THORLABS

PRO800 / PRO8000 (-4) Series
Modular Combined Laser Current
and Temperature Controllers

ITC8000
Operation Manual

2016

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Item No.: M0009-510-221

Contents

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 preceeded 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 ITC8000 Modules are combined Laser Current and Temperature Controllers that are capable to control laser diodes and TEC elements (Peltiers) at the same time in order to maintain the operating parameters of the connected laser diode.

For the PRO8000 mainframe series Thorlabs supplies LabVIEW®- and LabWindows/CVI®-drivers for Windows 32 bit.

Please refer to http://www.thorlabs.com for latest driver updates.

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.

Prior to applying power to the ITC8000, make sure that the protective conductor of the mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

Also make sure that your line voltage agrees with the voltage given on the letterplate of the unit and that the right fuse has been inserted!

Modules of the ITC8000 Series are allowed to be operated only a mainframe of the PRO8000 series.

To avoid damage to the modules used or to the mainframe, modules must not be installed or removed when the mainframe is switched on.

All modules must be fixed using the screws provided for this purpose.

The ITC8000 must not be operated in explosion endangered environments!

Do not remove covers! Do not obstruct the air ventilation slots in the housing!

Refer servicing to qualified personnel!

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

All connections to the load must be made using shielded cables, unless otherwise stated.

Semiconductor lasers can deliver up to several 100mW of possibly invisible laser radiation! Improper operation can cause severe eye and health damage!

Pay strict attention to the safety recommendations of the appropriate laser safety class!

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. 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 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. 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

Please refer to the actual catalog or the web for an actual list of available plug in modules and accessories and for the complete ordering codes.

Ordering Code	Short Description
ITC8022	Laser Controller ± 200 mA, Temperature Controller Module ± 2 A, 9 pin connector for laser diode, 15 pin connector for TEC
ITC8022DS15	Laser Controller ± 200 mA, Temperature Controller Module ± 2 A, One common 15 pin connector for laser and TEC
ITC8052	Laser Controller ± 500 mA, Temperature Controller Module ± 2 A, 9 pin connector for laser diode, 15 pin connector for TEC
ITC8052DS15	Laser Controller ± 500 mA, Temperature Controller Module ± 2 A, One common 15 pin connector for laser and TEC
ITC8102	Laser Controller ± 1 mA, Temperature Controller Module ± 2 A, 9 pin connector for laser diode, 15 pin connector for TEC
ITC8102DS15	Laser Controller ± 1 mA, Temperature Controller Module ± 2 A, One common 15 pin connector for laser and TEC
CAB400	Laser Diode Current Controller Connection Cable for ITC8000 modules, 1.5 m, to connect Thorlabs Laser Diode Mounts
CAB420-15	Temperature Controller Connection Cable for ITC8000 modules, 1.5 m, to connect Thorlabs Laser Diode Mounts
CAB430	Laser Diode Current and Temperature Controller Connection Cable for ITC8000DS15 modules, 1.5 m, to connect Thorlabs Laser Diode Mounts

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 ITC8000 mechanically and electrically.

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

1. ITC8000 Series Module
2. Operating Manual

2.2 Operating Principle

The ITC8000 modules are bidirectional current sources to control laser diodes that are combined with a TEC element (Peltier). Different types of temperature sensors are supported. Three types of modules are available with respect to the maximum laser current, resolution and accuracy (see Technical Data 64).

The ITC8000 modules contain a transimpedance amplifier input for the monitor diode (input impedance 0 Ω). Both polarities of the monitor diode are supported. The monitor diode can be operated either photovoltaic (without bias voltage) or photoconductive, i.e. with bias voltage.

The temperature controller comprises a closed loop amplifier with adjustable settings for P (proportional), I (integral) and D (differential) share.

Supported temperature sensors

- Standard thermistors (NTC - Negative Temperature Coefficient Thermistor) within two ranges - max. 20 kΩ and max. 200 kΩ
- IC temperature sensors (AD590, AD592, LM335)
- Pt-100 (RTD - Resistance Temperature Detectors)

All necessary value settings are made by the mainframe operating elements (keypad and rotational encoder) or via remote control by a computer. The only parameter that must be set manually, is the laser current limit ("absolute hardware limit").

The values for the laser diode current (constant current mode), the monitor diode current (constant power mode) and the set temperature or set resistance of the ITC8000 modules are set with 16 bit resolution.

The limit values for the laser diode and TEC current (software limit) as well as for the monitor diode current (limiting the laser output power) are set with a 12 bit resolution.

The monitor current and the actual temperature (resistance) are read back with 16 bit.

The laser diode current, the laser diode voltage, the limit for the laser diode current (hardware limit), the TEC current and the TEC voltage are read back with 15 bit plus sign.

The P, I and D shares of the analog control loop are set by three independent 12 bit DAC (Digital-to-Analog Converters)

The built-in mains filter in the mainframe and the careful shielding of the transformer, the micro processor as well as the module itself will provide an excellent suppression of noise and ripple.

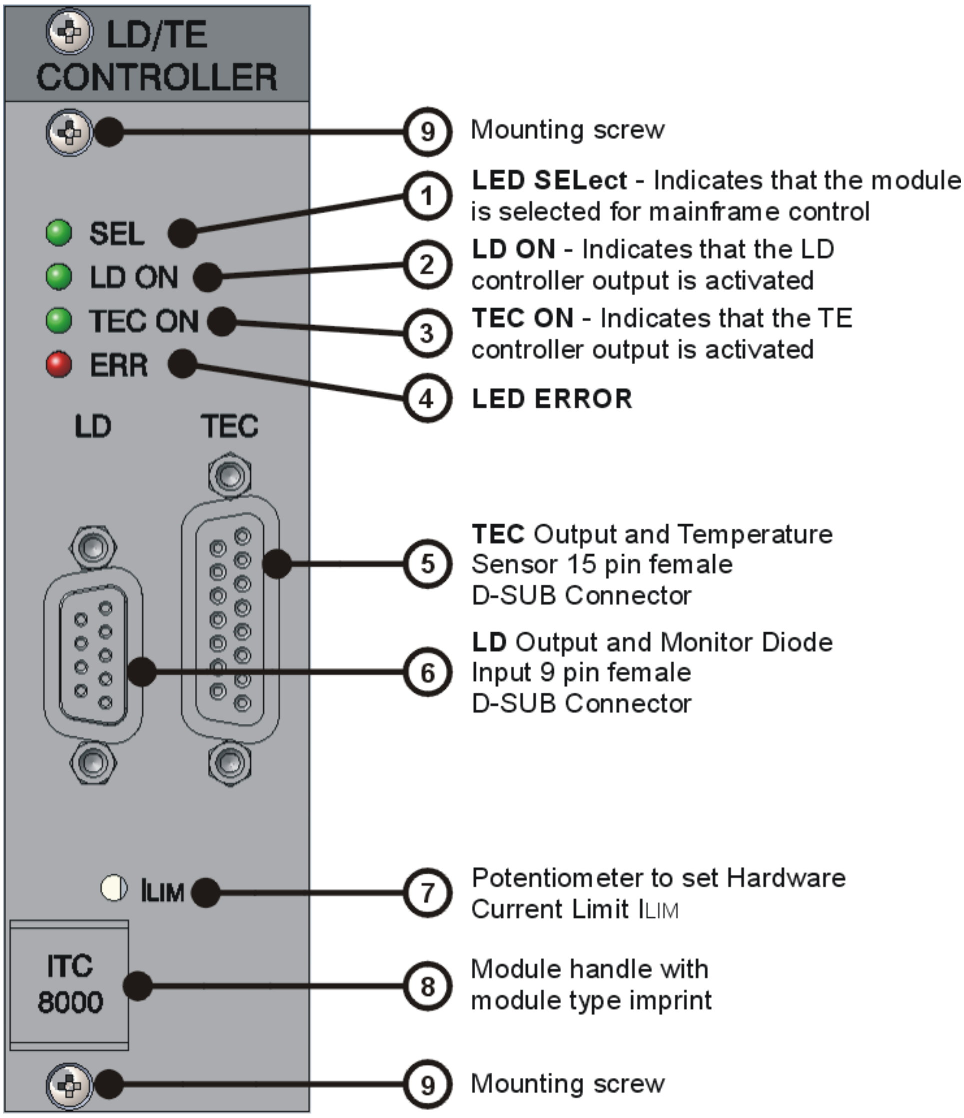
Protection Features

To protect the connected laser diode and the TEC element, the ITC8000 modules contain the following protection circuits:

- **Soft start when switching on the laser diode current**
  Protection from capacitive and inductive parasitic elements (switching peaks).
- **Software Limits of the laser and TEC current in all operating modes; additional hardware limit for the laser current.**
  Protection from destruction.
- **Interruption control of the connection cable to the laser diode (interlock)**
  Protection from accidental operation.
- **Contact protection of the laser diode (open circuit)**
  Protection from cable damage or bad contact.
- **Electronic short-circuit switch for the laser diode**
  Protection from electro-static discharge when touching the switched-off laser.
- **Sensor Protection**
  Protection from the use of not supported temperature sensors and from interrupted sensor connection.
- **Open-Circuit Protection of the connection cable to the TEC element**
  Protection from cable damage, bad contact or TEC element with too high resistance. When tripped, a warning is output, but the output remains switched on - the reason is that even a wrong TEC as still capable to cool the laser diode.
- **Separate on and off function for each module**
  Protection from operating errors.
- **Control LED for activated laser and TEC current**
  Protection from accidental disabling of the temperature control..
- **Separate over-temperature protection for each module**
  Protection against thermal failure of the module.
- **Line failure protection**
  In case of a line voltage failure the ITC8000 module must be switched on again manually.
- **Key-operated power switch**
  Protection against unauthorized or accidental use.
- **Action check**
  After power-up the ITC8000 modules are in LASER OFF mode.

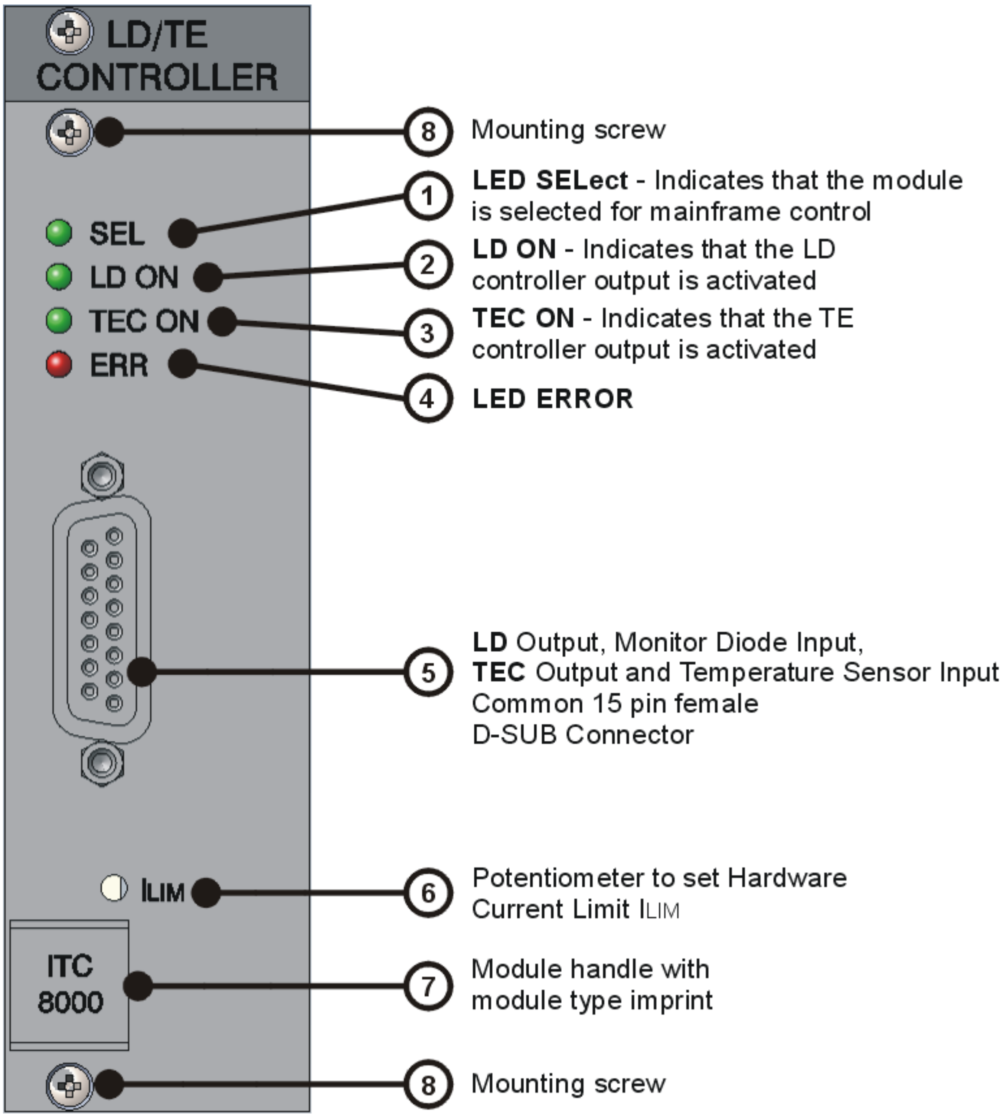
2.3 Operating Elements

ITC8000 Modules



Operating Elements ITC8000

ITC8000DS15 Modules



Operating Elements ITC8000DS15

3 External Connections ITC8xxx

Laser diodes are manufactured in many different housings. Normally the following components are installed together in the housing of the laser:

- Laser diode
- Monitor diode
- TEC element for setting the chip temperature
- Temperature sensor

The laser diode and the TEC element are always sourced against ground by the ITC8000. This is of a considerable advantage with respect to the protection of the connected devices and to the current stability.

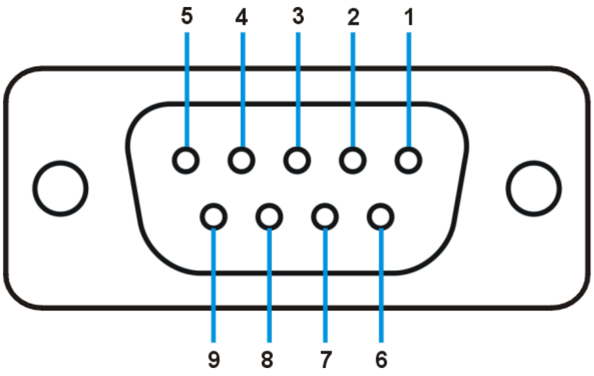
The modules have a monitor diode input that is set up as a transimpedance amplifier input (input impedance 0 Ω). The monitor diode input can be operated without or with bias voltage (0 V...10 V). The polarity for the monitor diode must be set accordingly, see section Bias Voltage for the Monitor Diode 30.

The ITC8000 modules come with separate inputs for laser forward voltage measurement. This allows a 4-wire connecting scheme that eliminates measurement errors due to the voltage drop caused by the injection current.

The temperature controller sensor input can handle different types of sensors. A missing sensor or selection of a wrong type is detected by the ITC8000.

3.1 Laser Diode Controller

Pin Assignment of the LD Output Connector



Female 9 pin D-SUB Connector

Pin	Connector
	Interlock; Status Display
1	Output Interlock; Status LED - Anode
5	Interlock return pin; Status LED - Cathode (GND)
	Laser Diode
7	LD cathode (with polarity AG)
8	LD anode (with polarity CG)
3	LD ground
	Monitor Diode
4	Input monitor (photo) diode
2	Ground monitor (photo) diode
	Laser Voltage Measurement Input
6	U_{LD}- (cathode)
9	U_{LD}+ (anode)

3.1.1 Connecting the Laser and Monitor Diodes

We recommend to use separate wires drilled in pairs (twisted pair) in a common shield for laser diode current, monitor diode current and laser voltage measurement, respectively. The shield must be connected to ground potential (pin 3).

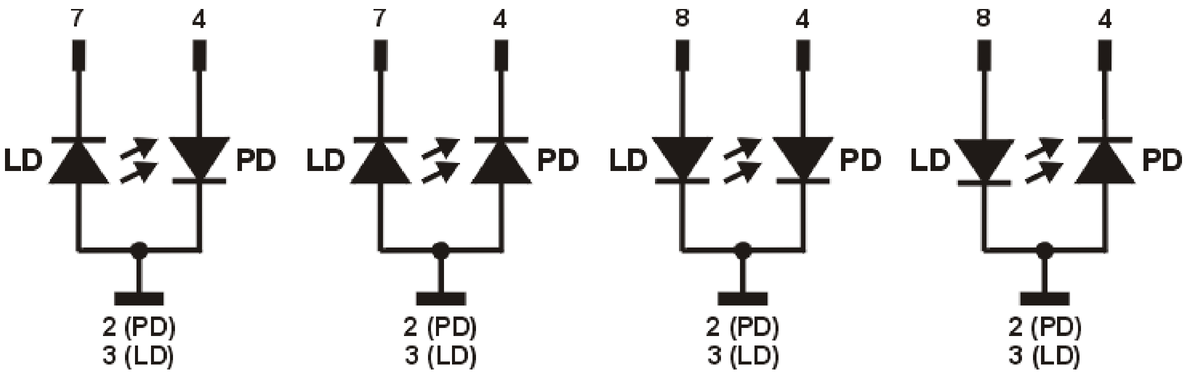
If an external monitor diode is used, it must be connected with a coaxial cable with the outer conductor to pin 2 and the inner conductor to pin 4.

Connect laser and monitor diode to the connector jack of the ITC8000 module.

The lines for voltage measurement of the laser diode (pin 6 and pin 9) must be connected as closely as possible to the laser diode to avoid measurement errors.

The ground conductor of the monitor diode (pin 2) can be connected to the ground conductor of the laser diode (pin 3). If this is necessary (e.g. laser diodes with integrated monitor diode and common ground), connect the ground conductors as closely as possible to the laser diode to avoid measurement errors when measuring the monitor diode current.

In this case the following pin assignments of the output jack are possible (shown without voltage measurement):



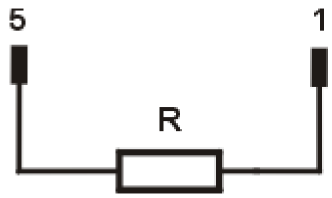
LD - Laser Diode; PD - Photo (Monitor) Diode

3.1.2 Connecting Interlock and Status Display

Interlock and cable damage monitoring

The interlock function provides a safety feature in order to switch off instantly the laser. Therefore, the connection between pin 1 and pin 5 of the connector jack serves as safety circuit:

- If the resistance between above mentioned pins is less than 430 Ω (short circuit allowed), the laser current is enabled and can be switched on.



R = 0 to 430 Ω

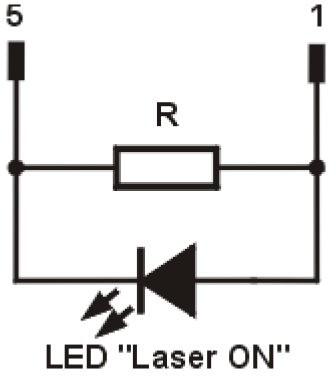
Note

Using a resistor > 430 Ω may lead to a malfunction as the status of the interlock is then in an undefined range.

- In the case that the current between the interlock pins is interrupted, the laser controller cannot be switched on. If this interruption happens during operation, the output will be switched off immediately and remains switched off until the interlock circuit is closed again and the laser current is switched on again.

Status display

For Laser On/Off status indication, a LED with a 470 Ω resistor in parallel can be connected between the two interlock pins. The LED will light up when the laser output is switched on.



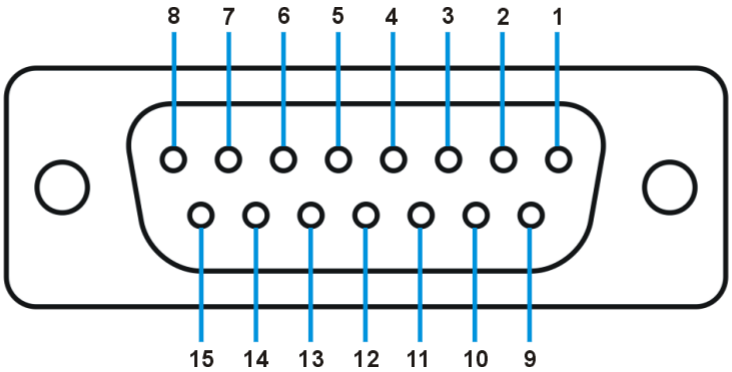
R = 470 Ω

Note

Mispoling the LED may lead to a malfunction as the status of the interlock is then in an undefined range.

3.2 Temperature Controller

Pin Assignment of the TEC Output Connector



Female 15 pin D-SUB Connector

Pin	Connector
	TEC Element
5, 6	TEC Element +
13, 14, 15	TEC Element - (GND)
	Status Display
1	Status LED - Anode
8	Status LED - Cathode (GND)
	Temperature Sensor
3	Thermistor - (GND)
4	Thermistor +
10	AD590 - (PT100 for ITC8xxxPT)
11	AD590 + (PT100 for ITC8xxxPT)

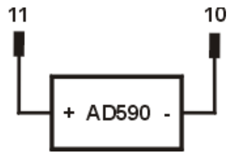
Connect the TEC element and the temperature sensor with shielded cables to the TEC connector. The shielding of the cable must be connected to ground (pin 13,14,15).

3.2.1 Connecting a Thermistor

The thermistor is connected between pin 3 and pin 4:

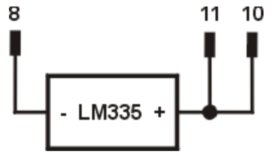
3.2.2 Connecting an AD590

The IC-temperature sensor AD590 is connected between pin 10 (-) and pin 11 (+).



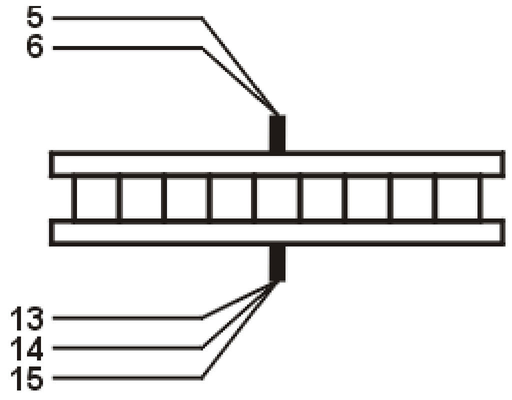
3.2.3 Connecting a LM335

The IC-temperature sensor LM335 is connected between pin 10, 11 (+) and pin 8 (-).



3.2.4 Connecting a TEC Element

The TEC element is connected between pins 5, 6 (plus pole) and pins 13, 14, 15 (minus pole).



Connecting a TEC Element

Attention

An reverse poled TEC element may lead to a thermal runaway and destruction of the connected components. Please refer to section Polarity Check of the TEC Element 17.

3.2.5 Polarity Check of the TEC Element

Pre-Settings

- Connect TEC element and temperature sensor. The sensor must be in good thermal contact to the active surface of the TEC element.
- Switch on the PRO8000 (-4) / PRO800 system.
- Select the ITC8000 module.
- Select the correct type of sensor.
- Set the correct value for $I_{TEC, MAX}$.

Polarity check of the TEC element

Observe T_{ACT} (or R_{ACT}) and switch on the module by pressing the key "ON/OFF"

- If T_{ACT} (or R_{ACT}) runs away from T_{SET} (or R_{SET}), the TEC element is reverse poled. Change polarity and repeat the procedure.
- If T_{ACT} (or R_{ACT}) is oscillating around the value T_{SET} (or R_{SET}), the TEC element is connected correctly, but the P, I and D share values of the control loop are still incorrect. (Refer to section PID Ajustment 23)
- If T_{ACT} (or R_{ACT}) is settling properly to the value T_{SET} (or R_{SET}), the TEC element has been connected correctly, the values for the P-, I- and D-share of the control loop may still need improvement.

3.2.6 Connecting the Status Display LED

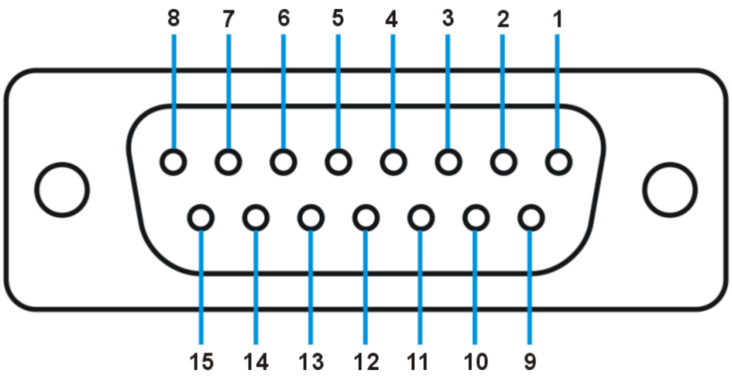
To display the operating status of the temperature controller, a standard LED may be used between pin 1 and pin 8. The LED will light up when the current output is switched on.

Note Not for ITC8000DS15!

4 External Connections ITC8xxxDS15

The ITC8000DS15 Combined Controllers come with a single output connector that accommodates the external connections for both the laser current and the temperature controllers. The functionality is the same, except for the TEC controller status LED. Therefore, in this section are stated the external connections of the common 15 pin output connector with respect to the different pin assignment.

Pin Assignment of the Common LD/TEC Output Connector



Female 15 pin D-SUB Connector

Pin	Connector
	TEC Element
7	TEC Element +
8	TEC Element - (GND)
	Temperature Sensor
14	Thermistor - (GND)
15	Thermistor +
13	AD590 -
6	AD590 +
	Laser Diode
10	LD cathode (with polarity AG)
11	LD anode (with polarity CG)
3	LD ground
	Monitor Diode
4	Monitor (photo) diode anode (or cathode with bias)
2	Monitor (photo) diode ground
	Laser Voltage Measurement Input
9	U_{LD}- (cathode)
12	U_{LD}+ (anode)
	Interlock; Status Display
1	Output Interlock; Status LED - Anode
5	Interlock return pin; Status LED - Cathode (GND)

4.1 Connecting the Laser and Monitor Diodes - ITC8000DS15

We recommend to use separate wires drilled in pairs (twisted pair) in a common shield for laser diode current, monitor diode current and laser voltage measurement, respectively. The shield must be connected to ground potential (pin 3).

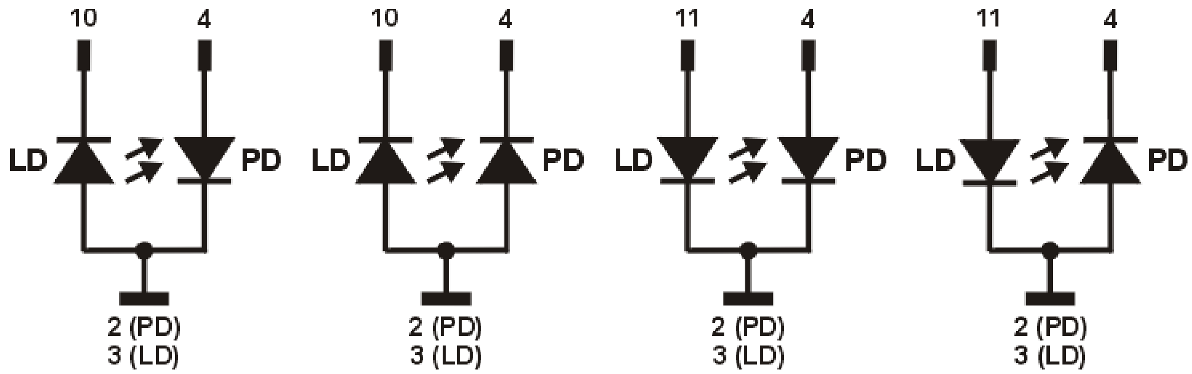
If an external monitor diode is used, it must be connected with a coaxial cable with the outer conductor to pin 2 and the inner conductor to pin 4.

Connect laser and monitor diode to the connector jack of the ITC8000 module.

The lines for voltage measurement of the laser diode (pin 9 and pin 12) must be connected as closely as possible to the laser diode to avoid measurement errors.

The ground conductor of the monitor diode (pin 2) can be connected to the ground conductor of the laser diode (pin 3). If this is necessary (e.g. laser diodes with integrated monitor diode and common ground), connect the ground conductors as closely as possible to the laser diode to avoid measurement errors when measuring the monitor diode current.

In this case the following pin assignments of the output jack are possible (shown without voltage measurement):



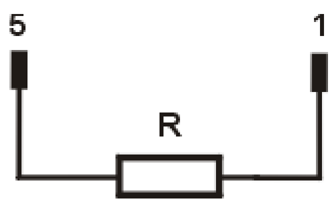
LD - Laser Diode; PD - Photo (Monitor) Diode

4.2 Connecting Interlock and Status Display - ITC8000DS15

Interlock and cable damage monitoring

The interlock function provides a safety feature in order to switch off instantly the laser. Therefore, the connection between pin 1 and pin 5 of the connector jack serves as safety circuit:

- If the resistance between above mentioned pins is less than 430 Ω (short circuit allowed), the laser current is enabled and can be switched on.



R = 0 to 430 Ω

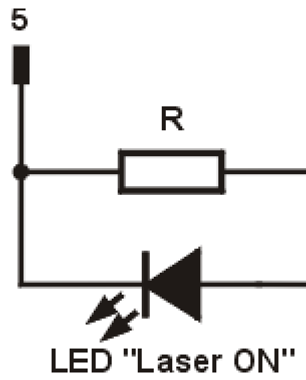
Note

Using a resistor > 430 Ω may lead to a malfunction as the status of the interlock is then in an undefined range.

- In the case that the current between the interlock pins is interrupted, the laser controller cannot be switched on. If this interruption happens during operation, the output will be switched off immediately and remains switched off until the interlock circuit is closed again and the laser current is switched on again.

Status display

For Laser On/Off status indication, a LED with a 470 Ω resistor in parallel can be connected between the two interlock pins. The LED will light up when the laser output is switched on.



R = 470 Ω

Note

Mispoling the LED may lead to a malfunction as the status of the interlock is then in an undefined range.

4.3 Connecting a Thermistor - ITC8000DS15

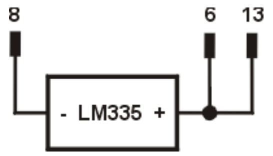
The thermistor is connected between pin 14 and pin 15:

4.4 Connecting an AD590 - ITC8000DS15

The IC-temperature sensor AD590 is connected between pin 6 (+) and pin 13 (-).

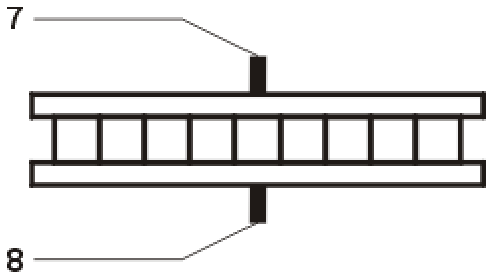
4.5 Connecting a LM335 - ITC8000DS15

The IC-temperature sensor LM335 is connected between pin 6, 10 (+) and pin 8 (-).



4.6 Connecting a TEC Element - ITC8000DS15

The TEC element is connected between pins 7 (plus pole) and pins 8 (minus pole).



Connecting a TEC Element

Attention

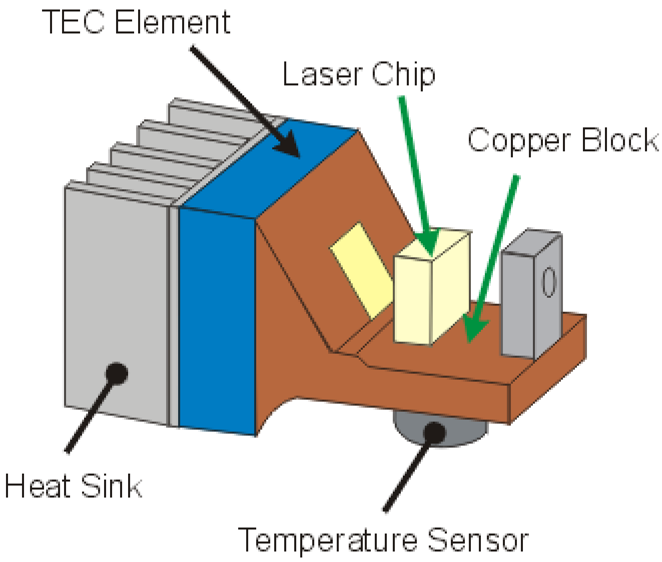
An reverse poled TEC element may lead to a thermal runaway and destruction of the connected components. Please refer to section Polarity Check of the TEC Element 17.

5 Optimization of Temperature Control

5.1 Principle Setup and Function

A typical laser diode module comprises

- the laser diode chip that needs to be temperature controlled;
- the temperature sensor;
- the TEC element;
- the thermal conductor (copper block) that establishes the thermal contact between the laser and the TEC, as well between the laser and the temperature sensor and
- the heat sink.



Possible error sources that impact the temperature control

1. The sensor is not in direct thermal contact with the laser chip. The inhomogeneous temperature within the copper block ("temperature gradient") influences the measurement. Even within the laser chip a temperature gradient is present. Thus, a correct measurement of the real laser chip temperature is not possible. Offset and gain errors of the sensor allow only an estimate of the laser temperature.

   Possible optimization: Sensor calibration

2. A change of the internal power dissipation of the laser, e.g. due to change of the laser current, changes the temperature gradient between laser and sensor as well. This results in a measurement error depending on the mechanical setup of the laser chip and the sensor. Slow changes of the ambient temperature, however, will be compensated well by the control loop since the influence of the ambient temperature on the laser diode can be neglected.

   Possible solution: optimized thermal design

3. The transient response after setting a new temperature is limited since the heat transport in the copper block is relatively slow. Furthermore, the sensor must settle to the laser temperature - it also has a non-negligible thermal capacity.

   Possible optimization: careful adjustment of PID parameters

5.2 PID Adjustment

Temperature control loops are comparatively slow; control oscillations appear with a frequency in the range of several Hz or parts of Hz. The PID adjustment allows to optimize the dynamic behavior. The ITC8000 modules allow to set the three parameters P, I and D independently within the range from 0.1% to 100%.

Example of a PID adjustment

(Pre-conditions: All limit values have been 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.
- Set the P-, I- and D-share to 1%. Please refer to section Setting the P, I and D Share of the Control Loop 32.
- Switch on the output and observe the temperature.

P-share

- Change the set temperature repeatedly between 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 make the system oscillate.

The P-share has been set correctly when the actual temperature remains stable near the set temperature after 2-3 overshoots.

D-share

- Change the set temperature repeatedly between 18 °C and 22 °C while observing again 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 near the set temperature after a minimum of overshoots.

I-share

- Turn on the I-share.
- Change the set temperature repeatedly between 18 °C and 22 °C .
- 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.

6 Operating Instruction

Note

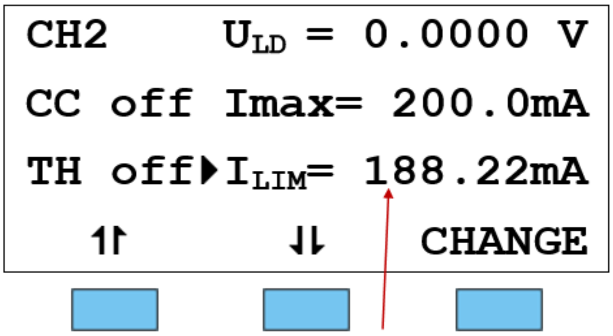
All settings that are made to the ITC8000 modules via the Control Panel of the PRO8000 mainframe are applied immediately; no need to confirm settings.

6.1 Pre-Settings

The maximum laser and TEC current values can be limited in order to protect the laser and the TEC element. There are three different limits:

Setting the Laser Hardware Current Limit I_{LIM}

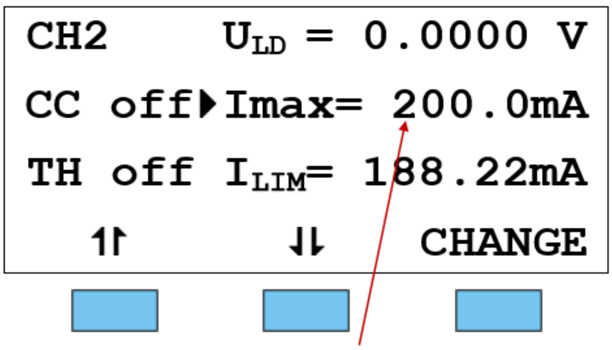
The laser current hardware limit I_{LIM} is set with the potentiometer 9 marked **I_{LIM}** at the front panel of the module. The value is displayed continuously in the channel menu of the module so you can observe it during adjustment:



Hardware limit I_{LIM}

Software Laser Current Limit I_{MAX}

The software laser current limit I_{MAX} is set in the channel menu or via the IEEE488 interface by the control software, and affects the laser current control of the ITC8000 module via the D/A converter. It yields exactly the same protective function as the hardware limit. See section Changing Parameters 29.



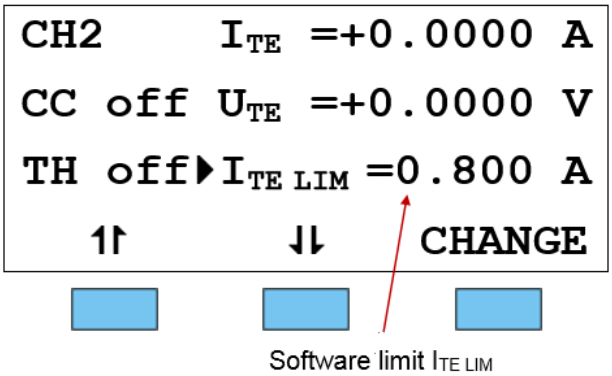
Software limit I_{MAX}

Note

The laser current limitation is enabled at the lower value of the two limits I_{MAX} or I_{LIM}.

Software TEC Current Limit I_{MAX}

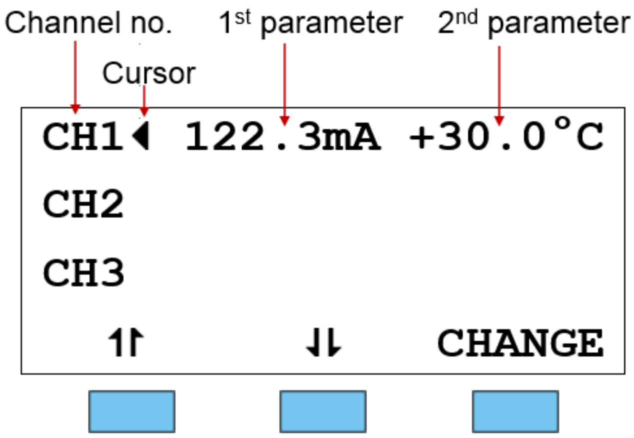
The software laser current limit $I_{TE\ LIM}$ is set in the channel menu or via the IEEE488 interface by the control software, and affects the TEC current control of the ITC8000 module via the D/A converter. See section Changing Parameters 29.



6.2 Functions in the Main Menu

Display

The main menu shows the channel number and the 2 most important operating parameters of the ITC8000 module.



Main Parameters

In ***constant current mode*** the first parameter is the laser current I_{LD} in mA or A and the second value is the temperature T in °C.

In ***constant power mode*** the first parameter is the optical power P_{LD} in mW and the second value is the temperature T in °C.

If the LD and TEC controllers are switched off, the **set values** (I_{LD}/P_{LD}/T_S) are displayed. If one or both controllers are turned on the corresponding **actual values** appear (I_{LD}/P_{LD}/T_A).

Selecting a Module

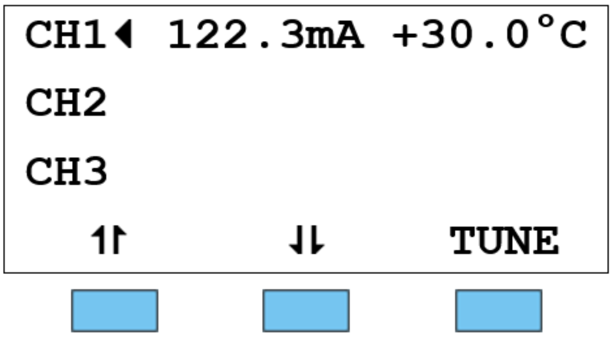
Select a module for further input by setting the cursor to the channel number of the desired module using the soft keys ⇈ and ⇊.

CH2◂

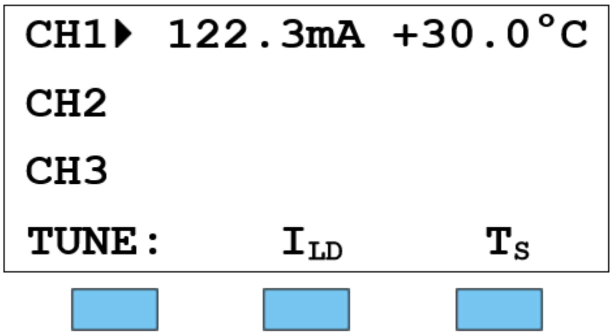
Pressing CHANNEL will lead to the channel menu 27.

Setting the main parameters

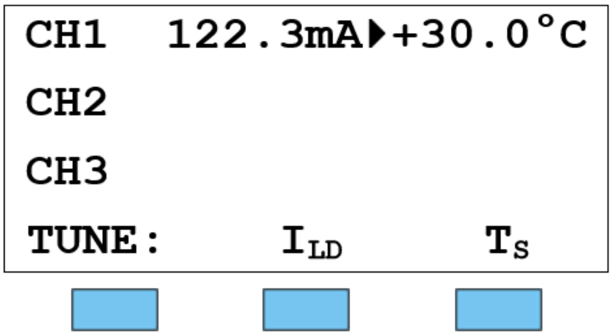
To set the main parameters in the main menu, select the corresponding module (here CH1) with the cursor:



Pressing the key (**TUNE**) will turn the cursor pointing now to the right. Press the soft key **I_{LD}** to adjust the laser set current by means of the tuning knob.



Press the soft key **T_S** to adjust the set temperature by means of the tuning knob:



Pressing the 

key completes the procedure.

Note

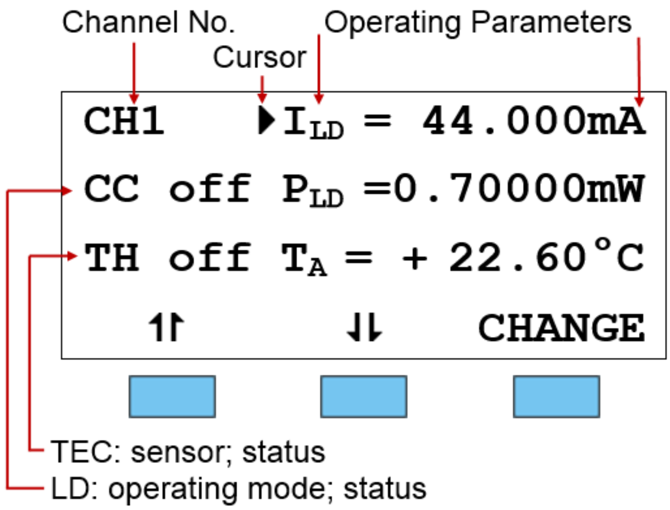
If the TEC current is switched ON, the actual temperature is displayed. In this case the set temperature can still be changed but is not displayed.

6.3 Functions in the Channel Menu

The channel menu is opened from the main menu by pressing the key CHANNEL.
Push CHANNEL or ESC again to return to the main menu.

6.3.1 Display

In the channel menu all parameters of the selected module are shown:



The above screen displays some key information:

Display	Operating mode	Sensor	Output state
CC off [on]	Constant Current mode		Laser off [on]
CP off [on]	Constant Power mode		Laser off [on]
AD off [on]		AD590	TEC off [on]
TH off [on]		Thermistor	TEC off [on]

If an error appeared, the appropriate message is stated in the display footer:

Display	Operating mode
Open	TEC **ON**, but too high resistance
ILK	Interlock open
OVL	LD output open
LIM	LD **ON**, laser current reached the limit value
WIN	Temperature out of the activated temperature window
■Vcc■ ■fail■	Internal power failure. Please contact Thorlabs 72.
■OTP■	Over-temperature
■SENSE■	No sensor recognized, or recognized sensor does not match the setting.

Only three parameters can be shown at a time, so there is a scroll function. All parameters are sorted in a virtual list, which can be run through with the cursor:

I_{LD} = 44.000mA
P_{LD} = 0.70000mW
T_A = + 22.60°C
T_S = + 15.00°C
U_{LD} = -1.86V
I_{max} = 50.00mA
I_{LIM} = 55.6mA
I_{PD} = 0.0500mA
C = 1.00000A/W
U_{BIA} = 2.000 V
MODE = Iconst
LDPOL = AG
PDPOL = CG
T_{WIN} = 0.461°C
T_{WIN} off
TEC off
I_{TE} = 0.000 A
U_{TE} = -0.48 V
$I_{TE\ LIM}$ = 1.000 A
Psh = 5.0 %
Ish = 15.0 %
Dsh = 10.0 %
Ishare ON
Thermistor
Rs = 10.000 kΩ
R_A = 40.959 kΩ
R_{WIN} = 0.200 kΩ
Exponential
R0 = 10.000 kΩ
B = 3900.0 kΩ
T0 = +25.00 °C
C1 = 1.0628e-3
C2 = 2.4277e-4
C3 = 7.0471e-8

The field "Sensor Type" shows:

AD590	If the sensor is an AD590, LM335 or equivalent
Th	If the sensor is a thermistor

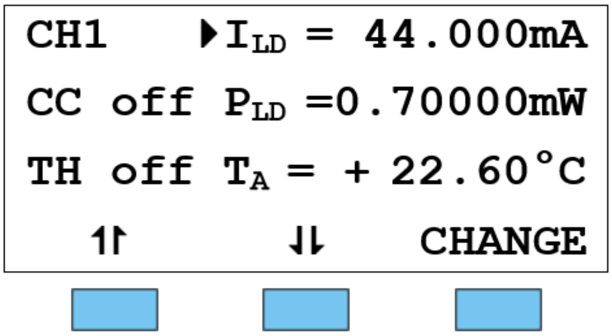
Further lines follow, depending on the sensor type (examples shown):

Thermistor	**Th.range=low** **Exponential** **RS = 9.1234 kΩ** **RA = 9.1234 kΩ** **Rwin= 6.1234kΩ** **R0= 10.000 kΩ** **B = 3900.0** **T0= 25.000 °C** **C1= 1.1234E-3** **C2= 2.1234E-4** **C3= 3.1234E-6**
AD590	**AD590**

6.3.2 Changing Parameters

To set or change a numerical parameter in the channel menu, select the respective line with the cursor:

Example: Change **ILD**:



Pressing the soft key **CHANGE** activates the tuning knob to change the selected parameter. If the parameter is only to toggle (e.g., the polarity of the laser diode), the function of the soft keys will change:

Pressing the right soft key changes the sensor; pressing the ESC key terminates the procedure.

Note

Some parameters can not be changed, as they are measurement values (i.e. the TEC voltage) or cannot be changed while the TEC current output switched on. In these cases the access is denied indicated by a long beep.

6.3.3 Selecting the Polarity of the Laser and the Monitor Diodes

To change the polarity of the **laser diode** select the parameter
LDPOL = and select the desired polarity with **CHANGE** and toggle with **AG/CG**.

To change the polarity of the **monitor diode** select the parameter
PDPOL = and select the desired polarity with **CHANGE** and toggle with **AG/CG**.

6.3.4 Calibration of the Monitor Diode

In order to display the correct optical power based on the monitor current, the actual efficiency coefficient **C** of the monitor diode must be entered.

Select the parameter **C**.

C = 0.2000A/W

If, for example, **C** is 0.5 A/W this can be entered in the channel menu by pressing the soft key **CHANGE** and changing the default value using the tuning knob. Then press the ESC key to terminate the procedure.

If this parameter is not given in the specification of the laser, it can be calculated from the measured actual optical power out of the laser and the monitor current:

$$\mathbf{C} = I_M / P_{opt} \quad [A/W]$$

6.3.5 Bias Voltage for the Monitor Diode

If required, the monitor diode can be operated with a bias voltage of 10 V.

Attention

Prior to switching on the bias voltage make sure that the photodiode polarity is set correctly (inverse direction). If the photodiode is biased forward, the current flow through the PD can damage it.

The bias voltage can be set in the channel menu of the ITC8000 module

`Ubia =`

6.3.6 Selecting Constant Current or Constant Power Mode

The ITC8000 laser current controller modules offer two operating modes for the laser diodes: constant current and constant power mode.

In ***CC (constant current) mode*** the laser diode current is maintained constant. A temperature change of the laser changes the optical power as well, since the laser efficiency will change.

In ***CP (constant power) mode*** a monitor diode is used to measure the emitted laser power. A constant monitor current is equivalent to a constant optical power. To maintain the monitor current constant, the laser diode current is controlled correspondingly.

Note

For constant power mode a monitor diode is required. Changing the operating mode is possible only when the laser current is switched off.

In order to change the operating mode of the laser diodes, the parameter **`MODE =`** can be toggled between **`Iconst`** (Constant current mode) and **`Pconst`** (Constant power mode).

6.3.7 Selecting the Type of the Temperature Sensor

The sensor type can be selected in the ITC8000 modules by selecting the line "Thermistor" respectively "AD590".

`AD590` = AD590 and LM335 families

`Thermistor` = Thermistor.

Select the desired type and press 

.

6.3.8 Thermistor Calibration

Select the calculation method

If the relation between temperature and resistance for a given thermistor is known, the PRO8 system is able to display temperature directly in °C instead of resistance in Ω. Therefore, a calibration of the sensor in °C is necessary.

Two well known methods to calculate the resistance from temperature are implemented:

- The Exponential Method
- The Steinhart-Hart Method

In the channel menu the approximation method can be selected and the corresponding parameters can be entered. Select the line

`Steinh.-Hart` or **`Exponential`**

The right soft key toggles between the two methods. Select the desired type and press ESC to apply the setting.

Exponential method

The dependency between resistance and temperature of an NTC (thermistor) can be described by the formulas:

$$R(T) = R_0 \times e^{B_{val} * \left(\frac{1}{T} - \frac{1}{T_0}\right)} \quad \Leftrightarrow \quad T(R) = \frac{B_{val} \times T_0}{T_0 \times \ln\left(\frac{R}{R_0}\right) + B_{val}}$$

with:
- R(T) Thermistor resistance at a given temperature T
- R_0 Thermistor nominal resistance at temperature T_0
- T_0 Nominal temperature (typ. 298.15 K = 25° C)
- B_{val} Energy constant

(Temperature always given in Kelvin)

For R_0, T_0 and B_{val}, please refer to the data sheet of the thermistor. To change the three parameters select them one by one and change them to the desired value. Press ESC to apply the setting. See also Changing Parameters 29.

Steinhart-Hart method

A further way of representing the relation between temperature and thermistor resistance is the method according to Steinhart-Hart

$$\frac{1}{T} = C1 + C2 * \ln(R) + C3 * (\ln(R))^3$$

with the three parameters C1, C2 and C3.

To change the three parameters in accordance with the actual thermistor, select them one by one and set them to the desired value.

Pressing ESC terminates the input and applies value.

6.3.9 Temperature Window

A temperature window can be set to ensure that a laser diode is operated within a defined temperature interval. Particularly, this function can be used with an external control computer. In local mode, the “ERR” led will light up, if the temperature exceeds the window.

To set the window select the parameter **Twin** and adjust the desired value.

Press [ESC] to apply the setting.

Activating the temperature protection

To activate or deactivate the temperature protection select the parameter **Twin ON** resp. **Twin OFF** in the channel menu of the module.

6.3.10 Setting the P, I and D Share of the Control Loop

The temperature control behavior of the ITC8000 can be adapted to the individual laser setup by optimizing the P, I and D share parameters of the control loop.

They can be set separately in a range between 2.5 % and 100 %:

Psh = P share
Ish = I share
Dsh = D share

To change the three parameters select them one by one and set them to the desired value.

Press [ESC] to apply the setting.

For adjustment of the parameters, it is sometimes necessary to switch off the I-share completely. There is a separate switch parameter for this purpose:

Ishare = ON/OFF

Toggle the function using the right soft key.

Press [ESC] to terminate input.

6.4 Switching ON and OFF

Attention

ITC8000 modules can be switched on or off at any time, with no regard if any parameters have been set! So make sure that the appropriate Pre-Settings 24 are made prior to switching on the module!

Select the module to be switched on or off in the main menu 25. The LED “SEL” of the selected module lights up.

Switching ON / OFF the laser current I_{LD} in the channel menu

Press the key [ON/OFF] to switch on the laser current of the selected module. The LED “LD ON” of the selected module will light up, this way indicating that the laser current is enabled.

The status display changes from **CC [CP] off** to **CC [CP] on**; in the main menu (main parameters) the displayed set current value is replaced by the actual laser current.

Note

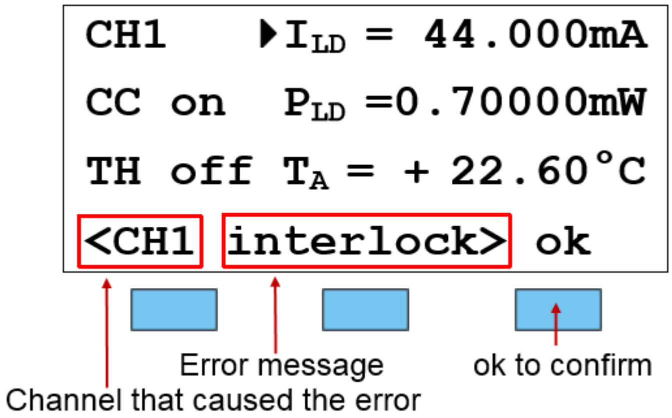
Due to the soft start function of the module it takes about 1 second for the laser current to reach the set value!

Switching on/off the TEC current in the channel menu

To switch on the TEC current select **TEC off** in the channel menu and toggle to **TEC on** and vice versa. The LED "TEC ON" on the front panel of the selected module lights up when switched on and the status display changes from **TH off** to **TH on**; iIn the main menu the displayed temperature set value **TS** changes to the actual temperature **TA**.

6.5 Error Messages

Error messages are shown in the bottom line of the display independent of the actual menu (main menu or channel menu). If an error occurs while the module is switched on, the display shows for example:



Possible error messages for an ITC8000 module

1. During operation (operation interrupted)

`Vcc fail`	Internal supply voltage failure. Please contact Thorlabs 72.
`OTP`	**O**ver **T**emperature **P**rotection. Module has been switched off due to overheating. The module can be switched on only after cooling down.
`ctrl TEMP`	TACT exceeded TWIN. Laser current switched off.
`OPEN`	Connection to the laser was interrupted during operation, or the laser forward voltage exceeded the compliance voltage of the ITC8000 module. The laser current switched off.
`OPEN TEC`	Connection to the TEC element was interrupted during operation, or TEC resistance increased too high. TEC current switched off.
`SENSOR`	Connection to the sensor was interrupted during operation. TEC current switched off.
`INTERLOCK`	Interlock circuit was interrupted during operation. Laser current switched off.

2. When attempting to change parameters during operation

`NOT IF LD ON`	The parameters **`LDPOL`**, **`PDPOL`**, **`C`** and **`Twin`** cannot be changed when the laser is switched on.
`NOT IF TEC ON`	The thermistor calibration parameters, the thermistor calibration method and the sensor type cannot be changed when the TEC is switched on.

3. When attempting to switch on the laser current

`Vcc fail`	Internal supply voltage failure. Please contact Thorlabs 72.
`OTP`	**O**ver **T**emperature **P**rotection. Module has been switched off due to overheating. The module can be switched on only after cooling down.
`INTERLOCK`	Interlock circuit is open. Laser current cannot switched on.

`Twin` Temperature is out of the activated temperature window. Laser current cannot switched on.

4. When attempting to switch on the TEC current

`NO SENSOR` No sensor connected or the recognized sensor does not match with the setting.

`OTP` **O**ver **T**emperature **P**rotection. Module has been switched off due to overheating. The module can be switched on only after cooling down.

`Vcc fail` Internal supply voltage failure. Please contact Thorlabs 72.

If an error occurs during operation, it is displayed in brackets:

`<CH3 Sens.fail>`

If the error occurs when trying to switch on, it is displayed in cursor arrows:

`▶CH1 No Sensor◀`

Any error must be confirmed by pushing the "**`ok`**" soft key. Any further operation is locked until "**`ok`**" soft key is pushed.

7 Communication with a PC

The description of the PRO8000 Series mainframe includes all instructions of how to prepare and execute the programming of the system via a computer interface.

Special operation features of the ITC8000 module are described here. See also section Operating Instruction 24.

Note

All analog values are read and written in SI units, i.e. A (not mA), W (not mW) etc. Letters may be written in lower or upper cases.

Attention

Prior to programming a ITC8000 module, the limit value of the laser diode current I_{LIM} (hardware limit) must be set using a screwdriver.
The corresponding potentiometer is marked I_{LIM} and is located on the front panel 9 of the ITC8000 module.
The value I_{LIM} is constantly measured by the PRO8000 Series mainframe and can be checked in the channel menu 24 of the ITC8000 during setting.

7.1 Nomenclature

Program messages (PC to PRO8000) are written in inverted commas:	`"*IDN?"`
Response messages (PRO8000 to PC) are written in brackets:	`[:SLOT 1]`
Decimal point:	`1.234`
Subsequent parameters are separated with commas:	`"PLOT 2,0"`
Subsequent commands are separated with semicolons:	`*IDN?;*STB?"`

7.2 Data Format

According to the IEEE 488.2 specifications all data variables are divided into 4 different data formats:

Character response data (<CRD>) is a single character or a string.
Examples: **A** or **ABGRS** or **A125TG** or **A1.23456A**

(See IEE488.2 66, section 8.7.1)

Numeric response data Type 1 (<NR1>) is a numerical value with sign in integer notation.
Examples: **1** or **+1** or **-22** or **14356789432**

(See IEE488.2 66, section 8.7.2)

Numeric response data Type 2 (<NR2>) is a numerical value with or without sign in floating point notation without exponent.
Examples: **1.1** or **+1.1** or **-22.1** or **14356.789432**

(See IEE488.2 66, section 8.7.3)

Numeric response data Type 3 (<NR3>) is a numerical value with or without sign in floating point notation with exponent with sign.
Examples: **1.1E+1** or **+1.1E-1** or **-22.1E+1** or **143.56789432E+306**

(See IEE488.2 66, section 8.7.4)

7.3 Commands and Queries

7.3.1 Select the Module Slot (SLOT)

Command	Explanation Response Example
":SLOT <NR1>"	Selects a slot for further programming **<NR1>** = 1…8 PRO8000, PRO8000-4 **<NR1>** = 1…2 PRO800
":SLOT?"	Queries the selected slot [:SLOT <NR1><LF>]

7.3.2 Query Type of Module (TYPE)

Command	Explanation Response Example
Reading	
":TYPE:ID?"	Reads the module ID (here 159 for ITC8000) [:TYPE: 159<LF>]

7.3.3 Selecting the Photo Diode Polarity (PDPOL)

Command	Explanation Response Example
Programming	
":PDPOL AG"	Selects Anode Grounded
":PDPOL CG"	Selects Cathode Grounded
Reading	
":PDPOL?"	Reads the monitor diode polarity: [:PDPOL AG<LF>] [:PDPOL CG<LF>]

7.3.4 Selecting the Operation Mode (MODE)

Command	Explanation Response Example
Programming	
":MODE CC"	Constant current mode
":MODE CP"	Constant power mode
Reading	
":MODE?"	Reads the mode of operation [:MODE CC<LF>] [:MODE CP<LF>]

7.3.5 Programming the BIAS Voltage (VBIAS)

Command	Explanation **Response Example**
Programming	
":VBIAS:SET <NR3>"	Programs the bias voltage
":VBIAS:START <NR3>"	Programs the bias start voltage for "ELCH" *)
":VBIAS:STOP <NR3>"	Programs the bias stop voltage for "ELCH"
Reading	
":VBIAS:SET?"	Reads the bias voltage **[:VBIAS:SET <NR3><LF>]**
":VBIAS:MIN?"	Reads the allowed minimum bias voltage **[:VBIAS:MIN <NR3><LF>]**
":VBIAS:MAX?"	Reads the allowed maximum bias voltage **[:VBIAS:MAX <NR3><LF>]**
":VBIAS:MIN_W?"	Reads the minimum bias voltage for U_{BIAS} - DAC = 0000 **[:VBIAS:MIN_W <NR3><LF>]**
":VBIAS:MAX_W?"	Reads the maximum bias voltage for U_{BIAS} - DAC = FFFF **[:VBIAS:MAX_W <NR3><LF>]**
":VBIAS:START?"	Reads the bias start voltage for "ELCH" **[:VBIAS:START <NR3><LF>]**
":VBIAS:STOP?"	Reads the bias stop voltage for "ELCH" **[:VBIAS:STOP <NR3><LF>]**

*) ELCH = **EL**ectrical **CH**aracterization, a PRO8000 Macro Function. Please see the PRO8000 Series Mainframe Manual for details.

7.3.6 Selecting the Laser Diode Polarity (LDPOL)

Command	Explanation **Response Example**
Programming	
":LDPOL AG"	Selects Anode Grounded
":LDPOL CG"	Selects Cathode Grounded
Reading	
":LDPOL?"	Reads status of the laser output **[:LDPOL AG<LF>]** **[:LDPOL CG<LF>]**

7.3.7 Reading the Laser Diode Hardware Limit (LIMCP)

Command	Explanation Response Example
Reading	
":LIMCP:ACT?"	Reads the actual hardware-limit [:LIMCP:ACT <NR3><LF>]
":LIMCP:MIN_R?"	Reads I_{max} - ADC = 0000 [:LIMCP:MIN_R <NR3><LF>]
":LIMCP:MAX_R?"	Reads I_{max} - ADC = FFFF [:LIMCP:MAX_R <NR3><LF>]

7.3.8 Programming the Laser Diode Software Limit (LIMC)

Command	Explanation Response Example
Programming	
":LIMC:SET <NR3>"	Programs the laser diode current limit
Reading	
":LIMC:SET?"	Reads the laser diode current limit [:LIMC:SET <NR3><LF>]
":LIMC:MIN?"	Reads the minimum possible laser diode current limit [:LIMC:MIN <NR3><LF>]
":LIMC:MAX?"	Reads the maximum possible laser diode current limit [:LIMC:MAX <NR3><LF>]
":LIMC:MIN_W?"	Reads the laser diode current limit for I_{LIM} - DAC = 0000 [:LIMC:MIN_W <NR3><LF>]
":LIMC:MAX_W?"	Reads the laser diode current limit for I_{LIM} - DAC = FFFF [:LIMC:MAX_W <NR3><LF>]

See also section Pre-Settings 24.

7.3.9 Setting the Laser Diode Current (ILD)

Command	**Explanation** **Response Example**
Programming	
":ILD:SET <NR3>"	Programs the laser diode set current
":ILD:START <NR3>"	Programs the laser diode start current for "ELCH" *)
":ILD:STOP <NR3>"	Programs the laser diode stop current for "ELCH"
":ILD:MEAS <NR1>"	Programs the laser diode current as measurement value on position <NR1> in the output string for "ELCH" (<NR1> = 1....8)
Reading	
":ILD:SET?"	Reads the laser diode set current **[:ILD:SET <NR3><LF>]**
":ILD:ACT?"	Reads the actual laser diode current **[:ILD:ACT <NR3><LF>]**
":ILD:MIN?"	Reads the allowed minimum laser diode current **[:ILD:MIN <NR3><LF>]**
":ILD:MAX?"	Reads the allowed maximum laser diode current **[:ILD:MAX <NR3><LF>]**
":ILD:MIN_W?"	Reads the minimum laser diode current for I_{LD} - DAC = 0000 **[:ILD:MIN_W <NR3><LF>]**
":ILD:MAX_W?"	Reads the maximum laser diode current for I_{LD} - DAC = FFFF **[:ILD:MAX_W <NR3><LF>]**
":ILD:MIN_R?"	Reads the minimum laser diode current for I_{LD} - ADC = 0000 **[:ILD:MIN_R <NR3><LF>]**
":ILD:MAX_R?"	Reads the maximum laser diode current for I_{LD} - ADC = FFFF **[:ILD:MAX_R <NR3><LF>"]**
":ILD:START?"	Reads the laser diode start current for "ELCH" **[:ILD:START <NR3><LF>]**
":ILD:STOP?"	Reads the laser diode stop current for "ELCH" **[:ILD:STOP <NR3><LF>]**
":ILD:MEAS?"	Reads the position of the laser diode current as measurement value in the output string for "ELCH" (**1....8, 0** if not selected**)** **[:ILD:MEAS <NR1><LF>]**

*) ELCH = **EL**ectrical **CH**aracterization, a PRO8000 Macro Function. Please see the PRO8000 Series Mainframe Manual for details.

7.3.10 Setting the Monitor Diode Current (IMD)

Command	Explanation Response Example
Programming	
":IMD:SET <NR3>"	Programs the monitor diode set current
":IMD:START <NR3>"	Programs the monitor diode start current for "ELCH" *)
":IMD:STOP <NR3>"	Programs the monitor diode stop current for "ELCH"
":IMD:MEAS <NR1>"	Programs the monitor diode current as measurement value in the "ELCH" output string on position <NR1> (1....8)
Reading	
":IMD:SET?"	Reads the monitor diode set current [:IMD:SET <NR3><LF>]
":IMD:ACT?"	Reads the actual monitor diode current [:IMD:ACT <NR3><LF>]
":IMD:MIN?"	Reads allowed minimum monitor diode set current [:IMD:MIN <NR3><LF>]
":IMD:MAX?"	Reads allowed maximum monitor diode set current [:IMD:MAX <NR3><LF>]
":IMD:MIN_W?"	Reads minimum monitor diode current for I_{PD} - DAC = 0000 [:IMD:MIN_W <NR3><LF>]
":IMD:MAX_W?"	Reads maximum monitor diode current for I_{PD} - DAC = FFFF [:IMD:MAX_W <NR3><LF>]
":IMD:MIN_R?"	Reads minimum monitor diode current for I_{PD} - ADC = 0000 [:IMD:MIN_R <NR3><LF>]
":IMD:MAX_R?"	Reads maximum monitor diode current for I_{PD} - ADC = FFFF [:IMD:MAX_R <NR3><LF>]
":IMD:START?"	Reads the monitor diode start current for "ELCH" [:IMD:START <NR3><LF>]
":IMD:STOP?"	Reads the monitor diode stop current for "ELCH" [:IMD:STOP <NR3><LF>]
":IMD:MEAS?"	Reads the position of the monitor diode current as measurement value in the "ELCH" output string (**1....8**, **0** if not selected) [:IMD:MEAS <NR1><LF>]

*) ELCH = **EL**ectrical **CH**aracterization, a PRO8000 Macro Function. Please see the PRO8000 Series Mainframe Manual for details.

7.3.11 Calibrating a Photodiode (CALPD)

Command	**Explanation** **Response Example**
Programming	
":CALPD:SET <NR3>"	Programs the sensitivity calibration factor (η) of the monitor diode in [A/W]
Reading	
":CALPD:SET?"	Reads the sensitivity (η) of the monitor diode in [A/W] **[:CALPD:SET <NR3><LF>]**
":CALPD:MIN?"	Reads the minimum allowed sensitivity (η) of the module **[:CALPD:MIN <NR3><LF>]**
":CALPD:MAX?"	Reads the maximum allowed sensitivity (η) of the module **[:CALPD:MAX <NR3><LF>]**

7.3.12 Programming the Optical Power (POPT)

Command	**Explanation** **Response Example**
Programming	
":POPT:SET <NR3>"	Programs the laser diode set current
Reading	
":POPT:SET?"	Reads the optical power **[:POPT:SET <NR3><LF>]**
":POPT:ACT?"	Reads the actual optical power **[:POPT:ACT <NR3><LF>]**
":POPT:MIN?"	Reads the minimum possible optical power **[:POPT:MIN <NR3><LF>]**
":POPT:MAX?"	Reads the maximum possible optical power **[:POPT:MAX <NR3><LF>]**
":POPT:MIN_W?"	Reads the optical power for P_{LD} - DAC = 0000 **[:POPT:MIN_W <NR3><LF>]**
":POPT:MAX_W?"	Reads the optical power for P_{LD} - DAC = FFFF **[:POPT:MAX_W <NR3><LF>]**
":POPT:MIN_R?"	Reads the optical power for P_{LD} - ADC = 0000 **[:POPT:MIN_R <NR3><LF>]**
":POPT:MAX_R?"	Reads the optical power for P_{LD} - ADC = FFFF **[:POPT:MAX_R <NR3><LF>"]**

7.3.13 Activating the Temperature Protection (TP)

Command	**Explanation** **Response Example**
Programming	
":TP ON"	Switches temperature protection on
":TP OFF"	Switches temperature protection off
Reading	
":TP?"	Reads status of the temperature protection **[:TP ON<LF>]** **[:TP OFF<LF>]**

7.3.14 Switching the Laser Output On and Off (LASER)

Command	**Explanation** **Response Example**
Programming	
":LASER ON"	Turns the laser output on
":LASER OFF"	Turns the laser output off
Reading	
":LASER?"	Reads status of the laser output **[:LASER ON<LF>]** **[:LASER OFF<LF>]**

7.3.15 Reading the Laser Diode Voltage (VLD)

Command	Explanation **Response Example**
Programming	
":VLD:MEAS <NR1>"	Programs the laser diode voltage as measurement value in the "ELCH" *) output string on position <NR1> (1....8)
Reading	
":VLD:ACT?"	Reads the actual laser diode voltage **[:VLD:ACT <NR3><LF>]**
":VLD:MIN_R?"	Reads U_{LD} - ADC = 0000 **[:VLD:MIN_R <NR3><LF>]**
":VLD:MAX_R?"	Reads U_{LD} - ADC = FFFF **[:VLD:MAX_R <NR3><LF>]**
":VLD:MEAS?"	Reads the position of U_{LD} in the "ELCH" output string (**1....8**, **0** if not selected) **[:VLD:MEAS <NR1><LF>]**

*) ELCH = **EL**ectrical **CH**aracterization, a PRO8000 Macro Function. Please see the PRO8000 Series Mainframe Manual for details.

7.3.16 Programming the TEC Current Software Limit (LIMT)

Command	Explanation **Response Example**
Programming	
":LIMT:SET <NR3>"	Programs the TEC software current limit
Reading	
":LIMT:SET?"	Reads the TEC software current limit **[:LIMT:SET <NR3><LF>]**
":LIMT:MIN?"	Reads the minimum allowed TEC software current limit **[:LIMT:MIN <NR3><LF>]**
":LIMT:MAX?"	Reads the maximum allowed TEC software current limit **[:LIMT:MAX <NR3><LF>]**
":LIMT:MIN_W?"	Reads $I_{TE\,LIM}$ - ADC = 0000 **[:LIMC:MIN_W <NR3><LF>]**
":LIMT:MAX_W?"	Reads $I_{TE\,LIM}$ - ADC = FFFF **[:LIMC:MAX_W <NR3><LF>]**

7.3.17 Programming the Temperature (TEMP)

Command	Explanation **Response Example**
Programming	
":TEMP:SET <NR3>"	Programs the set temperature
":TEMP:MEAS <NR1>"	Programs **TEMP** to be the measurement value for "ELCH[1])" on position <NR1> (1...8) in the output string.
Reading	
":TEMP:SET?"	Reads the set temperature **[:TEMP:SET <NR3><LF>]**
":TEMP:ACT?"	Reads the actual temperature **[:TEMP:ACT <NR3><LF>]**
":TEMP:MIN?"	Reads the minimum allowed set temperature **[:TEMP:MIN <NR3><LF>]**
":TEMP:MAX?"	Reads the maximum allowed set temperature **[:TEMP:MAX <NR3><LF>]**
":TEMP:MIN_W?"	Reads T - DAC = 0000 **[:TEMP:MIN_W <NR3><LF>]**
":TEMP:MAX_W?"	Reads T - DAC = FFFF **[:TEMP:MAX_W <NR3><LF>]**
":TEMP:MIN_R?"	Reads T - ADC = 0000 **[:TEMP:MIN_R <NR3><LF>]**
":TEMP:MAX_R?"	Reads T - ADC = FFFF **[:TEMP:MAX_R <NR3><LF>]**
":TEMP:MEAS?"	Reads the position of **TEMP** as measurement value in the "ELCH" output string (**1....8**, **0** if not selected) **[:TEMP:MEAS <NR1><LF>]**

[1]) **EL**ectrical **CH**aracterization

7.3.18 Programming the Temperature Window (TWIN)

Command	Explanation Response Example
Programming	
":TWIN:SET <NR3>"	Programs the temperature window.
Reading	
":TWIN:SET?"	Reads the temperature window. [:TWIN:SET <NR3><LF>]
":TWIN:MIN?"	Reads the minimum allowed temperature window. [:TWIN:MIN <NR3><LF>]
":TWIN:MAX?"	Reads the maximum allowed temperature window. [:TWIN:MAX <NR3><LF>]
":TWIN:MIN_W?"	Reads TWIN - DAC = 0000 [:TWIN:MIN_W <NR3><LF>]
":TWIN:MAX_W?"	Reads RWIN - DAC = FFFF [:RWIN:MAX_W <NR3><LF>]

7.3.19 Programming the Resistance Window (RWIN)

Command	Explanation Response Example
Programming	
":RWIN:SET <NR3>"	Programs the resistance window.
Reading	
":RWIN:SET?"	Reads the set resistance window. [:RWIN:SET <NR3><LF>]
":RWIN:MIN?"	Reads the minimum allowed set resistance window. [:RWIN:MIN <NR3><LF>]
":RWIN:MAX?"	Reads the maximum allowed set resistance window. [:RWIN:MAX <NR3><LF>]
":RWIN:MIN_W?"	Reads RWIN - DAC = 0000 [:RWIN:MIN_W <NR3><LF>]
":RWIN:MAX_W?"	Reads RWIN - DAC = FFFF [:RWIN:MAX_W <NR3><LF>]

7.3.20 Selecting the Sensor (SENS)

Command	Explanation **Response Example**
Programming	
":SENS AD"	Sensor: AD590 / LM335 Series
":SENS TH"	Sensor: Thermistor
Reading	
":SENS?"	Reads the actual sensor type **[:SENS AD<LF>]** **[:SENS TH<LF>]**

7.3.21 Programming the Resistance of the Temperature Sensor (RESI)

Command	Explanation **Response Example**
Programming	
":RESI:SET <NR3>"	Programs the set resistance of the temperature sensor (thermistor, Pt-100, Pt-1000)
":RESI:MEAS <NR1>"	Programs **RESI** to be the measurement value for "ELCH[1])" on position <NR1> (1...8) in the output string.
Reading	
":RESI:SET?"	Reads the set resistance of the temperature sensor **[:RESI:SET <NR3><LF>]**
":RESI:ACT?"	Reads the actual resistance of the temperature sensor **[:RESI:ACT <NR3><LF>]**
":RESI:MIN?"	Reads the minimum allowed set resistance of the sensor **[:RESI:MIN <NR3><LF>]**
":RESI:MAX?"	Reads the maximum allowed set resistance of the sensor **[:RESI:MAX <NR3><LF>]**
":RESI:MIN_W?"	Reads R - DAC = 0000 **[:RESI:MIN_W <NR3><LF>]**
":RESI:MAX_W?"	Reads R - DAC = FFFF **[:RESI:MAX_W <NR3><LF>]**
":RESI:MIN_R?"	Reads R - ADC = 0000 **[:RESI:MIN_R <NR3><LF>]**
":RESI:MAX_R?"	Reads R - ADC = FFFF **[:RESI:MAX_R <NR3><LF>]**
":RESI:MEAS?"	Reads the position of R as measurement value in the "ELCH" output string (**1....8**, **0** if not selected) **[:RESI:MEAS <NR1><LF>]**

[1]) **EL**ectrical **CH**aracterization

7.3.22 Thermistor Calibration - Exponential Method

Command	Explanation **Response Example**
Programming	
":CALTB:SET <NR3>"	Programs the energy constant B_{val}
":CALTR:SET <NR3>"	Programs the nominal resistance R_0
":CALTT:SET <NR3>"	Programs the nominal temperature T_0
Reading	
":CALTB:SET?"	Reads the energy constant B_{val} **[:CALTB:SET <NR3><LF>]**
":CALTR:SET?"	Reads the nominal resistance R_0 **[:CALTR:SET <NR3><LF>]**
":CALTT:SET?"	Reads the nominal temperature T_0 **[:CALTT:SET <NR3><LF>]**
":CALTB:MIN?"	Reads the minimum allowed energy constant B_{val} **[:CALTB:MIN <NR3><LF>]**
":CALTR:MIN?"	Reads the minimum allowed nominal resistance R_0 **[:CALTR:MIN <NR3><LF>]**
":CALTT:MIN?"	Reads the minimum allowed nominal temperature T_0 **[:CALTT:MIN <NR3><LF>]**
":CALTB:MAX?"	Reads the maximum energy constant B_{val} **[:CALTB:MAX <NR3><LF>]**
":CALTR:MAX?"	Reads the maximum allowed nominal resistance R_0 **[:CALTR:MAX <NR3><LF>]**
":CALTT:MAX?"	Reads the maximum allowed nominal temperature T_0 **[:CALTT:MAX <NR3><LF>]**

Refer to section Thermistor Calibration - Exponential Method 48.

Attention

These commands ***do not*** apply to ITC8000-KRYO!

Note

The selection by which method (exponential or Steinhart-Hart) the sensor calibration will be executed, depends on the order in which the coefficients are transmitted:

- If the last transmitted calibration command belongs to the exponential method (see above), then the calculation is also done with the exponential method.
- If the last command was a Steinhart-Hart parameter, then this method is selected.

7.3.23 Thermistor Calibration - Steinhart-Hart Method

Command	**Explanation** **Response Example**
Programming	
":CALTC1:SET <NR3>"	Programs the Steinhart-Hart coefficient C1
":CALTC2:SET <NR3>"	Programs the Steinhart-Hart coefficient C2
":CALTC3:SET <NR3>"	Programs the Steinhart-Hart coefficient C3
Reading	
":CALTC1:SET?"	Reads the Steinhart-Hart coefficient C1 **[:CALTB:SET <NR3><LF>]**
":CALTC2:SET?"	Reads the Steinhart-Hart coefficient C2 **[:CALTR:SET <NR3><LF>]**
":CALTC3:SET?"	Reads the Steinhart-Hart coefficient C3 **[:CALTT:SET <NR3><LF>]**
":CALTC1:MIN?"	Reads the minimum allowed Steinhart-Hart coefficient C1 **[:CALTB:MIN <NR3><LF>]**
":CALTC2:MIN?"	Reads the minimum allowed Steinhart-Hart coefficient C2 **[:CALTR:MIN <NR3><LF>]**
":CALTC3:MIN?"	Reads the minimum allowed Steinhart-Hart coefficient C3 **[:CALTT:MIN <NR3><LF>]**
":CALTC1:MAX?"	Reads the maximum allowed Steinhart-Hart coefficient C1 **[:CALTB:MAX <NR3><LF>]**
":CALTC2:MAX?"	Reads the maximum allowed Steinhart-Hart coefficient C2 **[:CALTR:MAX <NR3><LF>]**
":CALTC3:MAX?"	Reads the maximum allowed Steinhart-Hart coefficient C3 **[:CALTT:MAX <NR3><LF>]**

Refer to section Thermistor Calibration - Steinhart-Hart Method 49.

Attention

These commands ***do not*** apply to ITC8000-KRYO!

Note

The selection by which method (exponential or Steinhart-Hart) the sensor calibration will be executed, depends on the order in which the coefficients are transmitted:

- If the last transmitted calibration command belongs to the exponential method (see above), then the calculation is also done with the exponential method.
- If the last command was a Steinhart-Hart parameter, then this method is selected.

7.3.24 Programming the PID Shares (SHAREP, SHAREI, SHARED)

Command	**Explanation** **Response Example**
Programming	
":SHAREP:SET <NR3>"	Programs the P share
":SHAREI:SET <NR3>"	Programs the I share
":SHARED:SET <NR3>"	Programs the D share
Reading	
":SHAREP:SET?"	Reads the P share **[:SHAREP:SET <NR3><LF>]**
":SHAREI:SET?"	Reads the I share **[:SHAREI:SET <NR3><LF>]**
":SHARED:SET?"	Reads the D share **[:SHARED:SET <NR3><LF>]**
":SHAREP:MIN?"	Reads the minimum allowed P share **[:SHAREP:MIN <NR3><LF>]**
":SHAREI:MIN?"	Reads the minimum allowed I share **[:SHAREI:MIN <NR3><LF>]**
":SHARED:MIN?"	Reads the minimum allowed D share **[:SHARED:MIN <NR3><LF>]**
":SHAREP:MAX?"	Reads the maximum allowed P share **[:SHAREP:MAX <NR3><LF>]**
":SHAREI:MAX?"	Reads the maximum allowed I share **[:SHAREI:MAX <NR3><LF>]**
":SHARED:MAX?"	Reads the maximum allowed D share **[:SHARED:MAX <NR3><LF>]**

Please see also PID Adjustment 23.

7.3.25 Switching the I Share On / Off (INTEG)

Command	**Explanation** **Response Example**
Programming	
":INTEG ON"	Switches the I share on
":INTEG OFF"	Switches the I share off
Reading	
":INTEG?"	Reads the status of the I share **[:INTEG ON<LF>]** **[:INTEG OFF<LF>]**

7.3.26 Switching the TEC On / Off (TEC)

Command	**Explanation** **Response Example**
Programming	
":TEC ON"	Switches the TEC output ON
":TEC OFF"	Switches the TEC output OFF
Reading	
":TEC?"	Reads the TEC output status: **[:TEC ON<LF>]** **[:TEC OFF<LF>]**

7.3.27 Reading the TEC Current (ITE)

Command	**Explanation** **Response Example**
Programming	
":ITE:MEAS <NR1>"	Programs I_{TEC} to be the measurement value for "ELCH[1])" on position <NR1> (1...8) in the output string.
Reading	
":ITE:ACT?"	Reads the actual TEC (or heater) current **[:ITE:ACT <NR3><LF>]**
":ITE:MIN_R?"	Reads the minimum TEC current for I_{TE} - ADC = 0000 **[:ITE:MIN_R <NR3><LF>]**
":ITE:MAX_R?"	Reads the maximum TEC current for I_{TE} - ADC = FFFF **[:ITE:MAX_R <NR3><LF>]**
":ITE:MEAS?"	Reads the position of the TEC current as measurement value in the "ELCH" output string (**1....8**, **0** if not selected) **[:ITE:MEAS <NR1><LF>]**

[1]) **EL**ectrical **CH**aracterization

7.3.28 Reading the TEC Voltage (VTE)

Command	**Explanation** **Response Example**
Programming	
":VTE:MEAS <NR1>"	Programs TEC (or heater) voltage to be the measurement value for "ELCH[1])" on position <NR1> (1...8) in the output string.
Reading	
":VTE:ACT?"	Reads the actual TEC (or heater) voltage **[:VTE:ACT <NR3><LF>]**
":VTE:MIN_R?"	Reads the minimum U_{TE} - ADC = 0000 **[:VTE:MIN_R <NR3><LF>]**
":VTE:MAX_R?"	Reads the maximum U_{TE} - ADC = FFFF **[:VTE:MAX_R <NR3><LF>]**
":VTE:MEAS?"	Reads the position of the TEC voltage as measurement value in the "ELCH" output string (**1....8**, **0** if not selected) **[:VTE:MEAS <NR1><LF>]**

[1]) **EL**ectrical **CH**aracterization

7.4 IEEE Error Messages

[1301,"Interlock is open"]

Reason: Attempt to switch on laser while interlock loop is open. Refer to Connecting Interlock and Status Display 13

[1302,"Open circuit"]

Reason: Connection to the laser interrupted or laser forward voltage higher than compliance voltage.

[1303,"Over temperature"]

Reason: **O**ver **T**emperature **P**rotection was tripped. The module is overheated and cannot be switched on. Wait until the module has cooled down.

[1304,"Internal power failure"]

Reason: Severe hardware error. Contact Thorlabs 72.

[1305,"No calibrating of sensor during TEC on"]

Reason: The sensor cannot be calibrated while the TEC output is switched on.

[1306,"No calibrating of PD during laser on in constant power mode"]

Reason: The monitor diode cannot be calibrated (for constant power mode) while laser output is switched on.

[1307,"No setting of ILD during constant power mode"]

Reason: The set value for I_{LD} (laser current) cannot be changed in CP (constant power) mode

[1308,"No setting of IMD in constant current mode"]

Reason: The set value for I_{PD} (monitor photo diode current) or P_{LD} (laser output power) cannot be changed in CC (constant current) mode.

[1309,"No LD polarity change during laser on"]

Reason: The polarity of the laser diode cannot be changed while the laser output is switched on.

[1310,"No PD polarity change during laser on"]

Reason: The polarity of the monitor diode cannot be changed while the laser output is switched on.

[1311,"No mode change during laser on"]

Reason: The operating mode CC or CP cannot be changed while the laser output is switched on.

[1312,"Wrong or no sensor"]

Reason: Attempt to switch on the TEC controller, while no sensor is connected or wrong sensor is selected.

[1313,"Wrong command for this sensor"]

Reason: The used command is not allowed for the selected sensor, e.g., attempt to set a thermistor resistance value, while the selected and recognized sensor is an AD590)

[1314,"No sensor change during TEC on allowed"]

Reason: The sensor type cannot be changed while the TEC output is switched on.

[1315,"Attempt to switch on laser while temperature is out of window"]

Reason: Attempt to switch on the laser while the laser temperature is outside of the temperature window.

[1316,"Attempt to activate Twin during laser on"]

Reason: The temperature window cannot be activated while the laser output is switched on.

7.5 Status Reporting

The ITC8000 module provides three 16 bit registers 56

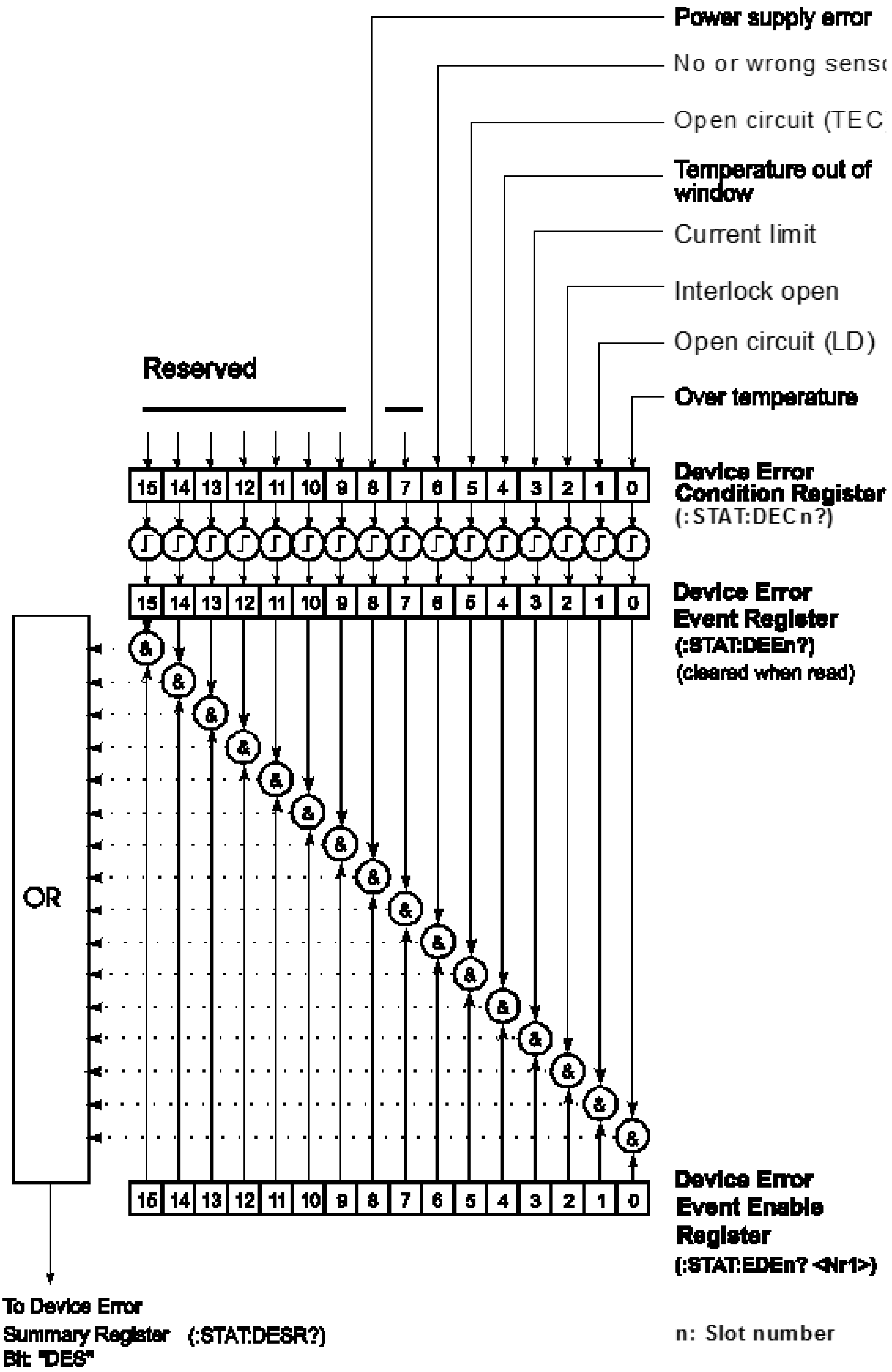
DEC	Device Error Condition Register
DEE	Device Error Event Register
EDE	Device Error Event Enable Register

together with four 8 bit registers 57 of the PRO8000 mainframe

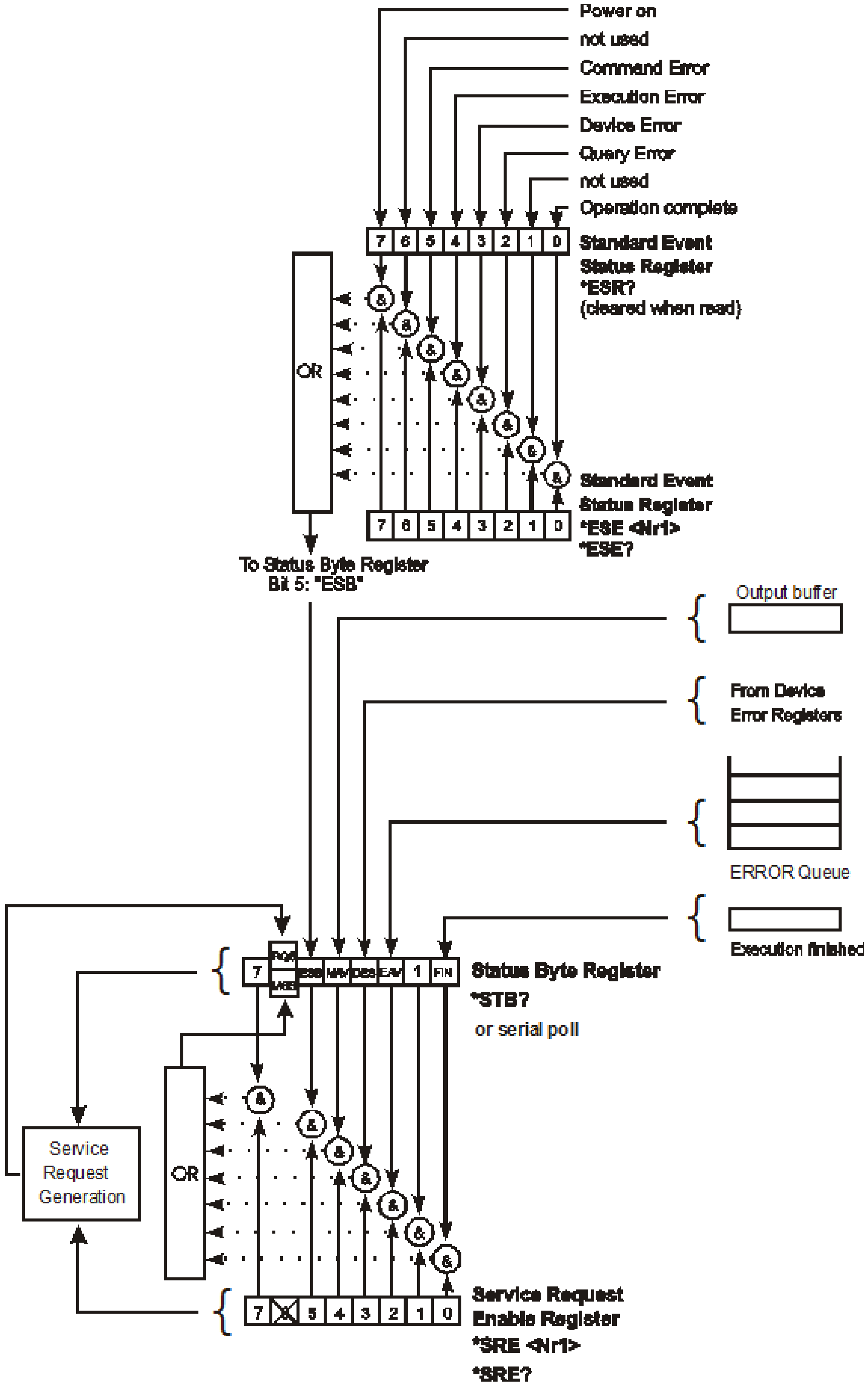
ESR	Standard event status register
ESE	Standard event Status Enable Register
STB	Status Byte Register
SRE	Service Request Enable Register

to program various service request functions and status reporting.

See also IEE488.2 Standard 66, section 11.



Structure of the registers DEC, DEE and EDE



Structure of the registers ESR, ESE, STB and SRE

7.5.1 Standard Event Status Register (ESR)

Using the command **"*ESR?"**, the ESR can be read directly. Reading the ESR clears it at the same time. The content of the ESR can not be set.

The bits are active-high and represent the following standard events:

Power on :	This bit indicates the OFF to ON state of the power supply. State = HIGH after switching on the device for the first time.
User request :	(not used)
Command error:	A command error occurred.
Execution error:	An execution error occurred.
Device dependent error:	A device dependent error (module error) occurred.
Query error:	An error occurred when trying to query a value.
Request control:	not used
Operation complete:	Can be set with **"*OPC"**. All started operations have been completed. System is in idle mode.

7.5.2 Standard Event Status Enable Register (ESE)

The bits of the ESE are used to select which bits of the ESR shall influence bit 5 (ESB) of the Status Byte Register (STB).
The 8 bits of the ESE are connected by logical "AND" with the according 8 bits of the ESR. The 8 results are connected by logical "OR", so that any "hit" leads to a logical 1 of bit 5 (ESB) of the STB.
As any bit of the STB can assert an SRQ, every event (bit of the ESR) can be used to assert an SRQ.

7.5.3 Status Byte Register (STB)

The bits of this register show the status of the PRO8000 mainframe. The register can be read out using ***STB?**. The content of the STB can not be set. The bits are active-high.

RQS	**R**e**Q**uest **S**ervice message: Shows that this device has asserted SRQ (read via serial poll).
MSS	**M**aster **S**ummary **S**tatus: Shows that this device requests a service (read via **"*STB?"**).
MAV (Message AVailable)	This bit is HIGH after a query, as a result "waits" in the output queue to be fetched. If the output queue is empty, it is LOW.
DES (Device Error Status)	This bit is HIGH after a device error occurred. EDE defines which device errors this bit sets.
EAV (Error AVailable)	This bit is HIGH as long as there are errors in the error queue.
FIN (command FINished)	This bit is HIGH, after a command has finished and all bits of the STB have been set.

All bits except bit 6 of the STB can be used to assert a service request (SRQ 59). Alternatively the SRQ can be recognized using the command "*STB?" 59 or by serial poll 59.

7.5.4 Service Request Enable Register (SRE)

The bits of the SRE are used to select which bits of the STB shall assert an SRQ.

Bit 0, 1, 2, 3, 4, 5 and 7 of the STB are combined by logical "AND" with the according 7 bits of the SRE. These 7 results are combined by logical "OR", so that any "hit" leads to a logical 1 in bit 6 of the STB and asserts an SRQ.

7.5.5 Reading the STB by Detecting SRQ

If an SRQ 59 is asserted, bit 6 of the STB is set to logical 1, so that the controller can detect by auto serial polling, which device asserted the SRQ.

7.5.6 Reading the STB by *STB? Command

If the controller does not "listen" to SRQs at all, the service request can be detected by reading the status byte with the command **"*STB?"**.

If bit 6 is logical 1, a service request was asserted.

7.5.7 Reading STB by Serial Poll

If the controller does not support auto serial poll, the service request can also be detected via manual serial poll.

If bit 6 is logical 1, a service request was asserted.

7.5.8 Device Error Condition Register (DEC)

The bits of this register show the errors, that occur during operation (operation errors). The bits are active-high.
If the error disappears, the bits are reset to LOW.
For ITC8000 modules the bits 0 to 6 and 8 are used

Bit 0 - Over temperature
ITC8000 is overheated. Wait until the module has cooled down. Maintain proper air flow.

Bit 1 - Open circuit (LD)
Laser diode circuit is open.

Bit 2 - Interlock open
The interlock has opened or the path resistance is >430 W.

Bit 3 - Current limit
The current limit is reached and the protection circuit is active now. Noise and drift specs are not valid any more.

Bit 4 - Temperature out of window
Appropriate laser temperature (controlled by an TEC8xxx module) is out of specified window.

Bit 5 - Open circuit (TEC)
The TEC circuit is open (interrupted connection).

Bit 6 - No or wrong Sensor
A temperature sensor could not be recognized, or the type of the recognized sensor does not match the setting of the ITC8000.

Bit 8 - Power supply error
Internal power supply error.

The DEC can be read but not set. Reading does not clear the DEC.

7.5.9 Device Error Event Register (DEE)

The bits of this register hold the errors that occurred during operation (operation errors). So each bits of the DEC sets the according bit of the DEE.

The DEE can be read but not set.

Reading out clears the DEE.

7.5.10 Device Error Event Enable Register (EDE)

The bits of the EDE are used to select, which bits of the DEE shall influence bit 3 (DES) of the STB.

The 8 bits of the EDE are combined by logical "AND" to the according 8 bits of the DEE. These 8 results are combined by logical "OR" so that any "hit" leads to a logical 1 in bit 3 (DES) of the STB.

As any bit of the STB can assert an SRQ, every error (bit of the DEE) can be used to assert an SRQ.

8 Maintenance and Service

Protect the ITC8000 from adverse weather conditions. The ITC8000 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 contact Thorlabs 72 for return instructions.

Do not remove covers!

In order to ensure best performance, accuracy and reliable operation, Thorlabs recommends a **recalibration after 24 months.**

8.1 Troubleshooting

In the case that your ITC8000 shows malfunction please check the following topics:

◆ **The module does not work at all (no display on the mainframe):**

- Is the mainframe connected properly to the mains power supply?
  - Connect the mainframe to the power line, take care of the correct voltage setting and grounding of the mainframe.
- Is the mainframe turned on?
  - Turn on the power key switch.
- Check the fuse at the rear panel of the mainframe.
  - If blown, replace the fuse with the correct type (one spare fuse is inserted in the fuse holder). Please refer to section Exchanging the Mains Fuse in the PRO8000 Series Manual.

◆ **The display works, but not the module:**

- Is the module inserted correctly and are all mounting screws tightened?
  - Insert the module in the desired slot and tighten all mounting screws properly.
- Is the desired module selected?
  - Select the desired module on the display by means of the up- and down arrow keys. (LED “SEL” on the front panel lights up).
- Is the LD/TEC output turned ON in the main menu or one of the sub menus?
  - Change the status setting from “off” to “on”. The LED “LD ON” / "TEC ON" on the front panel of the module must light up.
- Is the hardware limit I_{LIM} and / or the software limit I_{MAX} set to 0?
  - Adjust the hardware limit I_{LIM} by means of the potentiometer on the ITC8000 front panel and the software limit I_{LIM} in the channel menu to appropriate values.

◆ **You don't get the desired laser output power**

- Is the interlock closed?
  - Verify that the resistance between the interlock pins of the connector jack does not exceed 430 Ω. See section Connecting Interlock and Status Display 13.
- Is the desired module selected?
  - Select the desired module on the display by means of the up- and down arrow keys. (LED "SEL" on the front panel lights up).
- Is the laser output turned ON in the main menu or one of the sub menus?
  - Change the status setting from "off" to "on". The LED "LD ON" on the front panel of the module must light.
- Is the hardware limit I_{LIM} or the software limit I_{MAX} set correctly?
  - Adjust the hardware limit I_{LIM} by means of the potentiometer on the ITC8000 front panel and the software limit I_{LIM} in the channel menu to appropriate values.
- Is the software limit P_{LIM} set to zero?
  - Correct the value in the channel menu to the desired limit.
- Is the laser diode installed properly?
  - Control the connection cable.
- Is the laser diode poled correctly?
  - If not, change the polarity of the laser diode corresponding to the type of ITC8000 module (AG or CG)
- Is the photo diode connected properly?
  - Check the connecting cable.
- Is the photo diode poled correctly?
  - If not, change the polarity with the **":PDPOL:SET"** command or in the channel menu.
- Are you using a bias voltage with the photo diode in photocurrent mode?
  - Turn off bias voltage in the channel menu, with the **":PDBIA OFF"** command or change the polarity of the diode for photo element mode.
- Is the correct photo diode efficiency set (A/W)?
  - Enter the coefficient in the channel menu or with the command **":CAL:SET"**
- Is the desired output power programmed correctly?
  - Adjust the desired output power P_{LD} in the channel display
- Do you use a temperature window with inappropriate setting or is the TEC not switched on?
  - Change settings, switch on TEC, or turn off the window function

- **You don't get the desired operation temperature**
  - Is the TEC element connected properly and are the temperature sensor parameters entered correctly?
    - Check all cable connections.
    - Check the software settings in the Channel menu 27.
    - Verify the temperature sensor selection.
    - Verify the temperature sensor parameter settings. See section Selecting the Type of the Temperature Sensor 30 and subsequent.

- **The actual temperature of the device under control differs from the set temperature**
  - Is the temperature sensor calibrated correctly?
    - Verify the entered temperature sensor parameters. See section Thermistor Calibration 30.
  - Is the PID loop set up correctly?
    - Verify the PID share adjustment, see section PID Adjustment 23.

If above hints could not resolve the malfunction, please contact Thorlabs 72 for technical support and/or return instructions.

9 Appendix

9.1 Technical Data

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

Parameter	ITC8022	ITC8052	ITC8102
Laser Controller: Current Control			
Laser Current Control Range	0 to ± 200 mA	0 to ± 500 mA	0 to ± 1 A
Compliance Voltage	> 5 V		
Setting Resolution	3 µA	7.5 µA	15 µA
Accuracy (Full Scale)	± 0.05 %	± 0.05 %	± 0.1 %
Noise w/o Ripple (10Hz to 10MHz, rms, typ.)	< 2 µA	< 5 µA	< 10 µA
Ripple (50 Hz, rms, typ.)	< 1 µA	< 1 µA	< 1.5 µA
Transients (processor, typ.)	< 15 µA	< 30 µA	< 50 µA
Transients (other, typ.)	< 200 µA	< 500 µA	< 1 mA
Drift (24hrs, at const. ambient temperature, typ.)	< 3 µA	< 10 µA	< 25 µA
Temperature Coefficient	< 50 ppm/ °C		
Laser Controller: Current Limit			
Setting Range	0 to ≥ 200 mA	0 to ≥ 500 mA	0 to ≥ 1 A
Resolution	6 µA	15 µA	30 µA
Accuracy	± 200 µA	± 500 µA	± 2 mA
Laser Controller: Power Control			
Monitor Current I_{PD} Range	10 µA to 2 mA [1])		
Resolution	30 nA		
Setting Accuracy	±0.1% f.s. (typ.)		
Drift (30 min., at constant the ambient temperature)	≤ 1 µA		
Monitor Diode BIAS Voltage	0 to 10 V (adjustable)		
Laser Voltage Measurement			
Measurement principle	4-wire		
Measurement range	0 to 10 V		
Resolution	0.3 mV		
Accuracy	± 5 mV		

Temperature Controller: Output	
TEC Current Control Range	-2 to +2 A
Compliance Voltage	> 8 V
Maximum Output Power	16 W
Measurement Resolution TEC Current	0.07 mA
Measurement Resolution TEC Voltage	0.3 mV
Noise and Ripple (typ.)	< 1 mA
Temperature Controller: Current Limit	
Setting Range	0 to ≥ 2 A
Resolution	0.5 mA
Setting Accuracy	± 20 mA
AD590 / AD592 / LM335 IC Sensors	
Control Range	-12.375 °C ... +90.000 °C
Measurement Accuracy	±0.1 °C
Measurement Resolution	0.0015 °C
Setting Accuracy	±0.1 °C
Setting Resolution	0.0015 °C
Temperature Stability (24h, typ.)	< 0.001 °C
Thermistor (Calibrated / Not Calibrated, Temperature Display in Ω)	
Measurement Current	50 µA
Control Range	200 Ω to 40 kΩ (10 kΩ nom. resistance at 25°C)
Resolution	0.7 Ω
Setting Accuracy	±10 Ω
Resistance Stability (24h, typ.)	< 1 Ω
Thermistor (Calibrated, Temperature Display in °C)	
Measurement Current	50 µA [1])
Control Range	Temperature at 40 kΩ to 150 °C [2])
Resolution	[2])
Setting Accuracy	[2])
Temperature Stability (24h, typ.)	[2])
Temperature Control Loop	
P, I and D Shares	To Be Set Separately
Setting Range	2.5 to 100 %
General	
Warm-up Time for Rated Accuracy	≤15 min
Module Width	1 Slot
Operating Temperature Range	0 - 40 °C
Storage Temperature Range	-40 to 70 °C
Output Connector LD TEC	 D-Sub 9 Pin, Female D-Sub 15 Pin, Female

[1]) Other ranges on request

[2]) Depending on Thermistor Specification

9.2 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	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions [2,3,4] and Immunity [2,3,5]
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance Criterion C)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance Criterion B)
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance Criterion C)
	IEC 61000-4-5	Power line Surge Immunity (Performance criterion C)
	IEC 61000-4-6	Conducted RF Immunity (Performance Criterion B)
	IEC 61000-4-11	Voltage Dips and Interruptions Immunity (Performance Criterion C)
	EN 61000-3-2	AC Power Line Harmonic Emissions
Australia / New Zeeland Declaration of Conformity - EMC	Complies with the Radiocommunications Act and demonstrated per EMC Emission standard [2,3,4]	
	AS/NZ 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, including with CAB4x series cables installed at the LD OUT and TEC OUT ports. ITC8022 testing included a LAB8000 Laser Diode Mount Box attached at the other end of the CAB4x cable.

[3] Compliance demonstrated with the ITC8000 Series modules installed in the Thorlabs PRO8xxx Series Mainframes.

[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.

9.3 Literature

[1] IEEE488.2-1992 - IEEE Standard Codes, Formats, Protocols, and Common Commands for Use With IEEE Std 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation

Available at http://www.ieee.org/publications_standards/index.html .

9.4 Warranty

Thorlabs warrants material and production of the ITC8000 for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs 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. The customer will carry the shipping costs to Thorlabs, in case of warranty repairs Thorlabs 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 warrants the hard- and/or software determined by Thorlabs for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs 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 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 does explicitly not warrant the usability or the economical use for certain cases of application.

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

9.5 Copyright and Exclusion of Reliability

Thorlabs 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.

Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.

Insofar as permitted under statutory regulations, we assume no liability for direct damage, indirect damage or damages suffered by third parties resulting from the purchase of this product. In no event shall any liability exceed the purchase price of the product.

Please note that the content of this document is neither part of any previous or existing agreement, promise, representation or legal relationship, nor an alteration or amendment thereof. All obligations of *Thorlabs* result from the respective contract of sale, which also includes the complete and exclusively applicable warranty regulations. These contractual warranty regulations are neither extended nor limited by the information contained in this document. Should you require further information on this product, or encounter specific problems that are not discussed in sufficient detail in the document, please contact your local *Thorlabs* dealer or system installer.

9.6 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 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 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 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

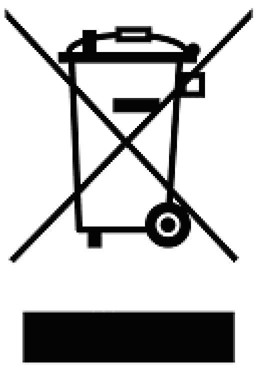
If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

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

9.7 List of Acronyms

The following abbreviations are used in this manual:

AC	Alternating Current
ADC	Analog to Digital Converter
AG	Anode Ground
CG	Cathode Ground
CLR	CLeaR
CR	Carriage Return
CRD	Character Response Data
DAC	Digital to Analog Converter
DC	Direct Current
DCL	Device Clear
DEC	Device Error Condition Register
DEE	Device Error Event Register
DES	Device Error Status
EAV	Error AVailable
EDE	Enable Device Error Event Register
EDFA	Erbium Doped Fiber Amplifier
ELCH	ELectrical Characterization
EOI	End Of Information
ESE	Standard Event Status Enable register
ESR	Event Status Register
FIN	Command FINished
GET	Group Execute Trigger
GTL	Go To Local
IEEE	Institute for Electrical and Electronic Engineering
LD	Laser Diode
LDC	Laser Diode Controller
LED	Light Emitting Diode
LF	Line Feed
LLO	Local Lockout
LS	Laser Source Module
NR1	Numeric Response data of type 1
NR2	Numeric Response data of type 2
NR3	Numeric Response data of type 3
MAV	Message AVailable
MSS	Master Summary Status

OTP	Over Temperature Protection
PC	Personal Computer
PD	Photo Diode
RQS	ReQuest Service Message
SDC	Selected Device Clear
SEL	SELect
SRE	Service Request Enable Register
SRQ	Service ReQuest
STB	STatus Byte Register
SW	Soft Ware
TEC	ThermoElectric Cooler (Peltier Element)
TRG	TRiGger

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