1.

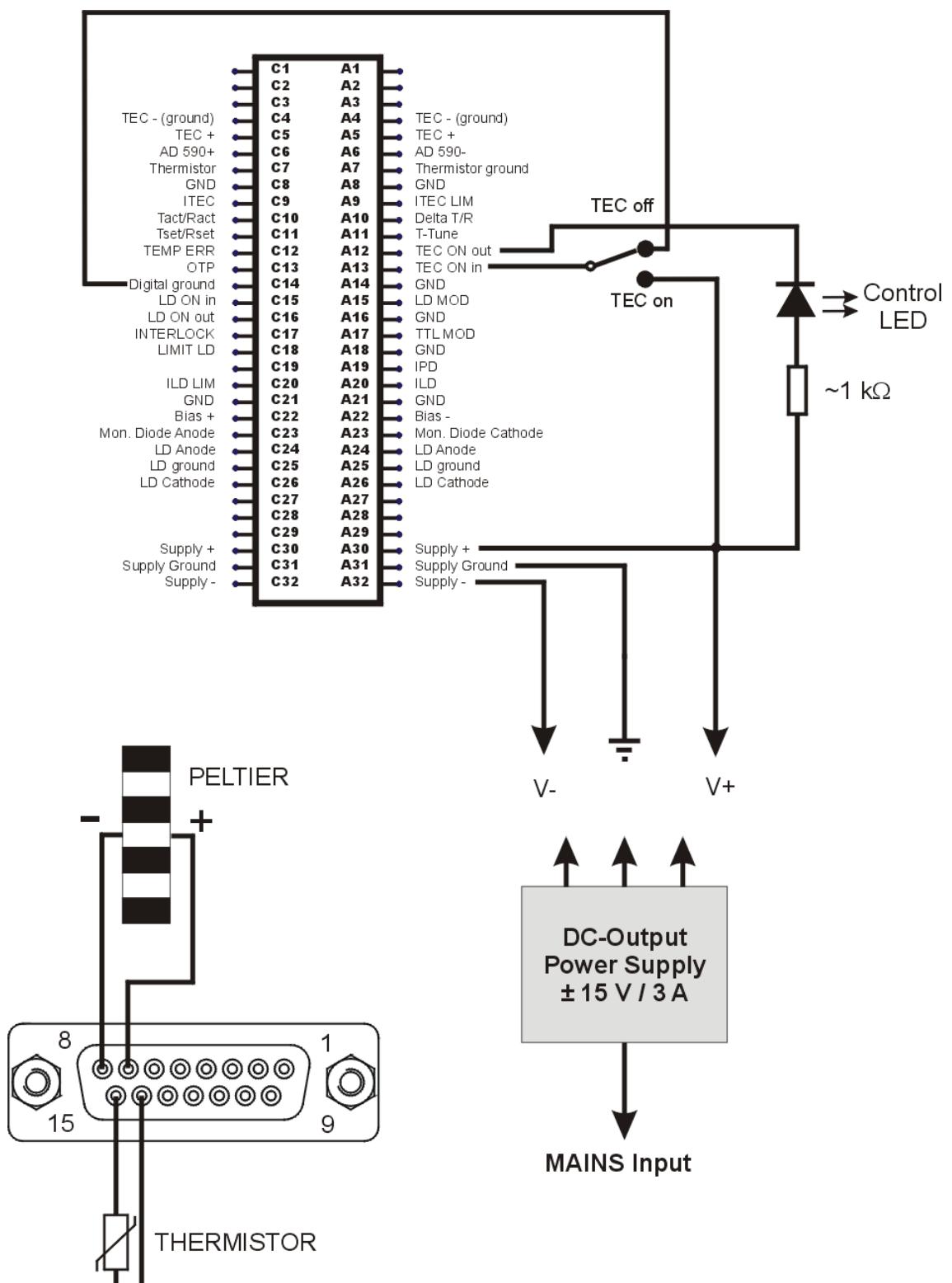


In the above schematic diagram a laser diode (AG - anode grounded) and a monitor (photo) diode (CG - cathode grounded) are connected to the 15 pin DSUB connector ST2.

5.2 Temperature Controller



In the above schematic diagram a TEC element (Peltier) and a thermistor temperature sensor are connected to the 64 pin ST1.



In the above schematic diagram the TEC element (Peltier) and the thermistor temperature sensor are connected to the 15 pin DSUB connector ST2.

6 Display Module ITC100D

Thorlabs GmbH offers an optional ITC100D display module that can be mounted directly to the ITC1xx board. The ITC100D module can be covered using the optional [ITC100F front panel](#).



An numeric 3½ digit display with selectable by the user decimal point position will display the selected by the rotary switch parameter. Below the parameters are listed in the order when turning the rotary switch from the left to the right stop:

- Monitor (photo) diode current I_{PD}
- Laser diode current I_{LD}
- Laser diode current limit $I_{LD,LIM}$
- Temperature set point T_{SET} (transducer) or R_{SET} (thermistor)
- Actual temperature T_{ACT} (transducer) or R_{ACT} (thermistor)
- TEC current limit $I_{TEC,LIM}$

6.1 Preparing the ITC100D

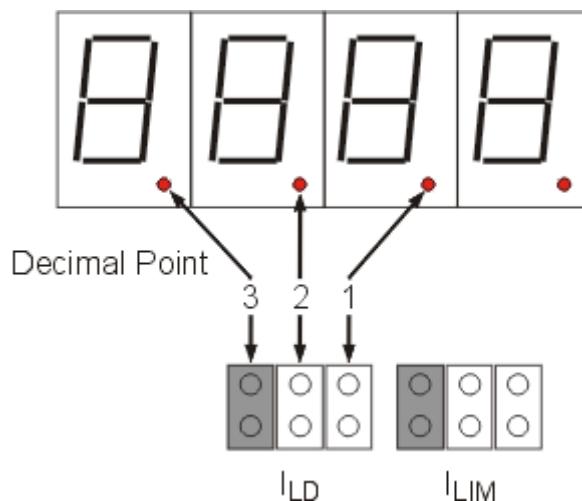
The ITC100D can be mounted directly to the ITC1xx board. Fix the display module to the threaded holes in the heat sink using the included two screws and distance holders.

Alternatively, the ITC100D can be mounted separately.

Insert the ribbon cable connector of the ITC100D into ST3 of the ITC1xx board.

6.2 ITC100D Jumper Settings

On the ITC100D PCB are two jumper banks (see [red marking](#)) that allow to set the position of the decimal point for the display according to the type of ITC1xx.



Set the jumpers depending on the ITC1xx type as listed below:

ITC1xx Type	Position of jumper " I_{LD} "	Position of jumper " I_{LIM} "
ITC102	1	1
ITC110	3	3
ITC133	2	2

This results in the following units for the six selectable parameters:

Parameter	ITC102	ITC110	ITC133
I_{PD}	mA	mA	mA
I_{LD}	mA	A	A
$I_{LD,LIM}$	mA	A	A
T_{SET} / T_{ACT} (transducer)	°C	°C	°C
R_{SET} / R_{ACT} (thermistor)	kΩ	kΩ	kΩ
$I_{TEC,LIM}$	A	A	A

6.3 ITC100D Adjustment

The ITC100D is factory adjusted. However, in order to ensure the best display accuracy, it is recommended to re-adjust it from time to time.

The adjustment is carried out at a single set point, using the [adjustment potentiometers P1 to P6](#):

P1 - Adjust I_{PD}

Inject a known current from an external source into the photo current input (pins [A23 and C23 of ST1](#)). The current should be about 90% of full scale.

Use P1 to adjust the display reading to the input current value.

P2 - Adjust I_{LD}

Set the laser controller to constant current mode. Adjust the laser current limit to maximum current and the laser current setting to about 90% of maximum current. Connect an ampere meter to the laser output pins.

Use P2 to adjust the ITC100D reading to the measured output current.

P3 - Adjust $I_{LD,LIM}$

Set the laser controller to constant current mode. Adjust the laser current limit to about 90% of maximum current and the laser current setting to maximum current. Connect an ampere meter to the laser output pins

Use P3 to adjust the ITC100D reading to the measured output current.

P5 - Adjust T_{ACT}

Set the temperature sensor to a well defined temperature and adjust the ITC100D reading to that temperature using P5.

P4 - Adjust T_{SET}

Adjust the set temperature to about 90% of the full scale value. Turn on the temperature control and wait until temperature has settled. Read the actual temperature T_{ACT} , switch to T_{SET} and bring the reading in accordance with T_{ACT} using the potentiometer P4.

Note

T_{ACT} must be calibrated first!

P6 - Adjust $I_{TEC,LIM}$

Connect an ampere meter to the TEC output pins. Adjust the TEC current limit to about 90% of full scale. Adjust the temperature set point to a significant higher value and turn on temperature control.

Adjust the $I_{TEC,LIM}$ reading to the ampere meter value using P6.

7 Maintenance and Service

Protect the ITC1xx from adverse weather conditions. The ITC1xx is not water resistant.

Attention

To avoid damage to the instrument, do not expose it to spray, liquids or solvents!

The unit does not need a regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please check first the section [Troubleshooting](#) prior to contact [Thorlabs GmbH](#) for return instructions.

7.1 Troubleshooting

- **Unit does not work at all (no display)**
 - Is the controller connected properly to the external power supply?
 - Connect the ITC1xx to a stable DC power supply with an output voltage (± 12 to ± 15 V) and make sure, it is switched on.
- **You don't get the desired laser output power**
 - Is the interlock closed?
 - Check the resistance between the [interlock pins](#) of the connector jack - it must not exceed 430Ω .
 - Is the laser output turned on?
 - Apply a logical "high" level to pin C15 of ST1 to turn on the laser output. The LED1a on the controller board must light up.
 - The hardware limit I_{LIM} might be set to 0.
 - Adjust the hardware limit I_{LIM} using P1 to the desired value ([pin C20 of ST1](#))
 - Is the laser diode installed properly?
 - Check the connection cables.
 - Is the switch S2 set according to the laser diode polarity?
 - Verify correct polarity and set S2 accordingly.
 - Is the photo diode connected properly?
 - Check the connecting cable.
 - Are you using a bias voltage with the photo diode in photo current mode?
 - Turn off bias voltage by interrupting the wiring bridge or change the polarity of the diode for photo element mode (refer to section [Connecting Laser Diode and Photo Diode](#))
 - Is the desired output power adjusted correctly?
 - Set the ITC1xx to constant power mode (S1) and adjust the desired output power P_{LD} , using P2.
 - Is the ITC1xx running in temperature protection mode?
 - Check if the temperature window is set correctly.
 - Check if the laser temperature is out of window (laser is then switched off automatically).

- **You don't get the desired laser operation temperature**
 - Is the TEC connected properly to the connector?
 - Check all connections and cables.
 - Check the correct [TEC polarity](#).
 - Is the temperature controller turned on?
 - Apply a logical "high" level to pin A13 of ST1 to turn on the laser output. The LED1b on the controller board must light up.
 - Is the temperature sensor connected properly and is the temperature set accordingly?
 - Check the connection and polarity of the temperature sensor - please refer to section [Connecting TEC and Temperature Sensor](#).
 - Adjust P4 to the desired temperature ([C11 of ST1](#)).
 - The TEC current limit might be set to 0?
 - Adjust P3 to the desired TEC current limit ([A9 of ST1](#)).
 - Is the ITC1xx set correctly for the used temperature sensor?
 - Select the temperature sensor using S3.
- **Set temperature differs from actual temperature (of the laser)**
 - Is the temperature oscillating?
 - Adjust the PID parameters carefully - please refer to section [PID Adjustment](#).

If an error or malfunction appears that is not listed above, please contact [Thorlabs](#).

8 Appendix

8.1 Technical Data

8.1.1 Laser Diode Controller

Parameter	ITC102	ITC110	ITC133
Current Control			
Display Laser Current on	LED		
Trim Potentiometers (15-Turn)	I_{LD} , I_{PD} resp. P_{LD} , $I_{LD,LIM}$		
Control Range of Laser Current	0 to ± 200 mA	0 to ± 1 A	0 to ± 3 A ¹⁾
Compliance Voltage	> 4 V		
Setting Accuracy / Repeatability (full scale)	$\pm 2\%$ typ. / $\pm 0.1\%$		
Noise (10Hz to 10MHz, rms)	< 2 μ A	< 6 μ A	< 25 μ A
Drift (30 min, 0 to 10Hz, typ.)	< 20 μ A	< 100 μ A	< 300 μ A
Temperature Coefficient	< 50 ppm/ $^{\circ}$ C		
Power Control			
Control Range Photo Diode Current	5 μ A to 2 mA		
Accuracy / Repeatability (full scale)	$\pm 2\%$ typ. / $\pm 0.1\%$		
Photodiode Reverse Bias Voltage	0 V or 5 V		
Current Limit			
Setting Range	0 to >200 mA	0 to >1 A	0 to >3 A
Setting Accuracy / Repeatability (full scale)	$\pm 2\%$ typ. / $\pm 0.1\%$		
Analog Modulation Input			
Input Resistance	10 k Ω		
Modulation coefficient, CC	40 mA/V $\pm 5\%$	200 mA/V $\pm 5\%$	600 mA/V $\pm 5\%$
Small Signal 3 dB-Bandwidth, CC	DC to 200 kHz	DC to 50 kHz	DC to 20 kHz
Modulation Coefficient, CP	0.4 mA/V $\pm 5\%$		
TTL Modulation Input			
Rise/Fall Time	< 10 μ s	< 50 μ s	< 100 μ s
TTL Control Input	LD ON		
Measurements and Control Outputs			
Analog Measurement Values	I_{LD} , I_{PD} , $I_{LD,LIM}$		
Measurements Outputs	0 to ± 5 V		
Measurements Accuracy typ. (Load > 500k Ω)	$\pm 2\%$		
TTL Control Outputs	LD ON, LIMIT		

¹⁾ The total combined current for the ITC133 is limited by the total thermal dissipation loss. Optimized cooling by fan or bigger heat sink allows 3 A LD and 3 A TEC at the same time provided the power supply provides 6.1 A.

All technical data are valid at $23 \pm 5^{\circ}$ C and $45 \pm 15\%$ rel. humidity (non condensing)

8.1.2 Temperature Controller

Parameter	ITC102	ITC110	ITC133
Temperature Control			
Display TEC current ON		LED	
Trim Potentiometers (15-Turn)		$I_{TEC,LIM}$, T_{SET} / R_{SET}	
Trim Potentiometers (1-Turn)		P, I and D Share	
TEC Output			
Control Range of TEC Current	-2 A to +2 A	-3 A to +3 A ¹⁾	
Compliance Voltage		> 6 V	
Maximum Output Power	12 W	18 W	
Noise and Ripple	< 1 mA	< 3 mA	
Thermistor Temperature Sensors			
Control Range	100 Ω to 80 k Ω		
Setting Accuracy (full scale, typ.)		$\pm 2\%$	
Repeatability (full scale)		$\pm 0.1\%$	
Temperature Stability typ.		< 2 Ω	
IC Temperature Sensors AD590, AD592, & LM335			
Control Range	- 20 °C to +80 °C		
Setting Accuracy (full scale, typ.)	$\pm 2\%$		
Repeatability (full scale)	$\pm 0.1\%$		
Temperature Stability typ.	< 0.004 °C		
TEC Current Limit			
Setting Range	0 to ≥ 2 A	0 to ≥ 3 A	
Accuracy typ.	$\pm 5\%$		
Temperature Control Inputs			
Analog Control Input	T_{SET} / R_{SET}		
Input Resistance	10 k Ω		
Input Coefficient Thermistor	16 k Ω /V		
Input Coefficient IC-Sensor	20 °C/V		
TTL Control Input	TEC ON		
Measurement and Control Outputs			
Analog Outputs	T_{SET}/R_{SET} , T_{ACT}/R_{ACT} , $I_{TEC,LIM}$ (I_{TEC} , $\Delta T/\Delta R$)		
Measurement Accuracy typ. (Load > 500 k Ω)	$\pm 2\%$		
TTL Control Outputs	TEC ON, TEMP OK		

¹⁾ The total combined current for the ITC133 is limited by the total thermal dissipation loss. Optimized cooling by fan or bigger heat sink allows 3 A LD and 3 A TEC at the same time provided the power supply provides 6.1 A.

All technical data are valid at 23 ± 5°C and 45 ± 15% rel. humidity (non condensing)

8.1.3 Common Specifications

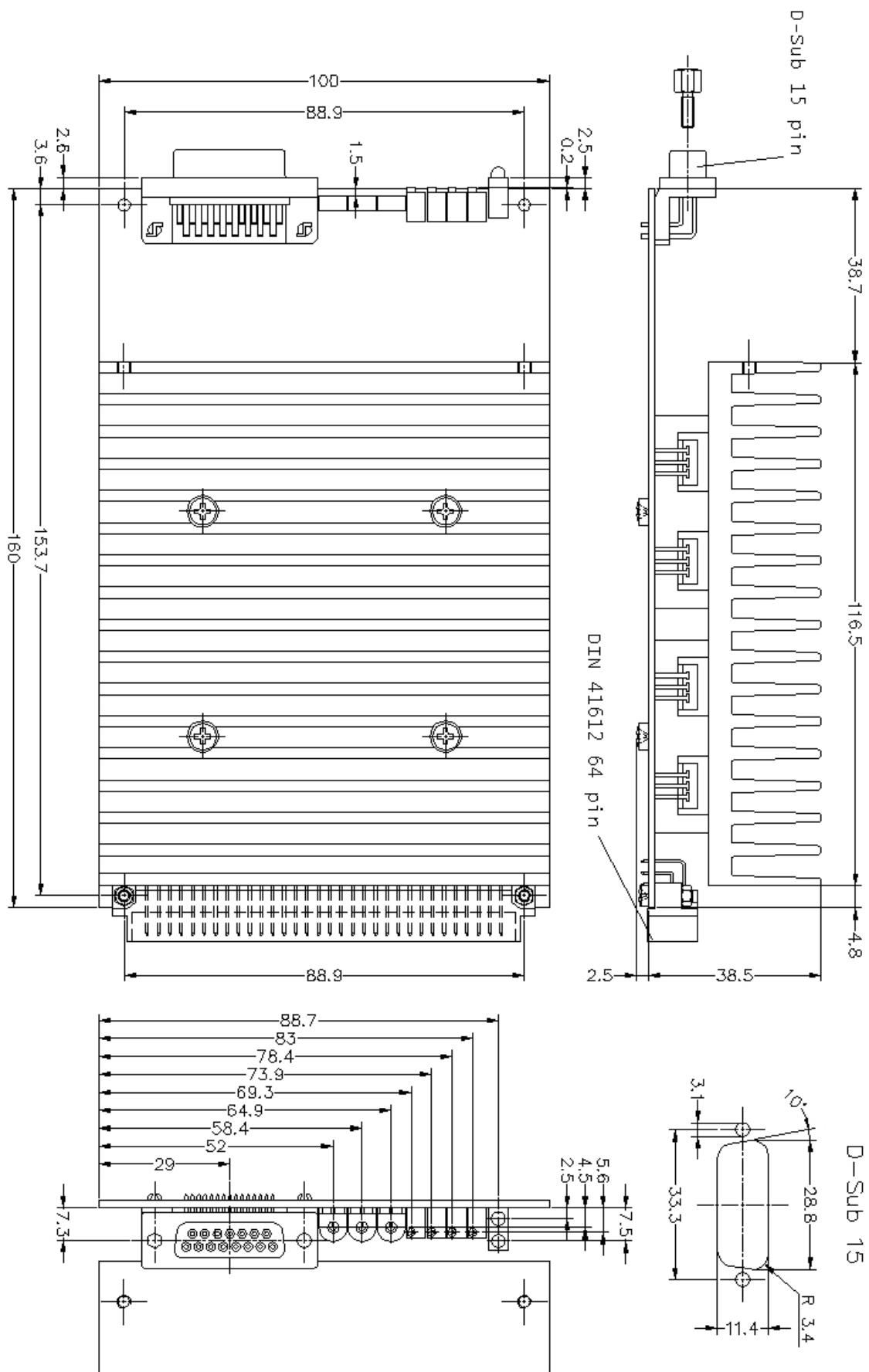
	ITC102	ITC110	ITC133
Supply Voltage/Current	± 12 V to ± 15 V 2.3 A	± 12 V to ± 15 V 3.1 A	± 12 V to ± 15 V 3.1 A ¹⁾
Operating Temperature	0 to + 40 °C		
Storing Temperature ²⁾	-40 °C to +70 °C		
Warm-Up Time for Rated Accuracy	10 min		
Dimensions (W x H x D)	100 x 42 x 160 mm (Eurocard)		
Weight	< 0.7 kg		

¹⁾ The total combined current for the ITC133 is limited by the total thermal dissipation loss. Optimized cooling by fan or bigger heat sink allows 3 A LD and 3 A TEC at the same time provided the power supply provides 6.1 A.

²⁾ non-condensing

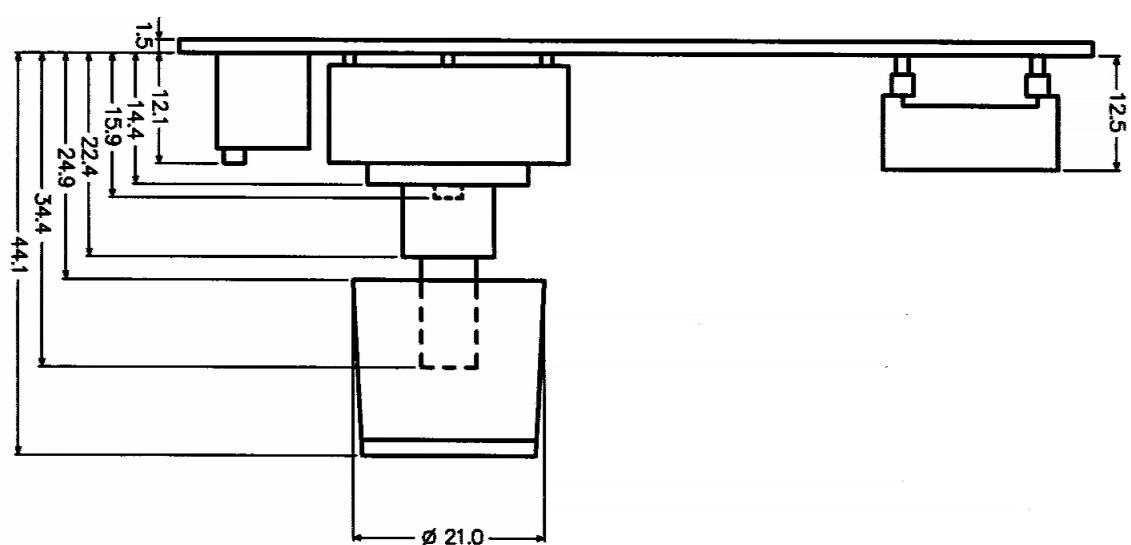
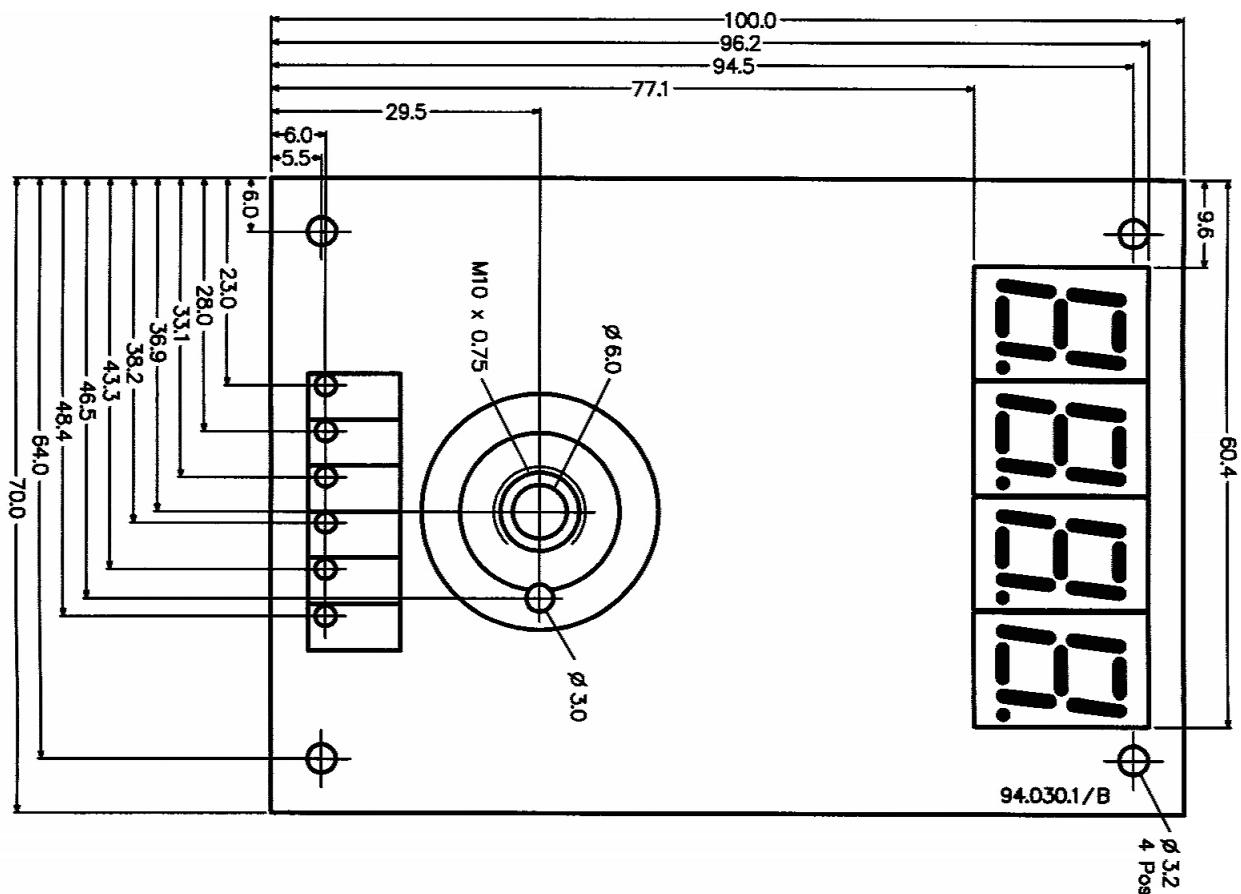
All technical data are valid at 23 ± 5 °C and $45 \pm 15\%$ rel. humidity (non condensing)

8.2 Dimensions ITC1xx



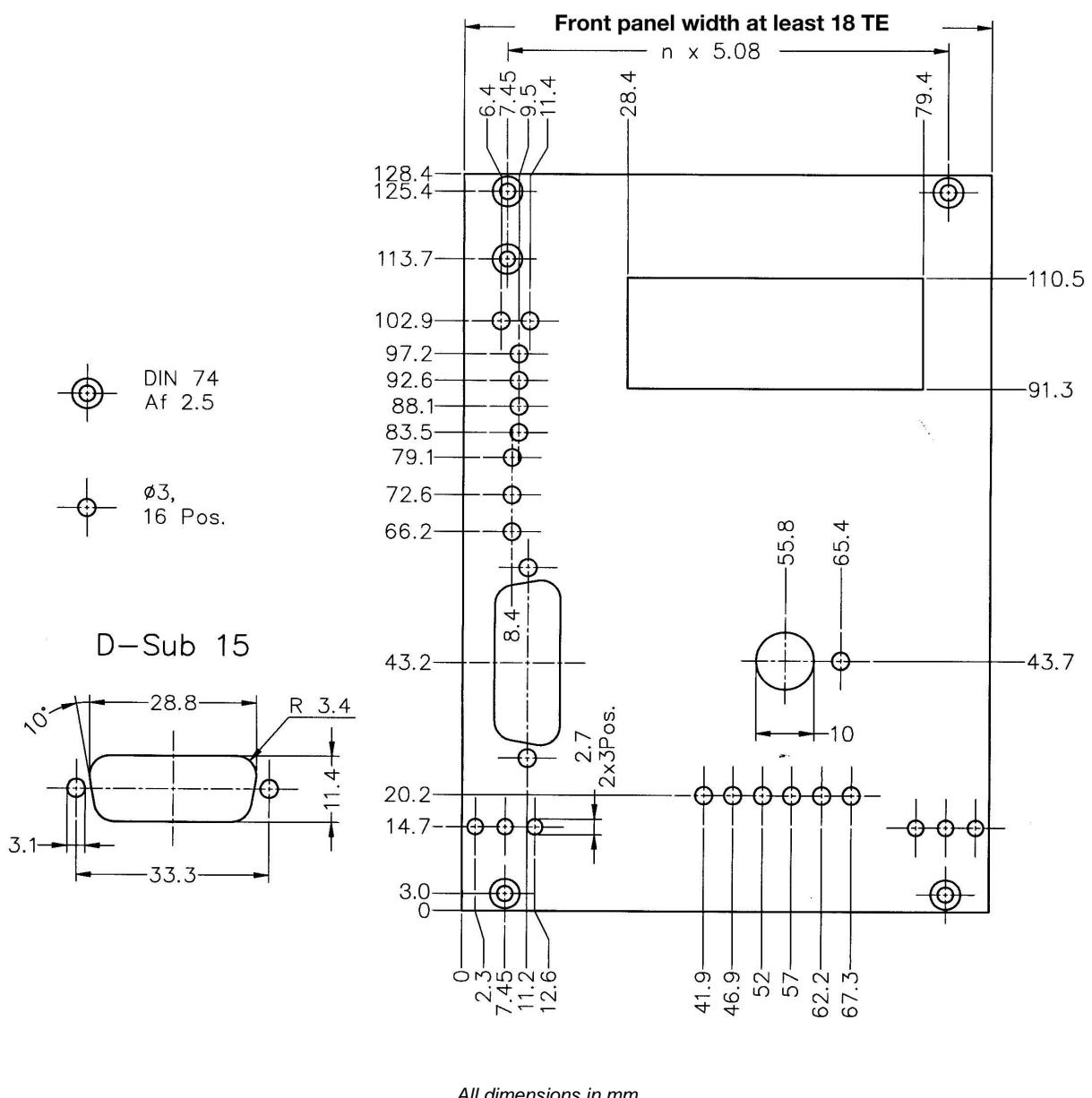
All dimensions in mm

8.3 Dimensions ITC100D



All dimensions in mm

8.4 Dimensions ITC100F



8.5 Certifications and Compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 2004/108/EC ¹ for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use – EMC requirements: Immunity: complies with basic immunity test requirements ^{2,3,5} . Emission: complies with EN 55011 Class A Limits ^{2,3,4}
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance Criterion B)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance Criterion B) ⁶
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance Criterion B)
	IEC 61000-4-6	Conducted RF Immunity (Performance Criterion B)
	EN 61000-3-2	AC Power Line Harmonic Emissions
Australia / New Zealand Declaration of Conformity	Complies with the Radiocommunications Act and demonstrated per EMC Emission standard 2,3,4: AS/NZS 2064 Industrial, Scientific, and Medical Equipment: 1992	
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B ^{2,3,4} .	

¹ Replaces 89/336/EEC.

² Compliance demonstrated using high-quality shielded interface cables shorter than or equal to 3 meters, including CAB400 cable installed at the CONTROL OUT port and with CAB430 cable installed at the LD/TEC port.

³ Compliance demonstrated with ITC100 series and DISP100 board modules installed in a Thorlabs PRO8000 mainframe unit (with PRO8000 display disabled).

⁴ Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

⁵ Minimum Immunity Test requirement.

⁶ MOD IN port capped at IEC 61000-4-3 test.

8.6 Warranty

Thorlabs GmbH warrants material and production of the ITC1xx for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs GmbH will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs GmbH. The customer will carry the shipping costs to Thorlabs GmbH, in case of warranty repairs Thorlabs GmbH will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs GmbH warrants the hard- and/or software determined by Thorlabs GmbH for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs GmbH does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs GmbH is not liable for consequential damages.

Restriction of warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs GmbH does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs GmbH reserves the right to change this instruction manual or the technical data of the described unit at any time.

8.7 Copyright and Exclusion of Reliability

Thorlabs GmbH has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

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8.8 Thorlabs 'End of Life' Policy

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs GmbH offers all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

This offer is valid for Thorlabs GmbH electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out "wheelie bin" logo (see figure below)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

As the WEEE directive applies to self contained operational electrical and electronic products, this "end of life" take back service does not refer to other Thorlabs GmbH products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB's, housings etc.).

Waste treatment on your own responsibility

If you do not return an “end of life” unit to Thorlabs GmbH, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS Directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE Directive is to enforce the recycling of WEEE. A controlled recycling of end-of-life products will thereby avoid negative impacts on the environment.



*Crossed out
"Wheelie Bin" symbol*

8.9 List of Acronyms

AC	<u>Al</u> n <u>t</u> e <u>ri</u> <u>ng</u> <u>C</u> urrent
ADC	<u>A</u> nalog to <u>D</u> igital <u>C</u> onverter
AG	<u>A</u> node <u>G</u> round
CC	<u>C</u> onstant <u>C</u> urrent
CG	<u>C</u> athode <u>G</u> round
CP	<u>C</u> onstant <u>P</u> ower
DAC	<u>D</u> igital to <u>A</u> nalog <u>Converter</u>
D Share	<u>D</u> ifferential share
DC	<u>D</u> irect <u>C</u> urrent
DIL	<u>D</u> ual <u>I</u> n-line
DIN	<u>D</u> eutsche <u>I</u> ndustrie <u>N</u> orm
IC	<u>I</u> ntegrated <u>C</u> ircuit
ILD	<u>I</u> (current) <u>L</u> aser <u>D</u>
IPD	<u>I</u> (current) <u>P</u> hoto <u>D</u>
I Share	<u>I</u> ntegral share
ITEC	<u>I</u> (current) – <u>T</u> emperature <u>Controller</u>
JP	<u>J</u> um <u>P</u> er
LD	<u>L</u> aser <u>D</u>
LDC	<u>L</u> aser <u>D</u> iode <u>Controller</u>
LED	<u>L</u> ight <u>E</u> mitting <u>D</u> iode
N.C.	<u>N</u> ot <u>C</u> onnected
PD	<u>P</u> hoto <u>D</u> iode
PID	<u>P</u> roportional, <u>I</u> ntegral, <u>Differential (regulator)</u>
P Share	<u>P</u> roportional share
SMB	<u>S</u> ub <u>M</u> iniature <u>C</u> onnecto <u>r</u> type "B"
TEC	<u>T</u> hermo <u>E</u> lectric <u>C</u> ooler (Peltier Element)

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