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Operating Manual
Thorlabs Blueline™ Series

PRO8000 (-4) / PRO800

Current module LDC8xxx



2003

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In the displays shown by the PRO8 you may find the name PROFILE.
PROFILE was the name of the manufacturer before it was acquired by Thorlabs and renamed to Thorlabs GmbH.

Thorlabs GmbH

This part of the instruction manual contains all the specific information on how to operate a current module LDC8xxx. A general description is followed by explanations of how to operate the unit manually. You will also find complete information about remote control via the IEEE 488 computer interface.

☝Attention☝

This manual contains “WARNINGS” and “ATTENTION” labels in this form, to indicate personal danger or possible damage to equipment.

Please read these advises carefully!

NOTE

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

1 General description of the current module LDC8xxx

1.1 Safety

☝ Attention ☝

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

Before applying power to your PRO8000 (-4) / PRO800 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 damages to your health or even death!

Modules may only be installed or removed with the mainframe switched off.

All modules must be fixed with all screws provided for this purpose.

Modules of the 8000 series must only be operated in the mainframe PRO8000, PRO8000-4 or PRO800.

All modules 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.

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☝ 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 PRO8000 / PRO800 plug-in module or 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.

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1.2 Warranty

Thorlabs GmbH warrants material and production of the LDC8xxx modules for a period of 24 months starting with the date of shipment. During this warranty period *Thorlabs GmbH* will see to defaults by repair or by exchange if these are entitled to warranty.
For warranty repairs or service the unit must be sent back to *Thorlabs GmbH (Germany)* or to a place determined by *Thorlabs GmbH* . The customer will carry the shipping costs to *Thorlabs GmbH,* in case of warranty repairs *Thorlabs GmbH* will carry the shipping costs back to the customer.
If no warranty repair is applicable the customer also has to carry the costs for back shipment.
In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

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

Restriction of warranty

The afore mentioned warranty does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient conditions (refer to the PRO8000 (-4) / PRO800 mainframe operation manual) stated by us or unauthorized maintenance.

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

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

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1.3 Features

1.3.1 Safety measures for the laser diode

To protect the connected laser diodes the laser diode control system PRO8000 (-4) / 800 and the LDC8xxx laser diode controller contain the following protection circuits:

- **Softstart when switching on the laser diode current**
  Protection against capacitive and inductive parasitic elements (switching peaks).

- **Limit for the injection current (hardware- and software limit) in all operating modes**
  Protection against thermal destruction of the laser chip.

- **Limit for the optical power in constant current (!) mode**
  Protection against thermal destruction of the mirrors caused by too high optical power.

- **Interruption control of the connecting cable to the laser diode (interlock)**
  Protection against accidental operation.

- **Contact protection of the laser diode (open circuit)**
  Protection against cable damage or bad contact.

- **Electronic short-circuit switch for the laser diode**
  Protection against static discharge when touching the inoperative laser.

- **Separate on and off function for each module**
  Protection against operating errors.

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- **Control LED for activated laser current**
  Laser protection when laser radiation is switched on.

- **Separate over-temperature protection for each module**
  Protection against thermal failure of the module.

- **Mains filter**
  Protection against line transients.

- **Line failure protection**
  In case of line failure or line damage the current module must explicitly be switched on anew since it cannot be taken for granted that all components of the measurement set-up are still working reliably.

- **Key-operated power switch**
  Protection against unauthorized or accidental use.

- **LabVIEW®- and LabWindows/CVI®-driver**
  For the PRO8000 (-4) / PRO800 *Thorlabs* supplies LabVIEW®- and LabWindows/CVI®-drivers for MS Windows 32.

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

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1.3.2 General functions

The current modules LDC8xxx are bipolar current sources for laser diodes. The different module types operate in the same way, they only differ in maximum current, resolution and accuracy.

➔ (Refer to chapter 1.4, "Technical data" starting on page 7)

The current modules LDC8xxx contain a monitor diode input realized as trans-impedance amplifier (input impedance 0 Ω). Both polarities of the monitor diode are allowed. The monitor diode may be driven either photovoltaic (without bias voltage) or photoconductive, i.e. with bias voltage (U_{BIA} = 5V).

All necessary value settings are carried out by the mainframe operating elements (keypad and rotational encoder) or via remote control by a computer. Only the laser diode current limit (hardware limit) has to be set manually as "absolute limit".
In an automated test set-up for different laser diodes no manual settings are required.

With the modules LDC8xxx the values for the laser diode current (constant current mode) or the monitor diode current (constant power mode) are set with a 16 bit resolution.

Limit values for the laser diode current (software limit) and the monitor diode current (limiting the optical output power) are set with a resolution of 12 bit. The monitor diode current is read back with 16 bit, the laser diode current, laser diode voltage and the limit for the laser diode current (hardware limit) with 15 bit plus sign.

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

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1.4 Technical data

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

1.4.1 Common data LDC8xxx

Resolution	16 Bit
Power control	
Range of monitor current I_{PDS}	10 µA ... 5 mA[1)]
Resolution	0.1 µA
Setting accuracy (f.s.)	± 0.05 %
Drift (30 min. without changing the ambient temperature.)	≤ 1 µA
Photodiode bias voltage	0 V / 5 V
Power control limit	
Setting range	0 ... 5 mA[1)]
Resolution	1.25 µA
Setting accuracy (f.s.)	± 50 µA
Laser voltage	
Measurement principle	4-wire
Measurement range	0 ... 5 V
Resolution	0.2 mV
Accuracy (f.s.)	± 5 mV
Analog modulation	
Input impedance	10 kΩ
Connector	BNC
Input voltage	-10V ..+10V
Warm-up time for rated accuracy	≤ 15 min

[1)] Other ranges on request

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1.4.2 Individual technical data

1.4.2.1 LDC8001 ULN

Current control

Range of laser current I_{LD}	0 ... ± 100 mA[1)]
Compliance voltage	> 2.5 V
Setting resolution	1.5 µA
Setting accuracy (f.s.)	± 0.05%
Measurement resolution	1 µA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 1 µA
Ripple (50/60 Hz, rms)	< 0.8 µA
Transients (processor)	≤ 10 µA
Transients (other, typ.[1)])	< 100 µA
Short-term fluctuations (15 s, 0 ... 10 Hz)	≤ 1 µA
Drift (30 min. without changing the ambient temperature)	≤ 0.5 µA
Drift (24 h. without changing the ambient temperature)	≤ 1.5 µA
Temperature coefficient	≤ 50 ppm/°C

Current limit

Setting range poti I_{LIM}	0 ... ≥ 100 mA
Setting range software I_{MAX}	0 ... ≥ 100 mA
Setting resolution	3 µA
Setting accuracy (f.s.)	± 100 µA

Analog modulation

3 dB - bandwidth (constant current mode)	DC ... 2.5 kHz
3 dB - bandwidth (constant power mode)	DC ... 1 kHz
Modulation coefficient (CP)	0.5 mA/V± 5%
Modulation coefficient (CC)	10 mA/V± 5%

Other data

Width of module	1 slot
Connector	9-pin D-sub

[1] Polarity of the laser diode free selectable

[1)] max. transients at the output, e.g. switching the unit on or off

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1.4.2.2 LDC8002

Current control

Range of laser current I_{LD}	0 ... ± 200 mA
Compliance voltage	> 5 V
Setting resolution	3 µA
Setting accuracy (f.s.)	± 0.05%
Measurement resolution	1 µA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 3 µA
Ripple (50/60 Hz, rms)	< 1 µA
Transients (processor)	≤ 15 µA
Transients (other, typ.[1)])	< 200 µA
Short-term fluctuations (15 s, 0 ... 10 Hz)	≤ 1.5 µA
Drift (30 min. without changing the ambient temperature)	≤ 1 µA
Drift (24 h. without changing the ambient temperature)	≤ 2 µA
Temperature coefficient	≤ 50 ppm/°C

Current limit

Setting range poti I_{LIM}	0 ... ≥ 200 mA
Setting range Software I_{MAX}	0 ... ≥ 200 mA
Setting resolution	6 µA
Setting accuracy (f.s.)	± 200 µA

Analog modulation

3 dB - bandwidth (constant current mode)	DC ... 200 kHz
3 dB - bandwidth (constant power mode)	DC ... 50 kHz
Modulation coefficient (CP)	0.5 mA/V± 5%
Modulation coefficient (CC)	20 mA/V± 5%

Other data

Width of module	1 slot
Connector	9-pin D-sub

[1)] max. transients at the output, e.g. switching the unit on or off

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1.4.2.3 LDC8005

Current control

Range of laser current I_{LD}	0 ... ± 500 mA
Compliance voltage	> 5 V
Setting resolution	7.5 µA
Setting accuracy (f.s.)	± 0.05%
Measurement resolution	15 µA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 5 µA
Ripple (50/60 Hz, rms)	< 1 µA
Transients (processor)	≤ 30 µA
Transients (other, typ.[1)])	< 500 µA
Short-term fluctuations (15 s, 0 ... 10 Hz)	≤ 4 µA
Drift (30 min. without changing the ambient temperature)	≤ 2 µA
Drift (24 h. without changing the ambient temperature)	≤ 5 µA
Temperature coefficient	≤ 50 ppm/°C

Current limit

Setting range poti I_{LIM}	0 ... ≥ 500 mA
Setting range software I_{MAX}	0 ... ≥ 500 mA
Setting resolution	15 µA
Setting accuracy (f.s.)	± 500 µA

Analog modulation

3 dB - bandwidth (constant current mode)	DC ... 100 kHz
3 dB - bandwidth (Constant power mode)	DC ... 20 kHz
Modulation coefficient (CP)	0.5 mA/V± 5%
Modulation coefficient (CC)	50 mA/V± 5%

Other data

Width of module	1 Slot
Connector	9-pin D-sub

[1)] max. transients at the output, e.g. switching the unit on or off

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1.4.2.4 LDC8010

Current control

Range of laser current I_{LD}	0 ... ± 1 A
Compliance voltage	> 5 V
Setting resolution	15 µA
Setting accuracy (f.s.)	± 0.1%
Measurement resolution	15 µA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 10 µA
Ripple (50/60 Hz, rms)	< 1.5 µA
Transients (processor)	≤ 50 µA
Transients (other, typ.[1)])	< 1 mA
Short-term fluctuations (15 s, 0 ... 10 Hz)	≤ 10 µA
Drift (30 min. without changing the ambient temperature)	≤ 5 µA
Drift (24 h. without changing the ambient temperature)	≤ 25 µA
Temperature coefficient	≤ 50 ppm/°C

Current limit

Setting range poti I_{LIM}	0 ... ≥ 1 A
Setting range software I_{MAX}	0 ... ≥ 1 A
Setting resolution	30 µA
Setting accuracy	± 2 mA

Analog modulation

3 dB - bandwidth (constant current mode)	DC ... 50 kHz
3 dB - bandwidth (constant power mode)	DC ... 10 kHz
Modulation coefficient (CP)	0.5 mA/V± 5%
Modulation coefficient (CC)	100 mA/V± 5%

Other data

Width of module	1 slot
Connector	9-pin D-sub

[1)] max. transients at the output, e.g. switching the unit on or off

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1.4.2.5 LDC8040

Current control

Range of laser current I_{LD}	0 ... ± 4 A
Compliance voltage	> 5 V
Setting resolution	70 µA
Setting accuracy (f.s.)	± 0.1%
Measurement resolution	130 µA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 50 µA
Ripple (50/60 Hz, rms)	< 4 µA
Transients (processor)	≤ 120 µA
Transients (other, typ.[1)])	< 4 mA
Short-term fluctuations (15 s, 0 ... 10 Hz)	≤ 50 µA
Drift (30 min. without changing the ambient temperature)	≤ 25 µA
Drift (24 h. without changing the ambient temperature)	≤ 200 µA
Temperature coefficient	≤ 50 ppm/°C

Current limit

Setting range poti I_{LIM}	0 ... ≥ 4 A
Setting range software I_{MAX}	0 ... ≥ 4 A
Setting resolution	130 µA
Setting accuracy	± 8 mA

Analog modulation

3 dB - bandwidth (constant current mode)	DC ... 20 kHz
3 dB - bandwidth (constant power mode)	DC ... 5 kHz
Modulation coefficient (CP)	0.5 mA/V± 5%
Modulation coefficient (CC)	0.4 A/V± 5%

Other data

Width of module	1 slot
Connector	9-pin D-sub

[1)] max. transients at the output, e.g. switching the unit on or off

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1.4.2.6 LDC8080

Current control

Range of laser current I_{LD}	0 ... ± 8 A
Compliance voltage	> 5 V
Setting resolution	130 µA
Setting accuracy (f.s.)	± 0.3%
Measurement resolution	250 µA
Noise without ripple (10 Hz ... 10 MHz, rms)	< 100 µA
Ripple (50 Hz, rms)	< 8 µA
Transients (processor)	≤ 200 µA
Transients (other, typ.[1)])	< 8 mA
Short-term fluctuations (15 s, 0 ... 10 Hz)	≤ 125 µA
Drift (30 min. without changing the ambient temperature)	≤ 100 µA
Drift (24 h. without changing the ambient temperature)	≤ 400 µA
Temperature coefficient	≤ 50 ppm/°C

Current limit

Setting range poti I_{LIM}	0 ... ≥ 8 A
Setting range software I_{MAX}	0 ... ≥ 8 A
Setting resolution	250 µA
Setting accuracy	± 50 mA

Analog modulation

3 dB - bandwidth (constant current mode)	DC ... 10 kHz
3 dB - bandwidth (constant power mode)	DC ... 2 kHz
Modulation coefficient (CP)	0.5 mA/V± 5%
Modulation coefficient (CC)	0.8 A/V± 5%

Other data

Width of module	2 slots
Connector	15-pin HD-sub

[1)] max. transients at the output, e.g. switching the unit on or off

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1.5 Operating elements at the front panel of the module

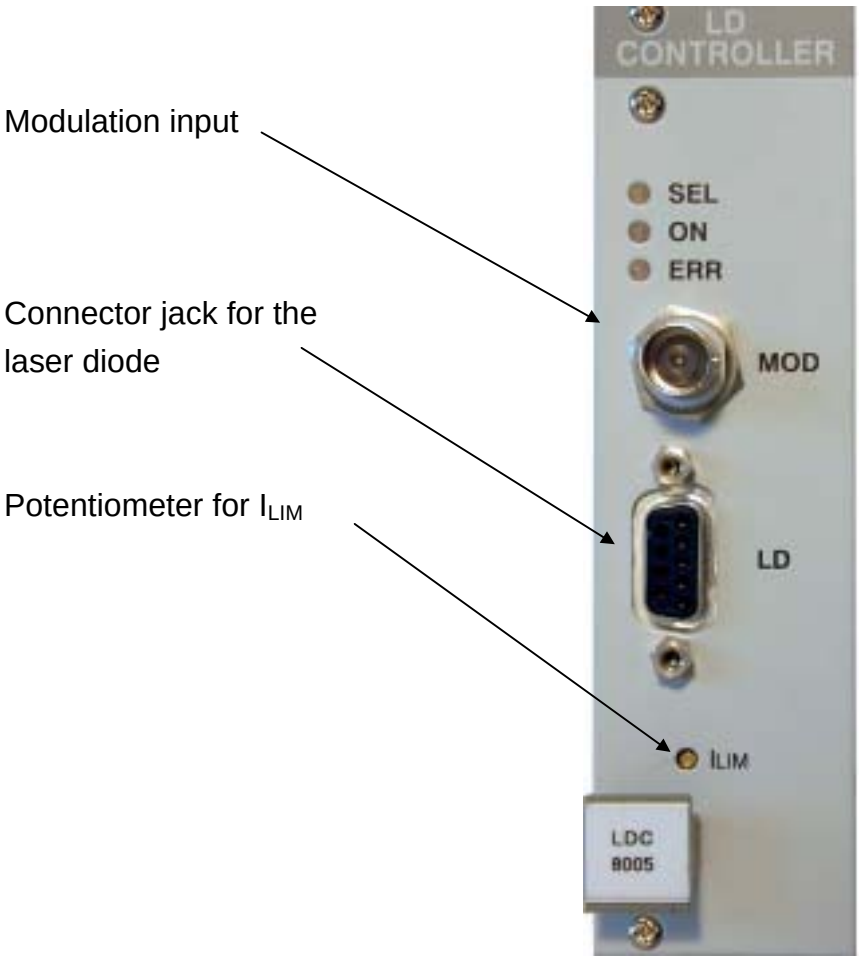


Figure 1 Front panel of an LDC module

NOTE

This figure is valid for all current modules with the exception of the LDC8080 which is of double width and uses a 15-pin HD-sub jack instead of the 9-pin D-sub jack depictured here.

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1.6 Pre-settings

1.6.1 Setting limit values

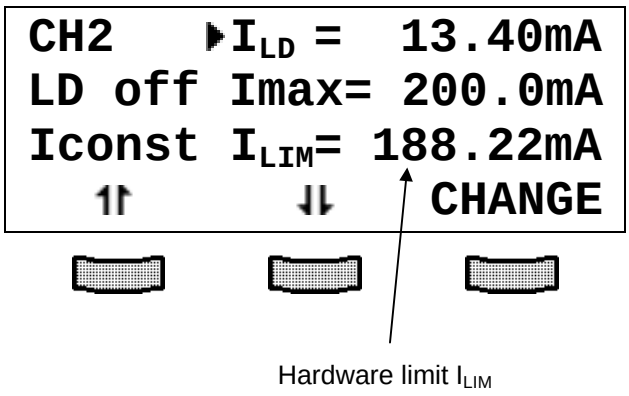
To protect the laser diode the maximum possible current can be limited.
Three ways to limit the current are possible: hardware limit, software limit and limit for optical power.

Hardware limit I_{LIM}

The hardware limit I_{LIM} is set with the potentiometer marked I_{LIM} at the front panel of the LDC8xxx module.

➔ (Refer to chapter 1.5, "Operating elements at the front panel of the module" on page 14)

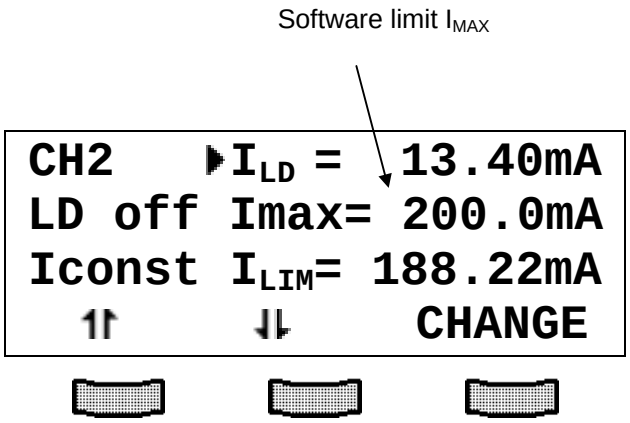
The value is displayed continuously in the channel menu of the module so you can watch it during adjustment:



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Software limit I_{MAX}

The software limit I_{MAX} is set and changed manually in the channel menu of the module or remote via control computer.



The software limit I_{MAX} effects the current regulation of the module via D/A converters and yields exactly the same protective function as the hardware limit.

➔ (Refer to chapter 2.2, "Functions in the channel menu" starting on page 31)

NOTE

The lower value of the two limits I_{MAX} or I_{LIM} will limit the laser diode current.

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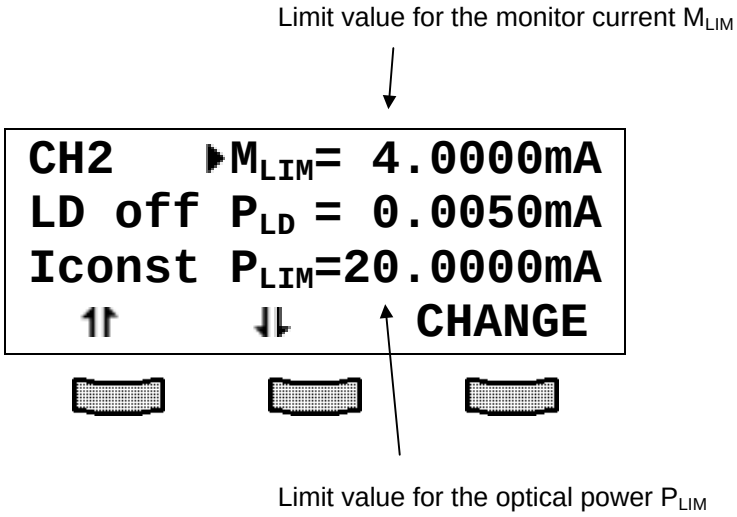
Limit value for the optical power P_{LIM} (monitor diode current M_{LIM})

When cooled, some laser diodes can reach such a high efficiency that danger of thermal destruction of the mirrors occurs if the maximum injection current allowed is used.

Therefore the LDC8xxx modules offer the possibility to limit the optical power.

The current limit of the monitor diode directly effects the current regulation of the module via A/D converters and reacts practically without any delay.

The limits for the monitor diode current M_{LIM} or the optical power P_{LIM} are set and changed manually in the channel menu of the module or remote by the control computer:



NOTE

The two values P_{LIM} and M_{LIM} are related to each other by the efficiency coefficient η of the monitor diode. This value is named "CAL" and has the unit A/W. It can be changed in the channel menu of the current module.

Changing P_{LIM} will automatically change M_{LIM} and vice versa.

The default value of η is 0.2000 A/W and is valid from the beginning.

➔ (Refer also to chapter 2.2.4, "Calibrating the monitor diode" on page 33)

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1.7 Connecting components

1.7.1 Pin assignment LDC8001 to LDC8040

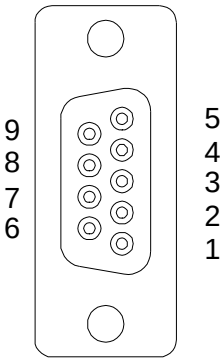


Figure 2 female 9-pole D-Sub pin assignment LDC8001 ... LDC8040

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

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1.7.2 Pin assignment LDC8xxx with true bipolar option

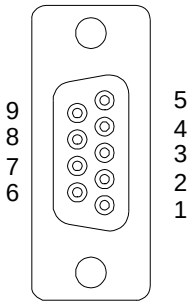


Figure 3 9-pole female D-SUB jack

Pin	Connector
	Interlock, status display
1	output for interlock and status LASER ON/OFF
5	pin 1 ground
	Laser diode
7	laser diode output
8	n.c.
3	laser diode ground
	Monitor diode
5	monitor diode input
2	monitor diode ground
	Measurement input for laser diode voltage
9	laser diode input
6	laser diode ground

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

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

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1.7.3 Pin assignment LDC8080

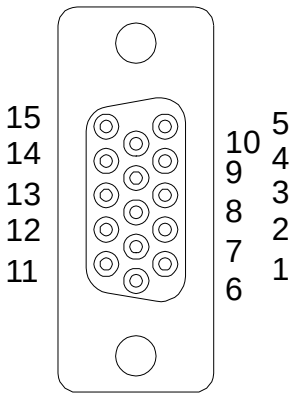


Figure 4 15-pole female HD-Sub pin assignment of LDC8080

Pin	Connector
	Interlock, status display
6	output for interlock and status LASER ON/OFF
15	pin 6 ground
	Laser diode
1,2,7	laser diode cathode (with polarity AG)
4,5,10	laser diode anode (with polarity CG)
3,8,9	laser diode ground
	Monitor diode
13	monitor diode input
12	monitor diode ground
	Measurement input for laser diode voltage
14	laser diode anode
11	laser diode cathode

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To connect the laser all three pins (1,2,7 and 3,8,9 or 4,5,10 and 3,8,9) must always be used.

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

If an external monitor diode is used it must be connected via coaxial cable with the shielding on pin 12 and the inner conductor on pin 13.

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1.7.4 Connecting laser- and monitor diodes

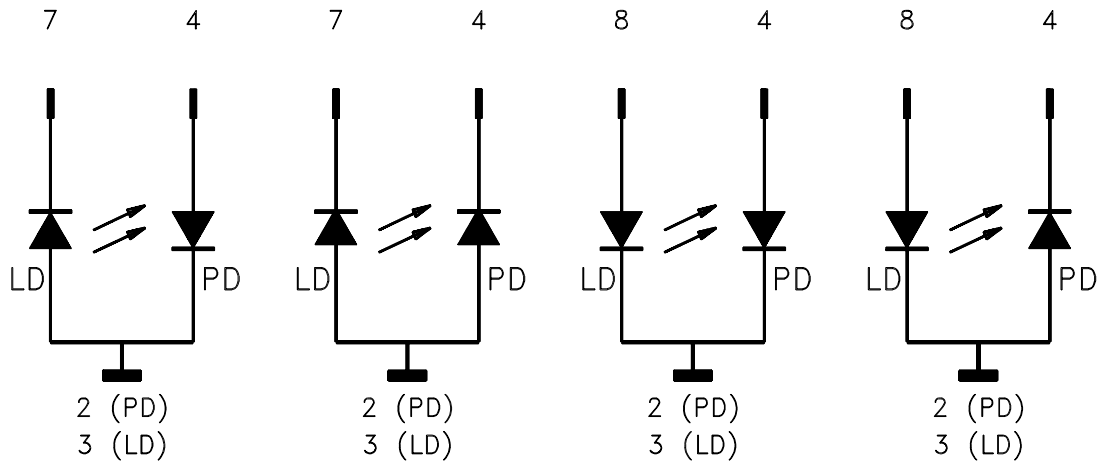
LDC8001 ULN to LDC8040

Connect laser and monitor diode to the connector jack of the LDC8xxx.
➔ (Refer to chapter 1.7.1, "Pin assignment LDC8001 to LDC8040" on page 18).

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

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

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



(LD) = laser diode
(PD) = monitor (photo-) diode

Figure 5 Diode pin assignments of LDC8001 .... LDC8040

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LDC8xxx (True bipolar option)

Connect laser and monitor diode to the connector jack of the LDC8xxx.
➔ (Refer to chapter 1.7.2, "Pin assignment LDC8xxx with true bipolar option" on page 19).

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

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

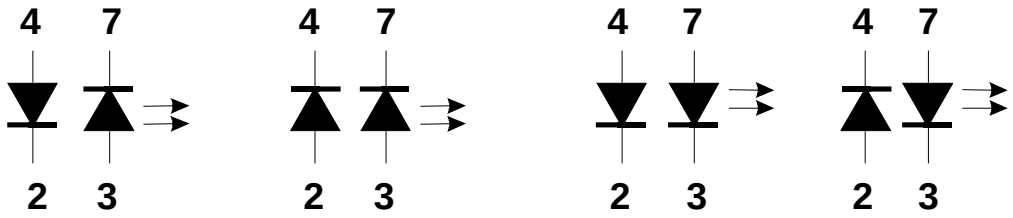


Figure 6 Pin assignments of laser- and photodiode (true bipolar option)

Attention

Using the true bipolar option and selecting the wrong polarity of the laser diode in the PRO8000 (-4) menu may lead to destruction of the laser diode due to the very low reverse breakdown voltage!

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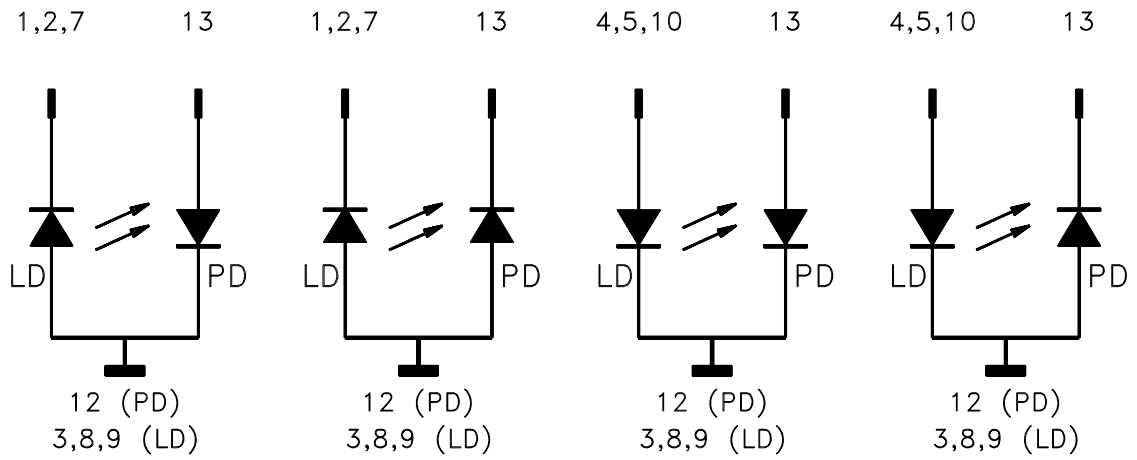
LDC8080

Connect laser and monitor diode to the connector jack of the LDC8080.
➔ (Refer to chapter 1.7.3, "Pin assignment LDC8080" on page 21).

The lines for voltage measurement of the laser diode (pin 11 and pin 14) must be connected as closely as possible to the laser diode to avoid measurement errors.

The ground conductor of the monitor diode (pin 12) may be connected to the ground conductor of the laser diode (pin 3,8,9). If this is necessary (e.g. with laser diodes with integrated monitor diode and shared ground connector) connect the ground conductors as closely as possible to the laser diode to avoid measurement errors while measuring the monitor diode current.

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



(LD) = laser diode
(PD) = monitor (photo-) diode

Figure 7 Pin assignments of laser- and photodiode (LDC8080)

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1.7.5 Connecting interlock and status display

Interlock, cable damage monitoring

Pin 1 and pin 5 (LDC8001 to LDC8040) or pin 6 and 15 (LDC8080) of the connector jack serve as safety connectors to determine whether the current output for the laser diode may be switched on. A short-circuit or a low resistance (R<430Ω) must be maintained between the two pins.

With the contacts open or resistance too high the current module cannot be switched on. Should the interlock contact open during operation the output will be switched off immediately.

Status display

It is also possible to use a LED with a 0.5 kΩ resistor in parallel between the two pins. The LED will light up if the current output is switched on.

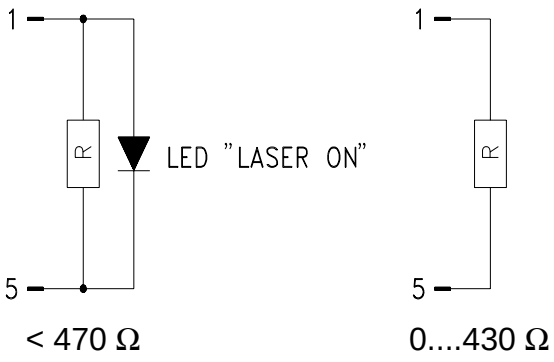
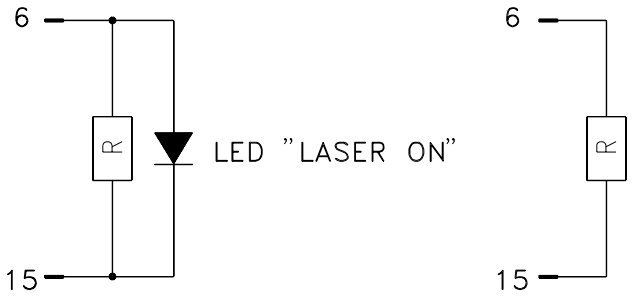


Figure 8 Interlock connection of LDC8001 .... LDC8040

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about 0.5 kΩ 0....430 Ω

Figure 9 Interlock connection of LDC8080

NOTE

Using a resistor above 430 Ω- without LED (or if the LED is incorrectly poled) may lead to malfunction as the status of the interlock is then in an undefined range.

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1.7.6 Using the modulation input

The current modules of the PRO8000 (-4) / PRO800 system have an modulation input which either modulates the laser diode current or the optical power, depending on the mode of operation (constant current or constant power).

The modulation current is added to the set values of current or power.
The advantage is that all protective functions will remain active and the laser will run absolutely safely.

Under normal operation a quiescent current is programmed as set value and then the small signal modulation current added.

The modulation coefficient is module specific.
➔ (Refer to chapter 1.4, "Technical data" starting on page 7)

Over-modulation will cause a laser diode current of below 0 mA or more than the specified final value of the module. Therefore, over-modulation must be avoided to guarantee a correct operation of the current module.

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2 Operating the LDC8xxx

➔ Before turning on the laser current please refer to chapter 1.6, "Pre-settings" starting on page 15

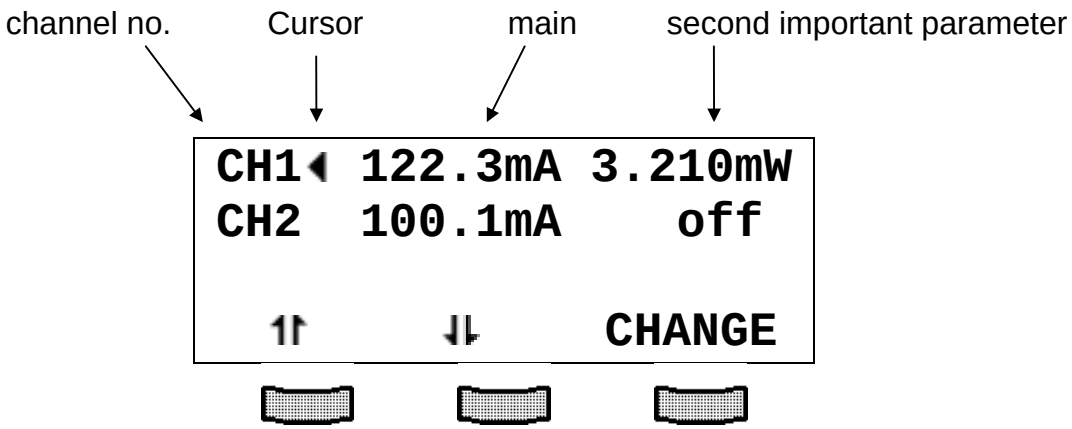
NOTE

With the LDC8xxx modules all settings are executed immediately.
It is not necessary to confirm the set values.

2.1 Functions in the main menu

2.1.1 Display

The main menu displays the channel number and the two most important operating parameters of the LDC8xxx module.



In constant current mode the most important parameter is the laser current I_{LD} in mA or A and the second value is the optical power P_{LD} in mW.

In constant power mode the most important parameter is the optical power P_{LD} in mW and the second value is the laser current I_{LD} in mA or A.

If the module is switched off, the second parameter is replaced by the letters "off".

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2.1.2 Selecting a module

Select a module for further input by setting the cursor to the channel number of the desired module using the softkeys ↑ and ↓ .

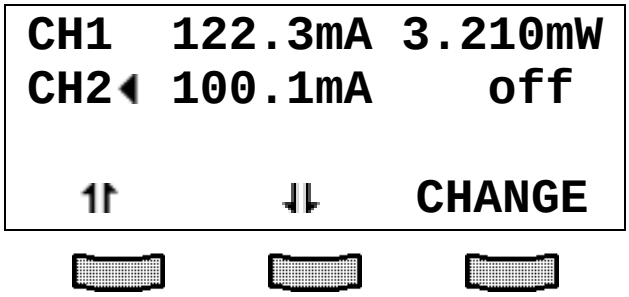
CH4◀

Pressing CHANNEL will lead to the channel menu

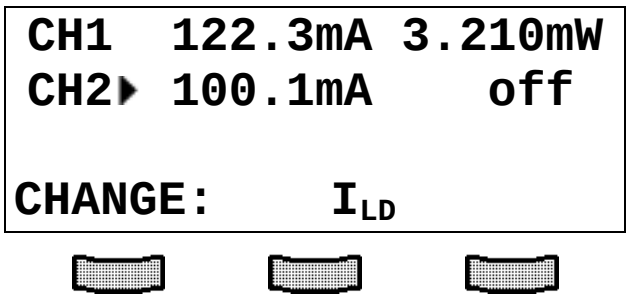
➔ (Refer to chapter 2.2, "Functions in the channel menu" starting on page 31)

2.1.3 Setting the main parameter

To set the main parameter in the main menu the corresponding module is selected with the cursor (here: CH2):



Pressing the key **(CHANGE)** will turn the cursor to the right:



The main parameter (here I_{LD} in mA) can be adjusted by means of the tuning knob. Pressing ESC will complete the procedure.

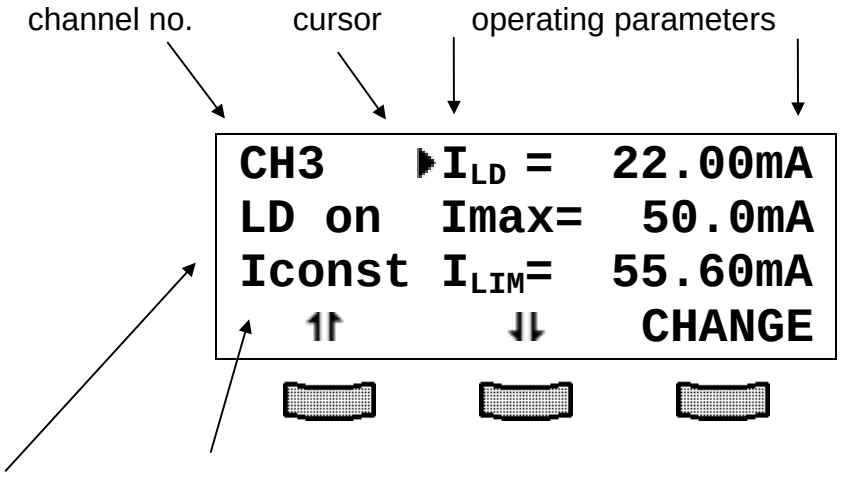
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2.2 Functions in the channel menu

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

2.2.1 Display

In the channel menu all essential parameters of the selected module will appear:



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

```
I_LD =  22.00mA
Imax=  50.0mA
I_LIM=  55.60mA
U_LD =   -1.86V
I_M  = 0.1400mA
M_LIM= 0.2000mA
P_LD = 0.7000mW
P_LIM= 1.0000mW
CAL=0.2000A/W
MODE = Iconst
LDPOL = AG
PDPOL = CG
Ubias = off
...
```


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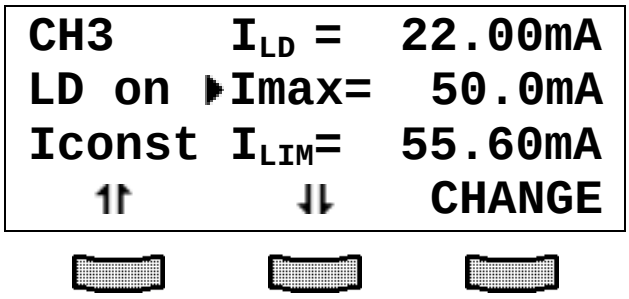
The operating mode / status field shows the actual status:

Iconst	Constant current mode
Pconst	Constant power mode
■ILIM■	Current limit reached during operation
■PLIM■	Optical power limit reached during operation

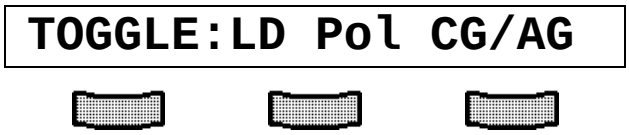
2.2.2 Changing parameters

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

Example: I_{MAX} is to change:



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



Pressing the right softkey will toggle the polarity.

Pressing 

will terminate the procedure.

NOTE

Some parameters cannot be changed, as they are measurement values (e.g. the laser voltage) or may not be changed while the laser is in operation. In these cases access is denied, indicated by a long beep.

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2.2.3 Selecting the polarity of the laser and the monitor diode

If the polarity of the **laser diode** should be changed, the parameter

LDPOL =

must be selected in the channel menu. It can than be changed to the desired polarity.

Should the polarity of the **monitor diode** be changed, the parameter

PDPOL =

has to be selected in the channel menu.

2.2.4 Calibrating the monitor diode

If the displayed optical power shall be calibrated, the efficiency coefficient η of the monitor diode must be entered.

If, for example, η is 0.5 A/W this can be done in the channel menu entering the value

CAL=0.2000A/W

The default value of η is 0.2000 A/W. It is valid without specific confirmation.

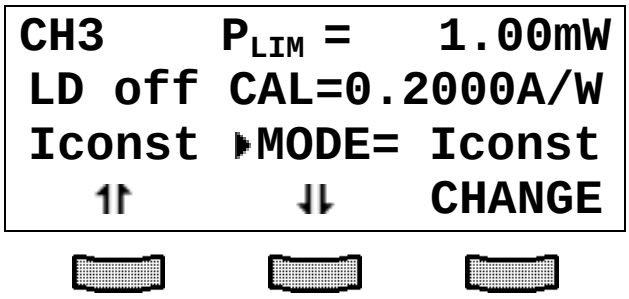
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2.2.5 Selecting constant current or constant power mode

The current modules LDC8xxx offer two operating modes for the laser diode.

In constant current mode the laser diode current will be kept constant. If the temperature of the laser changes the optical power will change too, since the laser efficiency will change.
In the channel menu you can select the mode Iconst.

If the set-up uses a monitor diode receiving a certain part of the laser light the measured monitor diode current can be kept constant by adjusting the laser diode current accordingly. Changes in temperature of the laser will cause a change of its efficiency but the laser diode current is re-set for the optical power to remain constant. This is called constant power mode, Pconst.



You can toggle between Iconst mode and Pconst mode in the channel menu.
For this purpose the laser diode must be in off-state!

NOTE

For "constant power" mode a monitor diode is necessary in the set-up.

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2.2.6 Selecting a TEC module for temperature protection

If the laser diode shall only operate within a specific temperature range (window) this could be carried out by using the temperature window function of a TED8xxx module.

➔ (Refer to manual of the TED8xxx)

Therefore this TED8xxx must be assigned to the LDC8xxx as described here. Two steps are necessary:

Firstly the TED8xxx must be assigned to the LDC8xxx by setting the parameter

`Twin slot =`

to the desired slotnumber of the TED8xxx.
If there is only one TED inserted in your PRO8000 (-4) / PRO800 the appropriate slot is recognized automatically.

2.2.7 Activating the temperature protection

Secondly the temperature protection must be switched ON:

`Twin ON`

If the temperature protection shall not be active it must be switched off again:

`Twin OFF`

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2.2.8 Bias voltage for the monitor diode

If required, the monitor diode may be driven with a bias voltage of 5V.

☝ Attention ☝

Before switching on bias voltage make sure that the photodiode is poled correctly (inverse direction).

If the photodiode is forward biased with a voltage, a current will flow through it that could damage or even destroy it.

The bias voltage is switched on by setting:

`Ubias = on`

in the channel menu of the module.

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2.3 Switching on and off

First select the module in the main menu.

☝ Attention ☝

Before switching on a current module LDC8xxx first set the laser diode current I_{LIM} (hardware limit) for the applied laser diode with a screwdriver.

The corresponding potentiometer is marked I_{LIM} and is located at the front panel of the current module.

➔ (Refer to chapter 1.6.1, "Setting limit values" starting on page 15)

Pressing the key 

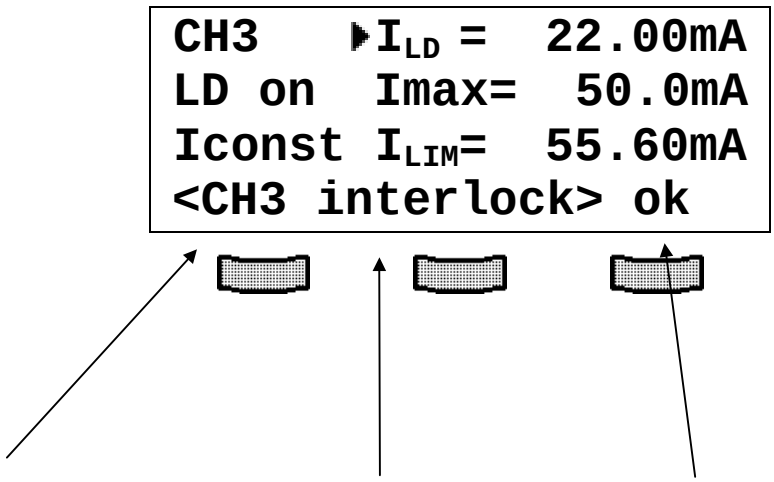
will switch the module on or off regardless of the menu you are in as long as the module is selected (LED “SEL” lights). The LED “ON” of the respective module will light up with the module turned on.

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2.4 Error messages

Error messages are shown in the bottom line of the display regardless of whether you are in the main menu or channel menu.

If an error occurs the display shows for example:



Channel causing the error Error message ok to accept

If the error occurs during operation it is written in brackets:

<CH3 interlock>

If the error occurs by trying to switch on it is written in cursor arrows:

▶CH3 interlock◀

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Possible error messages for a LDC8xxx module are:

interlock	Interlock line has opened / is open
open ckt	Wiring to the laser has opened (danger!)
OTP	Module is too hot. Operation is possible again after cooling down
Vcc fail	Internal supply voltage fails - module is damaged
NOT IF LD ON	Certain changes of parameters are not allowed with laser diode on
NOT IF BIAS	You cannot change the photodiode polarity with a bias voltage applied (danger of damage)
Twin	The laser cannot be turned on if an activated TEC-module signals that the temperature is out of window.

An error has to be acknowledged by the "**OK**" button.
Until acknowledgement further operation is locked.

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3 Communication with a control computer

3.1 General notes on remote control

The description of the mainframe of the PRO8000 (-4) / PRO800 includes all instructions of how to prepare and execute the programming of the system via IEEE 488 computer interface.

Special operation features of a LDC8xxx current module are described here.

➔ (Refer to chapter 2, "Operating the LDC8xxx" starting on page 29)

NOTE

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

☝ Attention ☝

Before programming a current module first set the laser diode current limit I_{LIM} (hardware limit) for the laser diode used with a screwdriver.

The corresponding potentiometer is marked I_{LIM} on the front panel of the LDC8xxx module.

The value I_{LIM} is constantly measured by the PRO8000 (-4) / PRO800 and can be checked in the sub-menu of the LDC8xxx during setting.

➔ (Refer to chapter 1.6.1, "Setting limit values" starting on page 15)

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3.1.1 Nomenclature

Program messages (PC ⇒ PRO8000 (-4)) are written in inverted commas:
"*IDN?"
Response messages (PRO8000 (-4) ⇒ PC) are written in brackets:
[:SLOT 1]
There is a decimal point: **1.234**
Parameters are separated with comma: **"PLOT 2,0"**
Commands are separated with semicolon: **"*IDN?;*STB?"**

3.1.2 Data format

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

Character response data (<CRD>)

Is a single character or a string. Examples:

A or **ABGRS** or **A125TG** or **A1.23456A**

➔ (Refer to IEE488.2 (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 IEE488.2 (8.7.2))

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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 IEE488.2 (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 IEE488.2 (8.7.4))

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3.2 Commands

3.2.1 Select the module slot

":SLOT <NR1>"	Selects a slot for further programming <Nr1>=1…8 (PRO8000), 1…2 (PRO800)
":SLOT?"	Queries the selected slot **[:SLOT <NR1><LF>]**

3.2.2 Calibrating a photo diode (CALPD)

Programming:

":CALPD:SET <NR3>"	Program the sensitivity calibration factor (η) of the monitor diode (A/W)

Reading:

":CALPD:SET?"	Read the sensitivity (η) of the monitor diode **[:CALPD:SET <NR3><LF>]**
":CALPD:MIN?"	Read the minimum allowed sensitivity (η) of this module **[:CALPD:MIN <NR3><LF>]**
":CALPD:MAX?"	Read the maximum allowed sensitivity (η) of this module **[:CALPD:MAX <NR3><LF>]**

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3.2.3 Programming the laser diode current (ILD)

Programming:

":ILD:SET <NR3>"	Program the laser diode set current
":ILD:START <NR3>"	Program the laser diode start current for "ELCH[1]"
":ILD:STOP <NR3>"	Program the laser diode stop current for "ELCH"
":ILD:MEAS <NR1>"	Program the laser diode current as measurement value on position <NR1> in the output string for "ELCH" **(<NR1> = 1....8)**

Reading:

":ILD:SET?"	Read the laser diode set current **[:ILD:SET <NR3><LF>]**
":ILD:ACT?"	Read the actual laser diode current **[:ILD:ACT <NR3><LF>]**
":ILD:MIN?"	Read the minimum laser diode current allowed **[:ILD:MIN <NR3><LF>]**
":ILD:MAX?"	Read the maximum laser diode current allowed **[:ILD:MAX <NR3><LF>]**
":ILD:MIN_W?"	Read the minimum laser diode current for Ild –DAC = 0000 **[:ILD:MIN_W <NR3><LF>]**
":ILD:MAX_W?"	Read the maximum laser diode current for Ild –DAC = FFFF **[:ILD:MAX_W <NR3><LF>]**
":ILD:MIN_R?"	Read the minimum laser diode current for Ild –ADC = 0000 **[:ILD:MIN_R <NR3><LF>]**
":ILD:MAX_R?"	Read the maximum laser diode current for Ild –ADC = FFFF **[:ILD:MAX_R <NR3><LF>]**

[1] "ELCH": Electrical CHaracterization

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":ILD:START?" Read the laser diode start current for “ELCH”

[:ILD:START <NR3><LF>]

":ILD:STOP?" Read the laser diode stop current for “ELCH”

[:ILD:STOP <NR3><LF>]

":ILD:MEAS?" Read the position of the laser diode current as measurement value in the output string for “ELCH” (**1....8, 0** if not selected**)**

[:ILD:MEAS <NR1><LF>]

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3.2.4 Programming the monitor diode current (IMD)

Programming:

":IMD:SET <NR3>"	Program the monitor diode set current
":IMD:START <NR3>"	Program the monitor diode start current for “ELCH”
":IMD:STOP <NR3>"	Program the monitor diode stop current for “ELCH”
":IMD:MEAS <NR1>"	Program the monitor diode current to be measurement value in the “ELCH” output string on position <NR1> (1....8)

Reading:

":IMD:SET?"	Read the monitor diode set current **[:IMD:SET <NR3><LF>]**
":IMD:ACT?"	Read the actual monitor diode current **[:IMD:ACT <NR3><LF>]**
":IMD:MIN?"	Read minimum monitor diode set current allowed **[:IMD:MIN <NR3><LF>]**
":IMD:MAX?"	Read maximum monitor diode set current allowed **[:IMD:MAX <NR3><LF>]**
":IMD:MIN_W?"	Read minimum monitor diode current for Ipd – DAC = 0000 **[:IMD:MIN_W <NR3><LF>]**
":IMD:MAX_W?"	Read maximum monitor diode current for Ipd – DAC = FFFF **[:IMD:MAX_W <NR3><LF>]**
":IMD:MIN_R?"	Read minimum monitor diode current for Ipd –ADC = 0000 **[:IMD:MIN_R <NR3><LF>]**
":IMD:MAX_R?"	Read maximum monitor diode current for Ipd –ADC = FFFF **[:IMD:MAX_R <NR3><LF>]**

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":IMD:START?" Read the monitor diode start current for “ELCH”

[:IMD:START <NR3><LF>]

":IMD:STOP?" Read the monitor diode stop current for “ELCH”

[:IMD:STOP <NR3><LF>]

":IMD:MEAS?" Read the position of the monitor diode current as measurement value in the “ELCH” output string (**1....8**, **0** if not selected)

[:IMD:MEAS <NR1><LF>]

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3.2.5 Switching the output on and off (OUTP)

Programming:

":LASER ON"	Switch the laser output on
":LASER OFF"	Switch the laser output off

Reading:

":LASER?"	Read status of the laser output **[:LASER ON<LF>]** **[:LASER OFF<LF>]**

3.2.6 Selecting the laser diode polarity (LDPOL)

Programming:

":LDPOL AG"	Select anode on ground
":LDPOL CG"	Select cathode on ground

Reading:

":LDPOL?"	Read the laser diode polarity **[:LDPOL AG<LF>]** **[:LDPOL CG<LF>]**

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3.2.7 Programming the laser diode software-limit (LIMC)

Programming:

":LIMC:SET <NR3>"	Program the laser diode current limit

Reading:

":LIMC:SET?"	Read the laser diode current limit **[:LIMC:SET <NR3><LF>]**
":LIMC:MIN?"	Read the minimum possible laser diode current limit **[:LIMC:MIN <NR3><LF>]**
":LIMC:MAX?"	Read the maximum possible laser diode current limit **[:LIMC:MAX <NR3><LF>]**
":LIMC:MIN_W?"	Read the laser diode current limit for Ilim – DAC = 0000 **[:LIMC:MIN_W <NR3><LF>]**
":LIMC:MAX_W?"	Read the laser diode current limit for Ilim – DAC = FFFF **[:LIMC:MAX_W <NR3><LF>]**

➔ (Refer to Chapter 1.6.1, "Setting limit values" starting on page 15)

3.2.8 Reading the laser diode hardware-limit (LIMCP)

Reading:

":LIMCP:ACT?"	Read the actual hardware-limit **[:LIMCP:ACT <NR3><LF>]**
":LIMCP:MIN_R?"	Read Imax – ADC = 0000 **[:LIMCP:MIN_R <NR3><LF>]**
":LIMCP:MAX_R?"	Read Imax – ADC = FFFF **[:LIMCP:MAX_R <NR3><LF>]**

➔ (Refer to Chapter 1.6.1, "Setting limit values" starting on page 15)

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3.2.9 Programming the monitor diode current limit (LIMM)

Programming:

":LIMM:SET <NR3>"	Program the monitor diode current limit

Reading:

":LIMM:SET?"	Read the monitor diode current -limit **[:LIMM:SET <NR3><LF>]**
":LIMM:MIN?"	Read the minimum monitor diode current -limit allowed **[:LIMM:MIN <NR3><LF>]**
":LIMM:MAX?"	Read the maximum monitor diode current –limit allowed **[:LIMM:MAX <NR3><LF>]**
":LIMM:MIN_W?"	Read I_{LIM} - ADC = 0000 **[:LIMM:MIN_W <NR3><LF>]**
":LIMM:MAX_W?"	Read I_{LIM} - ADC = FFFF **[:LIMM:MAX_W <NR3><LF>]**

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3.2.10 Programming the optical power limit (LIMP)

Programming:

":LIMP:SET <NR3>"	Program the optical power limit

Reading:

":LIMP:SET?"	Read the optical power limit **[:LIMP:SET <NR3><LF>]**
":LIMP:MIN?"	Read the minimum optical power limit allowed **[:LIMP:MIN <NR3><LF>]**
":LIMP:MAX?"	Read the maximum optical power limit allowed **[:LIMP:MAX <NR3><LF>]**
":LIMP:MIN_W?"	Read the optical power for Ilim – DAC = 0000 **[:LIMP:MIN_W <NR3><LF>]**
":LIMP:MAX_W?"	Read the optical power for Ilim – DAC = FFFF **[:LIMP:MAX_W <NR3><LF>]**

3.2.11 Selecting the mode of operation (MODE)

Programming:

":MODE CC"	Constant current mode
":MODE CP"	Constant power mode

Reading:

":MODE?"	Read the mode of operation **[:MODE CC<LF>]** **[:MODE CP<LF>]**

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3.2.12 Switching the bias voltage on and off (PDBIA)

Programming:

":PDBIA ON"	Switch bias voltage on
":PDBIA OFF"	Switch bias voltage off

Reading:

":PDBIA?"	Read the bias voltage switch **[:PDBIA ON<LF>]** **[:PDBIA OFF<LF>]**

3.2.13 Selecting the photo diode polarity (PDPOL)

Programming:

":PDPOL AG"	Selecting anode on ground
":PDPOL CG"	Selecting cathode on ground

Reading:

":PDPOL?"	Read the monitor diode polarity **[:PDPOL AG<LF>]** **[:PDPOL CG<LF>]**

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3.2.14 Programming the optical power (POPT)

Programming:

":POPT:SET <NR3>"	Program the optical power

Reading:

":POPT:SET?"	Read the set optical power **[:POPT:SET <NR3><LF>]**
":POPT:ACT?"	Read the actual optical power **[:POPT:ACT <NR3><LF>]**
":POPT:MIN?"	Read the minimum set optical power allowed **[:POPT:MIN <NR3><LF>]**
":POPT:MAX?"	Read the maximum set optical power allowed **[:POPT:MAX <NR3><LF>]**
":POPT:MIN_W?"	Read the optical power for P_{LD} – DAC = 0000 **[:POPT:MIN_W <NR3><LF>]**
":POPT:MAX_W?"	Read the optical power for P_{LD} – DAC = FFFF **[:POPT:MAX_W <NR3><LF>]**
":POPT:MIN_R?"	Read the optical power for P_{LD} –ADC = 0000 **[:POPT:MIN_R <NR3><LF>]**
":POPT:MAX_R?"	Read the optical power for P_{LD} –ADC = FFFF **[:POPT:MAX_R <NR3><LF>]**

3.2.15 Switching the temperature protection on and off (TP)

Programming:

":TP ON"	Switch temperature protection on
":TP OFF"	Switch temperature protection off

Reading:

":TP?"	Read status of the temperature protection **[:TP ON<LF>]** **[:TP OFF<LF>]**

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3.2.16 Selecting a TEC module for temperature protection (TPSLOT)

Programming:

":TPSLOT 3"	Selects the TEC in slot 3 for temperature protection
":TPSLOT 5"	Selects the TEC in slot 5 for temperature protection

Reading:

":TPSLOT?"	Read assigned slot for the temperature protection **[:TPSLOT <NR1><LF>]**

3.2.17 Querying the module type

":TYPE:ID?"	Read module type, here 191 for LDC8xxx **[:TYPE 191<LF>]**

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3.2.18 Reading the laser diode voltage (VLD)

Programming:

":VLD:MEAS <NR1>"	Program Vld to be a measurement value for “ELCH” on position <NR1> (1....8) in the output string.

Reading:

":VLD:ACT?"	Read the actual laser voltage **[:VLD:ACT <NR3><LF>]**
":VLD:MIN_R?"	Read Uld – ADC = 0000 **[:VLD:MIN_R <NR3><LF>]**
":VLD:MAX_R?"	Read Uld – ADC = FFFF **[:VLD:MAX_R <NR3><LF>]**
":VLD:MEAS?"	Read the position of Vld in the“ELCH” output string (**1....8, 0** if not selected) **[:VLD:MEAS <NR1><LF>]**

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3.3 1000 ... 1099 error messages of an LDC8xxx

[1001,"Interlock is open"]

Possible reason: Interlock line is open.

➔ (Refer to chapter 1.7.5, "Connecting interlock and status display" on page 26)

[1002,"Open circuit"]

Possible reason: Cable to the laser diode has opened. Compliance voltage not high enough.

[1003,"Over temperature"]

Possible reason: Module temperature too high. Switch off the output and wait until the module has cooled down. Maintain proper air flow.

[1004,"Internal power failure"]

Possible reason: Severe hardware error. Contact *Thorlabs GmbH*.

[1005,"No LD polarity change during laser on"]

Possible reason: The polarity of the laser diode cannot be changed with the laser diode output switched on.

[1006,"No PD polarity change during laser on"]

Possible reason: The polarity of the monitor diode cannot be changed with the laser diode output switched on.

[1007,"No setting of ILD during constant power mode"]

Possible reason: The set value of the laser diode current cannot be changed in constant power mode.

[1008,"No setting of IMD during constant current mode"]

Possible reason: The set value of the monitor diode current cannot be changed in constant current mode.

[1009,"Attempt to activate Twin during laser on"]

Possible reason: The temperature survey Twin cannot be activated while the laser is operating.

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[1010,"Attempt to switch on laser while temperature is out of window"]

Possible reason: The actual temperature of the TED8xxx that is assigned to the LDC8xxx is smaller than Tset - Twin or bigger than Tset + Twin.

➔ (Refer to chapter 3.2.16 and 3.2.15 on page 54)

[1011,"Attempt to activate Twin although there is no TEC in the system"]

Possible reason: No TEC module or TEC module recognized in this system.

[1013,"No PD polarity change during bias on "]

Possible reason: Change of photo diode polarity with bias voltage on is not allowed (possible destruction of PD)

[1014,"No calibrating of PD during laser on in constant power mode"]

Possible reason: The monitor diode “CAL” factor cannot be changed with the laser diode output switched on in constant power mode.

[1015,"No TEC in this slot "]

Possible reason: You tried to select a slot as survey TEC but no TEC is inserted.

[1016,"No mode change during laser on"]

Possible reason: It is not possible to change between constant current and constant power mode with the laser switched on.

[1019,"No bias change during laser on in constant power mode "]

Possible reason: You cannot turn on or off the bias voltage with the laser in constant power mode.

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3.4 Status reporting

The LDC8xxxx modules provide three 16 bit registers DEC, DEE and EDE (see Figure 10) and four 8 bit registers ESR, STB, ESE and SRE (see Figure 11) to program various service request functions and status reporting.

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

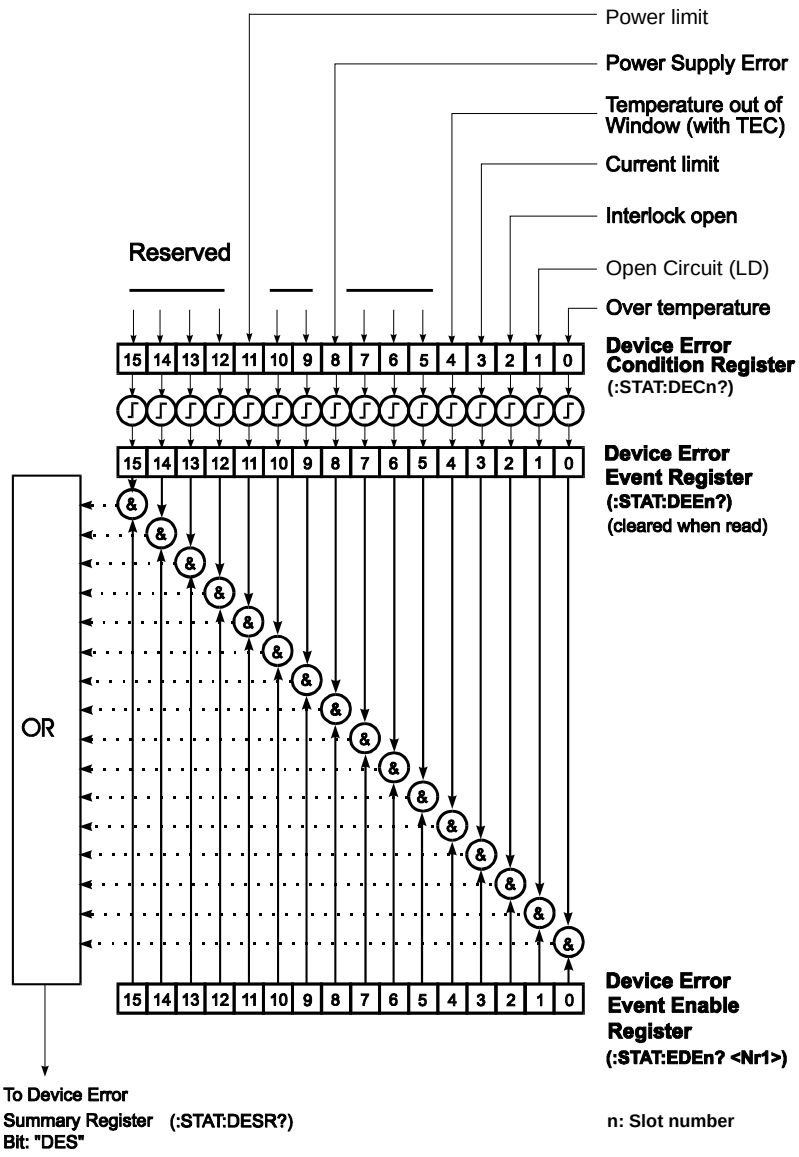


Figure 10 The LDC8xxx device error registers DEC, DEE and EDE

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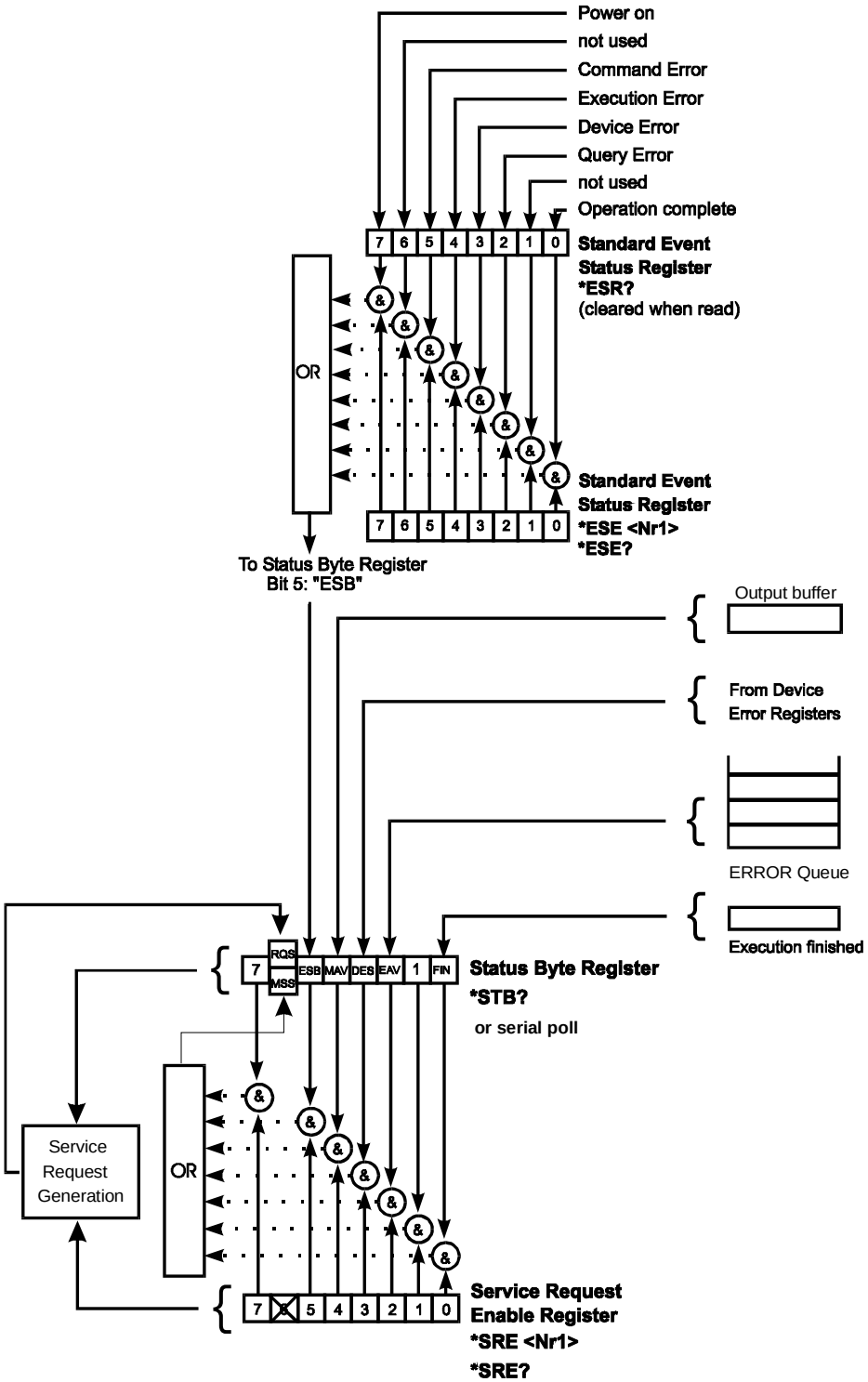


Figure 11 The PRO8000 (-4)/ PRO800 register ESR, ESE, STB and SRE

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3.4.1 Standard event status register (ESR)

The bits of this register represent 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 turning on the device for the first time.
User request	(Not used)
Command error	A command error occurred.
Execution error	An execution error occurred.
Device dependent error	A device dependent error 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 cannot be set.

The bits are active high.

3.4.2 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.

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3.4.3 Status byte register (STB)

The bits of this register are showing the status of the PRO8000 (-4) / PRO800.

RQS RQS: Request service message: Shows that this device has asserted SRQ (read 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" to be fetched in the output queue. It is low, if the output queue is empty.

DES (Device Error Status) This bit is high after a device error has occurred. Which device errors will set this bit is defined by 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 cannot 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 3.4.5). Alternatively the SRQ can be recognized using the command
➔ **"*STB?"** (Please refer to 3.4.6) or by serial poll (Please refer to 3.4.7).

3.4.4 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.

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3.4.5 Reading the STB by detecting SRQ

If an SRQ is asserted (see 3.4.4) bit 6 of the STB is set to logical 1, so that the controller can detect which device asserted the SRQ by auto serial polling.

3.4.6 Reading the STB by “*STB?” command

If the controller does not "listen" to SRQ’s 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.

3.4.7 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.

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3.4.8 Device error condition register (DEC)

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

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

For LDC8xxx laser diode controller modules bits 0 ... 4, 8 and 11 are used:

(0) Over temperature Laser temperature too high. Wait until the module has cooled down. Maintain proper air flow.

(1) Open circuit Laser diode circuit is open.

(2) Interlock open The interlock has opened or path resistance is >430 Ω.

(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 out of window Appropriate laser temperature (controlled by an TEC-module) is out of specified window.

(8) Power supply error Internal power supply error.

(11) Power limit The given hard- or software power limit is reached.

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

3.4.9 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.

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3.4.10 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.

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4 Service and Maintenance

4.1 General remarks

You should regularly control the correct function of the interlock.
With the laser in operation, interrupt the interlock connection: the laser output must go into “OFF” state immediately.

Otherwise the LDC8xxx modules do not need any further maintenance by the user.

If highest precision of measurements is vital to you, you should have the LDC8xxx module recalibrated about every two years.

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4.2 Troubleshooting

In case that one module of your PRO8000/800 system shows malfunction please check the following items:

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

- ➢ Mainframe PRO8000 (-4) / PRO800 connected properly to the mains?
  - ▪ Connect the PRO8000 (-4) / PRO800 to the power line paying attension to the right voltage setting of your mainframe.

- ➢ Mainframe PRO8000 (-4) / PRO800 turned on?
  - ▪ Turn on your PRO8000 (-4) / PRO800 with the key mains-switch.

- ➢ Control the fuse at the rear panel of the PRO8000 (-4) / PRO800 mainframe.
  - ▪ If blown up, replace the fuse by the correct type

➔ (refer to your PRO8000 (-4) / PRO800 mainframe operating manual to select the appropriate fuse)

◆ The PRO8000 (-4) / PRO800 display works, but not the module:

- ➢ Is the module inserted correctly and are all mounting screws tightened?
  - ▪ Insert the module in the desired slot and tighten all mounting screws properly.

◆ 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 1.7.5, "Connecting interlock and status display" on page 26)

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- Do you have selected the desired module?
  - (The LED "SEL" on the front panel of the module must be on)
    Select the desired module on the display by means of the up- and down arrow keys.

- Do you have turned on the laser output in the main menu or one of the sub-menus?
  - Change the status setting from "off" to "on".

➔ The LED "ON" on the front panel of the module must be on

- Are the hard- and/or software limits I_{LIM} and I_{MAX} set to 0?
  - Adjust the hardware limit I_{LIM} by means of the potentiometer on the LDC8xxx front panel and the software limit I_{MAX} in the channel menu to appropriate values.

- Is the software limit P_{LIM} set to 0?
  - Correct the value in the channel menu to the desired limit.

- Is the laser diode installed properly?
  - Control the connection cable.

- Is the laser diode poled correctly?
  - If not, change the polarity with the **":LDPOL:SET"** command or in the channel menu.

- Is the photo diode connected properly?
  - Check the connecting cable.

- Is the photo diode poled correctly?
  - If not, change the polarity with the **":PDPOL:SET"** command or in the channel menu.

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- Are you using a bias voltage with the photo diode in photocurrent mode?
  - Turn off bias voltage in the channel menu, with the **":PDBIA OFF"** command or change the polarity of the diode for photo element mode.

- Is the correct photo diode efficiency set (A/W)?
  - Enter the coefficient in the channel menu or with the command **":CAL:SET"**

- Is the desired output power programmed correctly?
  - Adjust the desired output power P_{LD} in the channel display

If you don't find the error source by means of the trouble shooting list or if more modules work in an erratic manner please first connect the *Thorlabs-Hotline (blueline@thorlabs.com)* before sending the whole PRO8000 (-4) / 800 system for checkup and repair to *Thorlabs*-Germany.

(refer to section 5.4, "Address " on page 72

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5 Listings

5.1 List of acronyms and abbreviations

The following abbreviations are used in this manual:

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

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NR2	Numeric Response data of type 2
NR3	Numeric Response data of type 3
MAV	Message AVailable)
MSS	Master Summary Status
OTP	Over TemPerature
PC	Personal Computer
PD	Photo Diode
RQS	ReQuest Service Message
SDC	Selected Device Clear
SEL	SELect
SRE	Service Request Enable Register
SRQ	Service ReQuest
STB	STatus Byte Register
SW	Soft Ware
TEC	ThermoElectric Cooler (Peltier Element)
TRG	TRiGger

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5.3 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 B)
	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, including with CAB4x series cables installed at the LD OUT ports and with a custom-made shielded cable installed at the LDC8080 module's LD OUT port.

[2] Compliance demonstrated with the LDC8x series modules installed in Thorlabs PRO8x series mainframes.

[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.

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5.4 Address

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