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Operation Manual

Thorlabs Blueline™ Series
PRO8000 (-4) / PRO800

Multi laser controller module MLC8xxx



2004

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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 operation manual contains every specific information on how to operate a multi laser diode controller module MLC8xxx. A general description is followed by explanations of how to operate the unit manually. You will also find every information 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 multi LD-controller MLC8xxx

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 (-4) / 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 MLC8xxx 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 GmbH 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 warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient 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 MLC8xxx modules 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 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 connection cable to the laser diode (interlock)**
  Protection against accidental operation.

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

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

- **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.

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- **Line failure protection**
  In case of power 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 MLC8xxx are unipolar current sources for laser diodes.
They can be ordered for laser diodes with anode grounded or cathode grounded. The MLC offers two current ranges.
The different module types operate 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 MLC8xxx 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 done 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.

All outputs can operate either in constant current or constant power mode simultaneously. All outputs are switched on and off together.

With the modules MLC8xxx the laser diode current (constant current mode) or the monitor diode current (constant power mode) are set with 12 bit resolution.

The monitor diode current is read back with 12 bit, the laser diode current, laser diode voltage and the limit for the laser diode current (hardware limit) with 11 bit plus sign.

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

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1.4 Technical data

1.4.1 MLC8025-8AG/CG

Selectable range	LOW	HIGH
Current ranges	5 mA	25 mA
Setting accuracy	± 15 µA	± 75 µA
Setting- / measurement resolution	1.2 µA	6 µA
Noise without ripple (10Hz...10MHz)	< 0.5 µA	< 0.5 µA
Ripple (50Hz, rms)	< 0.5 µA	< 0.5 µA
Short term fluctuations (15s)	< 0.15 µA	< 0.3 µA
Drift (30min, 0...10Hz)	< 0.3 µA	< 1 µA
Setting range HW-Limit	0 ... ≥ 5 mA	0 ... ≥ 25 mA
Setting accuracy HW-Limit	± 50 µA	± 125 µA
Resolution HW-Limit	1.2 µA	6 µA

1.4.2 MLC8050-8AG/CG

Selectable range	LOW	HIGH
Current ranges	10 mA	50 mA
Setting accuracy	± 30 µA	± 150 µA
Setting- / measurement resolution	2.5 µA	12 µA
Noise without ripple (10Hz...10MHz)	< 0.5 µA	< 0.5 µA
Ripple (50Hz, rms)	< 0.5 µA	< 0.5 µA
Short term fluctuations (15s)	< 0.25 µA	< 0.5 µA
Drift (30min, 0...10Hz)	< 0.5 µA	< 1.5 µA
Setting range HW-Limit	0 ... ≥ 10 mA	0 ... ≥ 50 mA
Setting accuracy HW-Limit	± 100 µA	± 250 µA
Resolution HW-Limit	2.5 µA	12 µA

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1.4.3 MLC8100-8AG/CG

Selectable range	LOW	HIGH
Current ranges	25 mA	100 mA
Setting accuracy	± 75 µA	± 300 µA
Setting- / measurement resolution	6 µA	25 µA
Noise without ripple (10Hz...10MHz)	< 0.5 µA	< 1 µA
Ripple (50Hz, rms)	< 0.5 µA	< 1 µA
Short term fluctuations (15s)	< 0.25 µA	< 1 µA
Drift (30min, 0...10Hz)	< 1 µA	< 3 µA
Setting range HW-Limit	0 ... ≥ 25 mA	0 ... ≥ 100 mA
Setting accuracy HW-Limit	± 0.25 mA	± 0.5 mA
Resolution HW-Limit	6 µA	25 µA

1.4.4 MLC8200-8AG/CG

Selectable range	LOW	HIGH
Current ranges	50 mA	200 mA
Setting accuracy	± 150 µA	± 600 µA
Setting- / measurement resolution	12 µA	50 µA
Noise without ripple (10Hz...10MHz)	< 0.5 µA	< 1.5 µA
Ripple (50Hz, rms)	< 0.5 µA	< 1 µA
Short term fluctuations (15s)	< 0.5 µA	< 2 µA
Drift (30min, 0...10Hz)	< 1.5 µA	< 5 µA
Setting range HW-Limit	0 ... ≥ 50 mA	0 ... ≥ 200 mA
Setting accuracy HW-Limit	± 0.5 mA	± 1 mA
Resolution HW-Limit	12 µA	50 µA

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1.5 Operating elements at the front of the module

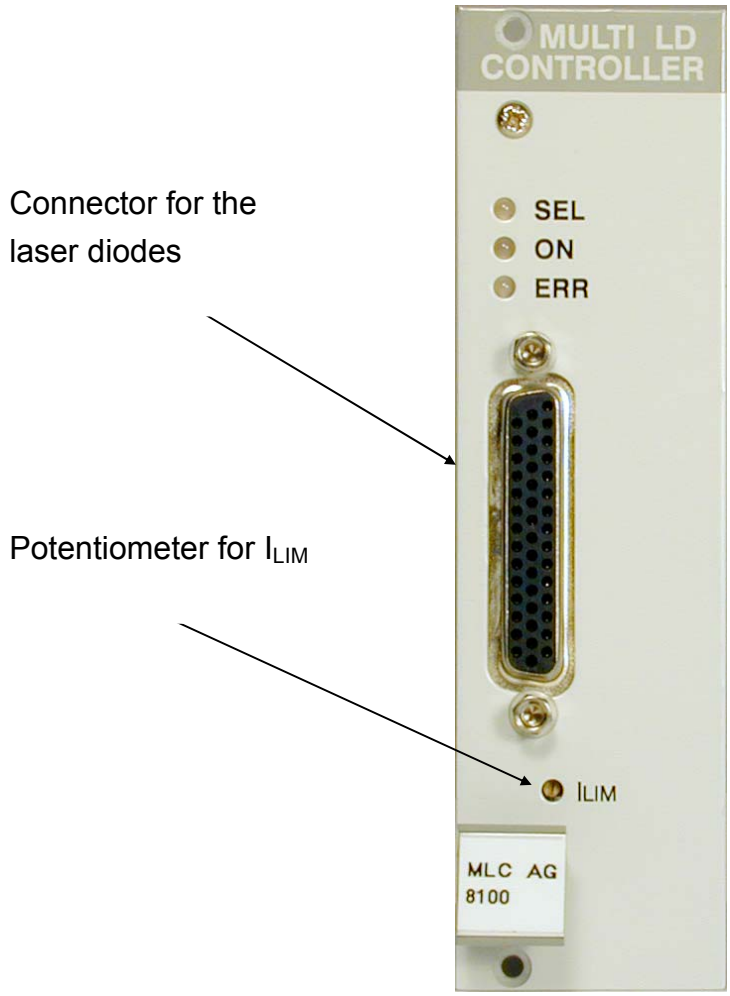


Figure 1 Operating elements on front panel.

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1.6 Pre-settings

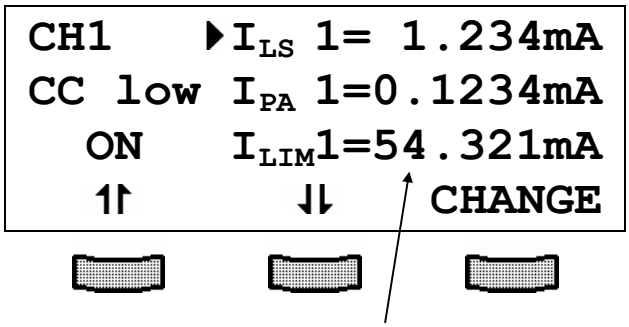
1.6.1 Setting hardware limit I_{LIM}

To protect the laser diode the maximum possible current can be limited by hardware setting.
The setting affects all outputs simultaneously.

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

➔ (Refer to chapter 1.5, "Operating elements at the front of the module" on page 9)

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



Hardware limit I_{LIM}

NOTE

$I_{LIM}1$ . . . $I_{LIM}8$ show the same value not regarding which one is used for setting the hardware limit.

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1.7 Connecting components (AG, Anode Ground Version)

1.7.1 Pinning of the output connector

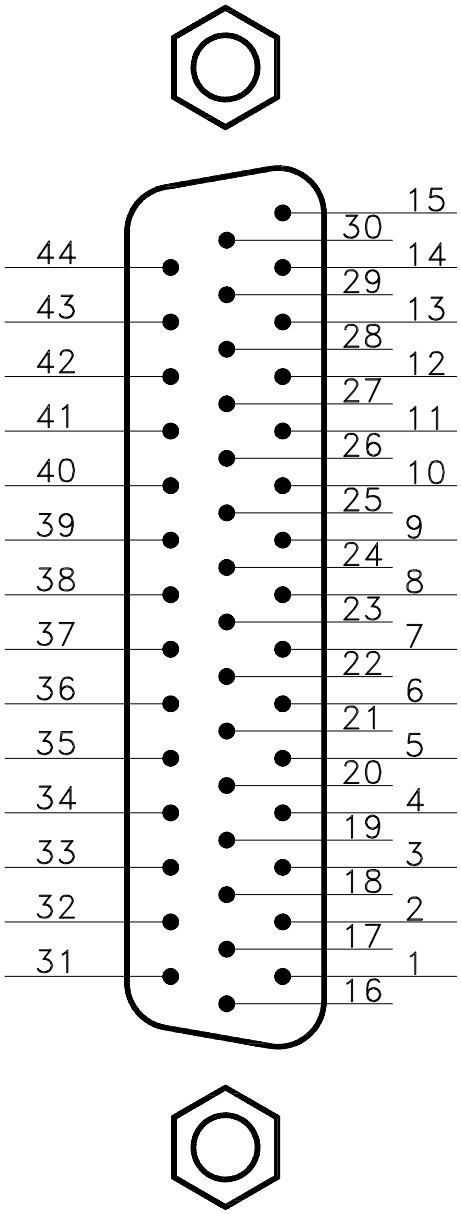


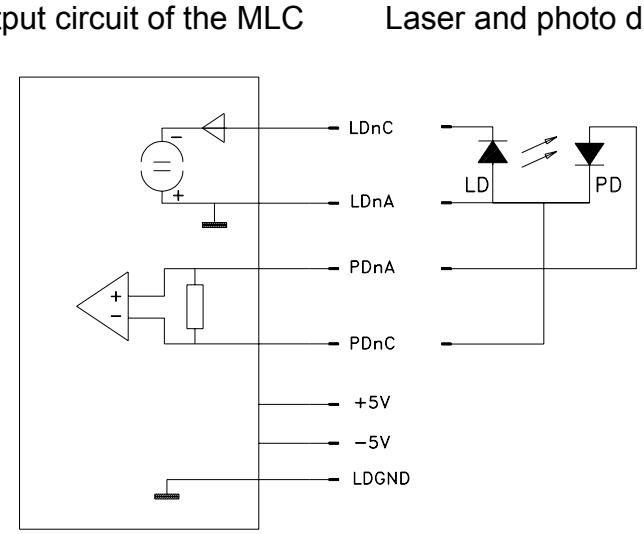
Figure 2 Pinning of the MLC8xxx output connector

(44-pole female HD-SUB)

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1.7.2 Pin assignment MLC8xxx

Each laser is connected to an output channel as shown:



(n = 1 ... 8)

Figure 3 Principle connections for every laser

We recommend to use separate lines drilled in pairs (twisted pair) in a common shield for laser diode current and monitor diode current respectively.
The shield must be connected to ground!.

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1.7.2.1 Pin assignment sorted by Function

Pin	Connector
14	LD1C cathode of laser # 1
12	LD2C cathode of laser # 2
11	LD3C cathode of laser # 3
9	LD4C cathode of laser # 4
8	LD5C cathode of laser # 5
6	LD6C cathode of laser # 6
5	LD7C cathode of laser # 7
3	LD8C cathode of laser # 8
29	LD1A anode of laser # 1
27	LD2A anode of laser # 2
26	LD3A anode of laser # 3
24	LD4A anode of laser # 4
23	LD5A anode of laser # 5
21	LD6A anode of laser # 6
20	LD7A anode of laser # 7
18	LD8A anode of laser # 8
13	PD1A anode photo diode # 1
42	PD2A anode photo diode # 2
10	PD3A anode photo diode # 3
39	PD4A anode photo diode # 4
7	PD5A anode photo diode # 5
36	PD6A anode photo diode # 6
4	PD7A anode photo diode # 7
33	PD8A anode photo diode # 8
43	PD1C cathode photo diode # 1
41	PD2C cathode photo diode # 2
40	PD3C cathode photo diode # 3
38	PD4C cathode photo diode # 4
37	PD5C cathode photo diode # 5
35	PD6C cathode photo diode # 6
34	PD7C cathode photo diode # 7
32	PD8C cathode photo diode # 8
31	GND ground
16	GND ground
17	GND ground
19	GND ground
22	GND ground
25	GND ground
28	GND ground

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30 GND ground

44 LEDA out for a LED to show the on/off status
15 Interlock to be shortened to any GND pin

1 + 5V
2 - 5V

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1.7.2.2 Pin assignment sorted by pin number

Pin	Connector
1	+ 5V
2	- 5V
3	LD8C cathode of laser # 8
4	PD7A anode photo diode # 7
5	LD7C cathode of laser # 7
6	LD6C cathode of laser # 6
7	PD5A anode photo diode # 5
8	LD5C cathode of laser # 5
9	LD4C cathode of laser # 4
10	PD3A anode photo diode # 3
11	LD3C cathode of laser # 3
12	LD2C cathode of laser # 2
13	PD1A anode photo diode # 1
14	LD1C cathode of laser # 1
15	Interlock to be shortened to any GND pin
16	GND ground
17	GND ground
18	LD8A anode of laser # 8
19	GND ground
20	LD7A anode of laser # 7
21	LD6A anode of laser # 6
22	GND ground
23	LD5A anode of laser # 5
24	LD4A anode of laser # 4
25	GND ground
26	LD3A anode of laser # 3
27	LD2A anode of laser # 2
28	GND ground
29	LD1A anode of laser # 1
30	GND ground
31	GND ground
32	PD8C cathode photo diode # 8
33	PD8A anode photo diode # 8
34	PD7C cathode photo diode # 7
35	PD6C cathode photo diode # 6
36	PD6A anode photo diode # 6
37	PD5C cathode photo diode # 5
38	PD4C cathode photo diode # 4
39	PD4A anode photo diode # 4

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40 PD3C cathode photo diode # 3
41 PD2C cathode photo diode # 2
42 PD2A anode photo diode # 2
43 PD1C cathode photo diode # 1
44 LEDA out for a LED to show the on/off status

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1.7.3 Connecting laser- and monitor diode

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

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

The laser diode is always sourced against ground by the current controller. This is of considerable advantage regarding the safety of the laser diode and the stability of the laser diode current.

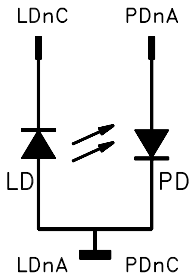
The monitor diode input is set up as trans-impedance amplifier with virtual ground (input impedance 0Ω).
The polarity of the photo diode may be selected free. It can also be floating.

The monitor diode input can be used with or without bias voltage (5 V or 0 V). Therefore wire bridges have to be connected depending on the individual configuration shown in the next section.

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1.7.4 Standard configurations, no bias voltage

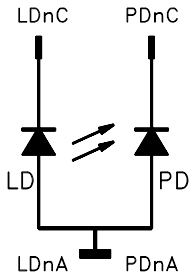
1.7.4.1 Laser anode on ground / photo diode cathode on ground



n = number of channel (1 to 8)

Figure 4 Laser AG / photo diode CG, no bias

1.7.4.2 Laser anode on ground / photo diode anode on ground

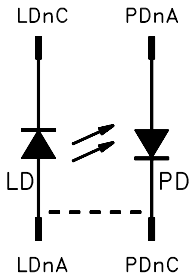


n = number of channel (1 to 8)

Figure 5 Laser AG / photo diode AG, no bias

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1.7.4.3 Laser anode on ground / photo diode floating



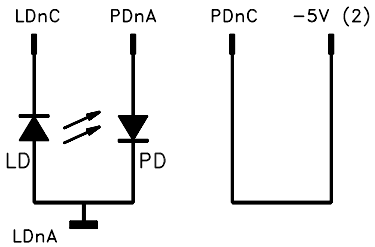
n = number of channel (1 to 8)

Figure 6 Laser AG / photo diode floating, no bias

a bridge (dashed line) may be used either at the laser or at the connector

1.7.5 Standard configurations with bias voltage 5V

1.7.5.1 Laser anode on ground / photo diode cathode on ground

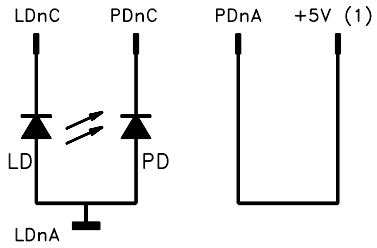


n = number of channel (1 to 8)

Figure 7 Laser AG / photo diode CG, 5V bias

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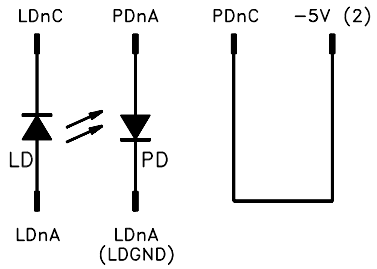
1.7.5.2 Laser anode on ground / photo diode anode on ground



n = number of channel (1 to 8)

Figure 8 Laser AG / photo diode AG, 5V bias

1.7.5.3 Laser anode on ground / photo diode floating



n = number of channel (1 to 8)

Figure 9 Laser AG / photo diode floating, 5V bias

☝ Attention ☝

Reverse connection of the photo diode using a bias voltage can cause permanent damage to the device.

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1.7.6 Connecting interlock and status display

Interlock, cable damage monitoring

Pin 15 connected to any GND pin of the connector jack will serve as test connector to determine whether the current output for the laser diode may be switched on. Between the two pins a low resistive (< 430Ω) connection must be maintained. Also short-circuiting is permitted. With the contacts open the multi laser controller module cannot be switched on.

Should the contact open during operation the output will be switched off immediately.

Status display

It is also possible to use a LED with anode to pin 44 and cathode to any GND pin as status display.
The LED will light up if the current output is switched on.

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1.8 Connecting components (CG, Cathode Ground Version)

1.8.1 Pinning of the output connector

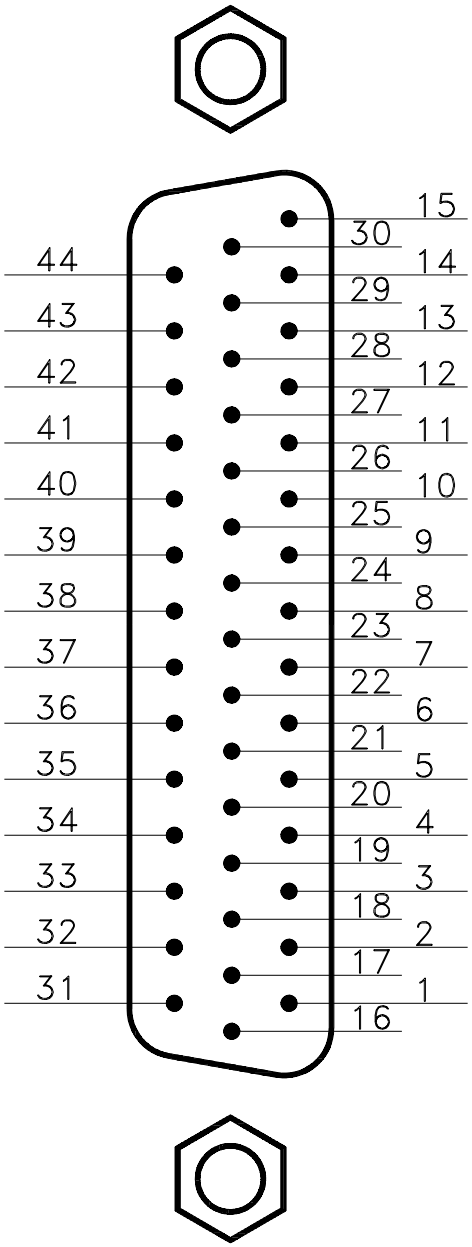


Figure 10 Pinning of the MLC8xxx output connector

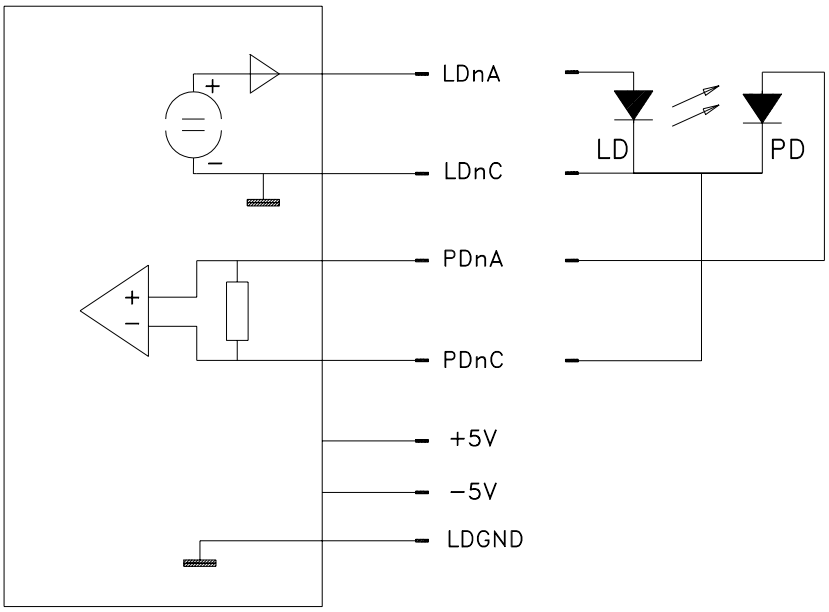
(44-pole female HD-SUB-D)

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1.8.2 Pin assignment MLC8xxx

Each laser is connected to an output channel as shown:

output circuit of the MLC Laser and photo diode



(n = 1 ... 8)

Figure 11 Principle connections for every laser

We recommend to use separate lines drilled in pairs (twisted pair) in a common shield for laser diode current and monitor diode current respectively.
The shield must be connected to ground.

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1.8.2.1 Pin assignment sorted by Function

Pin	Connector
14	LD1A anode of laser # 1
12	LD2A anode of laser # 2
11	LD3A anode of laser # 3
9	LD4A anode of laser # 4
8	LD5A anode of laser # 5
6	LD6A anode of laser # 6
5	LD7A anode of laser # 7
3	LD8A anode of laser # 8
29	LD1C cathode of laser # 1
27	LD2C cathode of laser # 2
26	LD3C cathode of laser # 3
24	LD4C cathode of laser # 4
23	LD5C cathode of laser # 5
21	LD6C cathode of laser # 6
20	LD7C cathode of laser # 7
18	LD8C cathode of laser # 8
13	PD1A anode of the photo diode of laser # 1
42	PD2A anode of the photo diode of laser # 2
10	PD3A anode of the photo diode of laser # 3
39	PD4A anode of the photo diode of laser # 4
7	PD5A anode of the photo diode of laser # 5
36	PD6A anode of the photo diode of laser # 6
4	PD7A anode of the photo diode of laser # 7
33	PD8A anode of the photo diode of laser # 8
43	PD1C cathode of the photo diode of laser # 1
41	PD2C cathode of the photo diode of laser # 2
40	PD3C cathode of the photo diode of laser # 3
38	PD4C cathode of the photo diode of laser # 4
37	PD5C cathode of the photo diode of laser # 5
35	PD6C cathode of the photo diode of laser # 6
34	PD7C cathode of the photo diode of laser # 7
32	PD8C cathode of the photo diode of laser # 8
31	GND ground
16	GND ground
17	GND ground
19	GND ground
22	GND ground
25	GND ground
28	GND ground

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30 GND ground

44 LEDA out for a LED to show the on/off status
15 Interlock to be shortened to any GND pin

1 + 5V
2 - 5V

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1.8.2.2 Pin assignment sorted by number of pin

Pin	Connector
1	+ 5V
2	- 5V
3	LD8A anode laser # 8
4	PD7A anode photo diode # 7
5	LD7A anode laser # 7
6	LD6A anode laser # 6
7	PD5A anode photo diode # 5
8	LD5A anode laser # 5
9	LD4A anode laser # 4
10	PD3A anode photo diode # 3
11	LD3A anode laser # 3
12	LD2A anode laser # 2
13	PD1A anode photo diode # 1
14	LD1A anode of laser # 1
15	Interlock to be shortened to any GND pin
16	GND ground
17	GND ground
18	LD8C cathode laser # 8
19	GND ground
20	LD7C cathode laser # 7
21	LD6C cathode laser # 6
22	GND ground
23	LD5C cathode laser # 5
24	LD4C cathode laser # 4
25	GND ground
26	LD3C cathode laser # 3
27	LD2C cathode laser # 2
28	GND ground
29	LD1C cathode laser # 1
30	GND ground
31	GND ground
32	PD8C cathode photo diode # 8
33	PD8A anode photo diode # 8
34	PD7C cathode photo diode # 7
35	PD6C cathode photo diode # 6
36	PD6A anode photo diode # 6
37	PD5C cathode photo diode # 5
38	PD4C cathode photo diode # 4
39	PD4A anode photo diode # 4

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40 PD3C cathode photo diode # 3
41 PD2C cathode photo diode # 2
42 PD2A anode photo diode # 2
43 PD1C cathode photo diode # 1
44 LEDA out for a LED to show the on/off status

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1.8.3 Connecting laser- and monitor diode

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

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

The laser diode is always sourced against ground by the current controller. This is of considerable advantage regarding the safety of the laser diode and the stability of the laser diode current.

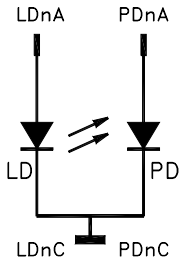
The monitor diode input is set up as trans-impedance amplifier with virtual ground (input impedance 0 Ω).
The polarity of the photo diode may be selected free. It can also be floating.

The monitor diode input can be used with or without bias voltage (5 V or 0 V). Therefore wire bridges have to be connected depending on the individual configuration shown in the next section.

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1.8.4 Standard configurations without bias voltage

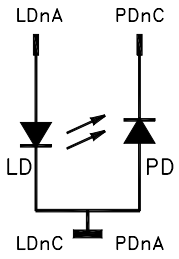
1.8.4.1 Laser cathode on ground / photo diode cathode on ground



n = number of channel (1 to 8)

Figure 12 Laser CG / photo diode CG, no bias

1.8.4.2 Laser cathode on ground / photo diode anode on ground

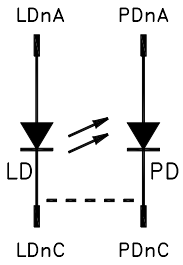


n = number of channel (1 to 8)

Figure 13 Laser CG / photo diode AG, no bias

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1.8.4.3 Laser cathode on ground / photo diode floating



n = number of channel (1 to 8)

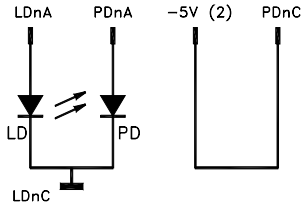
Figure 14 Laser CG / photo diode floating, no bias

a connection (dashed line) may be done either at the laser or at the connector

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1.8.5 Standard configurations with bias voltage 5V

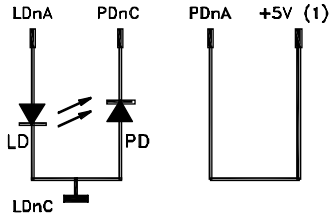
1.8.5.1 Laser cathode on ground / photo diode cathode on ground



n = number of channel (1 to 8)

Figure 15 Laser CG / photo diode CG, with 5 V bias

1.8.5.2 Laser cathode on ground / photo diode anode on ground

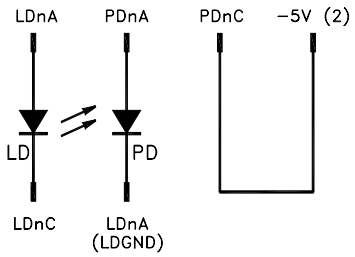


n = number of channel (1 to 8)

Figure 16 Laser CG / photo diode AG

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1.8.5.3 Laser cathode on ground / photo diode floating



n = number of channel (1 to 8)

Figure 17 Laser CG / photo diode floating, 5 V bias

☝ Attention ☝

Reverse connection of the photo diode can cause permanent damage to the device when using a bias voltage!

1.8.6 Connecting interlock and status display

Interlock, cable damage monitoring

Pin 15 connected to any GND pin of the connector jack will serve as test connector to determine whether the current output for the laser diode may be switched on. Between the two pins a low resistance (<430 Ω) must be maintained. Also short-circuiting is permitted. With the contacts open the multi laser controller module cannot be switched on.

Should the contact open during operation the output is switched off immediately.

Status display

It is also possible to use a LED with anode to pin 44 and cathode to any GND pin as status monitor.

The LED will light up if the current output is switched on.

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2 Operating the MLC8xxx

➔ Before switching on the laser current please refer to chapter 1.6, "Pre-settings" starting on page 10

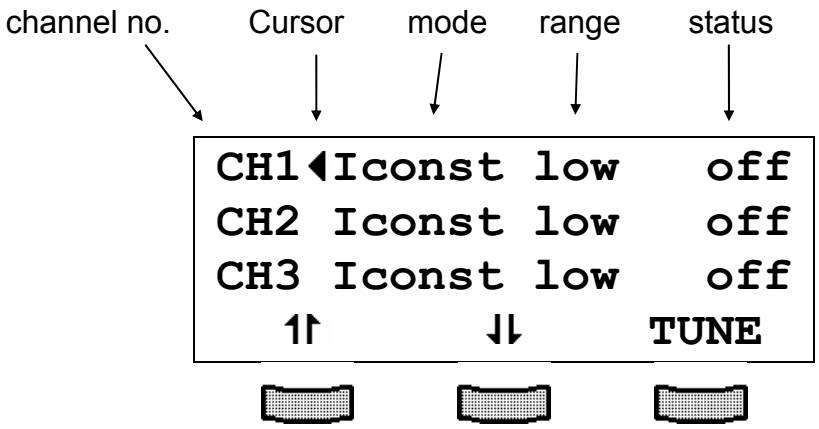
NOTE

With modules of the MLC8xxx series all settings are executed at once. It is not necessary to confirm the set values.

2.1 Functions in the main menu

2.1.1 Display

The main menu shows the channel number, mode, range and status of the MLC8xxx module.



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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 1↑ and 1↓ .

CH2◀

Pressing 

will lead to the channel menu

➔ (Refer to chapter 2.2, "Functions in the channel menu" starting on page 35)

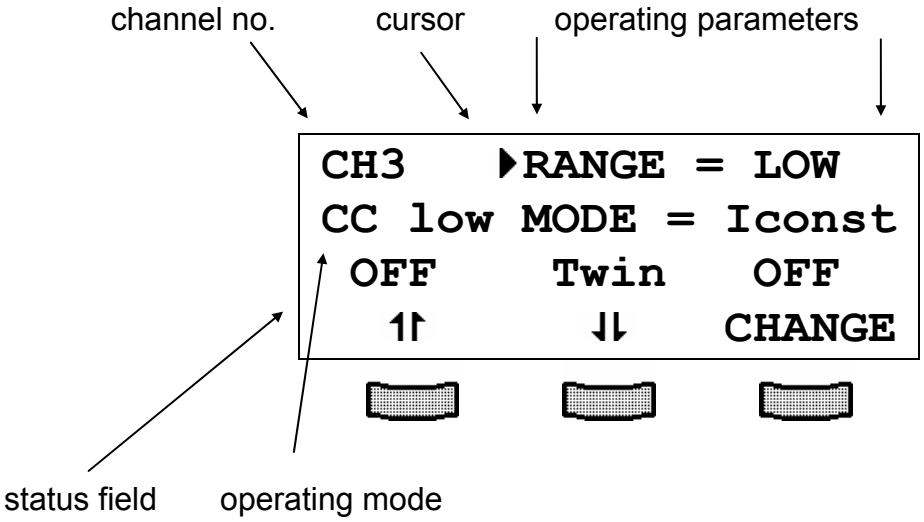
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2.2 Functions in the channel menu

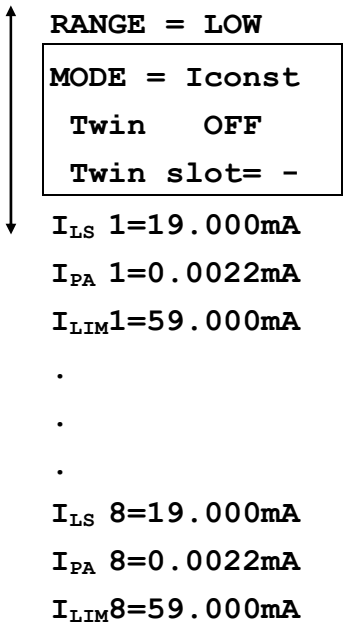
The channel menu is opened from the main menu by pressing the key CHANNEL.
Hit again CHANNEL or ESC to return to the main menu.

2.2.1 Display

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



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:



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The status field shows the actual status:

Normal operation

ON	Laser is on
OFF	Laser is off

Malfunction

■Vcc ■	Internal power supply failed – maintenance required
■OTP ■	Final stage overheated – switch off and wait 10 minutes
■ILCK■	Interlock is open
■ILIM■	Limit current reached during operation

In the channel menu you find some abbreviations which are explained as follows

In constant current mode:

I_{LS} 1 ... I_{LS} 8	**L**aser diode **s**et current of channel 1... 8
I_{PA} 1 ... I_{PA} 1	**P**hoto diode **a**ctual current of channel 1 ... 8

In constant power mode:

I_{PS} 1 ... I_{PS} 8	**P**hoto diode **s**et current of channel 1 ... 8
I_{LA} 1 ... I_{LA} 8	**L**aser diode **a**ctual current of channel 1 ... 8

In both modes

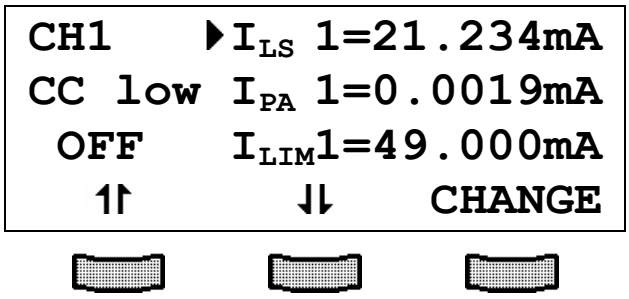
I_{LIM}1 ... I_{LIM}8	**Lim**it current (is the same for chanell 1 ... 8)

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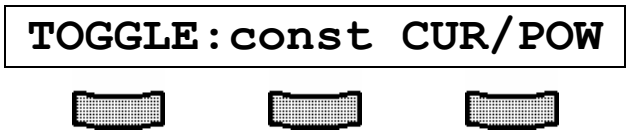
2.2.2 Changing parameters

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

Example: change I_{LS} 1:



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 toggles the mode.

Pressing ESC will terminate the procedure.

NOTE

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

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2.2.3 Selecting the laser diode current range

If the range of the laser diode current shall be changed, the parameter

RANGE =

has to be selected in the channel menu.
The right softkey will toggle between “high” and “low” range.

2.2.4 Selecting constant current or constant power mode

The multi laser controller modules MLC8xxx offer two operating modes for the laser diodes: constant current and constant power mode.

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 correspondingly. 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.

NOTE

For "constant power" mode a separate monitor diode will be necessary for each laser in the set-up.

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So if the operating mode of the laser diodes shall be changed, the parameter

MODE =

can be set to:

Iconst = Constant current mode
Pconst = Constant power mode

➔ (Refer to chapter 2.2.2, "Changing parameters" on page 37)

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2.2.5 Selecting a TEC module for temperature protection

If the laser diodes should be operated only in a specific temperature range (window) you can use the temperature window function of a TED 8xxx module.

➔ (Refer to manual of the TED8xxx)

The TED8xxx must be assigned to the MLC8xxx as described here. Two steps are necessary:

First the parameter

`Twin slot =`

must be set to the slot number of the desired TED8xxx.
(If only one TED8xxx is inserted, the slot number is recognized automatically)

2.2.6 Activating the temperature protection

Second the temperature protection must be switched ON:

`Twin ON`

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

`Twin OFF`

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2.3 Switching on and off

☝ Attention ☝

MLC8xxx modules can be switched on or off not regarding if any parameters have been set.

Please select the module to be switched on or off in the main menu.

➔ (Refer to chapter 2.1.2, "Selecting a module" on page 34)

☝ Attention ☝

Before switching on a multi laser diode controller module MLC8xxx first set the laser diode current limit I_{LIM} (hardware limit) for the applied laser diodes with a screwdriver.

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

(Refer to chapter 1.6.1, "Setting hardware limit I_{LIM} " on page 10

Pressing the key 

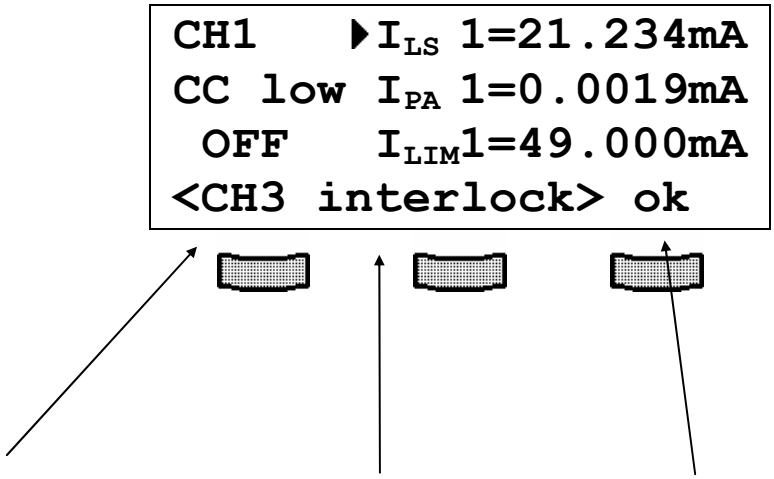
will switch on the module not regarding the menu you are in as long as the module is selected (LED “SEL” lights). The LED “ON” at the respective module will light up.

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2.4 Error messages

Error messages are shown in the bottom line of the display not regarding, if you are in the main menu or channel menu.

If an error occurs with the module switched on the display shows for example:



Channel causing the error Error message ok to accept

Possible error messages for an MLC8xxx module are:

INTERLOCK	Interlock line is open or has opened
ctrl Temp	Laser temperature left temperature window
OTP	Module is overheated. Operation is possible after cooling down.
Vcc fail	Internal supply voltage fails - module needs maintenance.
Not if LD on	Certain parameters are not allowed to be changed while laser is ON.
TWIN	Laser temperature left temperature window.

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

<CH1 INTERLOCK>

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

▶CH1 interlock◀

If an error occurs, it has to be acknowledged by pressing **"ok"** . Until acknowledgement further operation is locked.

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3 Communicating 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 a computer interface.

Special operation features of the MLC8xxx module are described here.

➔ (Refer to chapter 2, "Operating the MLC8xxx" starting on page 33)

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 multi laser diode controller module first set the limit value of the laser diode current I_{LIM} (hardware limit) for the applied laser diodes with a screwdriver.

The corresponding potentiometer is marked I_{LIM} and is situated at the front panel of the MLC8xxx module.

The value I_{LIM} is constantly measured by the PRO8000 (-4) / PRO800 and can be checked in the channel -menu of the MLC8xxx during setting.

➔ (Refer to chapter 1.6.1, "Setting hardware limit I_{LIM}" on page10)

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3.1.1 Nomenclature

Program messages (PC ⇒ PRO8000) are written in inverted commas: **"*IDN?"**
Response messages (PRO8000 ⇒ 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(-4)), 1…2 (PRO800)
":SLOT?"	Queries the selected slot **[:SLOT <NR1><LF>]**

3.2.2 Selecting the channel (PORT)

Programming:

":PORT 1"	Select port 1 for further commands
":PORT 2"	Select port 2 for further commands

Reading:

":PORT?"	Read the selected port **[:PORT <NR1><LF>]**

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3.2.3 Setting the laser diode current (ILD)

NOTE

These commands affect the laser diode current of the laser of one specific channel. Please select first this channel (port) with the command

"PORT <NR1>".

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>]**

[1] "ELCH": ELectrical CHaracterization

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":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>"]**
":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 Changing the monitor diode current (IMD)

NOTE

This commands affects the monitor diode current of the laser of one specific channel. Please first select this channel (port) with the command "PORT <NR1>".

➔ (Refer to Chapter 3.2.2, "Selecting the channel (PORT)" on page 47)

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>]**

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":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>]**
":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 (LASER)

Programming:

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

Reading:

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

3.2.6 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>]**

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3.2.7 Selecting the operation mode (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>]**

3.2.8 Setting the current range (RANGE)

Programming:

":RANGE <NR1>"	Setting the current range **0** (low current) or **1** (high current)

Reading:

":RANGE?"	Read the current range **[:RANGE <NR1><LF>]**

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3.2.9 Activating the temperature protection (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>]**

3.2.10 Assigning a TEC for temperature protection (TPSLOT)

Programming:

":TPSLOT <NR1>"	Program assigned slot number (1...8 for PRO8000(-4), 1...2 for PRO800)

Reading:

":TPSLOT?"	Read assigned slot number **[:TPSLOT <NR1><LF>]**

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3.2.11 Reading type of module (TYPE)

Reading:

":TYPE:ID? "	Read the module ID (here 47) **[:TYPE:ID 47<LF>]**
":TYPE:SUB? "	Read module subtype: 0: Anode ground version **[:TYPE:SUB 0<LF>]** 1: Cathode ground version **[:TYPE:SUB 1<LF>]**

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3.3 Error messages of an MLC8xxx

[1601, "Interlock is open"]

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

➔ (Refer to chapter 1.7.6, "Connecting interlock and status display" on page 21)

[1603, "Over temperature"]

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

[1604, "Internal power failure"]

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

[1607, "No setting of ILD during constant power mode"]

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

[1608, "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.

[1616, "No mode change during laser on"]

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

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[1619, "No changing of current range during laser on"]

Possible reason: The current range cannot be changed with the laser diode output switched on.

[1620, "Attempt to switch on laser while temperature is out of window"]

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

[1621, "Attempt to activate Twin although there is no TEC in the system"]

Possible reason: The temperature window protection can only be activated, if a TEC module is present in the PRO8000(-4) / PRO800.

[1622, "Attempt to activate Twin during laser on"]

Possible reason: The temperature window protection can only be activated, if the laser diode output is switched off.

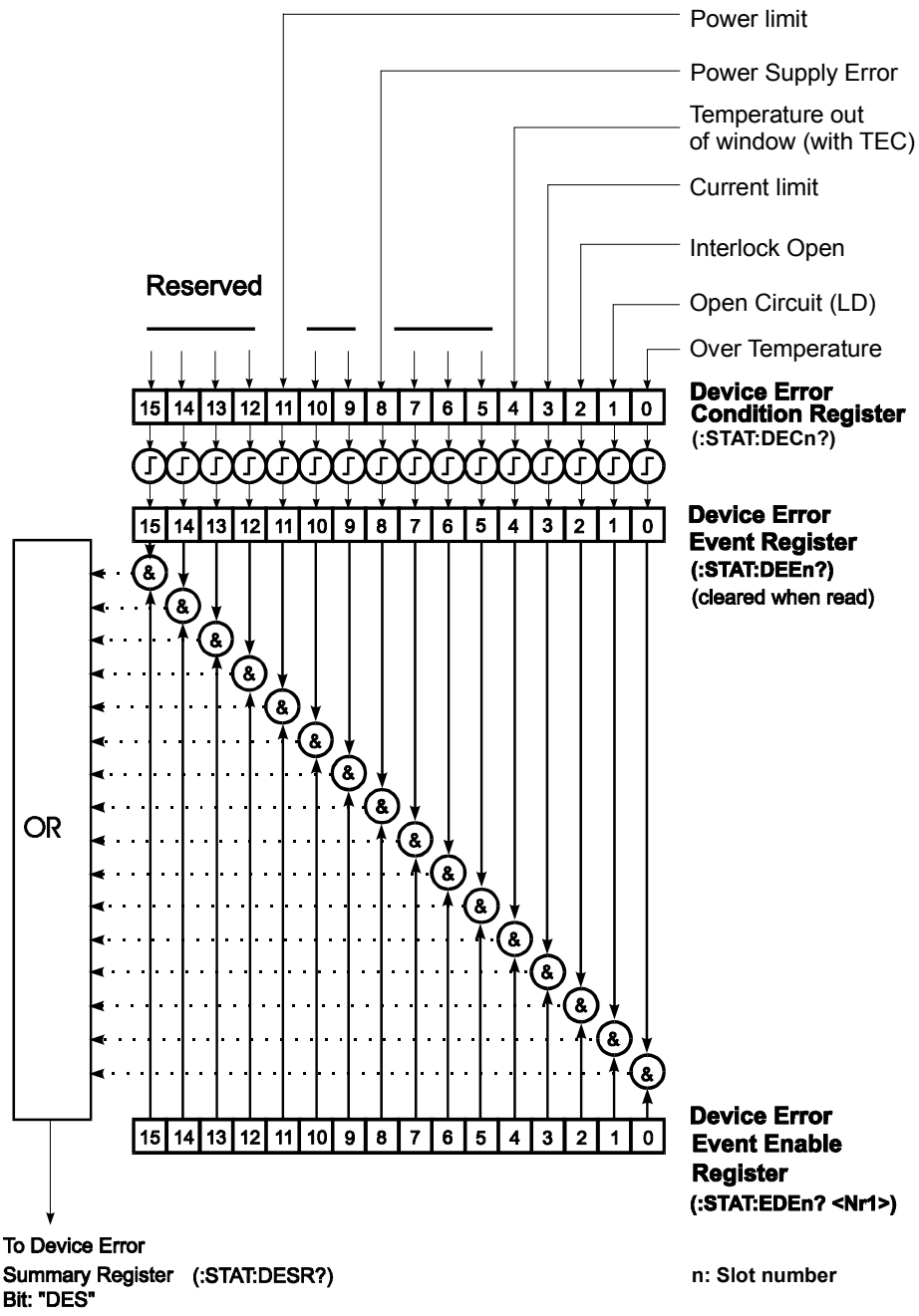
[1623, "No TEC in this slot"]

Possible reason: There is no TEC in the assigned slot.

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3.4 Status reporting.

The MLC8xxxx modules provide three 16 bit registers DEC, DEE and EDE (see Figure 18) and four 8 bit registers ESR, STB, ESE and SRE (see Figure 19) to program various service request functions and status reporting.



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

Figure 18 The MLC8xxx device error registers DEC, DEE and EDE

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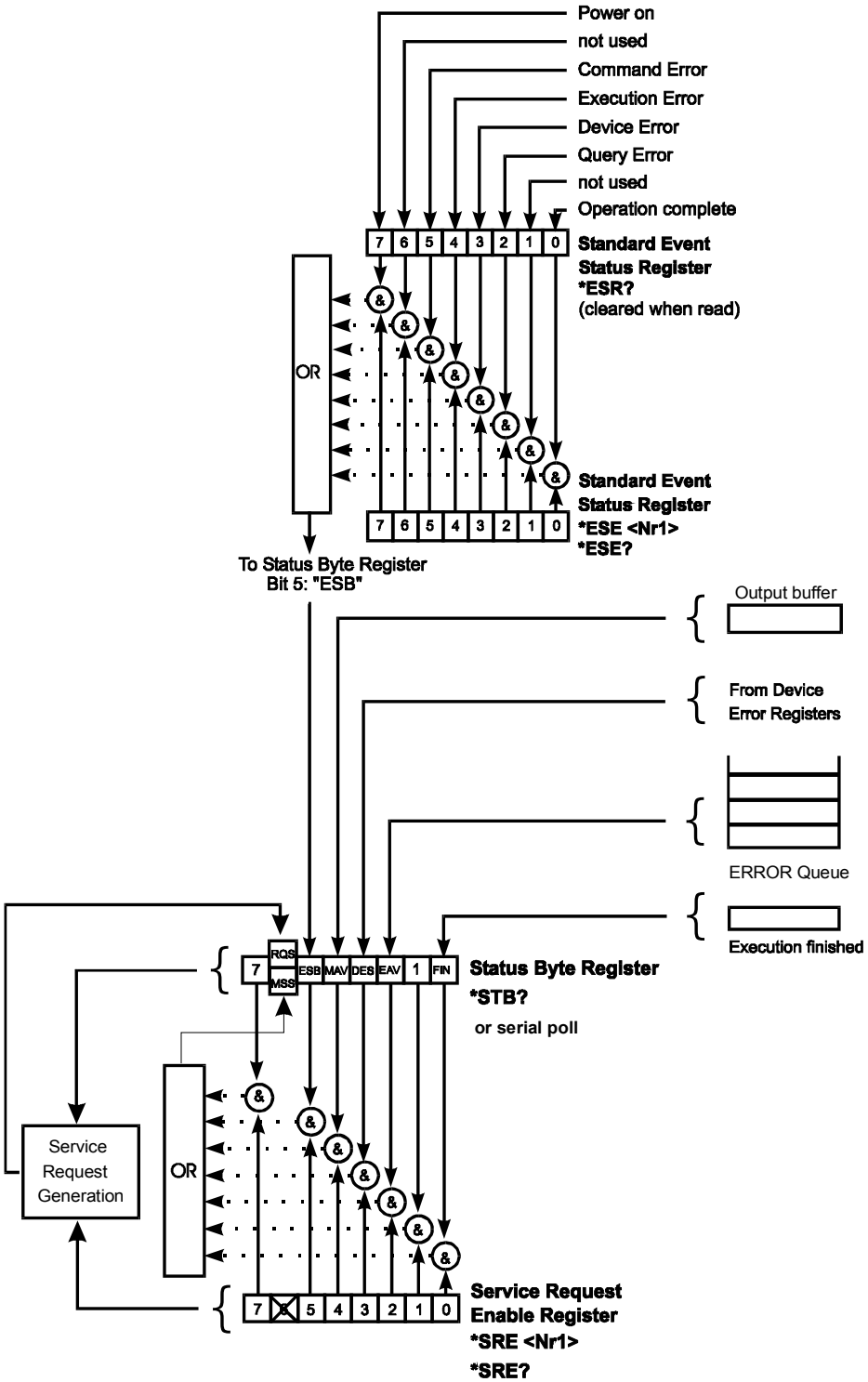


Figure 19 The PRO8000 (-4) / PRO800 register ESR, ESE, STB and SRE

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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 can not 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" 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 will 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 3.4.5). 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 MLC8xxx 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, disrupt the interlock connection: the laser output must go into “OFF” state immediately.

Besides the above mentioned point the MLC8xxx modules do not need any further maintenance by the user.

If highest precision of measurements is vital to you, you should have recalibrated the MLC8xxx module about every two years.

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4.2 Troubleshooting

In case that one module of your PRO8000 (-4) / PRO800 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, take care of 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.

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◆ 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 1.7.6, " Connecting interlock and status display" on page 21)

- 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 selected the desired port?
  - Select the desired port for input on the display by means of the up- and down arrow keys or by the **":PORT <NR1>"** command.

- 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

- Is the hardware limit I_{LIM} set to 0?
  - Adjust the hardware limit I_{LIM} by means of the potentiometer on the MLC8xxx front panel

- Is the laser current I_{PS} of the corresponding port set to 0?
  - Adjust the laser current in the channel menu to the desired value.

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

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- Is the laser diode poled correctly?
  - If not, change the polarity of the laser diode corresponding to the type of MLC-module used (AG or CG)

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

- Do you use a temperature window with inappropriate setting or with no TEC connected?
  - Change settings, install TEC or turn off the window function

If you don't find the error source by means of the trouble shooting list or if more modules work erratic 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, "Addresses " on page 73

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5 Listings

5.1 List of 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)
	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 a custom-made shielded cable installed at the LD OUT port.

[2] Compliance demonstrated with the MLC8x series modules installed in the Thorlabs PRO8x series of 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.

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5.4 Addresses

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