
Operation Manual
Thorlabs Instrumentation

Laser Diode Combi Controller

ITC502 (-IEEE)
ITC510 (-IEEE)



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Contents	page
1 General description of the ITC5xx controller	1
1.1 Packing List	1
1.2 Safety	1
1.3 Features	4
1.4 Mode of operation	6
1.5 Technical Data	7
1.5.1 Technical data ITC502	7
1.5.2 Technical data ITC510	10
1.6 Operating elements at the front panel	14
1.7 Operating elements at the rear panel	15
1.8 Pre-settings	16
1.8.1 Setting the limit of the laser current $I_{LD LIM}$	16
1.8.2 Setting the limit value of the TEC current	16
1.8.3 Setting the temperature window	16
1.8.4 DIP switch for “wake up“ preset	17
1.9 Connecting components	20
1.9.1 Pin assignment for the laser diode output	20
1.9.2 Pin assignment of the TEC output jack	22
1.9.3 Connecting a thermistor	23
1.9.4 Connecting a temperature sensor AD590 or AD592	24
1.9.5 Connecting a temperature sensor LM135 or LM335	25
1.9.6 Connecting a TEC element	25
1.9.7 Connecting the status indicator	27
1.9.8 Connecting laser- and monitor diode	27
1.9.9 Connecting interlock and status LED	29
1.9.10 Temperature tune input	30
2 Operating the ITC5xx	31
2.1 Mains voltage selector	31
2.2 Mains switch	31
2.3 Main setting knobs	31
2.4 Display	32
2.5 Select the value to be displayed	33
2.6 Operating Mode of the laser diode (MODE)	34
2.7 Polarity of the laser diode (LD POL)	36
2.8 Polarity of the monitor diode (PD POL)	36
2.9 Bias voltage of the monitor diode (BIAS)	36
2.10 Adjusting the bias voltage of the monitor diode	38

2.11	Adjusting the power display of an internal monitor diode	38
2.12	Temperature window protection	40
2.13	Selecting the temperature sensor	40
2.14	Polarity check of the TEC element	41
2.15	Setup and function of temperature controllers	42
2.15.1	Statements and implications	42
2.15.2	Demands to the ideal temperature control loop	43
2.15.3	Influences on the real temperature control loop	43
2.15.4	PID adjustment	45
2.16	Analog modulation input	48
2.17	Analog output (I_{LD})	49
2.18	Laser and TEC current ON/OFF	50
2.19	CP gain	51
2.20	BNC connector TEMP OUT	51
2.21	BNC connector Temp tune	52
2.22	Using the interlock input	52
2.22.1	Examples of various protection functions	53
2.23	Laser voltage measurement	54
3	Remote control by a PC (ITC5xx-IEEE)	55
3.1	IEEE488 Interface	56
3.1.1	Interface specifications	56
3.1.2	Setting up the Interface	57
3.1.3	Connecting the Instrument	59
3.1.4	IEEE488 bus commands	60
3.2	Before Programming	62
3.2.1	Nomenclature	62
3.2.2	Program and response messages	62
3.2.3	Data format	63
3.3	Common commands and queries	65
3.3.1	Identification query	65
3.3.2	Reset	65
3.3.3	Self-test query	65
3.3.4	Set Operation-complete bit	65
3.3.5	Operation-complete query	66
3.3.6	Wait	66
3.3.7	Event-Status-Enable-Register (ESE)	66
3.3.8	Query Standard-Event-Status-Register (ESR)	66
3.3.9	Service-Request-Enable-Register (SRE)	67
3.3.10	Query Status-Byte-Register (STB)	67

3.4 System command group	68
3.4.1 Answer mode	68
3.4.2 Error-LED mode	68
3.4.3 Querying the error queue	69
3.4.4 Averaging rate	69
3.5 Status command group	70
3.5.1 Query Device-Error-Condition-Register (DEC)	70
3.5.2 Query Device-Error-Event-Register (DEE)	70
3.5.3 Device-Error-Event-Enable-Register (EDE)	70
3.6 ITC5xx specific commands	71
3.6.1 Operation mode (MODE)	71
3.6.2 Laser diode polarity (LDPOL)	71
3.6.3 Photo diode polarity (PDPOL)	72
3.6.4 Reading the state of the temperature protection (TP)	72
3.6.5 Switching the bias voltage on and off (PDBIA)	73
3.6.6 Turn the output on and off (LASER)	74
3.6.7 Reading the laser diode hardware limit (LIMCP)	75
3.6.8 Laser diode current (ILD)	75
3.6.9 Monitor diode current (IMD)	76
3.6.10 Calibrating a photo diode (CALPD)	77
3.6.11 Optical power (POPT)	78
3.6.12 Reading the optical power from the display (POPTP)	79
3.6.13 Reading the laser diode voltage (VLD)	79
3.6.14 Reading the bias voltage (VBIAS)	79
3.6.15 Temperature Sensor (SENS)	80
3.6.16 Switching the TEC on and off (TEC)	80
3.6.17 Temperature (only AD590) (TEMP)	81
3.6.18 Resistance of the thermistor (RESI)	82
3.6.19 Reading the TEC current hardware limit (LIMTP)	83
3.6.20 Reading the TEC current (ITE)	83
3.6.21 Reading the temperature/resistance window (WIN)	83
3.6.22 Reading the TEC voltage (VTE)	83
3.7 Error messages of the ITC5xx	84
3.7.1 General errors	84
3.7.2 ITC5xx operation error messages	87
3.8 Status reporting	90
3.8.1 Standard event status register (ESR)	90
3.8.2 Standard event status enable register (ESE)	93
3.8.3 Status byte register (STB)	93

3.8.4	Service request enable register (SRE)	94
3.8.5	Reading the STB by detecting SRQ	94
3.8.6	Reading the STB by *STB? command	94
3.8.7	Reading the STB by serial poll	94
3.8.8	Device error condition register (DEC)	95
3.8.9	Device error event register (DEE)	96
3.8.10	Device error event enable register (EDE)	96
3.9	Hints for setting up control programs	97
4	Maintenance	100
4.1	Repair	100
4.2	Cleaning	100
4.3	Selecting the line voltage	100
4.4	Exchanging the line fuse	101
4.5	Trouble-shooting	103
5	Service	106
5.1	Exchange of internal fuses	106
6	Appendix	107
6.1	Warranty	107
6.2	Certifications and compliances	108
6.3	Thorlabs “End of Life” policy (WEEE)	109
6.3.1	Waste treatment on your own responsibility	110
6.3.2	Ecological background	110
6.4	List of acronyms	111
6.5	List of figures	113
7	Addresses	114

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to come up to your expectations and develop 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

This operation manual contains specific information on how to operate the laser diode controller ITC502 and ITC510. A general description is followed by explanations of how to operate the unit manually. You will also find informations about remote control via the IEEE 488 computer interface.

Attention

This manual contains “WARNINGS” and “ATTENTION” label in this form to indicate dangers for persons or possible damage of equipment.

Please read these advises carefully!

NOTE

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

1 General description of the ITC5xx controller

1.1 Packing List

- 1 ITC502 or ITC510 packed in plastic form parts
- 1 power cord, connector according to ordering country
- 1 operation manual
- 1 CD-ROM with Drivers (for ITC5xx-IEEE)
- 1 Connection cable CAB 400
- 1 Connection cable CAB 420-15

1.2 Safety

Attention

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

Before applying power to your ITC5xx system, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth contact of the socket outlet!

Improper grounding can cause electric shock with damage to your health or even death!

Also make sure that the line voltage setting marked on the rear panel agrees with your local supply and that the corresponding fuses are inserted. If not, please change the voltage (see 4.3) and the mains fuse (see section 4.4)

Prior to operation make sure that the correct line voltage is set and the appropriate fuse inserted.

All in- or outputs must only be operated with duly shielded connection cables.

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

This precision device is only dispatchable if duly packed into the complete original packaging including the plastic form parts. If necessary, ask for a replacement package.

 **Attention** 

Semiconductor laser modules can deliver up to several 100mW of (maybe) invisible laser radiation!

When operated incorrectly, this can cause severe damage to your eyes and health!

Be sure to pay strict attention to the safety recommendations of the appropriate laser safety class!
This laser safety class is marked on your external laser source used.

 **Attention** 

Mobile telephones, handy 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 EN 50 082-1.
To connect the unit to the mains, only use the supplied mains cable with safety mains plug. The unit is grounded via the protective conductor of this cable. To avoid electrical shock the plug of the mains cable is to be inserted into a correctly grounded socket.

To guarantee a safe operation of the ITC5xx always pay attention to keep the ventilation slots on the sides and the fan air inlet at the rear of the unit free from obstacles.

 **Attention** 

The unit must not be operated in explosion endangered environments!

The user must not open the unit during operation. An internal adjustment as well as a replacement of parts is only to be carried out by respectively trained service personnel. Parts must not be exchanged when the unit is switched on. Dangerous voltages may even be present with the unit off line and the power cord removed!.

1.3 Features

- **Key-operated power switch**

Protection against unauthorized or accidental use.

- **Defined states after switch-on**

When switching on the ITC5xx with the mains switch the laser and TEC current outputs are always switched off. The ITC5xx will always wake up in a mode that can be selected via a DIP switch at the rear.

- **Softstart**

The switch on delay of the softstart function protects the laser diode against undesired transients.

- **Limit for the laser diode- and the TEC current (hardware limit)**

Manually adjustable current limits restrict the maximum allowed current. The limit values are set with two 25-turn potentiometers at the front panel.

- **Interlock**

The interlock input realizes several protective functions simultaneously.

- Safety lock to prevent unintentional use
- Cable damage monitoring
- An external emergency switch may be connected
- Application of external automatic protection equipment, e.g. for the temperature of cooling water
- ON/OFF LED of the laser diode

The laser can only be operated with the interlock input being duly closed.

- **Contact protection of the laser diode (open circuit)**

If the cable connecting the laser should be interrupted even for a short time during operation, an emergency switch turns off laser current immediately.

- **Contact failure display of the TEC element (open circuit)**

Cable damage, bad contact or too high resistive TEC element is displayed with a LED. The output will remain switched on since also a wrong TEC element can still provide cooling and thus further protects the laser diode.

- **Protection of the DUT against sensor failure**
Protection against use of an incorrect temperature sensor / protection against line interruption to the temperature sensor.
- **Electronic short-circuit switch for the laser diode**
With the current module off an electronic switch will short-circuit the laser diode to protect against static discharges etc.
- **Control LED of laser- and TEC current being active**
If the current is switched on an LED lights up to indicate device is on.
- **Temperature window protection of the laser diode**
Operation in a specified temperature range.
- **Over-temperature protection**
The ITC5xx contains an automatic over-temperature protection in case that the allowed internal operating temperature of the ITC5xx should be exceeded. In this case the output is turned off. After internal temperature drop of about 10 °C the output current of the ITC5xx can be switched on again.
- **Mains filter**
Protection against line failures (protection against transients) and other electromagnetic interference's.
- **Line failure monitoring**
In case of line failure/line interruption the ITC5xx will wake up again with the laser output switched off.

1.4 Mode of operation

A fixed adjustable hardware limit limits the maximum deliverable laser current in each operating mode.

The laser diode is sourced unipolar against ground (anode or cathode to ground may be selected). This is of advantage regarding the stability of the laser current, noise and RF influences.

The monitor diode input is a transimpedance amplifier (input impedance 0Ω). Both polarities of the monitor diode can be selected. The monitor diode may either be operated photovoltaic (without bias voltage) or photoconductive, i.e. with bias voltage (selectable in a range from 0 ... 10 V).

The limit value for the TEC current and the temperature window are set with screw-driver potentiometers.

The TEC element always operates against ground. This is of considerable advantage regarding the safety of the TEC element and the stability of the TEC current.

The sensor input is designed for different types of temperature sensors. A missing sensor or the selection of a incorrect type will be detected.

The ITC5xx has an input for an IC temperature sensor of the AD590/592 or LM35/135/335 series as well as an input for a thermistor. If a thermistor is used you can choose between two resistance ranges (maximum resistance of the thermistor 20 k Ω or 200k Ω).

The set values for the temperature and the thermistor resistance are set with the 10-turn main dial knob.

The P-, I- and D-share of the analog control loop are set with „thumb-nail“-potentiometers.

All settings are done by the operating elements or via the IEEE488-interface (ITC5xx-IEEE) and a PC. Only the hardware limits for the currents must be set manually. No manual settings are required during automatic tests using a PC.

1.5 Technical Data

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

1.5.1 Technical data ITC502

General Data

Line voltage	100 V / 115 V / 230 V (-10%, +15 %) (fixed)
Line frequency	50 ... 60 Hz
Max. power consumption	90 VA
Supply mains overvoltage	Category II (Cat II)
Operating temperature ¹⁾	0 ... +40°C
Storage temperature	-40°C ... +70°C
Relative Humidity	Max. 80% up to 31 °C, decreasing to 50% at 40 °C
Pollution Degree (indoor use only)	2
Warm up time for rated accuracy	≤ 10 min
Operation altitude	< 3000 m
Weight	< 7 kg
Dimensions (W x H x D)	including operating elements 220 x 120 x 376 mm ³ without operating elements 220 x 110 x 351 mm ³

Current control

Range of laser current I_{LD}	0 ... ± 200 mA
Compliance voltage	> 6 V
Setting resolution (manual / remote control)	10 µA / 3 µA
Measurement resolution (manual / remote control)	10 µA / 1 µA
Accuracy	± 100 µA
Noise without ripple (10 Hz ... 10 MHz, rms), typ.	< 1.5 µA
Ripple (50/60 Hz, rms), typ.	< 1.5 µA
Transients, typ.	< 0.2 mA
Drift, 24 hours, typ. (0...10Hz, without changing the ambient temperature)	< 10 µA
Temperature coefficient	≤ 50 ppm/°C

Power control

Range of monitor current I_{PD}	5 µA ... 2 mA ²⁾
Setting resolution (manual / remote control)	0.1 µA / 0.03 µA

¹⁾ non condensing

²⁾ other ranges on request

Measurement resolution (manual / remote control)	0.1 μ A / 0.01 μ A
Accuracy	$\pm 2 \mu$ A
Photodiode bias voltage	0 ... 10 V

Laser voltage

Measurement principle	4-wire
Measurement range	0 ... 10 V
Measurement resolution (manual / remote control)	1 mV / 0.1 mV
Accuracy	± 20 mV

Analog control output

Load resistance	≥ 10 k Ω
Output voltage for 0 ... $I_{LD\ MAX}$	0 ... ± 10 V ¹⁾
Transmission coefficient	50 V/A $\pm 5\%$

LD Current limit

Setting range I_{LIM}	0 ... ≥ 200 mA
Measurement resolution (manual / remote control)	10 μ A / 1 μ A
Accuracy	± 0.5 mA

Analog modulation input

Input impedance	10 k Ω
Small signal 3 dB bandwidth (CC mode)	DC ... 500 kHz
Laser diode modulation coefficient (CC mode)	20 mA/V $\pm 5\%$
Laser diode modulation coefficient (CP mode)	0.2 mA/V $\pm 5\%$

Current output TEC element

Control range	- 2 A ... + 2 A
Maximum output power	16 W
Compliance voltage	> 8 V
Measurement resolution (manual / remote control)	1 mA / 0.1 mA
Measurement accuracy	± 10 mA
Noise and ripple (typ.)	< 1 mA
Measurement resolution TEC voltage (manual / remote control)	1 mV / 0.1 mV
Measurement accuracy TEC voltage	± 40 mV

¹⁾ sign depends on selected polarity

TEC Current limit

Setting range	0 ... \geq 2 A
Measurement resolution (manual / remote control)	1 mA / 0.1 mA
Accuracy	\pm 20 mA

Temperature sensors AD590, AD592, LM135, LM335

Control range (AD590, LM135)	- 45 °C ... + 145 °C
Control range (AD592)	- 25 °C ... + 105 °C
Control range (LM335)	- 40 °C ... + 100 °C
Setting resolution (manual / remote control)	0.01 °C / 0.003 °C
Measurement resolution (manual / remote control)	0.01 °C / 0.001 °C
Accuracy	\pm 0.1 °C
Temperature stability (24 hours)	\leq 0.001 °C

Thermistor (2 k Ω / 20 k Ω range)

Measurement current	100 μ A / 10 μ A
Control range	10 Ω ... 19.99 k Ω / 100 Ω ... 199.9 k Ω
Setting resolution (manual control)	1 Ω / 10 Ω
Setting resolution (remote control)	0.3 Ω / 3 Ω
Measurement resolution (manual control)	1 Ω / 10 Ω
Measurement resolution (remote control)	0.1 Ω / 1 Ω
Accuracy	\pm 5 Ω / \pm 50 Ω
Temperature stability (24 hours) ¹⁾	\leq 0.5 Ω / \leq 5 Ω

Temperature control input

Input resistance	10 k Ω
Control voltage	-10 ... +10 V
Transmission coefficient IC-sensors	2 °C/V \pm 5%
Transmission coefficient thermistor (20 k Ω / 200 k Ω range)	0.2 k Ω /V / 2 k Ω /V \pm 5%

¹⁾ Due to the nonlinear conversion from Ω to °C the stability in °C depends on the operating conditions and the characteristics of the thermistor. E.g. for a typical thermistor at a set point of 10k Ω (25°C), a 0.5 Ω stability translates into about 1mK temperature stability. At a set point of 5k Ω (38°C), the stability is about 2mK.

Temperature control Output

Load resistance	> 10 k Ω
Output voltage	0 ... \pm 10 V
Transmission coefficient IC sensors	50 mV / $^{\circ}$ C \pm 5%
Transmission coeff. thermistor (20 k Ω / 200 k Ω range)	500 mV/ k Ω / 50 mV/k Ω \pm 5%

Temperature window protection

Setting range T _{WIN}	0.5 $^{\circ}$ C ... 20 $^{\circ}$ C
Setting range R _{WIN} (20 k Ω / 200 k Ω range)	50 Ω ... 2 k Ω / 500 Ω ... 20 k Ω

Computer Interface

Setting resolution	16 Bit
Measurement resolution	12 ... 18 Bit ¹⁾

1.5.2 Technical data ITC510

General Data

Line voltage	100 V / 115 V / 230 V (-10%, +15 %) (fixed)
Line frequency	50 ... 60 Hz
Max. power consumption	150 VA
Supply mains overvoltage	Overvoltage category II (Cat II)
Operating temperature ²⁾	0 ... +40 $^{\circ}$ C
Storage temperature	-40 $^{\circ}$ C ... +70 $^{\circ}$ C
Relative Humidity	Max. 80% up to 31 $^{\circ}$ C, decreasing to 50% at 40 $^{\circ}$ C
Operation altitude	< 3000 m
Pollution Degree (indoor use only)	2
Warm up time for rated accuracy	\leq 10 min
Weight	< 7 kg
Dimensions	220 x 120 x 377 mm ³

¹⁾ in High Resolution mode, at reduced measurement speed

²⁾ non condensing

Current control

Range of laser current I_{LD}	0 ... ± 1 A
Compliance voltage	> 6 V
Setting resolution (manual / remote control)	100 μ A / 15 μ A
Measurement resolution (manual / remote control)	100 μ A / 10 μ A
Accuracy	± 1 mA
Noise without ripple (10 Hz ... 10 MHz, rms, typ.)	< 5 μ A
Ripple (50/60 Hz, rms, typ.)	< 3 μ A
Transients (typ.)	< 1 mA
Drift (24 hours, 0...10Hz, at constant ambient temperature, typ.)	< 30 μ A
Temperature coefficient	≤ 50 ppm/ $^{\circ}$ C

Power control

Range of monitor current I_{PD}	5 μ A ... 2 mA ¹⁾
Setting resolution (manual / remote control)	0.1 μ A / 0.03 μ A
Measurement resolution (manual / remote control)	0.1 μ A / 0.01 μ A
Accuracy	± 2 μ A
Photodiode bias voltage	0 ... 10 V

Laser voltage

Measurement principle	4-wire
Measurement range	0 ... 10 V
Measurement resolution (manual / remote control)	1 mV / 0.1 mV
Accuracy	± 20 mV

Analog control output

Load resistance	≥ 10 k Ω
Output voltage for 0 ... $I_{LD\ MAX}$	0 ... ± 10 V ²⁾
Transmission coefficient	10 V/A $\pm 5\%$

LD Current limit

Setting range I_{LIM}	0 ... ≥ 1 A
Measurement resolution (manual / remote control)	100 μ A / 10 μ A
Accuracy	± 2.5 mA

¹⁾ other ranges on request

²⁾ sign depends on selected polarity

Analog modulation input

Input impedance	10 k Ω
Small signal 3 dB bandwidth (CC mode)	DC ... 200 kHz
Laser diode modulation coefficient (CC mode)	100 mA/V \pm 5%
Laser diode modulation coefficient (CP mode)	0.2 mA/V \pm 5%

Current output TEC element

Control range	- 4 A ... + 4 A
Maximum output power	32 W
Compliance voltage	> 8 V
Measurement resolution (manual / remote control)	1 mA / 0.1 mA
Measurement accuracy	\pm 20 mA
Noise and ripple (typ.)	< 2 mA
Measurement resolution TEC voltage (manual / remote control)	1 mV / 0.1 mV
Measurement accuracy TEC voltage	\pm 40 mV

TEC Current limit

Setting range	0 ... \geq 4 A
Measurement resolution (manual / remote control)	1 mA / 0.1 mA
Accuracy	\pm 40 mA

Temperature sensors AD590, AD592, LM135, LM335

Control range (AD590, LM135)	- 45 $^{\circ}$ C ... + 145 $^{\circ}$ C
Control range (AD592)	- 25 $^{\circ}$ C ... + 105 $^{\circ}$ C
Control range (LM335)	- 40 $^{\circ}$ C ... + 100 $^{\circ}$ C
Setting resolution (manual / remote control)	0.01 $^{\circ}$ C / 0.003 $^{\circ}$ C
Measurement resolution (manual / remote control)	0.01 $^{\circ}$ C / 0.001 $^{\circ}$ C
Accuracy	\pm 0.1 $^{\circ}$ C
Temperature stability (24 hours)	\leq 0.001 $^{\circ}$ C

Thermistor (2 k Ω / 20 k Ω range)

Measurement current	100 μ A / 10 μ A
Control range	10 Ω ... 19.99 k Ω / 100 Ω ... 199.9 k Ω
Setting resolution (manual control)	1 Ω / 10 Ω
Setting resolution (remote control)	0.3 Ω / 3 Ω
Measurement resolution (manual control)	1 Ω / 10 Ω
Measurement resolution (remote control)	0.1 Ω / 1 Ω
Accuracy	\pm 5 Ω / \pm 50 Ω
Temperature stability (24 hours) ¹⁾	\leq 0.5 Ω / \leq 5 Ω

Temperature control input

Input resistance	10 k Ω
Control voltage	-10 ... +10 V
Transmission coefficient IC-sensors	2 $^{\circ}$ C/V \pm 5%
Transmission coefficient thermistor (20 k Ω / 200 k Ω range)	0.2 k Ω /V / 2 k Ω /V \pm 5%

Temperature control Output

Load resistance	> 10 k Ω
Output voltage	0 ... \pm 10 V
Transmission coefficient thermistor	500 mV/ k Ω / 50 mV/k Ω \pm 5%
Transmission coefficient IC sensors	50 mV / $^{\circ}$ C \pm 5%

Temperature window protection

Setting range T _{WIN}	0.5 $^{\circ}$ C ... 20 $^{\circ}$ C
Setting range R _{WIN} (20 k Ω / 200 k Ω range)	50 Ω ... 2 k Ω / 500 Ω ... 20 k Ω

Computer Interface

Setting resolution	16 Bit
Measurement resolution	12 ... 18 Bit ²⁾

¹⁾ Due to the nonlinear conversion from Ω to $^{\circ}$ C the stability in $^{\circ}$ C depends on the operating conditions and the characteristics of the thermistor. E.g. for a typical thermistor at a set point of 10k Ω (25 $^{\circ}$ C), a 0.5 Ω stability translates into about 1mK temperature stability. At a set point of 5k Ω (38 $^{\circ}$ C), the stability is about 2mK.

²⁾ in High Resolution mode, at reduced measurement speed

1.6 Operating elements at the front panel

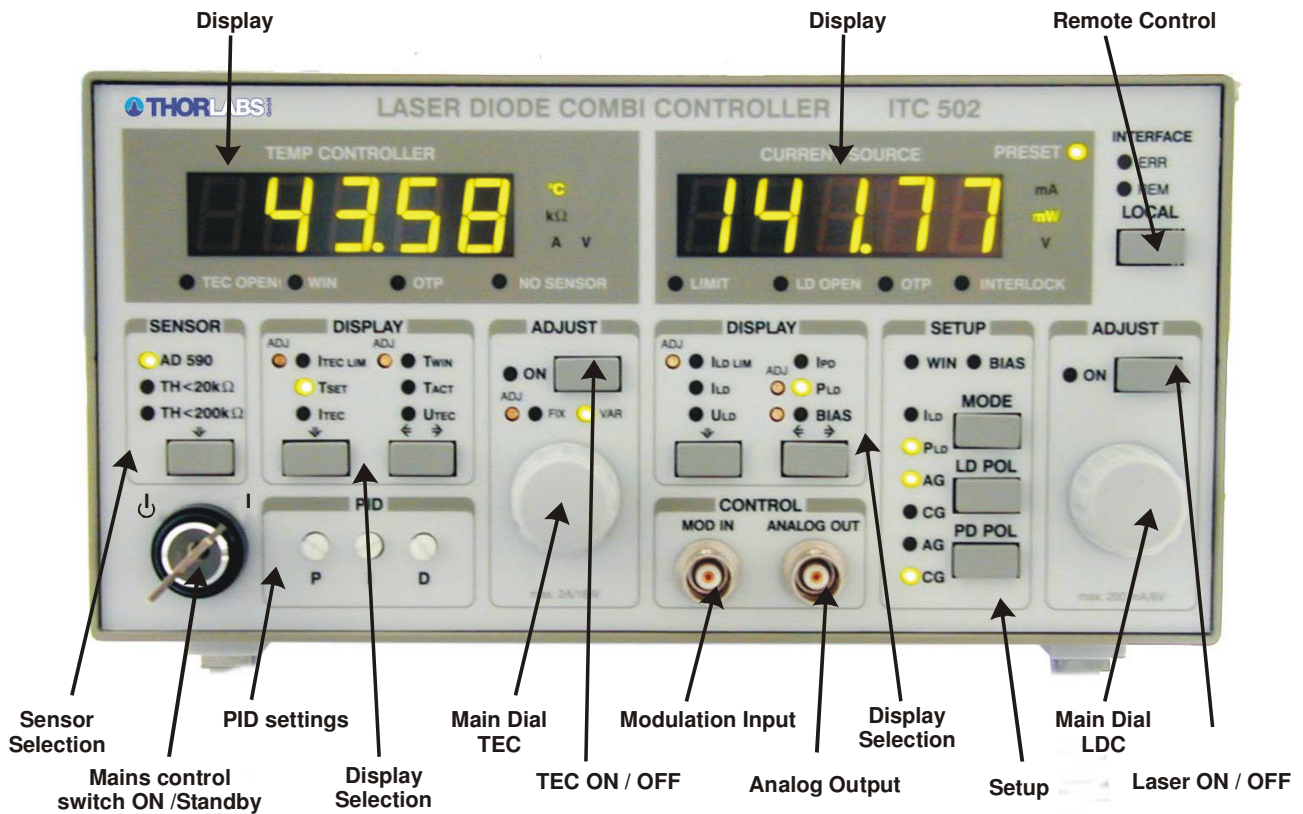


Figure 1 Operating elements at the front panel

1.7 Operating elements at the rear panel

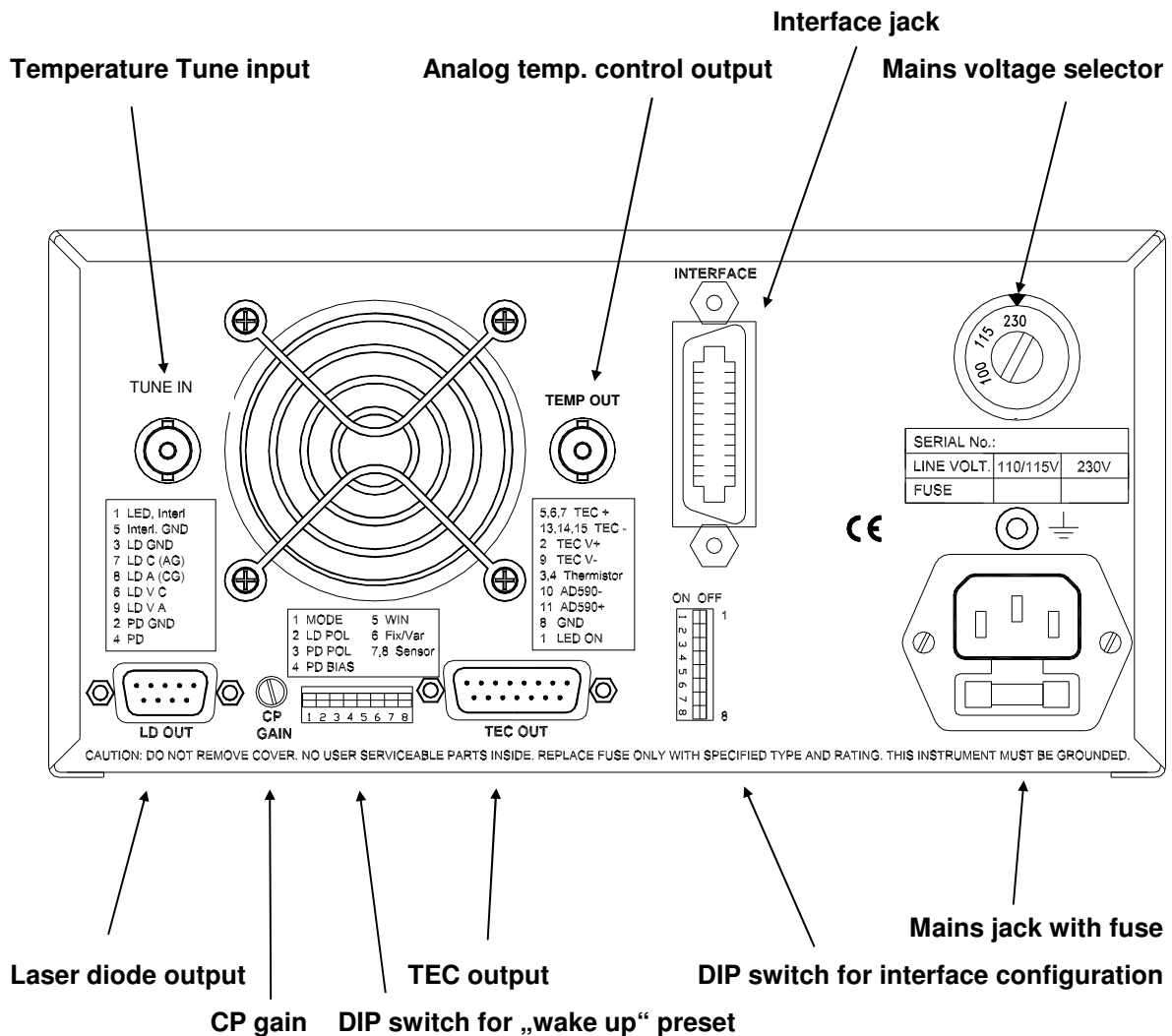


Figure 2 Operating elements at the rear panel

The rear panel of the combi controller ITC5xx contains the mains connector with fuse, the output jacks (9/15pin D-SUB), the analog temperature control output, the preset DIP switch bank and the PD gain control potentiometer.

If the ITC5xx is equipped with the IEEE488.2 there is an additional DIP switch bank to set the IEEE 488 device address. You will also find the 24pin IEEE488 jack.

1.8 Pre-settings

To protect the laser diode the maximum possible current at the output of the ITC5xx can be limited.

To protect the TEC element and the other components of the setup the maximum allowed TEC current, the maximum temperature as well as an operating temperature window may be selected.

1.8.1 Setting the limit of the laser current $I_{LD\ LIM}$

This hardware limit is set via the 25-turn potentiometer marked ADJ that is located next to the LED $I_{LD\ LIM}$ at the front of the ITC5xx. The hardware limit is displayed continuously on the display if the display $I_{LD\ LIM}$ is selected.

1.8.2 Setting the limit value of the TEC current

- Check the maximum allowed TEC current in the datasheet of your TEC element.
- Select the display $I_{TEC\ LIM}$.
- Change the limit value of the TEC current to the desired value with the screwdriver-potentiometer besides the LED $I_{TEC\ LIM}$.

1.8.3 Setting the temperature window

- Check the type of temperature sensor in your setup.
 - Select this sensor in the field marked "SENSOR".
 - Decide upon the range of the temperature window (or equivalent resistance window of your thermistor).
 - Select the display T_{WIN} .
 - Change the size of the window to the desired value with the screwdriver-potentiometer next to the LED T_{WIN} . The display shows a "plus-minus" – value, so if you select i.e. 5.000° , the window will reach from 5° below the set value to 5° above the set value.
 - Activate this function with DIP switch 5
- (Refer to chapter 1.8.4, "DIP switch for "wake up" preset" starting on page 17)

1.8.4 DIP switch for “wake up” preset

By means of these 8 switches you can define several preset functions to determine the wake up mode of the ITC5xx when switched on.

SW1 selects the default (wakeup) mode of operation:

SW1	function
up	const I
down	const P

You can select between constant current (I) or constant power (P) mode.

SW2 selects the default (wakeup) laser diode polarity:

SW2	function
up	CG
down	AG

SW3 selects the default (wakeup) photo diode polarity:

SW3	function
up	CG
down	AG

SW4 defines if the bias voltage is automatically switched on:

SW4	function
up	bias off
down	bias on

 **Attention** 

Before activating this function make sure, that the monitor diode polarity is set correctly when switching on (SW4 must be set correctly).

If the monitor diode is forward biased with a voltage the resulting current may damage or even destroy the monitor diode (= the laser module).

SW5 defines whether the laser diode temperature window protection is on or off, indicated by the LED WIN in the field **SETUP**:

SW5	function
up	WIN off
down	WIN on

SW6 defines which potentiometer for the TEC current is active:

SW6	function
up	VAR

down	FIX
------	-----

SW7 and **SW8** select the default (wakeup) sensor type:

SW7	SW8	function
up	up	AD 590
up	down	AD 590
down	up	TH <20k Ω
down	down	TH <200k Ω

1.9 Connecting components

1.9.1 Pin assignment for the laser diode output

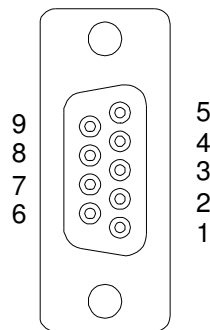


Figure 3 Pinning of the laser diode connector

<u>Pin</u>	<u>Connector</u>
	Interlock, status display
1	output for interlock and status LASER ON/OFF
5	digital ground for pin 1
	Laser diode
7	laser diode cathode (with polarity AG)
8	laser diode anode (with polarity CG)
3	ground for laser diode
	Monitor diode
2	ground potential for monitor diode
4	monitor diode input
	Measurement input for laser diode voltage
9	laser diode anode
6	laser diode cathode

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 has to be grounded.

1.9.2 Pin assignment of the TEC output jack

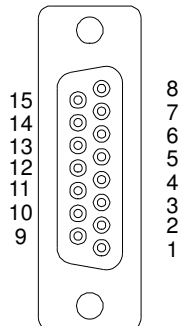


Figure 4 Pinning of the TEC connector

<u>Pin</u>	<u>Connector</u>
	TEC element
5,6,7	TEC element (+)
13,14,15	TEC element (-), ground
2	Voltage detector TEC element (+)
9	Voltage detector TEC element (-)
	Status indicator
1	Status-LED (+)
8	Status-LED (-), ground
	Temperature sensor
3	Thermistor (-), ground
4	Thermistor (+)
10	AD590/592 (-)
11	AD590/592 (+)
12	Supply voltage for <i>Thorlabs</i> -mounts

The TEC element and the temperature sensor are to be connected according to the shown pin assignment with shielded cables to the output jack at the rear of the ITC5xx.

The shielding of the cable has to be put on ground potential (pin 13,14,15).

1.9.3 Connecting a thermistor

The thermistor is set up between pin 3 and pin 4. The polarity is unimportant if the thermistor is floating. If one pin of the thermistor is grounded (for example in a laser module), this pin has to be connected to pin 3.

Using a thermistor, all temperatures are shown in ohms, therefore you have to look for the corresponding temperature in the datasheet of the thermistor.

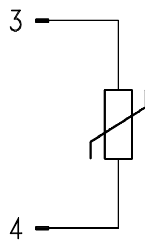


Figure 5 Connecting a thermistor

When the actual temperature "T_{ACT}" is chosen for display the thermistor resistance is shown. The DIP switches (SW7, SW8, Figure 2) select the resistance range of the thermistor, see 1.8.4 "DIP switch for "wake up" preset". In position "TH < 20 k Ω " the maximum thermistor range is 20 k Ω and the measurement current 100 μ A. In position "TH < 200 k Ω " the maximum thermistor resistance is 200 k Ω and the measurement current 10 μ A.

The dependency of resistance on temperature and vice versa of an NTC-thermistor is described by the formula:

$$R(T) = R^0 * e^{B_{val}(\frac{1}{T} - \frac{1}{T_0})} \Leftrightarrow T(R) = \frac{B_{val} * T_0}{T_0 * \ln(\frac{R}{R_0}) + B_{val}}$$

(temperatures in Kelvin)

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

For R_0 and B_{val} refer to the data sheet of the thermistor.

Evaluate the thermistor resistance for the desired set temperature.

Select with the display selection keys (see Figure 1) the display value "TSET" to show the set value and set the evaluated resistance value with the TEC main dial knob.

If the thermistor characteristic $R(T)$ is given in the data sheet the desired resistance can be read directly.

1.9.4 Connecting a temperature sensor AD590 or AD592

An IC-temperature sensor of the AD590 family is set up between pin 10 and pin 11. These sensors will map the temperature into an equivalent current that can be displayed and set directly in °C.

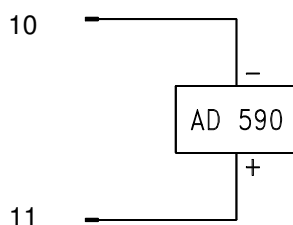


Figure 6 Connecting an AD590 or AD592

1.9.5 Connecting a temperature sensor LM135 or LM335

The IC-temperature sensor LM335 is set up between pin 8, 10 and 11. These sensors will map the temperature into an equivalent voltage that can be displayed and set directly in °C.

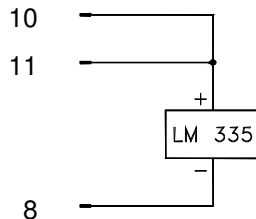


Figure 7 Connecting a LM135 or LM335

NOTE

When connecting a LM135 or LM335 you must select AD590 as temperature sensor !

1.9.6 Connecting a TEC element

The plus pole of the TEC must be connected to the pins 5,6,7 – the minus pole to the pins 13,14,15 of the jack.

NOTE

Always connect all three pins of the output jack!

If the voltage of the TEC element is to be measured and displayed as well, two additional cables must be connected directly from the two poles of the TEC element to pin 2 and 9 of the jack. (4-point measurement).

Pin 2 and pin 9 may also be left open but this will lead to a small measurement error. The displayed voltage will always be slightly too high.

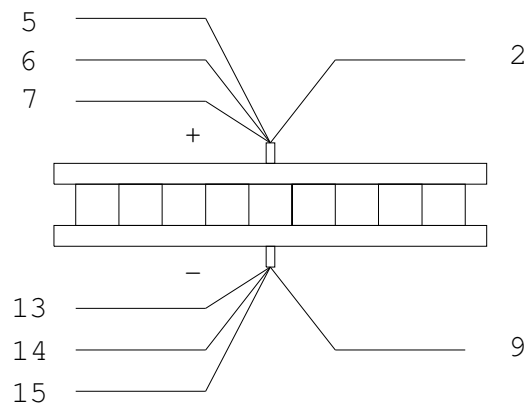


Figure 8 Connecting a TEC

👉 Attention 👈

A TEC element connected with wrong polarity may lead to thermal runaway and destruction of the connected components.

1.9.6.1 Polarity check of the TEC element

- Connect TEC element and temperature sensor. The sensor must have good thermal contact to the active surface of the TEC element.
- Switch on the ITC5xx.

➔ Now follow the steps described in chapter 1.8, “Pre-settings” on page 16

- Select the display T_{SET} and select a suitable temperature (resistance).
- Select the display T_{ACT} .
- Switch on the output (press TEC ON) and observe the actual temperature (resistance).

➔ If the temperature T_{ACT} is continually running away from T_{SET} the TEC element is reverse connected. Change the polarity and repeat the procedure.

→ If T_{ACT} is settling up and down evenly around the value T_{SET} the TEC element is connected correctly however the values for the P-, I- and D-share of the control loop are still incorrect.

→ (Refer to chapter 2.15.4, "PID adjustment" starting on page 45)

If T_{ACT} is settling properly to the value T_{SET} the TEC element is connected correctly but the values for the P-, I- and D-share of the control loop might still be improved.

1.9.7 Connecting the status indicator

To indicate the operating status a standard LED may be switched between pin 1 and pin 8. The LED will light up if the output for the TEC current has been switched on.

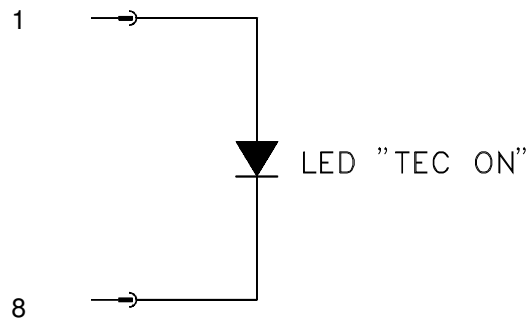


Figure 9 TEC status display

Poling and value of the TEC current is insignificant here.

1.9.8 Connecting laser- and monitor diode

Connect laser and monitor diode to the connector jack of the ITC5xx.

→ (Refer to chapter 1.9.1, "Pin assignment for the laser diode output" on page 20)

When measuring the voltage of the laser diode the wires for voltage measurement (pin 6 and pin 9) have to be connected as close as possible to the laser diode to avoid measurement errors.

The ground pin for the monitor diode (pin 2) may be connected to the ground pin of the laser diode (pin 3). If this should be necessary (e.g. with laser diodes with

integrated monitor diode and shared ground connector) use two separate wires for pin 2 (PD ground) and pin 3 (LD ground) and connect them only once as close as possible to the laser diode to avoid measurement errors when measuring the monitor diode current.

In this case the following pin assignment of the output jack will be valid:
(pins in () for voltage measurement)

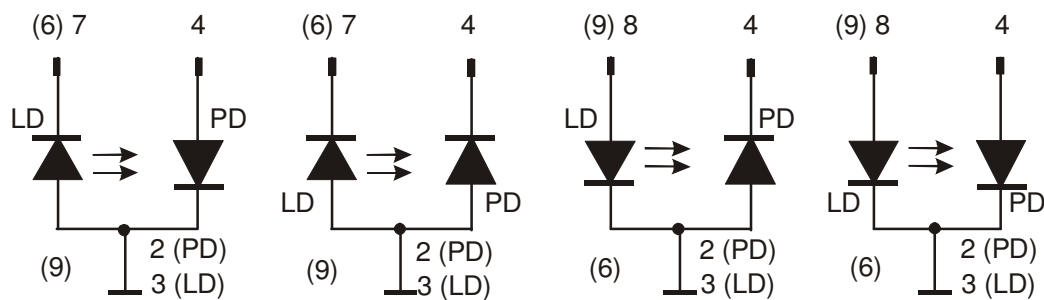


Figure 10 Connecting laser- and monitor diode

(LD) = laser diode

(PD) = monitor (photo-) diode

1.9.9 Connecting interlock and status LED

Interlock, cable damage monitoring

Pin 1 and pin 5 of the connector jack will serve as test connectors to determine whether the current output for the laser diode may be switched on. Between the two pins a low resistive ($<100\Omega$) connection must be maintained. Also short-circuiting is permitted. With the contacts open the current module cannot be switched on. Should the contact open during operation the output will be switched off immediately.

Status LED

It is also possible to switch a LED with a $0.5\text{ k}\Omega$ resistor in parallel between the two pins. The LED will light up if the current output is switched on.

Here are the two possibilities for the pin assignment:

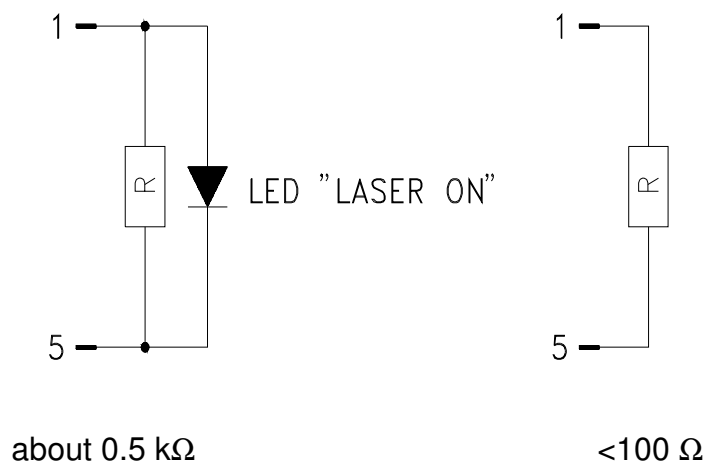


Figure 11 Interlock and status LED

NOTE

A $0.5\text{ k}\Omega$ - resistor without LED (or the LED is incorrectly poled) may lead to malfunction as the status of the interlock is then undetermined.

1.9.10 Temperature tune input

The ITC5xx is equipped with a temperature tune input, e.g. to externally lock the laser temperature.



The input is a BNC-jack at the rear panel above the Sub-D laser diode output connector.

⚠ Attention ⚠

Maximum input voltage of ± 10 V must not be exceeded!

The input resistance is $10 \text{ k}\Omega$ and the maximum input voltage is $\pm 10 \text{ V}$.

The sensitivity with an AD590: $1 \text{ }^\circ\text{C} / \text{V}$, with a thermistor $< 20 \text{ k}\Omega$: $0.2 \text{ k}\Omega / \text{V}$ and with a thermistor $< 200 \text{ k}\Omega$: $2 \text{ k}\Omega / \text{V}$.

2 Operating the ITC5xx

2.1 Mains voltage selector

The ITC5xx can operate with mains voltages of AC 100V, 115V or 230V. Please set the mains voltage selector at the rear of the unit to the proper value and change the fuse to the appropriate value before switching the ITC5xx on. Off factory the unit is configured for the mains voltage ordered.

2.2 Mains switch

With the mains switch (key-operated power switch) the ITC5xx is switched on and off.

NOTE

Do not switch off the unit with the key-operated power switch if the laser current is still switched on.

2.3 Main setting knobs

Through the 10-turn setting knob of the current source the set values for laser current, monitor current or optical power are set according to operating mode and status.

If the laser current is switched off the LED "PRESET" will light up. The set value of the selected parameter is displayed.

If the laser current is switched on the LED "PRESET" will remain off. The actual value of the selected parameter is displayed.

Through the 10-turn setting knob of the temperature controller the value for the temperature is set. As a protection against unintentional temperature adjustments the ITC5xx offers the possibility to set the temperature value via the 20-turn potentiometer labeled ADJ. The LED "FIX" or "VAR" indicates which potentiometer is in use. To change the potentiometer use the corresponding dip switch at the rear.

→ (Refer to chapter 1.8.4, "DIP switch for "wake up" preset" starting on page 17)

2.4 Display

The display consists of a 4 ½ digit display and 16 LED's

The display continuously shows the value selected in the field "**DISPLAY**".

If the value to be shown is a set value (i. e. the laser current with the output switched off) this is indicated with the LED "**PRESET**" lighting up.

If the value to be shown is a measurement value (i. e. the laser current with the output switched on) the LED "**PRESET**" will not light up.

Seven LED's show the unit of the selected values (**°C, kΩ, A, V, mA and mW**)

Eight LED's indicate errors:

TEC OPEN lights up if the TEC element has a too high impedance or is not connected

WIN lights up, if the actual TEC temperature leaves the window

OTP lights up if the internal temperature of the LD- or the TEC controller is too high. Wait until the LED extinguishes. Then the ITC5xx can be operated again.

NO SENSOR lights up if no or a wrong temperature sensor is connected

LIMIT lights up if the laser current limit value is reached

LD OPEN lights up if the wiring to the laser is interrupted while the laser is switched on or if the compliance voltage is too low (i. e. driving two lasers in series requiring more than the capable compliance voltage of the ITC5xx)

INTERLOCK lights up if the interlock loop is open.

2.5 Select the value to be displayed

Twelve different values can be displayed. The value is selected with the buttons “↓” and “← ⇒” in the field “**DISPLAY**”:

Left Display:

- TEC current limit $I_{\text{TEC LIM}}$
- TEC set temperature T_{SET}
- TEC current I_{TEC}
- Temperature window T_{WIN}
- Actual temperature T_{ACT}
- TEC voltage U_{TEC}

Right Display:

- Laser diode current limit $I_{\text{LD LIM}}$
- Laser diode current I_{LD}
- Laser diode voltage U_{LD}
- Internal monitor diode current I_{PD}
- Optical power measured with the monitor diode P_{LD}
- Monitor diode bias voltage **BIAS**

2.6 Operating Mode of the laser diode (MODE)

Two modes of operation can be selected

- Constant current
- Constant power mode using a (laser-internal) monitor diode

A corresponding LED indicates the selected mode.

Constant current mode

In constant current mode the laser diode current is kept constant. Thermal changes in the active zone of the laser will lead to a change of the output power and the central wavelength.

Attention

If in constant current mode the laser is cooled down during operation, the efficiency of the laser will increase. With some types of lasers this may cause the optical output power to exceed the allowed range and lead to a permanent damage of the laser.

Constant power mode

In constant power mode the current in the monitor diode (= the optical output power) is kept constant. Thermal changes of the active zone of the laser do not entail a change of the output power, however, a change of the central wavelength.

Attention

Should in constant power mode some lasers fail in a laser bar or laser stack, a laser current runaway may happen without being recognized, leading to more and more destruction in the laser pile. Therefore, we urgently recommend to set the limit value for the laser current carefully.

NOTE

For "constant power" mode a monitor diode is required.

2.7 Polarity of the laser diode (LD POL)

The laser diode can either be operated with anode or cathode connected to ground. If you have chosen the right pins of the output jack, you also have to select the right polarity with the button **LD POL** in the field SETUP at the front panel.

AG means laser diode anode is connected to ground.

CG means laser diode cathode is connected to ground.

The corresponding LED indicates the selection.

2.8 Polarity of the monitor diode (PD POL)

The monitor diode can either be operated with anode or cathode connected to ground. If you have chosen the right pins of the output jack, you also have to select the right polarity with the button **PD POL** in the field SETUP at the front panel.

If the polarity has been chosen correctly the display of the photo current is positive.

If the chosen polarity is wrong the display of the photo current is negative when driving the laser diode above the threshold current. In this case you **must never** switch on the bias voltage.

2.9 Bias voltage of the monitor diode (BIAS)

If required the monitor diode may be driven with a bias voltage of 0 ... 10 V.

By pressing the button **PD POL** again the bias voltage is in standby, indicated by the LED **BIAS** in the field SETUP at the front panel. The LED **PRESET** indicates that the bias voltage is switched on and off simultaneously with the laser diode current. When the bias voltage is present, the LED **PRESET** extinguishes.

The button **PD POL** repeatedly toggles between four different settings:

CG	(monitor diode cathode grounded)
CG + BIAS	(monitor diode cathode grounded with bias voltage)
AG	(monitor diode anode grounded)
AG + BIAS	(monitor diode anode grounded with bias voltage)
CG	
. . .	

Toggling values follows always this order. If the “wake up“ default is **AG**, the setting after pressing **PD POL** once will be **AG + BIAS**. If the “wake up“ default is **AG + BIAS**, the setting after pressing **PD POL** once will be **CG**, etc...

Attention

Before switching on the bias voltage make sure that the monitor diode polarity is set correctly.

If the monitor diode is forward biased with a voltage the resulting current can damage or even destroy the monitor diode (= the laser module).

2.10 Adjusting the bias voltage of the monitor diode

The bias voltage of the internal monitor diode may be adjusted in a range between 0 and 10 V. It is displayed continuously when selecting the display BIAS and can be set with the potentiometer marked ADJ located next to the LED "BIAS".

NOTE

The right polarity of the monitor diode can be checked this way:

- Set a correct limit value of the laser current ($I_{LD\ LIM}$)
- Set an allowed laser current above the threshold current and switch the laser on
- Select the display of the monitor current I_{PD} and check the polarity of the display. If you see a negative sign (-) the polarity is wrong. If you measure a positive value, the polarity is right and the bias voltage may be adjusted to the desired value.

2.11 Adjusting the power display of an internal monitor diode

The optical power can be displayed if P_{LD} is selected for display.

Therefore the monitor current is transferred into a power display that can be calibrated with the 25-turn potentiometer marked ADJ located next to the LED P_{LD} at the front of the ITC5xx.

The position of the potentiometer determines the calibration factor.

NOTE

This is the description of how to calibrate the power display in local mode using the display of the ITC5xx. When using the IEEE488 interface the calibration of the optical power is done completely different. The CAL potentiometer does not affect the value measured via the interface.

→ (Refer to chapter 3, "Remote control by a PC" starting on page 55)

Adjustment

During the whole procedure the laser remains switched off.

Select the operating mode P_{LD} and the display I_{PD} at the ITC5xx.

Take the nominal optical output power and the corresponding monitor current from the datasheet of the laser diode.

Set the preset value for the monitor current to this value.

Switch to the display P_{LD} so that the power belonging to the set monitor diode is shown. Use the potentiometer ADJ next to the LED P_{LD} to adjust this display to the corresponding value of the output power.

2.12 Temperature window protection

The ITC5xx offers the possibility to control the TEC temperature within a user defined range.

→ (Refer to chapter 1.8.3, "Setting the temperature window" on page 16)

There are two LED's related to the temperature protection:

The LED "WIN" in the field **SETUP** lights if the window protection is activated.

→ (Refer to chapter 1.8.4, "DIP switch for "wake up" preset" starting on page 17)

The control LED in the display lights if the TEC temperature moves out off the specified window, regardless if the window protection is active or not.

If the temperature window protection is switched on the laser diode will be switched off if the temperature leaves the window.

2.13 Selecting the temperature sensor

Three different types of sensors can be selected by toggling with the "↓" button :

- AD590 family
- Thermistor (two ranges)

A LED indicates the selected sensor.

2.14 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 ITC5xx.

➔ Now follow the steps described in chapter 1.8, "Pre-settings" starting on page 16.

- Select the display T_{SET} and select a suitable temperature (resistance).
- Select the display T_{ACT} .
- Switch on the output (press TEC ON) and observe the actual temperature (resistance).

➔ If the temperature T_{ACT} is continually running away from T_{SET} , The TEC element is reversed poled. Change polarity and repeat the procedure.

➔ If T_{ACT} is oscillating around the value T_{SET} , the TEC element has been connected correctly, however, the values for the P-, I- and D-share of the control loop are still incorrect.

➔ (Refer to chapter 2.15.4, "PID adjustment" starting on page 45)

➔ If T_{ACT} is settling properly to the value T_{SET} , the TEC element has been connected correctly, the values for the P-, I- and D-share of the control loop might still be improved.

➔ (Refer to chapter 2.15.4, "PID adjustment" starting on page 45)

2.15 Setup and function of temperature controllers

A temperature difference between two points in a room (thermal slope) results in a thermal flow trying to compensate the temperature differences.

When devices are tempered the following components will normally be involved:

- The component to be tempered (i.e. a laser diode)
- A sensor measuring the temperature of the laser
- A heat source or sink (air or water / cooling element)
- A heat conductor connecting the component to the source/sink (copper, alu)
- A "propulsion" to lead the flow of temperature (TEC element)

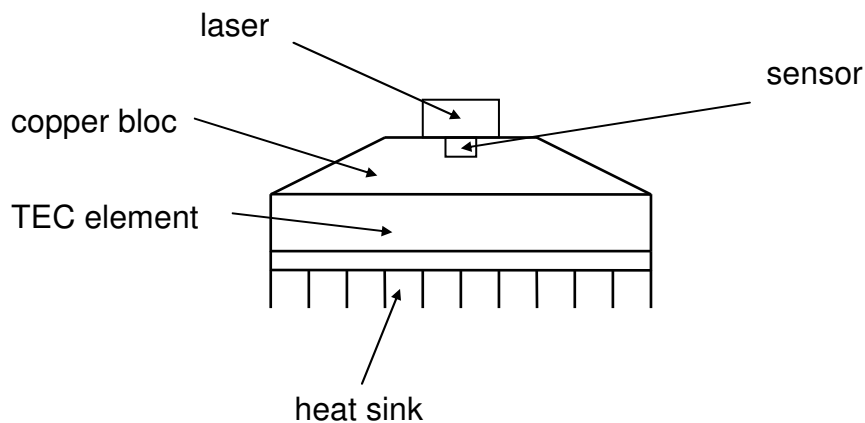


Figure 12 Typical thermal set-up of a diode laser

2.15.1 Statements and implications

- The temperature of the laser can be measured with the sensor.
- In the copper bloc is a heat flow between laser and TEC element.
- In the TEC element is a heat flow between copper bloc and heat sink.
- In the heat sink is a heat flow between TEC element and environment.
- The difference in temperature in the TEC element can be controlled via the TEC current. This will directly influence the heat flow in the copper bloc and in the heat sink.

→ So the temperature of the laser can be influenced with the TEC current. The quantity of heat flowing from the laser into the copper bloc and the size of the block effects the thermal settling time of the setup.

Usually very small components (laser diodes) are tempered with relatively extensive cooling elements (TEC elements). Thus the thermal energy is lead away quickly and the components are as far as possible kept at a constant temperature.

2.15.2 Demands to the ideal temperature control loop

1. Knowledge of the absolute laser temperature
2. Stability of the laser temperature under any influence
3. Immediate settling to a new laser temperature when changing the set value of the temperature

2.15.3 Influences on the real temperature control loop

To 1: Offset and gain errors of the sensor will only allow a relative knowledge about the laser temperature.

The sensor will never be fixed to the laser chip in such a way that it will exclusively measure its temperature. So the temperature in the copper bloc being inhomogeneous due to the heat flow will be measured as well. Even within the laser chip the temperature will not be the same in all spots.

Possibility of optimization: calibration of sensor

To 2. If the internal power dissipation changes (e.g. the laser current is changed) also the temperature gradient between laser and sensor will change. This results in a measurement error depending on the mechanical setup laser/sensor. Changes in the ambient temperature, however, will be compensated well from the control loop since they will almost only have an effect on the heat slope between TEC element and cooling element.

Possibility of optimization: best possible thermal design

To 3. The transient response by setting a new temperature is limited since the heat transport in the copper bloc is relatively slow. Furthermore, the temperature slope in the copper must form anew. The sensor (which also possesses a significant heat capacity) must settle to the laser temperature.

Possibility of optimization: PID adjustment

2.15.4 PID adjustment

Temperature control loops are comparatively slow control loops with control oscillations in the Hertz range.

The PID adjustment will optimize the dynamic behavior. With the ITC5xx the three parameters P, I and D may be selected independently.

2.15.4.1 Example of a PID adjustment

(Preconditions: All limit values have been set correctly, all polarities are correct, a suitable sensor is connected and selected.)

1. Set the P- I- and D-share to 0 (7 o'clock)
2. Switch on the output (button TEC ON) and observe the actual temperature.
(In some cases it is useful to connect a storage oscilloscope to the **TEMP OUT** output)

2.15.4.2 P-share

3. Change the set temperature repeatedly between values of ambient temperature +2°C and ambient temperature -2°C and observe the settling behavior of the actual temperature.
Increase the P-share gradually by turning the corresponding potentiometer clockwise.
Higher values will increase the settling speed, at the same time the stability reserve will be decreased so that number and amplitude of the overshoots will increase.
The P-share has been set correctly when the actual temperature remains stable near the set temperature after only 2-3 overshoots.

2.15.4.3 D-share

4. Change the set temperature repeatedly between values of ambient temperature $+2^{\circ}\text{C}$ and ambient temperature -2°C and observe the settling behavior of the actual temperature.

Increase the D-share gradually by turning the corresponding potentiometer clockwise.

Higher values will decrease the amplitude of the overshoots.

The D-share has been set correctly when the actual temperature remains stable near the set temperature after a minimum of overshoots.

2.15.4.4 I-share

5. Change the set temperature repeatedly between values of ambient temperature $+2^{\circ}\text{C}$ and ambient temperature -2°C and observe the settling behavior of the actual temperature.

Increase the I-share gradually by turning the corresponding potentiometer clockwise.

Higher values will accelerate the settling to the set temperature.

The I-share has been set correctly when the actual temperature settles in shortest time to the set temperature.

2.15.4.5 I-Share disconnection

For some cases, particularly for slow thermal loads, this procedure will not work satisfactory.

Please follow the steps listed below to obtain a better adjustment.

Attention

**This procedure should only be done by qualified service personnel!
Hazardous voltages exist within the device. As shipped from the
factory, all parts carrying line voltage are covered to reduce the
likelihood of contact. Use only isolated tools and be careful not to
touch any Mains..**

- Pull the line plug
- Remove the cover of the ITC5xx
- Set jumper JP8 on the mainboard
- Adjust the P- and D-share as usual
- Remove the jumper JP8 again
- Adjust the I-share at last
- Reinstall the cover

2.16 Analog modulation input

The laser diode controller ITC5xx has an input to modulate the laser diode current in constant current mode.

As the internal set value for the laser diode current is modulated all laser protections remain active (!).

The modulation input is designed for input voltages between -10V ... 10V and specified for small signal operation. In large signal operation the 3 dB bandwidth is reduced. (See datasheet for version dependent bandwidth)

Commonly you will select a DC current with the main dial knob and modulate this current with the modulation input. Please note that this DC current and the modulation current are added, so you will use a modulation voltage without a DC share!

The modulation coefficient is version dependent.

→ (See chapter 1.5, "Technical Data" starting on page 7)

As modulation source you can use any commercially available function generator or any signal source with output voltage in the specific range.

NOTE

Over-modulation is defined as producing a **set value** for the laser diode current of below 0 mA, above the limit value or above the maximum current your ITC5xx can deliver.

To guarantee a proper operation of the ITC5xx please avoid over-modulation because it can lead to overshoots in the laser current.

If you are uncertain please try with a high current rectifier instead of the laser diode and watch the analog output. You should never see overshoots!

2.17 Analog output (I_{LD})

At the analog output (BNC jack) a voltage directly proportional to the laser current is available.

Due to the wide bandwidth the output is an exact replica of the laser current. Possible deviations of the control output from control input are due to limited bandwidth and rise time of the laser output.

The transmission coefficient of this output depends on the type of ITC5xx.

10 V correspond to the maximum output current, so e.g. for a 1 A ITC510 10 V correspond to 1 A and the transmission coefficient is $10\text{V} / 1\text{A} = 10 \text{ V/A}$. (Respectively for LD polarity AG: 0 ... -10 V)

2.18 Laser and TEC current ON/OFF

The laser current and/or the TEC current can be switched on by pressing the button **ON** in the corresponding **ADJUST** field. When the ITC5xx is switched on with the mains switch, the currents are always OFF to prevent the laser to be activated unintentionally.

The laser current cannot be switched on if:

- the interlock loop is not closed
- the ITC5xx is overheated (display OTP)
- no laser has been connected or the wiring to the laser is interrupted (display LD OPEN when trying to switch on)
- the temperature window protection is activated and the temperature is outside the window

→ (Please refer to chapter 2.12, "Temperature window protection" on page 40)

The TEC current cannot be switched on if:

- no or a wrong temperature sensor is connected
- the ITC5xx is overheated (display OTP)

Attention

Before switching on the laser or TEC current first set the appropriate current limit $I_{LD\ LIM}$ and $I_{TEC\ LIM}$ for the connected devices with a screwdriver.

2.19 CP gain

With this potentiometer the speed of the regulation loop in constant power mode can be adapted to the setup.

This potentiometer will usually be in a 7 o'clock position for standard speed.

If the speed is too high and overshoots occur, please turn the potentiometer counterclockwise to achieve a slower settling time.

If you want to have a faster settling time, please turn the potentiometer clockwise. Nevertheless the settling time also depends on the set power.

2.20 BNC connector TEMP OUT

An analog output **TEMP OUT** is provided at the rear of the ITC5xx. Here a voltage proportional to the actual temperature "TACT" is applied for monitoring purposes, e.g. to supervise the settling behavior of the temperature control loop.

<u>voltage</u>	<u>range</u>	<u>sensor</u>
0 ... 10 V	0 ... 20 k Ω	thermistor
0 ... 10 V	0 ... 200 k Ω	thermistor
-2.5 V ... +7.5 V	-45 °C ... +145 °C	AD590, LM335

External devices to supervise the operation may be connected to this output, e.g. to see if certain temperature limits of the device under test are exceeded.

The output **TEMP OUT** operates against ground. Thus an oscilloscope or a strip chart recorder can be connected directly. Devices connected to these outputs should have an internal resistance of ≥ 10 k Ω .

2.21 BNC connector Temp tune

This BNC connector is the temperature tuning input.

This input allows tuning of the temperature with an external voltage of max. ± 10 V e.g. to lock the temperature to an external process.

Attention

Maximum input voltage of ± 10 V must not be exceeded!

2.22 Using the interlock input

The interlock consists of two pins that have to be connected (closed) in operation.

These are pin 1 and pin 5 of the 9pin D-SUB jack respectively pin 6 and pin 15 of the 15pin HD jack at the rear of the unit.

If the connection is open (Interlock loop open) the laser cannot be switched on.

Furthermore, if the interlock is open a red LED "INTERLOCK" on the front panel of the ITC5xx will light.

If the interlock opens with the laser on there will be an acoustic signal and the laser is switched off immediately.

It is possible to connect several switches in series to the pins of the interlock setting up a closed loop that can be opened by each switch. Thus different protection functions can be realized simultaneously via the interlock.

2.22.1 Examples of various protection functions

2.22.1.1 External Emergency key in the lab

An external emergency key (opener) is connected to the two pins of the interlock.

If there are other safety switch functions connect all switches in series.

2.22.1.2 Temperature control

Sometimes you may want to monitor the cooling loop of a high-power diode laser, e.g. the temperature of the cooling water. A suitable setup offers a switch that will open in case of an error.

If only a certain temperature range is to be monitored, a suitable (fast) thermo switch can be used.

This switch (opener) is connected between the two pins of the interlock.

→ (Please see also chapter 2.12, "Temperature window protection" on page 40)

2.22.1.3 Safety-door monitoring

If the laser is to be operated in a closed setup (lab) a switch should be installed in a suitable position, interrupting when the setup (lab-door) is opened.

This switch (opener) is connected to the two pins of the interlock.

2.22.1.4 Cable damage monitoring

If the interlock line is installed in parallel to the line for the laser current, a cable damage monitoring may be realized as well.

An interruption of this line will open the interlock.

2.22.1.5 Laser ON/OFF-Display

The interlock can also be closed by switching a LED with the anode to pin 1 and the cathode to pin 5 of the 9pin D-SUB jack in parallel with a 500 Ω resistor. The current is about 7 mA, this will make any commercially available LED light up.

This LED (only one LED is allowed) may be looped in at any point into the interlock line and may thus serve as an independent ON/OFF display.

2.23 Laser voltage measurement

The ITC5xx constantly measures the laser voltage at the output jacks of the unit. For a precise measurement connect pin 6 directly to the LD-cathode and pin 9 directly to the LD-anode (respectively pin 11 and pin 14) to avoid measuring the voltage drop of the wiring (4 pole measurement).

We recommend to use “twisted pair” wiring for the monitor diode current, bias voltage and laser voltage measurement respectively in a common shield. The shield has to be connected to ground (pin 3).

→ (Refer to chapter 1.9.1, “Pin assignment for the laser diode output“ on page 20)

3 Remote control by a PC (ITC5xx-IEEE)

NOTE

The following operating elements are still working with the remote control active:

- The display
- The display selection
- all potentiometers except the main dial knob

NOTE

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

Attention

Before programming an ITC5xx first set the limit value of the laser diode current $I_{LD\ LIM}$ (hardware limit) for the applied laser diode with a screwdriver.

The corresponding potentiometer is marked ADJ and located next to the LED $I_{LD\ LIM}$ situated at the front of the ITC5xx.

The value $I_{LD\ LIM}$ is constantly measured and can be checked if the LED $I_{LD\ LIM}$ selects the display of the limit current.

3.1 IEEE488 Interface

The IEEE488 interface of the ITC5xx-IEEE is based on the IEEE488.2 standard. This includes the IEEE488.1 standard for the hardware settings. There is a standard 24-pin IEEE488 jack at the rear of the unit. The address of the ITC5xx must differ from that of other devices on the IEEE488 bus.

➔ (Please refer to chapter 3.1.2, “Setting up the Interface“, starting on page 57)

3.1.1 Interface specifications

Function	Part set
Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T6
Listener	L4
Service Request	SR1
Remote/Local	RL1
Parallel Poll	PP0
Device Clear	DC1
Device Trigger	DT0
Electrical Interface	E1

3.1.2 Setting up the Interface

Address

The device address of the ITC5xx can be changed by using the IEEE488 DIP switch at the rear panel of the ITC5xx. SW1 to SW5 have to be set according to this table:

Address	SW5	SW4	SW3	SW2	SW1
0	Off	Off	Off	Off	Off
1	Off	Off	Off	Off	On
2	Off	Off	Off	On	Off
3	Off	Off	Off	On	On
4	Off	Off	On	Off	Off
5	Off	Off	On	Off	On
6	Off	Off	On	On	Off
7	Off	Off	On	On	On
8	Off	On	Off	Off	Off
9	Off	On	Off	Off	On
10	Off	On	Off	On	Off
11	Off	On	Off	On	On
12	Off	On	On	Off	Off
13	Off	On	On	Off	On
14	Off	On	On	On	Off
15	Off	On	On	On	On

Continued next page

Address	SW5	SW4	SW3	SW2	SW1
16	On	Off	Off	Off	Off
17	On	Off	Off	Off	On
18	On	Off	Off	On	Off
19	On	Off	Off	On	On
20	On	Off	On	Off	Off
21	On	Off	On	Off	On
22	On	Off	On	On	Off
23	On	Off	On	On	On
24	On	On	Off	Off	Off
25	On	On	Off	Off	On
26	On	On	Off	On	Off
27	On	On	Off	On	On
28	On	On	On	Off	Off
29	On	On	On	Off	On
30	On	On	On	On	On or Off

NOTE

The device address is valid after switching off and on again.

String Terminator

The string terminator of the ITC5xx is preset to <LF><EOI>. This is fixed and cannot be changed.

The ITC5xx will accept any combination of <LF> and <EOI> as string terminator.

3.1.3 Connecting the Instrument

- Connect the ITC5xx and the PC to the line
- Connect the units with shielded IEEE488 cables
- Switch on all units on the bus and the control computer

To guarantee a safe transmission of data the IEEE488 cable between two units should not be longer than 2 meters and the total cable length should not be more than 20 meters.

The ITC5xx will automatically enter REMOTE mode after the first character is transferred to the ITC5xx.

NOTE

Programming the control software will vary with the type of computer, the user interface, the programming language, the interface card used as well as with the driver software and the correspondingly supplied software interfaces. Please refer to the documentation of these components.

→ (Also refer to chapter 3.9, "Hints for setting up control programs" on page 97)

3.1.4 IEEE488 bus commands

To communicate via the IEEE488 bus the standard control signals [MLA], [MTA], [UNL], [UNT], [ATN], [REN], [SPE], [SPD] are used.

If the control program for the ITC5xx is written in a higher programming language as e.g. BASIC, then these IEEE488 control signals are automatically transmitted to the ITC5xx according to the used driver software and do not have to be explicitly produced in the control program.

Also in the LabVIEW[®]- or LabWindows/CVI[®]-drivers from [Thorlabs](#) these functions are implemented.

When receiving the IEEE488 bus commands **[GET]**, **[LLO]**, **[GTL]**, **[DCL]** and **[SDC]** the ITC5xx will execute the following functions:

[LLO] Local Lockout

The command [LLO] will disable the button . Return to LOCAL mode (manual operation) will only be possible with the command [GTL] (see below).

[GTL] Go To Local

The command [GTL] will bring the ITC5xx into LOCAL mode (manual operation). The previously set values for laser current, laser power etc. will no more be valid. The set values are determined by the main dial knob.

[DCL] Device Clear

The command [DCL] will clear the input buffer and output queue. It will also reset the parser unit and the execution unit

NOTE

The command [DCL] will set back all units connected to the IEEE488 bus.

[SDC] Selected Device Clear

The command [SDC] will clear the input buffer and output queue. It will also reset the parser unit and the execution unit

NOTE

In contrast to the command [DCL] the command [SDC] will only set back the device addressed.

3.2 Before Programming

3.2.1 Nomenclature

Program messages (PC ⇒ ITC5xx) are written in inverted commas: "***IDN?**"
Response messages (ITC5xx ⇒ PC) are written in brackets: **[MODE CC]**
There is a decimal point: **1.234**
Parameters are separated with comma: "**PLOT 2,0**"

3.2.2 Program and response messages

Blocks of message data are transferred between the controller and the ITC5xx during communication. Messages sent from the controller to the ITC5xx are called program messages, and messages sent back from the ITC5xx to the controller are called response messages. If a program message contains a query command, i.e. a command which requests a response, the ITC5xx returns a response message.

Program messages

With program messages, settings are effected (command) at the ITC5xx and response messages are selected (query). Program messages can be separated with semicolon. All program messages are executed sequentially (one by one).

Examples:

" :MODE CC "	select the mode "constant current" (command)
" *IDN? "	request the identification (query)
" :LDPOL CG;:PDPOL AG "	select the laser diode polarity and the photodiode polarity.

Response messages

With response messages, measurement values and status information is transferred to the PC. All response messages are generated when the query (program message) is parsed.

Example:

[:ILD:ACT 7.123456E-05] measure the actual laser current

3.2.3 Data format

According to the IEEE488.2 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

→ (Refer to IEEE488.2-1992 standard, chapter 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

→ (Refer to IEEE488.2-1992 standard, chapter 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

→ (Refer to IEEE488.2-1992 standard, chapter 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

→ (Refer to IEEE488.2-1992 standard, chapter 8.7.4)

3.3 Common commands and queries

The common commands are independent of the instrument's functions, and are specified in the IEEE488.2 standard.

3.3.1 Identification query

Syntax: "***IDN?**"

Response: [**PROFILE, ITC510, 0, 2.17**]

Description: A reply consists of the following sequence:

 <Manufacturer>, <Model>, <Serial No.>, <Firmware version>

3.3.2 Reset

Syntax: "***RST**"

Description: All outputs are switched off. All values are set to default.

3.3.3 Self-test query

Syntax: "***TST?**"

Response: [**0**]

Description: 0: Self-test finished.

3.3.4 Set Operation-complete bit

Syntax: "***OPC**"

Description: The ITC5xx will set the OPC-bit in the Standard-Event-Status-Register.

3.3.5 Operation-complete query

Syntax: "***OPC?**"
Response: [**1**]
Description: 1: Operation completed.

3.3.6 Wait

Syntax: "***WAI**"
Description: The ITC5xx will wait until the last operation is completed.

3.3.7 Event-Status-Enable-Register (ESE)

Programming:

Syntax: "***ESE <NR1>**"
Valid Range: 0..255
Default Value: 0
Description: Sets the Event-Status-Enable-Register (ESE).

Reading:

Syntax: "***ESE?**"
Response: [**<NR1>**]
Description: Queries the Event-Status-Enable-Register (ESE) and returns the content in decimal notation. The content is not modified.

3.3.8 Query Standard-Event-Status-Register (ESR)

Syntax: "***ESR?**"
Response: [**<NR1>**]
Description: Queries the Standard-Event-Status-Register (ESR) and returns the content in decimal notation. The content is cleared.

3.3.9 Service-Request-Enable-Register (SRE)

Programming:

Syntax: "***SRE** <NR1>"

Valid Range: 0..255

Default Value: 0

Description: Sets the Service-Request-Enable-Register (SRE).

Reading:

Syntax: "***SRE?**"

Response: [<NR1>]

Description: Queries the Service-Request-Enable-Register (SRE) and returns the content in decimal notation. The content is not modified.

3.3.10 Query Status-Byte-Register (STB)

Syntax: "***STB?**"

Response: [<NR1>]

Description: Queries the Status-Byte-Register (STB) and returns the content in decimal notation. Bit 6 (MSS) is set to 0, the other bits keep unchanged.

3.4 System command group

3.4.1 Answer mode

Programming:

Syntax: "**:SYST:ANSW FULL**"
 "**:SYST:ANSW VALUE**"

Default Value: FULL

Description: When switched to "**VALUE**" the ITC5xx will send only the requested parameter without designator.

Example: When requesting the actual laser diode current with "**:ILD:ACT?**" the ITC5xx will only send [**5.123456E-02**] instead of [**:ILD:ACT 5.123456E-02**]. This is **not** according to the IEEE488.2 standard but useful, if you want to increase speed.

Reading:

Syntax: "**:SYST:ANSW?**"
Response: [**:SYST:ANSW FULL**]
 [**:SYST:ANSW VALUE**]

Description: Queries the answer mode.

3.4.2 Error-LED mode

Programming:

Syntax: "**:SYST:ERRLED OFF**" (default)
 "**:SYST:ERRLED ON**"

Default Value: OFF

Description: When "**ON**" the ITC5xx will switch on the interface ERRor LED as long as there are errors in the error queue. When switched to "**OFF**" the interface ERRor LED is dark.

Reading:

Syntax: "**:SYST:ERRLED?**"
Response: [**:SYST:ERRLED OFF**]
 [**:SYST:ERRLED ON**]

Description: Queries the Error-LED mode.

3.4.3 Querying the error queue

Syntax: `":SYST:ERR?"`

Response: `[0, "No Error"]`

Description: Queries the error queue of the ITC5xx. The reply consists of the following sequence: <Error No.>, "<Error text>". If the error queue is empty: `[0, "No error"]` is given.

➔ (Please refer to chapter 3.7, "Error messages of the ITC5xx", starting on page 84)

3.4.4 Averaging rate

Programming:

Syntax: `":SYST:OSR <NR1>"`

Valid Range: 0..7

Default Value: 5

Description: Sets the ITC5xx averaging rate (see table below).

Reading:

Syntax: `":SYST:OSR?"`

Response: `[<NR1>]`

Description: Queries the averaging rate.

Sampling rate	Resolution	Measurement speed
0	11 Bit + sign	18 / s
1	12 Bit + sign	13 / s
2	13 Bit + sign	10 / s
3	14 Bit + sign	8 / s
4	15 Bit + sign	6 / s
5	16 Bit + sign	4 / s
6	17 Bit + sign	3 / s
7	18 Bit + sign	2 / s

3.5 Status command group

→ (Refer to chapter 3.8, "Status reporting" on page 90)

3.5.1 Query Device-Error-Condition-Register (DEC)

Syntax: `" : STAT : DEC ? "`

Response: `[: STAT : DEC <NR1>]`

Description: Queries the Device-Error-Condition-Register (DEC) and returns the content in decimal notation. The content is not modified.

3.5.2 Query Device-Error-Event-Register (DEE)

Syntax: `" : STAT : DEE ? "`

Response: `[: STAT : DEE <NR1>]`

Description: Queries the Device-Error-Event-Register (DEE) and returns the content in decimal notation. The content is cleared.

3.5.3 Device-Error-Event-Enable-Register (EDE)

Programming:

Syntax: `" : STAT : EDE <NR1> "`

Valid Range: 0...65535

Default Value: 0

Description: Sets the Device-Error-Event-Enable-Register (EDE).

Reading:

Syntax: `" : STAT : EDE ? "`

Response: `[: STAT : EDE <NR1>]`

Description: Queries the Device-Error-Event-Enable-Register (EDE) and returns the content in decimal notation. The content is not modified.

3.6 ITC5xx specific commands

3.6.1 Operation mode (MODE)

Programming:

Syntax: ":**MODE** **CC**"
 ":**MODE** **CP**"

Assumption: The laser diode output is switched off.

Description: Changes the mode of operation. Sets the laser diode current, the photo diode current and the optical power to default values.

Reading:

Syntax: ":**MODE?**"
Response: [:**MODE** **CC**]
 [:**MODE** **CP**]

Description: Queries the mode of operation.

3.6.2 Laser diode polarity (LDPOL)

Programming:

Syntax: ":**LDPOL** **CG**"
 ":**LDPOL** **AG**"

Assumption: The laser diode output is switched off.

Description: Switches the laser diode polarity. Sets the laser diode current, the photo diode current and the optical power to default values.

Reading:

Syntax: ":**LDPOL?**"
Response: [:**LDPOL** **AG**]
 [:**LDPOL** **CG**]

Description: Queries the polarity of the laser diode.

3.6.3 Photo diode polarity (PDPOL)

Programming:

Syntax: "**:PDPOL CG**"
 "**:PDPOL AG**"

Assumption: The laser diode output and the bias voltage is switched off.

Description: Selects the photo diode polarity. Sets the laser diode current, the photo diode current and the optical power to default values.

Reading:

Syntax: "**:PDPOL?**"
Response: [**:PDPOL AG**]
 [**:PDPOL CG**]

Description: Queries the polarity of the photo diode.

3.6.4 Reading the state of the temperature protection (TP)

Syntax: "**:TP?**"
Response: [**:TP OFF**]
 [**:TP ON**]

Description: Queries the state of the temperature protection.

3.6.5 Switching the bias voltage on and off (PDBIA)

Programming:

Syntax: ":PDBIA OFF"
 ":PDBIA ON"

Assumption: The laser diode output is switched off.

Description: Switches the photo diode bias voltage on or off.

Reading:

Syntax: ":PDBIA?"
Response: [:PDBIA OFF]
 [:PDBIA ON]

Description: Queries the state of the photo diode bias voltage.

Attention

Before switching on the bias voltage make sure that the monitor diode polarity is set correctly.

If the monitor diode is forward biased with a voltage the resulting current may damage or even destroy the monitor diode (= the laser module).

→ (For checking the right polarity please refer to chapter 2.10, "Adjusting the bias voltage of the monitor diode" on page 38)

3.6.6 Turn the output on and off (LASER)

Programming:

Syntax: "**:LASER OFF**"
 "**:LASER ON**"

Default Value: OFF

Assumption: To switch the output on there must be no device errors (interlock open, open circuit, over temperature, ...).

Description: Switches the laser diode output on or off.

Reading:

Syntax: "**:LASER?**"
Response: [**:LASER OFF**]
 [**:LASER ON**]

Description: Queries the state of the laser diode output.

NOTE

To switch on the laser while a "open circuit" error is present (see Device Error Condition Register), you have to reset the "open circuit" error with the command: "**:LASER ON**". With the next command "**:LASER ON**" the laser will switch on again.

3.6.7 Reading the laser diode hardware limit (LIMCP)

Syntax: `" : LIMCP : ACT ? "`

Response: `[: LIMCP : ACT <NR3>]`

Description: Queries the laser diode limit current (adjusted via potentiometer).

→ (Refer to Chapter 1.8.1, "Setting the limit of the laser current I_{LD_LIM} " on page 16)

3.6.8 Laser diode current (ILD)

Programming:

Syntax: `" : ILD : SET <NR3> "`

Valid Range: Depends on the instrument type.

Default Value: 0 A

Assumption: The operation mode is switched to constant current.

Description: Sets the laser diode current. Unit: [A].

Reading the set current:

Syntax: `" : ILD : SET ? "`

Response: `[: ILD : SET <NR3>]`

Description: Queries the programmed laser diode current. Unit: [A].

Reading the minimum current:

Syntax: `" : ILD : MIN ? "`

Response: `[: ILD : MIN <NR3>]`

Description: Queries the minimum allowed laser diode current. Unit: [A].

Reading the maximum current:

Syntax: `" : ILD : MAX ? "`

Response: `[: ILD : MAX <NR3>]`

Description: Queries the maximum allowed laser diode current. Unit: [A].

Reading the actual current:

Syntax: `" : ILD : ACT ? "`

Response: `[: ILD : ACT <NR3>]`

Description: Queries the actual laser diode current. Unit: [A].

3.6.9 Monitor diode current (IMD)

Programming:

Syntax: " **: IMD : SET <NR3>**"

Valid Range: Depends on the instrument type.

Default Value: 0 A

Assumption: The operation mode is set to constant power.

Description: Sets the photo diode current. Unit: [A].

Reading the set current:

Syntax: " **: IMD : SET?**"

Response: [**: IMD : SET <NR3>**]

Description: Queries the programmed photo diode current. Unit: [A].

Reading the minimum current:

Syntax: " **: IMD : MIN?**"

Response: [**: IMD : MIN <NR3>**]

Description: Queries the minimum allowed photo diode current. Unit: [A].

Reading the maximum current:

Syntax: " **: IMD : MAX?**"

Response: [**: IMD : MAX <NR3>**]

Description: Queries the maximum allowed photo diode current. Unit: [A].

Reading the actual current:

Syntax: " **: IMD : ACT?**"

Response: [**: IMD : ACT <NR3>**]

Description: Queries the actual photo diode current. Unit: [A].

3.6.10 Calibrating a photo diode (CALPD)

Programming:

Syntax: " : CALPD : SET <NR3> "

Valid Range: Depends on the instrument type.

Default Value: 1.0 A/W

Assumption: The laser diode output is switched off.

Description: Sets the sensitivity (η) of the monitor diode. Unit: [A/W].

Reading the set sensitivity:

Syntax: " : CALPD : SET? "

Response: [: CALPD : SET <NR3>]

Description: Queries the programmed sensitivity of the monitor diode. Unit: [A/W].

Reading the minimum sensitivity:

Syntax: " : CALPD : MIN? "

Response: [: CALPD : MIN <NR3>]

Description: Queries the minimum allowed sensitivity of the monitor diode.
Unit: [A/W].

Reading the maximum sensitivity:

Syntax: " : CALPD : MAX? "

Response: [: CALPD : MAX <NR3>]

Description: Queries the maximum allowed sensitivity of the monitor diode.
Unit: [A/W].

NOTE

This calibration is used for the command POPT. It differs from the calibration factor set with the potentiometer located next to the LED P_{LD} that is responsible for the 4 ½ digit display. If the value on the display shall be equal to that read back via the interface, a manual calibration has to be done too.

→ (Refer to chapter 2.11, "Adjusting the power display of an internal monitor diode" on page 38)

3.6.11 Optical power (POPT)

Programming:

Syntax: `" : POPT : SET <NR3> "`

Valid Range: Depends on the instrument type and the programmed sensitivity of the monitor diode.

Default Value: 0 W

Assumption: The operation mode is set to constant power.

Description: Sets the optical power. Unit: [W].

Reading the set power:

Syntax: `" : POPT : SET? "`

Response: `[: POPT : SET <NR3>]`

Description: Queries the programmed optical power. Unit: [W].

Reading the minimum power:

Syntax: `" : POPT : MIN? "`

Response: `[: POPT : MIN <NR3>]`

Description: Queries the minimum allowed optical power. Unit: [W].

Reading the maximum power:

Syntax: `" : POPT : MAX? "`

Response: `[: POPT : MAX <NR3>]`

Description: Queries the maximum allowed optical power. Unit: [W].

Reading the actual power:

Syntax: `" : POPT : ACT? "`

Response: `[: POPT : ACT <NR3>]`

Description: Queries the actual optical power. Unit: [W].

→ (See note at command CALPD on page 77)

3.6.12 Reading the optical power from the display (POPTP)

Syntax: `" :POPTP:ACT?"`

Response: `[:POPTP:ACT <NR3>]`

Description: Queries the actual optical power, that is calculated from the position of the potentiometer marked ADJ next to the LED P_{LD}. This is the optical power shown on the display. Unit: [W]

NOTE

This queries the optical power measured by the internal monitor diode that is displayed on the 4 ½ digit display.

3.6.13 Reading the laser diode voltage (VLD)

Syntax: `" :VLD:ACT?"`

Response: `[:VLD:ACT <NR3>]`

Description: Queries the actual laser diode voltage. Unit: [V]

3.6.14 Reading the bias voltage (VBIAS)

Syntax: `" :VBIAS:ACT?"`

Response: `[:VBIAS:ACT <NR3>]`

Description: Queries the actual photo diode bias voltage. Unit: [V]

NOTE

This query always tells the bias voltage set with the potentiometer ADJ next to the LED PD BIAS even with the bias voltage switched off.

3.6.15 Temperature Sensor (SENS)

Programming:

Syntax: ": SENS AD" (AD590 family)
 ": SENS THL" (thermistor, 20 k Ω range)
 ": SENS THH" (thermistor, 200 k Ω range)

Assumption: The TEC output is switched off.

Description: Selects the type of temperature sensor. Sets the programmed temperature / resistance to default values.

Reading:

Syntax: ": SENS?"
Response: [: SENS AD]
 [: SENS THL]
 [: SENS THH]

Description: Queries the type of the temperature sensor.

3.6.16 Switching the TEC on and off (TEC)

Programming:

Syntax: ": TEC OFF"
 ": TEC ON"

Default Value: OFF

Assumption: To switch the TEC on there must be no device errors (no sensor, TEC open, over temperature, ...).

Description: Switches the TEC output on or off.

Reading:

Syntax: ": TEC?"
Response: [: TEC OFF]
 [: TEC ON]

Description: Queries the state of the TEC output.

3.6.17 Temperature (only AD590) (TEMP)

Programming:

Syntax: " : **TEMP : SET** <NR3> "

Valid Range: Depends on the instrument type.

Default Value: 25 °C

Assumption: The temperature sensor is set to AD590.

Description: Sets the TEC temperature. Unit: [°C].

Reading the set temperature:

Syntax: " : **TEMP : SET?** "

Response: [: **TEMP : SET** <NR3>]

Assumption: The temperature sensor is set to AD590.

Description: Queries the programmed temperature. Unit: [°C].

Reading the minimum temperature:

Syntax: " : **TEMP : MIN?** "

Response: [: **TEMP : MIN** <NR3>]

Assumption: The temperature sensor is set to AD590.

Description: Queries the minimum allowed temperature. Unit: [°C].

Reading the maximum temperature:

Syntax: " : **TEMP : MAX?** "

Response: [: **TEMP : MAX** <NR3>]

Assumption: The temperature sensor is set to AD590.

Description: Queries the maximum allowed temperature. Unit: [°C].

Reading the actual temperature:

Syntax: " : **TEMP : ACT?** "

Response: [: **TEMP : ACT** <NR3>]

Assumption: The temperature sensor is set to AD590.

Description: Queries the actual temperature. Unit: [°C].

3.6.18 Resistance of the thermistor (RESI)

Programming:

Syntax: `" :RESI :SET <NR3> "`

Valid Range: Depends on the instrument type and the selected temperature sensor.

Default Value: Depends on the selected thermistor range.

Assumption: The temperature sensor is set to thermistor (high or low range).

Description: Sets the TEC thermistor resistance. Unit: [Ω].

Reading the set resistance:

Syntax: `" :RESI :SET? "`

Response: `[:RESI :SET <NR3>]`

Assumption: The temperature sensor is set to thermistor (high or low range).

Description: Queries the programmed thermistor resistance. Unit: [Ω].

Reading the minimum resistance:

Syntax: `" :RESI :MIN? "`

Response: `[:RESI :MIN <NR3>]`

Assumption: The temperature sensor is set to thermistor (high or low range).

Description: Queries the minimum allowed thermistor resistance. Unit: [Ω].

Reading the maximum resistance:

Syntax: `" :RESI :MAX? "`

Response: `[:RESI :MAX <NR3>]`

Assumption: The temperature sensor is set to thermistor (high or low range).

Description: Queries the maximum allowed thermistor resistance. Unit: [Ω].

Reading the actual resistance:

Syntax: `" :RESI :ACT? "`

Response: `[:RESI :ACT <NR3>]`

Assumption: The temperature sensor is set to thermistor (high or low range).

Description: Queries the actual thermistor resistance. Unit: [Ω].

3.6.19 Reading the TEC current hardware limit (LIMTP)

Syntax: " : **LIMTP : ACT?** "

Response: [: **LIMTP : ACT** <NR3>]

Description: Queries the actual TEC current hardware-limit. Unit: [A]

→ (Refer to Chapter 1.8.2, "Setting the limit value of the TEC current" on page 16)

3.6.20 Reading the TEC current (ITE)

Syntax: " : **ITE : ACT?** "

Response: [: **ITE : ACT** <NR3>]

Description: Queries the actual TEC current. Unit: [A]

3.6.21 Reading the temperature/resistance window (WIN)

Syntax: " : **WIN : ACT?** "

Response: [: **WIN : ACT** <NR3>]

Description: Queries the actual temperature/resistance window. Depending on the temperature sensor the temperature window or the resistance window is returned. Unit: [°C], [Ω]

3.6.22 Reading the TEC voltage (VTE)

Syntax: " : **VTE : ACT?** "

Response: [: **VTE : ACT** <NR3>]

Description: Queries the actual TEC voltage. Unit: [V]

3.7 Error messages of the ITC5xx

Devices following the IEEE488.2 standard provide an error queue storing errors one by one.

An Error may occur as result of a program message (refer to chapter 3.2.2, "Program and response messages" on page 62).

Errors are divided into four categories (refer to chapter 3.8.1, "Standard event status register (ESR)" on page 90).

Every query "**:SYST:ERR?**" will read out one error from the error queue until the error queue is empty (refer to 3.4.3, "Querying the error queue" on page 69).

The error queue can keep 32 errors.

If the queue is empty, the error message [0, "No error"] is sent to the PC

3.7.1 General errors

[0, "No errors"]

Category: None

Possible reason: The error queue is empty.

[100, "Unknown command"]

Category: Command Error

Possible reason: ":HELLO WORLD". This string sent to the ITC5xx was not recognized as valid command.

[101, "Invalid character"]

Category: Command Error

Possible reason: "!". This character sent to the ITC5xx does not belong to the allowed set of characters.

[102, "Invalid numeric parameter"]

Category: Command Error

Possible reasons: ":ILD:SET 1.2a3". This parameter is not valid.

[103, "Invalid text parameter"]

Category: Command Error

Possible reasons: ":SENS hhh". This parameter is not valid.

[109, "Wrong compound"]

Category: Command Error

Possible reason: ":ILD:ERR?". This combination is not allowed.

[110, "Unknown compound"]

Category: Command Error

Possible reason: ":ILD:XXX?". This compound is not known.

[111, "Wrong parameter"]

Category: Command Error

Possible reason: ":LASER CG". This compound is not valid for this command.

[190, "Parser buffer overflow"]

Category: Command Error

Possible reason: The string sent to the ITC5xx was too long for the parser.

[200, "Data out of range"]

Category: Execution Error

Possible reason: ":ILD:SET 10E+30" sent to the ITC5xx but this current is much too high.

[300, "Hardware error"]

Category: Device Error

Possible reason: Many. Device must probably be maintained.

[301, "Software error"]

Category: Device Error

Possible reason: Unexpected error. Please contact [Thorlabs](#).

[302, "Not implemented yet"]

Category: Device Error

Possible reason: Feature not enabled. Please contact [Thorlabs](#).

[303, "Key emulation error"]

Category: Device Error

Possible reason: Internal communication problem. Please contact [Thorlabs](#).

[400, "Too many errors"]

Category: Device Error

Possible reason: Error queue overflow (32 errors max).

[410, "Query interrupted"]

Category: Query Error

Possible reason: More than one query sent to the ITC5xx before the read command.

[420, "Query unterminated"]

Category: Query Error

Possible reason: There is no data in the output buffer.

[500, "IEEE488 receive buffer overflow"]

Category: Device Error

Possible reason: The string sent to the ITC5xx was too long for the IEEE488 receive buffer (250 char max).

3.7.2 ITC5xx operation error messages

[1301, "Interlock is open"]

Category: Execution Error

Possible reason: Try to switch on the output while the Interlock line is open.

→ (Refer to chapter 2.22, "Using the interlock input" on page 52)

[1302, "Open circuit"]

Category: Execution Error

Possible reason: Try to switch on the output while the laser diode has opened or the compliance voltage is not high enough.

[1303, "Over temperature"]

Category: Execution Error

Possible reason: Try to switch on the output while the internal temperature is too high. Wait until the ITC5xx has cooled down. Maintain proper air flow.

[1304, "Internal power failure"]

Category: Execution Error

Possible reason: Try to switch on the output while an internal power failure occurred.

[1306, "No calibrating of PD during laser on"]

Category: Execution Error

Possible reason: The monitor diode cannot be calibrated during the laser diode output is switched on.

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

Category: Execution Error

Possible reason: The set value of the laser diode current can not be changed during constant power mode.

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

Category: Execution Error

Possible reason: The set value of the monitor diode current and the optical power cannot be changed during constant current mode.

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

Category: Execution Error

Possible reason: The polarity of the laser diode can not be changed during the laser diode output switched on.

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

Category: Execution Error

Possible reason: The polarity of the monitor diode can not be changed during the laser diode output switched on.

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

Category: Execution Error

Possible reason: The operating mode CC or CP cannot be changed during the laser diode output is switched on.

[1312, "Wrong or no sensor"]

Category: Execution Error

Possible reason: The ITC5xx detected no sensor at the output jack.

[1313, "Wrong command for this sensor"]

Category: Execution Error

Possible reason: The released command does not fit to the connected sensor.

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

Category: Execution Error

Possible reason: The type of sensor may not be changed during the output switched on.

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

Category: Execution Error

Possible reason: The actual temperature of the laser diode is outside the temperature window.

[1317, "Limit of temperature/resistance reached"]

Category: Execution Error

Possible reason: The set value of the temperature/resistance reached the temperature limit.

[1318, "No bias change during laser on"]

Category: Execution Error

Possible reason: The bias voltage may not be switched on or off during laser on.

[1319, "No PD polarity change during bias on"]

Category: Execution Error

Possible reason: The polarity of the monitor diode may not be changed with the bias voltage on.

3.8 Status reporting

The ITC5xx provides four 8 bit registers ESR, STB, ESE and SRE and three 16 bit registers DEC, DEE and EDE to program various service request functions and status reporting.

➔ (Please refer to the IEEE488.2-1992 standard chapter 11)

3.8.1 Standard event status register (ESR)

The bits of this register mirror the following standard events:

Power on	This event bit indicates, that an off to on transition has occurred in the power supply. So it is 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 error	A device dependent error occurred.
Query error	A query error occurred.
Request control	(Not used)
Operation complete	Can be set with " *OPC ".

The ESR can be read directly with the command "***ESR?**". This read command clears the ESR. The content of the ESR can not be set.

The bits are active high.

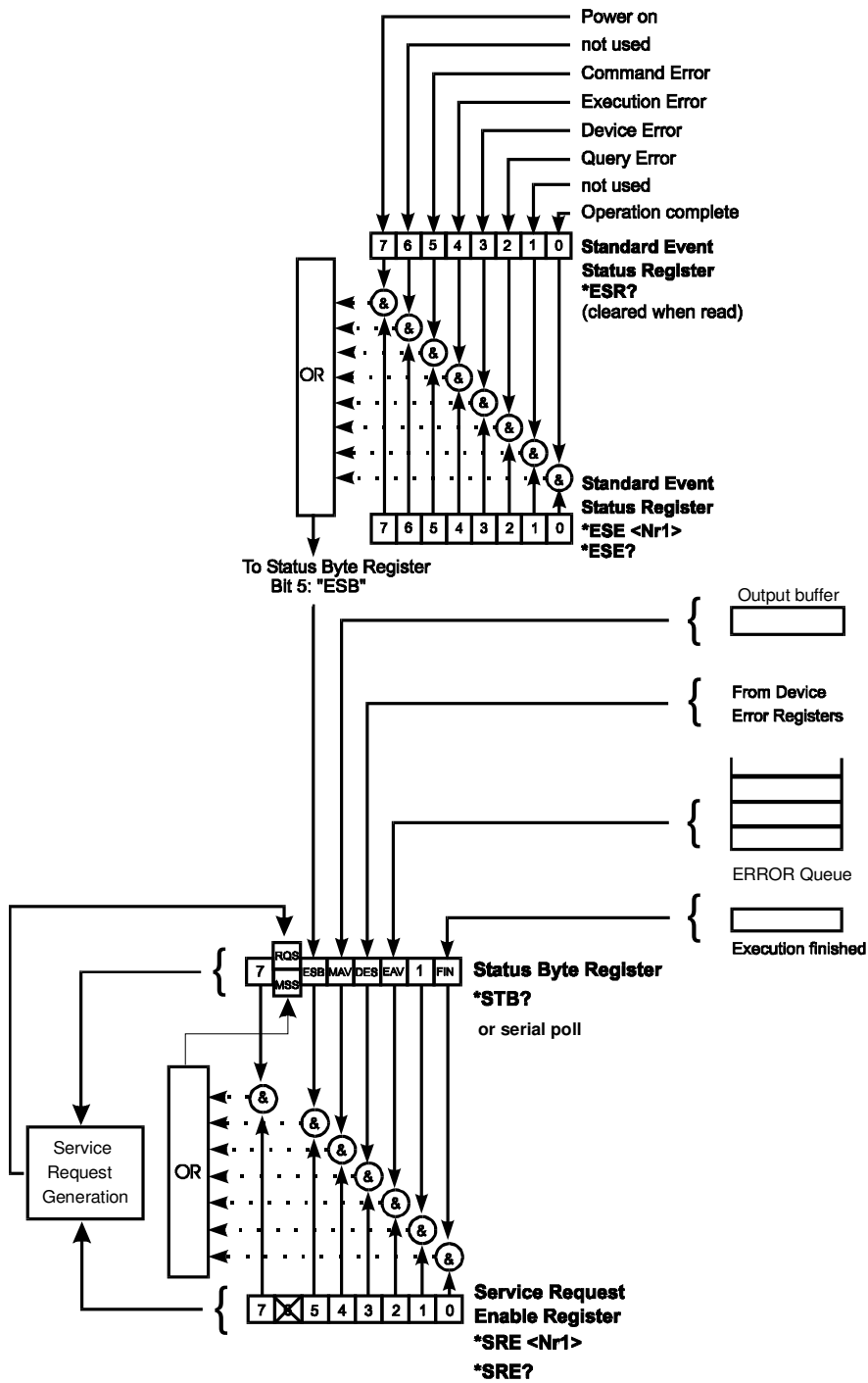


Figure 13 ITC5xx Status registers ESR, ESE, STB and SRE

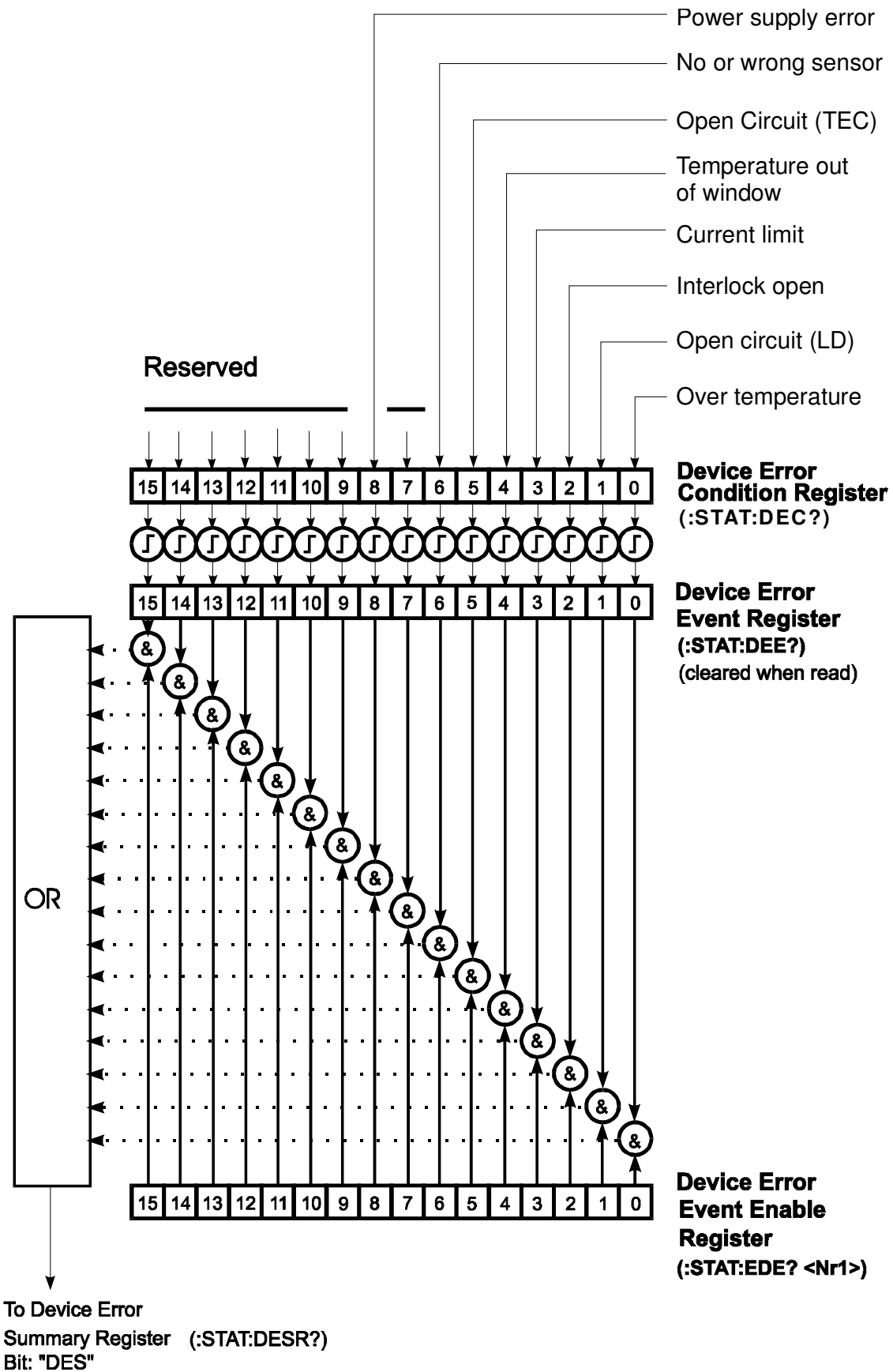


Figure 14 ITC5xx Status registers DEC, DEE and EDE

3.8.2 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 STB. The 8 bits of the ESE are combined with the according 8 bits of the ESR via a wired "AND"-function. These 8 results are combined with a logical "OR"-function, so that any "hit" leads to a logical 1 in 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.

3.8.3 Status byte register (STB)

The bits of this register are showing the status of the ITC5xx.

RQS	RQS: Request service message: Shows, that this device has asserted SRQ (red via serial poll).
MSS	Master summary status: Shows that this device requests a service (read via " *STB ").
MAV	(message available) This bit is high after a query request, as a result "waits" in the output queue to be fetched. It is low, if the output queue is empty.
DES	(device error status) This bit is high after a device error occurred. Which device errors shall set this bit is defined with the EDE.
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.

The STB can be read directly with the command "***STB?**". The content of the STB can not be set. The bits are active high.

All bits except bit 6 of the STB can be used to assert a service request (SRQ) (Please refer to 3.8.5). Alternatively the SRQ can be recognized using the command "`*STB?`" (Please refer to 3.8.6) or by serial poll (Please refer to 3.8.7).

3.8.4 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 related to the according 7 bits of the SRE by logical "AND". These 7 results are combined by a logical "OR", so that any "hit" leads to a logical 1 in bit 6 of the STB and asserts an SRQ.

3.8.5 Reading the STB by detecting SRQ

If an SRQ is asserted (see 3.8.4) 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.

3.8.6 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.

3.8.7 Reading the 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.

3.8.8 Device error condition register (DEC)

The bits of this register show the errors, that occur during operation (device errors). The bits are active high.

If the error disappears, the bits are reset to low.

For an ITC5xx bits 0 ... 6, 8 are used:

- | | |
|-------------------------------|--|
| (0) Over temperature | Internal temperature too high. Wait until the ITC5xx has cooled down. Maintain proper air flow. |
| (1) Open circuit | Cable to the laser diode has opened.
Compliance voltage not high enough |
| (2) Interlock open | Interlock line is open. |
| (3) Current limit | The current limit is reached and the protection circuit is active now. Noise and drift specs are not valid any more. |
| (4) Temperature window | The temperature module detected a temperature window violation. |
| (5) Open circuit | The TEC element to has a too high resistance or is not present. |
| (6) No sensor | A wrong temperature sensor is connected to the output jack, or the contact is bad. |
| (8) Power supply error | Internal power supply error. |

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

3.8.9 Device error event register (DEE)

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

The DEE can be read but not set. Reading clears the DEE.

3.8.10 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 related by logical "AND" to the according 8 bits of the DEE. This 8 results are connected 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.

3.9 Hints for setting up control programs

The following flowcharts show the communication sequences between a control computer and an ITC5xx using the IEEE488 interface. Use these sequences to ensure fast and secure communication.

Flowchart for writing device commands

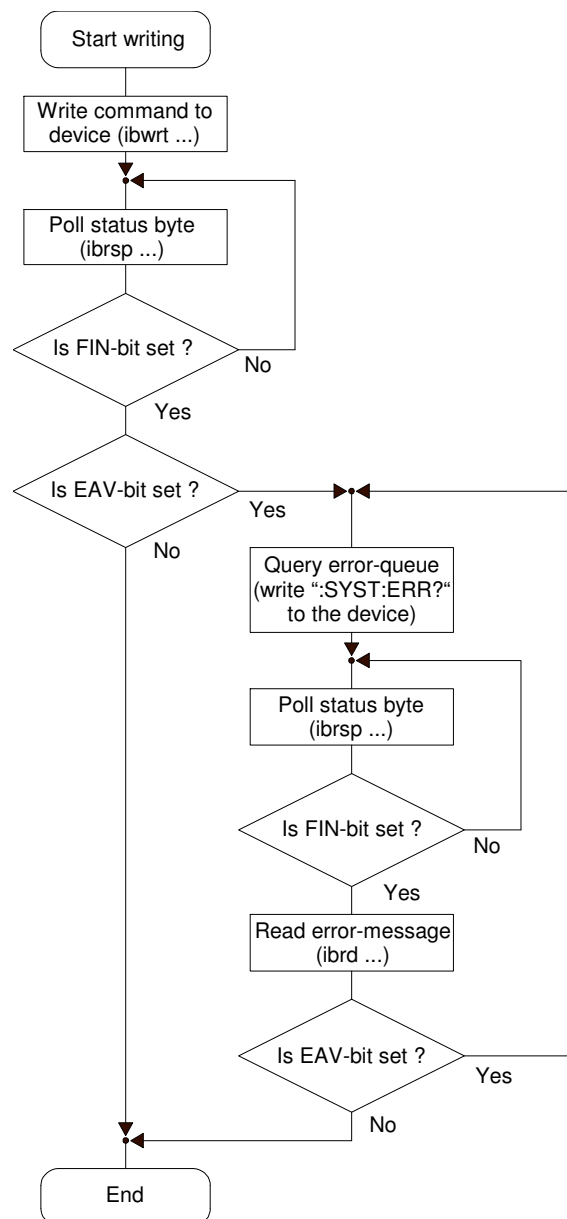


Figure 15 Flowchart for writing device commands

Flowchart for reading device messages

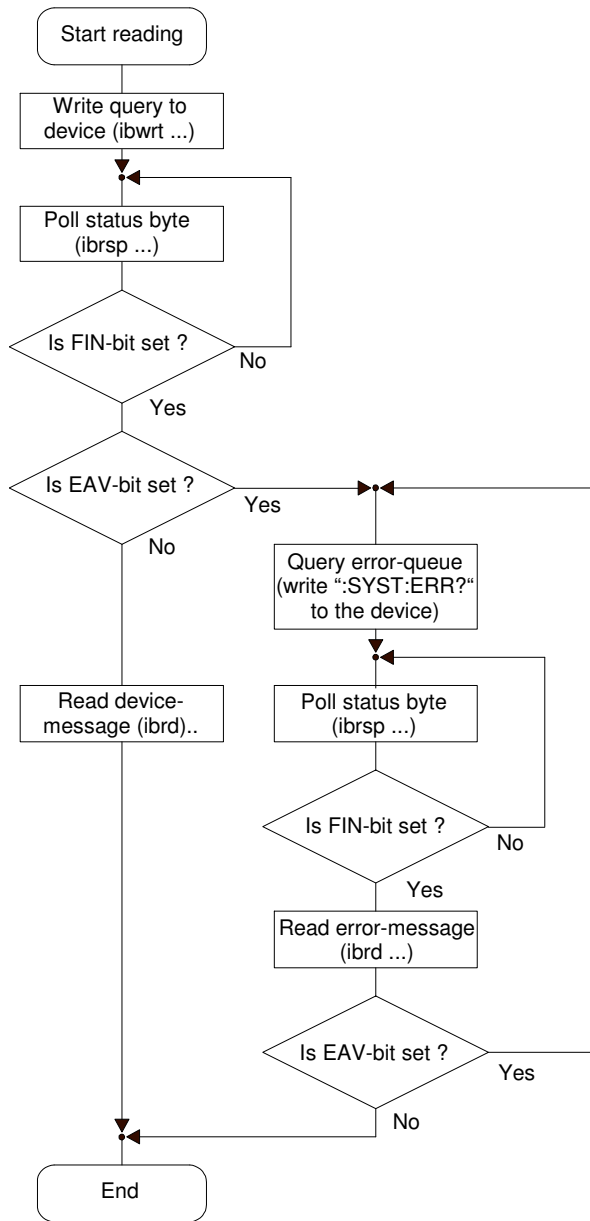


Figure 16 Flowchart for reading device messages

NOTE

During the test phase of control programs all program messages should be transmitted separately. Each command should be followed by a status request (response message) so that possible errors are read out directly after the command causing them.

NOTE

The producer of the interface card of the control computer will provide communication functions for both directions between PC and ITC5xx for all common software packages. These will be embedded into the programming text and accomplish the data transfer between control computer and ITC5xx. We recommend to build these write and read back commands into separate functions and then use these functions for the data transfer.

In these functions a globally set flag should be requested that would determine whether the write or read back communication is to be read out together with talker and listener address at IEEE488 systems additionally into a data file or on the printer. When communication problems should occur at the bus, or in case of error messages that cannot be explained, the evaluation of the data transfer between the ITC5xx and the control computer will then be possible without much effort.

4 Maintenance

4.1 Repair

The ITC5xx does not contain any components to be repaired by the user. If any disturbances in function should occur, please contact [Thorlabs](#) or your local representative for help or ask for a RMA Number, before sending the unit back for repair.

4.2 Cleaning

Inspect the instrument as often as operating conditions require. To clean the exterior surface, perform the following steps:

1. Remove loose dust on the outside of the instrument with a lint-free cloth. Use care to avoid scratching the clear plastic display filter.
2. Use a soft cloth dampened with water to clean the instrument. Use an aqueous solution of 75% isopropyl alcohol for more efficient cleaning.

Attention

To avoid damage to the surface of the instrument, do not use any abrasive or chemical cleaning agents.

To maintain the specifications for a long period of time we recommend to have the unit re-calibrated by [Thorlabs \(Germany\)](#) every two years.

4.3 Selecting the line voltage

The line voltage can be selected with the line voltage selector on the rear panel of the ITC5xx (above the mains plug). The ITC5xx can be operated with 100V 115V or 230V (If you change the line voltage setting, you must also change the fuse!!)

4.4 Exchanging the line fuse

If the line fuse should have blown due to line disturbances, incorrectly set voltage or other influences from the outside, it can be exchanged at the rear without opening the unit.

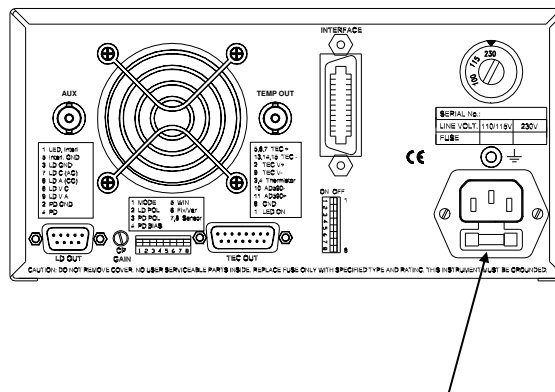
Attention

To avoid fire hazard only the appropriate fuse for the corresponding line voltage must be used (ITC502 and ITC510):

100V / 115V : T4H250V

230V : T2H250V

(IEC 60127-2/V, 5 x 20mm, 250V, slow response)



mains plug with fuse and spare fuse

Figure 17 Rear view of the ITC5xx

Execution

- Switch the ITC5xx off and remove the mains cable from the mains jack.
- Remove the cover of the fuse holder by means of a screwdriver. A small drawer will open up. If available, first the replacement fuse will be visible. The active fuse is located at the rear part of the drawer.

-

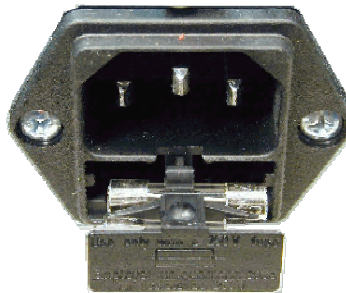


Figure 18 ITC5xx fuse holder

- Remove the fuse holder completely and exchange the defective fuse. We recommend to check the same time if a replacement fuse is provided and if this fuse is still useable.
- Push the fuse holder back until is has snapped in.
- Execute a function test of the ITC5xx by switching it on. In case the ITC5xx could not be switched on despite the correct fuse being inserted, please contact your supplier or [Thorlabs \(Germany\)](#).

4.5 Trouble-shooting

◆ Unit does not work at all (no display on the mainframe):

- Controller connected properly to the mains?
 - Connect the ITC5xx to the power line, take care of the right voltage setting.
 - ITC5xx controller turned on?
 - Turn on the unit with the key mains-switch.
 - Control the fuse at the rear panel of the ITC5xx.
 - If the fuse has opened, replace the fuse by the correct type
- ➔ (refer to 4.4, "Exchanging the line fuse" on page 101)

◆ You don't get the desired laser output power

- Is the interlock closed?
 - Control the resistance between the interlock pins of the connector jack not to be more than 430 Ω .
(refer to section 1.9.9, "Connecting interlock and status LED " on page29)
 - Do you have turned on the laser output?
 - Change the status setting from "off" to "on" either manually or by the remote command " : **LASER ON**".
- ➔ The LED "ON" on the front panel of the unit must be on
- Is the hardware limit $I_{LD\ LIM}$ set to 0?
 - Adjust the hardware limit $I_{LD\ LIM}$ by means of the potentiometer on the ITC5xx front panel to an appropriate value.
 - Is the laser diode installed properly?
 - Control the connection cable.
 - Is the laser diode poled correctly?

- If not, change the polarity at the front panel, with the "**:LDPOL AG/CG**" command or change the connection at the laser output jack.
- Is the photo diode connected properly?
 - Check the connecting cable.
- Is the photo diode poled correctly?
 - If not, change the polarity with the "**:PDPOL AG/CG**" command or at the front panel of the unit.
- Are you using a bias voltage with the photo diode in photocurrent mode?
 - Turn off bias voltage manually, with the "**:PDBIA OFF**" command or change the polarity of the diode for photo element mode.
- Is the desired output power programmed correctly?
 - Turn to constant power mode and adjust the desired output power P_{LD} with the tuning knob or with the "**:POPT:SET<NR3>**" command.
- Is the ITC5xx running in temperature protection mode?
 - Check if the temperature window is set correctly.
 - Check if the laser temperature is out of window (laser is then switched off automatically).
- ◆ You don't get the desired operation temperature
 - Is the TEC connected properly to the connector?
 - Check all cables.
 - Check the correct polarity (see section 2.14 on page 41)
 - Do you have turned on the temperature controller manually or by the "**:TEC ON/OFF**" command?
 - Change the status setting from "off" to "on".
 - ➔ The LED "ON" on the front panel of the module must be on

- Is the correct temperature sensor connected properly and is the temperature set accordingly at the front panel or with the "**: TEMP : SET <NR3>**" command?
 - Check the corresponding connections and polarities of the temperature sensor (refer to chapter 1.9.6, "Connecting a TEC element" on page 25)

- Do you have chosen the right temperature sensor?
 - Select the corresponding temperature sensor manually or with the "**: SENS AD/THL/THH**" command.
 - Enter the right set-value for resistance manually or by the "**: RESI : SET <NR3>**" command.

- Is the TEC hardware current limit set to 0?
 - Adjust it with the ITEC LIM potentiometer to an appropriate value

◆ Set temperature differs from actual temperature (of the laser)

- Is the temperature not stable?
 - Adjust the corresponding PID-parameters carefully (refer to 2.15.4, "PID adjustment" on page 45)

If you don't find the error source by means of the trouble shooting list please first connect the [Thorlabs-Hotline](#) before sending the whole system for checkup and repair to [Thorlabs](#)-Germany.

(refer to section 7, "Addresses " on page 114)

5 Service

👉 Attention 👈

Only qualified service personnel should perform service procedures.

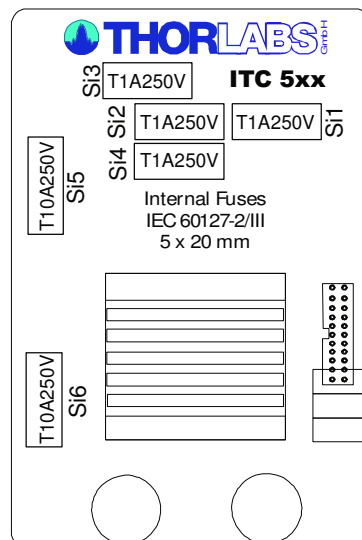
Hazardous voltages exist within the device.

5.1 Exchange of internal fuses

Disconnect Power. To avoid electrical shock, first switch off the ITC5xx power, and then disconnect the power cord from the mains power.

With the ITC5xx turned over, remove the two screws that secure the cover to the chassis.

Remove the unit by sliding it out of the cover. With the unit set upright, you will find the label depicting names, values and positions of internal fuses at the outer wall of the transformer section.



Replace the defective fuse, and reattach the cover.

6 Appendix

6.1 Warranty

Thorlabs warrants material and production of the ITC5xx 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 still entitled to warranty. For warranty repairs or service the unit must be sent back to *Thorlabs* or to a place determined by *Thorlabs*. The customer will carry the shipping costs back 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 will also carry the costs for shipment. If the unit is sent back to *Thorlabs* from abroad the customer will carry all shipping costs, duties etc. which should arise for sending the goods back to *Thorlabs*.

Thorlabs warrants the hardware and software determined by *Thorlabs* for this unit to operate without fault provided that they are handled according to our statements. However, *Thorlabs* does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special purposes nor this instruction manual to be fault free. We will not carry responsibility for ensuing damages.

Restriction of warranty

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

6.2 Certifications and compliances

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 89/336/EEC 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 ^{1,2,3} and Immunity. ^{1,2,4}
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion C)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion B) ⁵
	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 C)
	IEC 61000-4-11	Voltage Dips and Interruptions Immunity (Performance criterion C)
	EN 61000-3-2	AC Power Line Harmonic Emissions
Australia / New Zealand Declaration of Conformity - EMC	Complies with the Radiocommunications Act and demonstrated per EMC Emission standard ^{1,2,3} :	
	AS/NZS 2064	Industrial, Scientific, and Medical Equipment: 1992
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B ^{1,2,3} .	

¹ Compliance demonstrated using high-quality shielded interface cables.

² Compliance demonstrated with CAB400 cable installed at the LD Output port and CAB450 cable installed at the TEC OUTPUT port.

³ Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

⁴ Minimum Immunity Test requirement.

⁵ MOD IN port capped at IEC 61000-4-3 test.

EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC
--	--

Certifications and compliances

Category	Standards or description	
	EN 61010-1/A2:1995	Safety requirements for electrical equipment for measurement control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1	Standard for electrical measuring and test equipment.
	ANSI/ISA S82.01:1994	Safety standard for electrical and electronic test, measuring, controlling, and related equipment.
Canadian Certification	CAN/CSA C22.2 No. 1010.1	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC61010-1/A2:1995	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Equipment Type	Test and measuring	
Safety Class	Class 1 (as defined in IEC 61010-1, Annex H) - grounded product	

6.3 Thorlabs “End of Life” policy (WEEE)

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 19)
- 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.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

6.3.1 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.

6.3.2 Ecological background

It is well known that WEEE 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.

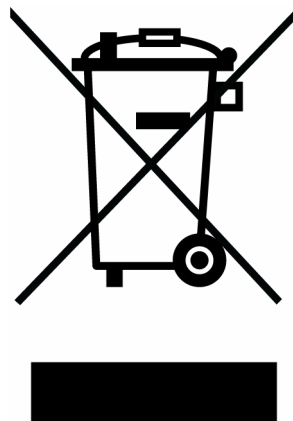


Figure 19 Crossed out “wheelevator bin” symbol

6.4 List of acronyms

AC	<u>A</u> lternating <u>C</u> urrent
AG	<u>A</u> node <u>G</u> round
ASCII	<u>A</u> merican <u>S</u> tandard <u>C</u> ode for <u>I</u> nformation <u>I</u> nterchange
CC	<u>C</u> onstant <u>C</u> urrent
CG	<u>C</u> athode <u>G</u> round
CLR	<u>C</u> lea <u>R</u>
CMOS	<u>C</u> omplementary <u>M</u> etal <u>O</u> xide <u>S</u> emiconductor
CP	<u>C</u> onstant <u>P</u> ower
CR	<u>C</u> arriage <u>R</u> eturn
CRD	<u>C</u> haracter <u>R</u> esponse <u>D</u> ata
D-Share	<u>D</u> ifferential share
DC	<u>D</u> irect <u>C</u> urrent
DCL	<u>D</u> evice <u>C</u> lear
DEC	<u>D</u> evice <u>E</u> rror <u>C</u> ondition Register
DEE	<u>D</u> evice <u>E</u> rror <u>E</u> vent Register
DES	<u>D</u> evice <u>E</u> rror <u>S</u> tatus
DIP	<u>D</u> ual <u>I</u> n-line <u>P</u> ackage
DUT	<u>D</u> evice <u>U</u> nder <u>T</u> est
EAV	<u>E</u> rror <u>A</u> vailable
EDE	<u>E</u> nable <u>D</u> evice <u>E</u> rror Event Register
EOI	<u>E</u> nd <u>O</u> f <u>I</u> nformation
ERR	<u>E</u> RRor
ESE	Standard <u>E</u> vent <u>S</u> tatus <u>E</u> nable register
ESR	<u>E</u> vent <u>S</u> tatus <u>R</u> egister
FIN	Command <u>F</u> INished
GET	<u>G</u> roup <u>E</u> xecute <u>T</u> rigger
GTL	<u>G</u> o <u>T</u> o <u>L</u> ocal
GPIB	<u>G</u> eneral <u>P</u> urpose <u>I</u> nterface <u>B</u> us
IC	<u>I</u> ntegrated <u>C</u> ircuit
IEEE	<u>I</u> nstitute for <u>E</u> lectrical and <u>E</u> lectronic <u>E</u> ngineering
ILD	<u>I</u> (current) <u>L</u> aser <u>D</u> iode
IPD	<u>I</u> (current) <u>P</u> hoto <u>D</u> iode
I-Share	<u>I</u> ntegral share
LD	<u>L</u> aser <u>D</u> iode
LDC	<u>L</u> aser <u>D</u> iode <u>C</u> ontroller

LED	<u>L</u> ight <u>E</u> mitting <u>D</u> iode
LF	<u>L</u> ine <u>F</u> eed
LLO	<u>L</u> ocal <u>L</u> ockout
LS	<u>L</u> aser <u>S</u> ource Module
NR1	<u>N</u> umeric <u>R</u> esponse data of type <u>1</u>
NR2	<u>N</u> umeric <u>R</u> esponse data of type <u>2</u>
NR3	<u>N</u> umeric <u>R</u> esponse data of type <u>3</u>
MAV	<u>M</u> essage <u>A</u> vailable)
MSS	<u>M</u> aster <u>S</u> ummary <u>S</u> tatus
OTP	<u>O</u> ver <u>T</u> em <u>P</u> erature
PC	<u>P</u> ersonal <u>C</u> omputer
PD	<u>P</u> hoto <u>D</u> iode
PID	<u>P</u> roportional, <u>I</u> ntegral, <u>D</u> ifferential (regulator)
P-Share	<u>P</u> roportional share
RF	<u>R</u> adio <u>F</u> requency
RMS	<u>R</u> oot <u>M</u> ean <u>S</u> quared
RQS	<u>R</u> e <u>Q</u> uest <u>S</u> ervice Message
SDC	<u>S</u> electe <u>D</u> <u>D</u> evice <u>C</u> lear
SEL	<u>S</u> E <u>L</u> ect
SRE	<u>S</u> ervice <u>R</u> equest <u>E</u> nable Register
SRQ	<u>S</u> ervice <u>R</u> e <u>Q</u> uest
STB	<u>S</u> Tatus <u>B</u> yte Register
SW	<u>S</u> oft <u>W</u> are
TEC	<u>T</u> hermo <u>E</u> lectric <u>C</u> ooler (Peltier Element)
TRG	<u>T</u> Ri <u>G</u> ger
TTL	<u>T</u> ransistor- <u>T</u> ransistor <u>L</u> ogic

6.5 List of figures

Figure 1	Operating elements at the front panel.....	14
Figure 2	Operating elements at the rear panel.....	15
Figure 3	Pinning of the laser diode connector.....	20
Figure 4	Pinning of the TEC connector.....	22
Figure 5	Connecting a thermistor.....	23
Figure 6	Connecting an AD590 or AD592.....	24
Figure 7	Connecting a LM135 or LM335.....	25
Figure 8	Connecting a TEC.....	26
Figure 9	TEC status display.....	27
Figure 10	Connecting laser- and monitor diode.....	28
Figure 11	Interlock and status LED.....	29
Figure 12	Typical thermal set-up of a diode laser.....	42
Figure 13	ITC5xx Status registers ESR, ESE, STB and SRE.....	91
Figure 14	ITC5xx Status registers DEC, DEE and EDE.....	92
Figure 15	Flowchart for writing device commands.....	97
Figure 16	Flowchart for reading device messages.....	98
Figure 17	Rear view of the ITC5xx.....	101
Figure 18	ITC5xx fuse holder.....	102
Figure 19	Crossed out “wheelie bin” symbol.....	110

7 Addresses

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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