Operation Manual

Thorlabs Blueline™ Series

Laser diode controller

LDC340 (-IEEE)

2006

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

Thorlabs GmbH

This part of the instruction manual contains specific information on how to operate a laser diode controller LDC340. A general description is followed by explanations of how to operate the unit manually. You will also find the information about remote control of the LDC340-IEEE 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 Information

1.1 At a Glance

The LDC340 is a compact laser driver with optional IEEE488.2 interface for driving laser diodes up to 4A laser current.

The LDC340 especially excels in:

- Very low noise
- Two current ranges
- The universal possibilities of connecting components
- The operating comfort of its compact construction
- Extensive protections for the laser diode
- The possibility to drive two lasers in series at the same time
- Two independent monitor diode inputs
- CW mode with modulation input up to 50 kHz
- Interlock for automatic switch-off by an external control signal (e.g. cooling loop monitoring)
- LabVIEW®- and LabWindows/CVI® instrument drivers.

The laser diodes can be operated in constant current as well as in constant power mode.

In remote operation (LDC340-IEEE only) all settings except the limits and 2 calibration values can be done from the PC.

A wide variety of protection features protect the laser diode from damage.
These features are:

- **Key-operated power switch**

Prevents unauthorized switching on of the laser diode.

- **Softstart**

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

- **Limit for the injection current (hardware limit)**

A manually adjustable current limit limits the maximum allowed laser current. The limit value can be set with a 25-turn potentiometer on the front panel.

- **Interlock**

The interlock input enables to realize several protection functions simultaneously.

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

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

➔ (Refer to chapter 3.2.2, “Using the interlock input“ starting on page 16)

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

If the line to the laser is interrupted even for a short time during operation an emergency switch off is immediately released.

- **Electronic short-circuit switch for the laser diode**

With the current module switched off an electronic switch will shortcircuit the laser diode so that no voltage is applied to the laser contacts.

- **Control LED for laser current being active**

When the laser current is switched on an LED in the switch LD ON lights up.

- **Temperature-window protection of the laser diode**

Operation in the specified temperature range. (Only in combination with a *Thorlabs GmbH* TED 350)

- **Over-temperature protection**

The LDC340 has an automatic over-temperature protection in case that the allowed internal operating temperature should be exceeded. In this case the output will switch off and after temperature decay of about 10 °C the output current of the LDC340 can be switched on again.

- **Defined states after switch-on**

When switching on the LDC340 with the mains switch the laser current output is always switched off. The LDC340 will always wake up in a mode that can be selected with a DIP switch at the rear.

- **Mains filter**

Protection against line failure or transients.

- **Line failure monitoring**

In case of line failure/line interruption the LDC340 will wake up anew as if it has been switched on. So the laser output remains switched off.

1.2 Safety

☝ Attention ☝

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

Before applying power to your LDC340 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!

Also make sure that your line voltage agrees with the voltage indicated by the switch setting on the back of the unit and that the right fuse has been inserted!

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

The LDC340 must not be operated in explosion endangered environments!

☝ Attention ☝

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

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

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

☝ Attention ☝

Mobile telephones, handy phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to EN 50 082-1.

1.3 Ordering codes and Accessories

Ordering-code	Short description
LDC340	Laser diode controller, current range 0 ... 4 A / 6 V
LDC340-IEEE	Laser diode controller, current range 0 ... 4 A / 6 V with IEEE488 interface
	laser diode mounts for different laser diode packages:
TCLDM9	Temperature controlled laser diode mount for 3- and 4-pin TO18-packages (9 mm CD, 5.6 mm CD)
LDM21	Miniature sized temperature controlled laser diode mount for 3- and 4-pin TO18-packages (9 mm CD, 5.6 mm CD)
LM14S2	laser diode mount for laser modules in a 14-pin butterfly-package (programmable pinning)
	Shielded cable:
CAB400	Cable to connect the laser diode controller LDC340 to a Laser Diode Mount

2 Getting Started

2.1 Unpacking

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the LDC340 mechanically and electrically.

Verify that you have received the following items:

1 LDC340
1 power cord, connector according to ordering country
1 operation manual
1 CD with drivers and software (LDC340-IEEE only)
1 Connection cable CAB400

2.2 Preparation

Prior to starting operating the LDC340, check if the line voltage indicated on the mains voltage selector agrees with your local supply and if the appropriate fuse is inserted. (To change the line voltage see 5.2)

Connect the unit to the line with the provided mains cable. Turn the unit on by means of the mains switch.

Via the 4mm banana jack of the chassis ground the external optical build-up can be connected to ground potential, if required.

2.3 Operating elements

2.3.1 Front panel

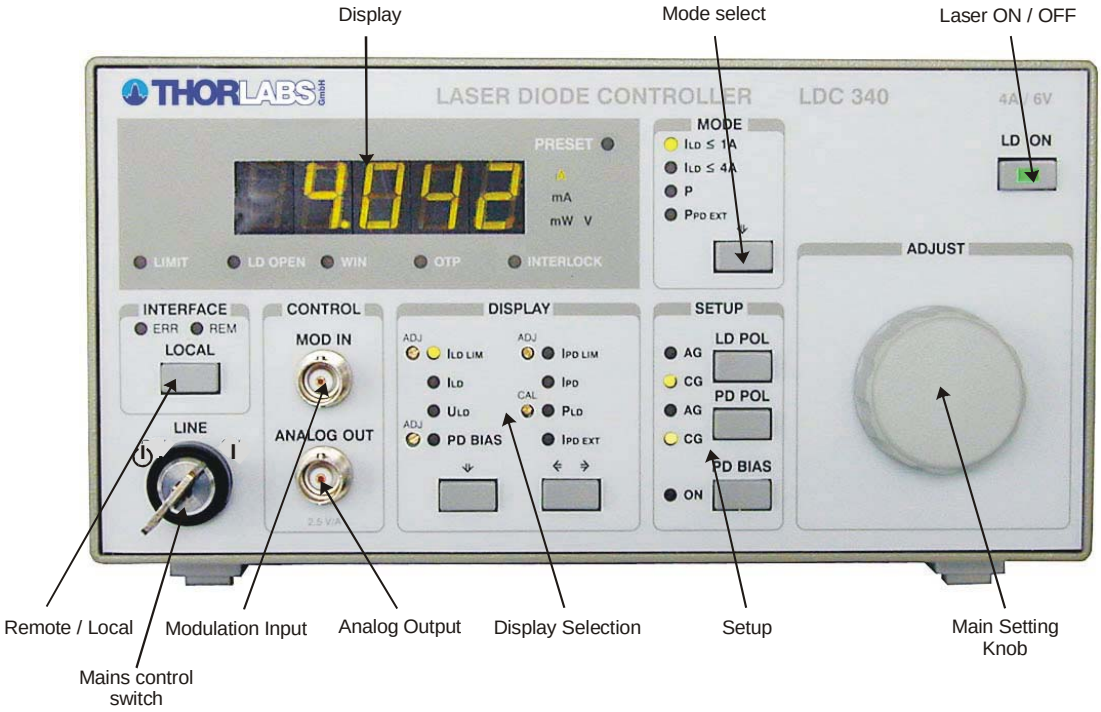


Figure 1 Operating elements at the front panel

Line	Key operated power switch, ON / Standby
Interface	Change between remote and local
LED Display	4 ½ digit display
Mode	Select operation mode
Adjust	Main tuning knob
Setup	Set diode polarities and bias voltage
Display	Select the value to be displayed
Control	Modulation in (max. ± 10 V) / Analog out (max. ± 10 V) BNC-jacks

2.3.2 Rear panel

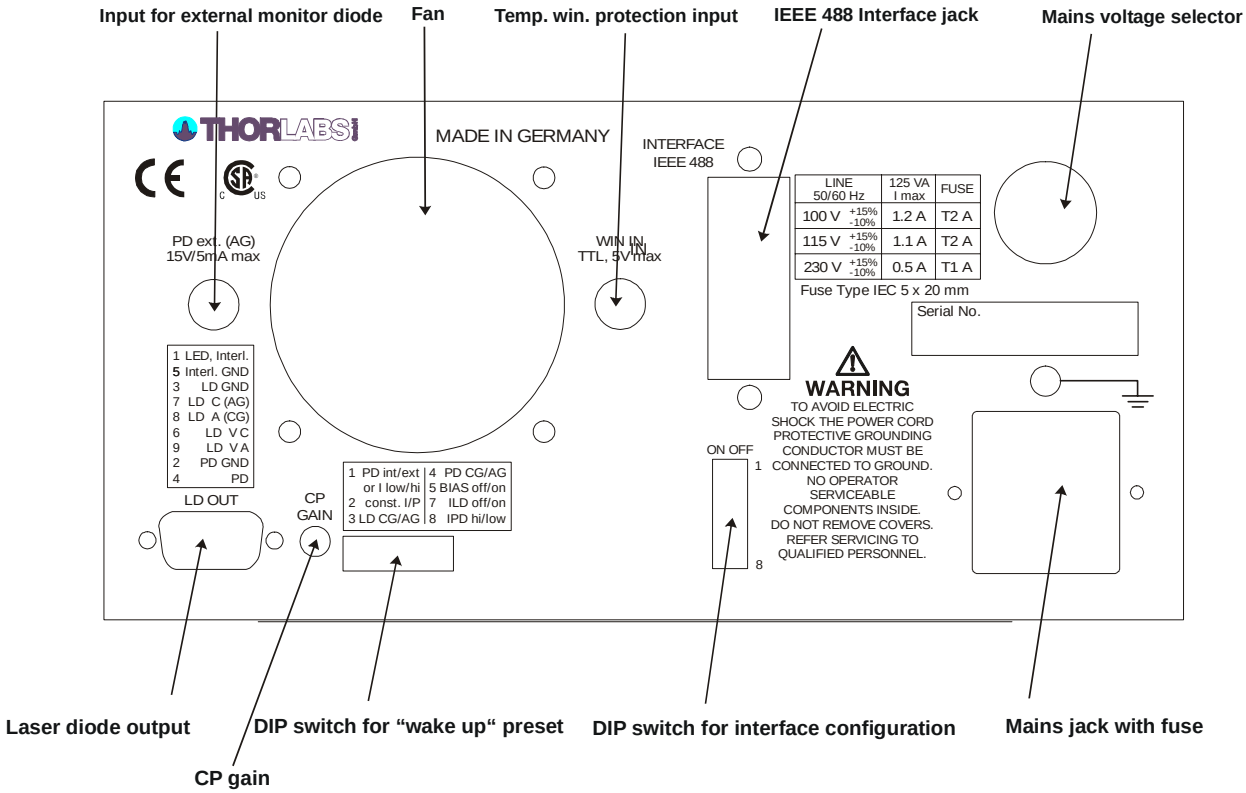


Figure 2 Operating elements at the rear panel

The rear panel of the laser diode controller LDC340 contains the mains connector with fuse, the output jack (9pin D-SUB), the external monitor diode input (BNC), the temperature window protection input (BNC) as well as the preset DIP switch bank and the PD gain control potentiometer.

If the LDC340 is equipped with the IEEE488.2 interface (LDC340-IEEE) there is an additional DIP switch bank to set the IEEE 488 device address. You will also find the 24pin IEEE488 jack.

2.4 First operation

☝Attention☝

Prior to switching on your LDC340 please check if the line voltage set with the voltage selector at the rear panel corresponds to your mains voltage!

Turn the unit on by means of the line switch.

Via the 4mm banana jack of the chassis ground the external optical build-up can be connected to ground potential, if required. The ground pin of the laser diode is internally connected to chassis ground.

After switching on the unit, the LED display must get visible. If no display is shown please check line voltage and line fuse.

By using the display selection keys you can select the desired value to be displayed at any time.

The LDC340 is immediately ready to use after turning on. The rated accuracy is reached, however, after a warming-up time of approx. 10 minutes.

3 Operating the LDC340

3.1 Presettings

3.1.1 DIP switch for “wake up“ preset

By means of these 8 switches several preset functions define in which mode the LDC340 will wake up when switched on.

SW1 and SW2 define the mode the LDC340 wakes up:

Mode	SW1	SW2
const. current low range	up	up
const. current high range	down	up
const. power (internal PD)	up	down
const. power (external PD)	down	down

SW3 defines the polarity of the laser diode

LD polarity	SW3
CG	up
AG	down

SW4 defines the polarity of the monitor diode

PD polarity	SW4
CG	up
AG	down

SW5 defines if the bias voltage is automatically switched on when switching on the LDC340

bias voltage	SW5
off	up
auto on	down

☝ Attention ☝

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

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

SW6 not used

SW7 defines if the laser current (!) is switched on automatically if the LDC340 is switched on (option).

laser current	SW7
off	up
auto on	down

NOTE

This is an option that has to be ordered explicitly. This option can be retrofitted.

SW8 defines the range of the monitor diode current

Depending on the type of monitor current and the power range you are working in your monitor diode will deliver a monitor current in a wide range. Therefore the LDC340 provides two monitor current ranges:

I_{PD} range	SW8
high	up
low	down

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

To protect the laser diode the maximum possible current at the output of the LDC340 can be limited.

This hardware limit is set by the 25-turn potentiometer marked ADJ located next to the LED $I_{LD\ LIM}$ at the front of the LDC340. The hardware limit is displayed continuously on the display if the display $I_{LD\ LIM}$ is selected.

3.1.3 Setting the limit of the monitor diode current $I_{PD\ LIM}$

To protect the laser diode the maximum possible optical output power can be limited. Therefore a maximum monitor diode current can be set.

This maximum monitor current is set with the 25-turn potentiometer marked ADJ located next to the LED $I_{PD\ LIM}$ at the front of the LDC340. The maximum monitor current is displayed continuously on the display if the display $I_{PD\ LIM}$ is selected.

☝ Attention ☝

The monitor diode current limit has a slow reaction time so you might see overshoots in some special cases. This overshoots are limited by the laser diode current limit according 3.1.2.

3.1.4 Adjusting the power display of an internal monitor diode

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

Therefore the monitor current is translated into power display that can be calibrated with the 25-turn potentiometer marked CAL located next to the LED P_{LD} at the front of the LDC340.

The position of the potentiometer determines which monitor current corresponds to which optical power.

NOTE

This is the description of how to calibrate the power display in local mode using the display of the LDC340. When using the IEEE488 interface the calibration of the optical power is done completely different. The CAL potentiometer does not affect the value measured via interface.

➔ (Refer to chapter 4, “Communicating with a control computer“ on page 27)

Adjustment

During the whole procedure the laser remains switched off.

First select the operating mode P and the display I_{PD} at the LDC340.

Then take the maximum optical output power and the corresponding monitor current from the datasheet of the laser diode. Sometimes you must calculate one value using the monitor diode efficiency (parameter η).

Now set the pre-set value for the monitor current to this value.

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

3.2 Connecting components

3.2.1 Pin assignment of the output jack

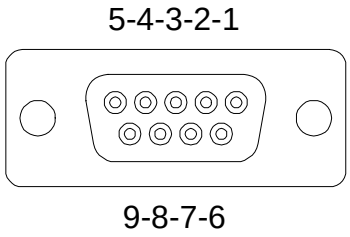


Figure 3 Pin assignment of the 9-pin D-SUB output jack (female)

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

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

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

3.2.2 Using the interlock input

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

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

If the two pins are not connected (Interlock loop open) the laser cannot be switched on.

Furthermore a red LED "INTERLOCK" on the front panel of the LDC340 will indicate the interlock to be open.

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

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

3.2.2.1 Examples of various protective functions

External Emergency key in the lab

An external emergency key (opener) is connected to the two pins of the interlock or in series to other interlock switches.

Temperature control

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

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

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

Safety-door monitoring

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

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

Cable damage monitoring

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

An interruption of this line will open the interlock.

Laser ON/OFF-Display

The interlock can also be closed with a red LED with anode to pin 1 and cathode to pin 5. The current is about 7 mA this will make any commercially available LED light up.

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

3.2.3 Connecting the monitor diode

3.2.3.1 Connecting an internal monitor diode

The monitor diode input is realized as trans-impedance amplifier with virtual ground (input impedance 0 Ω). The two pins are floating i.e. they are not in direct connection to the laser diode ground. The common voltage against ground must not exceed ± 5 V. It is allowed to connect any pin of the monitor diode to the laser diode ground.

Should this be necessary (e.g. with laser diodes with integrated monitor diode and common ground) the connection of the ground lines should be done as near as possible to the laser diode to avoid measurement errors in measuring the monitor diode current.

The internal monitor diode input may be operated without or with bias voltage (0 ... 10 V). The bias voltage is switched on via a delay-switch on the front panel.

➔ (Refer to chapter 3.2.1, “Pin assignment of the output jack“ on page 15)

➔ (Refer to chapter 3.9.4, “Adjusting the bias voltage of the monitor diode“ on page 24)

3.2.3.2 Connecting an external monitor diode

If an external monitor diode is used it must be connected via coaxial cable to the corresponding jack**, PD ext. (AG)** at the rear panel of the LDC340.

The external monitor diode input offers no bias voltage and must be connected with grounded anode (AG), that means the anode connected to the outer shield of the BNC jack..

☝ Attention ☝

Input voltage / current must not exceed 15V / 5mA!

3.2.4 Laser voltage measurement

The LDC340 constantly measures the laser voltage at the output jacks of the unit. For a precise measurement connect pin 6 directly to the LD-cathode and pin 9 directly to the LD-anode to avoid measuring the voltage drop in the connection lines (4 pole measurement).

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

3.2.5 Temperature window protection input (WIN IN)

If you use the LDC340 together with a temperature controller you can use the temperature window input (WIN IN) to switch off the laser current, if the temperature leaves a predefined window. Please connect the according output of a TED350 by means of a BNC cable to this BNC input to get the advantages of a temperature protection.

☝ Attention ☝

WIN IN input voltage must not exceed TTL level (5V max.!)

3.3 Display

The display is a 4 ½ digit LED-display and shows the value selected in the field marked “Display selection“ continuously. Additionally 10 single LED's indicate the unit of the displayed value (A, mA, mW and V) and possible errors.

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

Possible error messages:

LIMIT lights up if a limit value is reached

LD OPEN lights up if the wiring to the laser is interrupted while the laser is switched on or if the compliance voltage is insufficient (e.g. operating two lasers in series requiring more than the capable compliance voltage of the LDC340)

WIN lights up if the temperature window function of a TED 350 connected to the LDC340 via BNC cable protects the laser from being switched on.

OTP lights up if the internal temperature of the LDC340 is too high. Please wait until the LED extinguishes. Then the LDC340 can be operated again.

INTERLOCK lights up if the interlock loop is open.

3.4 Main setting knob

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

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

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

3.5 Mode Select

Four modes of operation can be selected by consecutively pressing the "mode select" key:

- Constant current mode in the high current range (version dependent)
- Constant current mode in the low current range (version dependent)
- Constant power mode using an internal monitor diode
- Constant power mode using an external monitor diode

A corresponding LED indicates the selected mode.

3.6 Display select

Eight different values can be displayed. The value is selected with the buttons "⇓" and "⇐ ⇒" in the field "DISPLAY":

- Laser diode current limit $I_{LD\ LIM}$
- Laser diode current I_{LD}
- Laser diode voltage U_{LD}
- Internal monitor diode bias voltage PD BIAS
- Monitor diode current limit (optical power limit) $I_{PD\ LIM}$
- Internal monitor diode current I_{PD}
- Optical power measured with the monitor diode P_{LD}
- External monitor diode current $I_{PD\ EXT}$

NOTE

The monitor diode power limit supports the internal and the external monitor diode input.

➔ (The functions of the potentiometers in this field are explained in chapter 3.1, "Presettings" on page 11)

3.7 Analog modulation input

The laser diode controller LDC340 has an input for modulating the laser diode current in constant current mode.

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

The modulation input is designed for input voltages between –10 V ...+10 V and specified for small signal operation. In large signal operation the 3 dB bandwidth is not quite reached.

3.8 Analog output

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

The bandwidth of this output is that wide that the laser current is shown exactly in its actual course of time.

The transmission coefficient of this output is depending on the type of the LDC340. 10 V are corresponding to the maximum output current, so e.g. for a 4A LDC340 10 V correspond to 4A thus the transmission coefficient is 10 V / 4 A = 2.5 V/A.

The shape of the output signal of the LDC340 is limited by the bandwidth and the rise time of the laser output. This may lead to deviations in the shape of the signal at the control input compared to that at the control output.

3.9 Setup of polarities and bias voltage

Three hardware presettings can be selected:

3.9.1 Polarity of the Laser diode (LD POL)

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

AG means laser diode anode is connected to ground.
CG means laser diode cathode is connected to ground.

A corresponding LED indicates the selection

3.9.2 Polarity of the internal monitor diode (PD POL)

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

If the polarity has been chosen correctly the display of the photo current is positive when driving the laser diode above the threshold current.

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

3.9.3 Bias voltage of the monitor diode (PD BIAS)

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

The bias voltage is switched on by pressing the key PD BIAS for about one second.

☝ Attention ☝

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

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

NOTE

To protect the monitor diode from accidental biasing the, switch PD BIAS must be pressed for about 1 second to switch on the bias voltage.

3.9.4 Adjusting the bias voltage of the monitor diode

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

The external monitor diode input does not provide a bias voltage.

NOTE

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

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

Note

For the external monitor diode input this information is regardless as there is no bias voltage for this input. If you use a monitor diode with reverse polarity at this input (not AG) you will

- measure a negative monitor current I_{PD}
- still display a positive optical power P_{LD}
- not be able to operate in constant power mode

3.10 Laser current ON/OFF (LD ON)

The laser current can be switched on by pressing the key LD ON. When the LDC340 is switched on with the mains switch this switch is always in position OFF to prevent the laser to be activated mistakenly.

If the laser output is switched on an LED in this key lights up.

The laser current cannot be switched on if

- the interlock loop is not closed
- the LDC340 is overheated (display OTP)
- no laser has been connected or the wiring to the laser is interrupted (display LD OPEN when trying to switch on)

If you try to switch on now a beeper will signal the error.

☝ Attention ☝

Before switching on the laser current first set the laser diode current limit $I_{LD\ LIM}$ (hardware limit) for the applied laser diode.

The corresponding potentiometer is marked $I_{LD\ LIM}$ and is situated at the front panel of the LDC340.

3.11 CP gain

With this potentiometer at the back panel of the LDC340 the speed of the regulation loop in constant power mode can be adapted to the setup.

This potentiometer will usually be in a 6 o'clock position for standard speed.

If the speed is too high and overshoots occur please turn the potentiometer clockwise to achieve slower settling.

If you want to have a faster settling please turn the potentiometer counterclockwise.

Nevertheless the settling time also depends on the set power.

4 Communicating with a control computer (LDC340-IEEE)

4.1 General remarks

NOTE

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

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

NOTE

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

☝ Attention ☝

Before programming a LDC340-IEEE first set the limit value of the laser diode current $I_{LD\ LIM}$ (hardware limit) for the applied laser diode with a screwdriver.

The corresponding potentiometer is marked ADJ and located next to the LED $I_{LD\ LIM}$ situated at the front of the LDC340.

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

4.2 IEEE488 Interface

The IEEE488 interface of the LDC340 is based on the IEEE488.2 standard. This includes the IEEE488.1 standard for the hardware settings. There is a standard 24-pin IEEE488 jack at the rear of the unit. The address of the LDC340 must differ from that of other devices at the IEEE488 bus.

➔ (Please refer to chapter 4.2.2, “Setting up the Interface“, starting on page 29)

4.2.1 Interface specifications (IEEE 488 subsets)

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

4.2.2 Setting up the Interface

Address

The device address of the LDC340 can be changed by using the IEEE488 DIP switch located at the rear of the LDC340. SW1 to SW5 have to be set according to this table:

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

continued next page

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

NOTE

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

String Terminator

The string terminator of the LDC340 is preset to **<LF><EOI>**. This is fixed and cannot be changed.

The LDC340 will accept any combination of **<LF>** and **<EOI>** as terminator.

4.2.3 Connecting the Instrument

- Connect the LDC340 and the PC to the line
- Connect the units with shielded IEEE488 cables
- Switch on all units at the bus and the control computer

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

The LDC340 will automatically switch into REMOTE mode after the first character is transferred to it.

NOTE

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

➔ (Also refer to chapter 4.10, "Hints for setting up control programs" on page 64)

4.2.4 IEEE488 bus commands

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

If the control program for the LDC340 is written in a basic language as e.g. BASIC, then these IEEE488 control signals are automatically transmitted to the LDC340 according to the used driver software and do not have to be explicitly produced in the control program.

Also in the LabVIEW®- or LabWindows/CVI®-drivers from *Thorlabs GmbH* these functions are implemented (refer to our homepage: http://www.Thorlabs GmbH.com for latest driver updates).

When receiving the IEEE488 bus commands [GET], [LLO], [GTL], [DCL] and [SDC] the LDC340 will execute the following functions:

[LLO] Local Lockout

The command **[LLO]** will disable the button LOCAL. Switching back into LOCAL mode (manual operation) is only possible with the command **[GTL]** (see below.).

[GTL] Go To Local

The command **[GTL]** switches the LDC340 into LOCAL mode (manual operation). The previously set values for laser current, laser power etc. will no more be valid. The set values are determined by the main dial knob.

[DCL] Device Clear

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

NOTE

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

[SDC] Selected Device Clear

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

NOTE

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

4.3 Before Programming

4.3.1 Nomenclature

Program messages (PC ⇒ LDC340) are written in inverted commas: **"*IDN?"**
Response messages (LDC340 ⇒ PC) are written in brackets: **[MODE CC]**
There is a decimal point: **1.234**
Parameters are separated by comma: **"PLOT 2,0"**

4.3.2 Program and response messages

Blocks of message data are transferred between the controller and the LDC340 during communications. Messages sent from the controller to the LDC340 are called program messages and messages sent back from the LDC340 to the controller are called response messages. If a program message contains a query command i.e. a command which requests a response the LDC340 returns a response message.

Program messages

With program messages settings are effected (command) at the LDC340 and response messages are selected (query). Program messages can be separated with semicolon. All program messages are executed sequentially (one after the other).

Examples:

":MODE CC"	selecting the mode “constant current“ (command)
"*IDN?"	requesting the identification (query)
":LDPOL CG;:PDPOL AG"	selecting the laser diode polarity and the photo diode polarity.

Response messages

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

Example:

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

4.3.3 Data format

According to the IEEE488.2 specifications all data variables are divided into 4 different data formats:

Character response data (<CRD>)

Is a single character or a string. Examples:

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

➔ (Refer to IEEE488.2-1992 standard, chapter 8.7.1)

Numeric response data Type 1 (<NR1>)

Is a numerical value with sign in integer notation. Examples:

1 or **+1** or **-22** or **14356789432**

➔ (Refer to IEEE488.2-1992 standard, chapter 8.7.2)

Numeric response data Type 2 (<NR2>)

Is a numerical value with or without sign in floating point notation without exponent. Examples:

1.1 or **+1.1** or **-22.1** or **14356.789432**

➔ (Refer to IEEE488.2-1992 standard, chapter 8.7.3)

Numeric response data Type 3 (<NR3>)

Is a numerical value with or without sign in floating point notation with exponent with sign . Examples:

1.1E+1 or **+1.1E-1** or **-22.1E+1** or **143.56789432E+306**

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

4.4 Common commands and queries

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

4.4.1 Identification query

Syntax: **"*IDN?"**
Response: **[THORLABS GMBH, LDC340, 0, 2.17]**
Description: A reply consists of the following sequence:
<Manufacturer>, <Model>, <Serial No.>, <Firmware revision>

4.4.2 Reset

Syntax: **"*RST"**
Description: All set values will be reset to the default values. All outputs will switch off.

4.4.3 Self-test query

Syntax: **"*TST?"**
Response: **[0]**
Description: 0: Self-test finished with success.

4.4.4 Set Operation-complete bit

Syntax: **"*OPC"**
Description: The LDC340 will set the OPC-bit in the Standard-Event-Status-Register.

4.4.5 Operation-complete query

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

4.4.6 Wait

Syntax: **"*WAI"**
Description: The LDC340 will wait until the last operation is completed.

4.4.7 Event-Status-Enable-Register (ESE)

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

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

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

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

4.4.9 Service-Request-Enable-Register (SRE)

Programming:

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

Valid Range: 0..255

Default Value: 0

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

Reading:

Syntax: **"*SRE?"**

Response: **[<NR1>]**

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

4.4.10 Query Status-Byte-Register (STB)

Syntax: **"*STB?"**

Response: **[<NR1>]**

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

4.5 System command group

4.5.1 Answer mode

Programming:

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

Default value: FULL

Description: When switched to **"VALUE"** the LDC340 will send only the requested parameter without designator.

Example: When requesting the actual laser diode current with **":ILD:ACT?"** the LDC340 will only send **[5.123456E-02]** instead of **[:ILD:ACT 5.123456E-02]**. This is ☝ **not** ☝ according to the IEEE488.2 standard but useful if you want to increase speed.

Reading:

Syntax: **":SYST:ANSW?"**

Response: **[:SYST:ANSW FULL]**
[:SYST:ANSW VALUE]

Description: Queries the answer mode.

4.5.2 Error-LED mode

Programming:

Syntax: **":SYST:ERRLED OFF"**
":SYST:ERRLED ON"

Default Value: OFF

Description: When switched to **"ON"** the LDC340 will switch on the interface ERRor LED as long as there are errors in the error queue. When switched to **"OFF"** the interface ERRor LED will be dark.

Reading:

Syntax: **":SYST:ERRLED?"**

Response: **[:SYST:ERRLED OFF]**
[:SYST:ERRLED ON]

Description: Queries the Error-LED mode.

4.5.3 Querying the error queue

Syntax: **":SYST:ERR?"**

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

Description: Queries the error queue of the LDC340. The reply consists of the following sequence: **<Error No.>**, "**<Error text>**". If the error queue is empty: **[0, "No error"]** will response.

➔ (Please refer to chapter 4.8, “Error messages of the LDC340“ on page 52)

4.5.4 Oversampling rate

Programming:

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

Valid Range: 0..7

Default Value: 5

Description: Sets the LDC340 oversampling rate (see table below).

Reading:

Syntax: **":SYST:OSR?"**

Response: **[<NR1>]**

Description: Queries the oversampling rate.

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

4.6 Status command group

➔ (Refer to chapter 4.9, "Status reporting" on page 57)

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

Syntax: **":STAT:DEC?"**
Response: **[<NR1>]**
Description: Queries the Device-Error-Condition-Register (DEC) and returns the content in decimal notation. The content is not modified.

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

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

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

Programming:
Syntax: **":STAT:EDE <NR1>"**
Valid Range: 0...65535
Default Value: 0
Description: Sets the Device-Error-Event-Enable-Register (EDE).

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

4.7 LDC340 specific commands

4.7.1 Operation mode (MODE)

Programming:

Syntax: **":MODE CC"** (constant current)
":MODE CPI" (constant power, internal photo diode)
":MODE CPE" (constant power, external photo diode)

Assumption: The laser diode output is switched off.

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

Reading:

Syntax: **":MODE?"**

Response: **[:MODE CC]**
[:MODE CPI]
[:MODE CPE]

Description: Queries the mode of operation.

4.7.2 Laser diode polarity (LDPOL)

Programming:

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

Assumption: The laser diode output is switched off.

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

Reading:

Syntax: **":LDPOL?"**

Response: **[:LDPOL AG]**
[:LDPOL CG]

Description: Queries the polarity of the laser diode.

4.7.3 Photo diode polarity (PDPOL)

Programming:

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

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

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

Reading:

Syntax: **":PDPOL?"**

Response: **[:PDPOL AG]**
[:PDPOL CG]

Description: Queries the polarity of the photo diode.

4.7.4 Photo diode range (PDRANGE)

Programming:

Syntax: **":PDRANGE LOW"**
":PDRANGE HIGH"

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

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

Reading:

Syntax: **":PDRANGE?"**

Response: **[:PDRANGE HIGH]**
[:PDRANGE LOW]

Description: Queries the actual photo diode range.

NOTE

It is not possible to switch the photo diode range in local operation mode via the front panel.

4.7.5 Switching the bias voltage on and off (PDBIA)

Programming:

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

Assumption: The laser diode output is switched off.

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

Reading:

Syntax: **":PDBIA?"**

Response: **[:PDBIA OFF]**
[:PDBIA ON]

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

☝ Attention ☝

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

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

➔ (For checking the right polarity please refer to chapter 3.9.4, "Adjusting the bias voltage of the monitor diode" on page 24)

4.7.6 Switching the output on and off (LASER)

Programming:

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

Default Value: OFF

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

Description: Switches the laser diode output on or off.

Reading:

Syntax: **":LASER?"**

Response: **[:LASER OFF]**
[:LASER ON]

Description: Queries the state of the laser diode output.

NOTE

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

4.7.7 Reading the laser diode hardware limit (LIMCP)

Syntax: **":LIMCP:ACT?"**

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

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

➔ (Refer to 3.1.2, "Setting the limit of the laser current $I_{LD\ LIM}$" on page 13)

4.7.8 Laser diode current (ILD)

Programming:

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

Valid Range: Depends on the instrument type.

Default Value: 0 A

Assumption: The operation mode is switched to constant current.

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

Reading the set current:

Syntax: **":ILD:SET?"**

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

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

Reading the minimum current:

Syntax: **":ILD:MIN?"**

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

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

Reading the maximum current:

Syntax: **":ILD:MAX?"**

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

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

Reading the actual current:

Syntax: **":ILD:ACT?"**

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

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

4.7.9 Monitor diode current (IMD)

Programming:

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

Valid Range: Depends on the instrument type.

Default Value: 0 A

Assumption: The operation mode is switched to constant power.

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

Reading the set current:

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

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

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

Reading the minimum current:

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

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

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

Reading the maximum current:

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

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

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

Reading the actual current:

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

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

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

4.7.10 Calibrating a photo diode (CALPD)

Programming:

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

Valid Range: Depends on the instrument type.

Default Value: 1.0 A/W

Assumption: The laser diode output is switched off.

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

Reading the set sensitivity:

Syntax: **":CALPD:SET?"**

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

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

Reading the minimum sensitivity:

Syntax: **":CALPD:MIN?"**

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

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

Reading the maximum sensitivity:

Syntax: **":CALPD:MAX?"**

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

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

NOTE

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

➔ (Refer to chapter 3.1.4, “Adjusting the power display of an internal monitor diode“ on page 14)

4.7.11 Optical power (POPT)

Programming:

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

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

Default Value: 0 W

Assumption: The operation mode is switched to constant power.

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

Reading the set power:

Syntax: **":POPT:SET?"**

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

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

Reading the minimum power:

Syntax: **":POPT:MIN?"**

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

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

Reading the maximum power:

Syntax: **":POPT:MAX?"**

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

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

Reading the actual power:

Syntax: **":POPT:ACT?"**

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

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

➔ (See note at command CALPD on page 48)

4.7.12 Reading the optical power from the display (POPTP)

Syntax: **":POPTP:ACT?"**
Response: **[:POPTP:ACT <NR3>]**
Description: Queries the actual optical power, that is calculated from the position of the potentiometer marked ADJ next to the LED P_{LD}. This is the optical power shown on the display. Unit: [W]

NOTE

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

4.7.13 Reading the laser diode voltage (VLD)

Syntax: **":VLD:ACT?"**
Response: **[:VLD:ACT <NR3>]**
Description: Queries the actual laser diode voltage. Unit: [V]

4.7.14 Reading the bias voltage (VBIAS)

Syntax: **":VBIAS:ACT?"**
Response: **[:VBIAS:ACT <NR3>]**
Description: Queries the actual photo diode bias voltage. Unit: [V]

NOTE

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

4.7.15 Reading the monitor diode limit current (LIMMP)

Syntax: **":LIMMP:ACT?"**
Response: **[:LIMMP:ACT <NR3>]**
Description: Queries the actual monitor diode limit current.

4.7.16 Reading the internal photo diode current (IPDI)

Syntax: **":IPDI:ACT?"**
Response: **[:IPDI:ACT <NR3>]**
Description: Queries the actual photo diode current of the internal photo diode. Unit: [A]

4.7.17 Reading the external photo diode current (IPDE)

Syntax: **":IPDE:ACT?"**
Response: **[:IPDE:ACT <NR3>]**
Description: Queries the actual photo diode current of the external photo diode. Unit: [A]

4.8 Error messages of the LDC340-IEEE

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

An Error may occur as a result of a program message (refer to chapter 4.3.2, “Program and response messages“ on page 34).

Errors are divided into four categories (refer to chapter 4.9.1, “Standard event status register (ESR)“ on page 59).

Every query "**:SYST:ERR?**" will read out one error from the error queue until the error queue is empty (refer to 4.5.3, “Querying the error queue“ on page 40).

The error queue can keep 32 errors.

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

4.8.1 General errors

[0,"No errors"]

Category: None
Possible reason: The error queue is empty.

[100, "Unknown command"]

Category: Command Error
Possible reason: "**:HELLO WORLD**". This string sent to the LDC340 was not recognized as valid command.

[101, "Invalid character"]

Category: Command Error
Possible reason: "**!**". This character sent to the LDC340 does not belong to the allowed set of characters.

[102, "Invalid numeric parameter"]

Category: Command Error
Possible reasons: "**:ILD:SET 1.2a3**". This parameter is not valid.

[103, "Invalid text parameter"]

Category: Command Error
Possible reasons: "**:MODE hhh**". This parameter is not valid.

[109, "Wrong compound"]

Category: Command Error
Possible reason: "**:ITE:ERR?**". This combination is not allowed.

[110, "Unknown compound"]

Category: Command Error
Possible reason: "**:ITE:XXX?**". This compound is not known.

[111, "Wrong parameter"]

Category: Command Error
Possible reason: "**:MODE THL**". This compound is not valid for this command.

[190, "Parser buffer overflow"]

Category: Command Error
Possible reason: The string sent to the LDC340 was too long for the parser.

[200, "Data out of range"]

Category: Execution Error
Possible reason: "**:ILD:SET 10E+30**" sent to the LDC340 but this current is much too high.

[300, "Hardware error"]

Category: Device Error
Possible reason: Many. Device must probably be maintained.

[301, "Software error"]

Category: Device Error
Possible reason: Unexpected error. Please contact *Thorlabs GmbH*.

[302, "Not implemented yet"]

Category: Device Error
Possible reason: Feature not enabled. Please contact *Thorlabs GmbH*.

[303, "Key emulation error"]

Category: Device Error

Possible reason: Internal communication problem. Please contact *Thorlabs GmbH*.

[400, "Too many errors"]

Category: Device Error

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

[410, "Query interrupted"]

Category: Query Error

Possible reason: More than one query sent to the LDC340 before the read command.

[420, "Query unterminated"]

Category: Query Error

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

[500, "IEEE488 receive buffer overflow"]

Category: Device Error

Possible reason: The string sent to the LDC340 was too long for the IEEE488 receive buffer (250 char max).

4.8.2 LDC340 operation error messages

[1001,"Interlock is open"]

Category: Execution Error

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

➔ (Refer to chapter 3.2.2, "Using the interlock input" on page 16)

[1002,"Open circuit"]

Category: Execution Error

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

[1003,"Over temperature"]

Category: Execution Error

Possible reason: Try to switch on the output while the internal temperature is too high. Wait until the LDC340 has cooled down. Maintain proper air flow.

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

Category: Execution Error

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

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

Category: Execution Error

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

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

Category: Execution Error

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

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

Category: Execution Error

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

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

Category: Execution Error

Possible reason: The actual temperature of the TED 350 connected to the LDC340 is outside the temperature window.

[1012,"No bias change during laser on"]

Category: Execution Error

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

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

Category: Execution Error

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

[1014,"No calibrating of PD during laser on"]

Category: Execution Error

Possible reason: The monitor diode may not be calibrated during laser on.

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

Category: Execution Error

Possible reason: The mode of operation may not be changed during laser on.

[1017,"No PD range change during laser on"]

Category: Execution Error

Possible reason: The monitor diode range cannot be changed while the laser is on.

[1018,"No PD range change during bias on"]

Category: Execution Error

Possible reason: The monitor diode range cannot be changed while the bias voltage is supplied.

4.9 Status reporting

The LDC340 provides four 8 bit registers ESR, STB, ESE and SRE and three 16 bit registers DEC, DEE and EDE to program various service request functions.

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

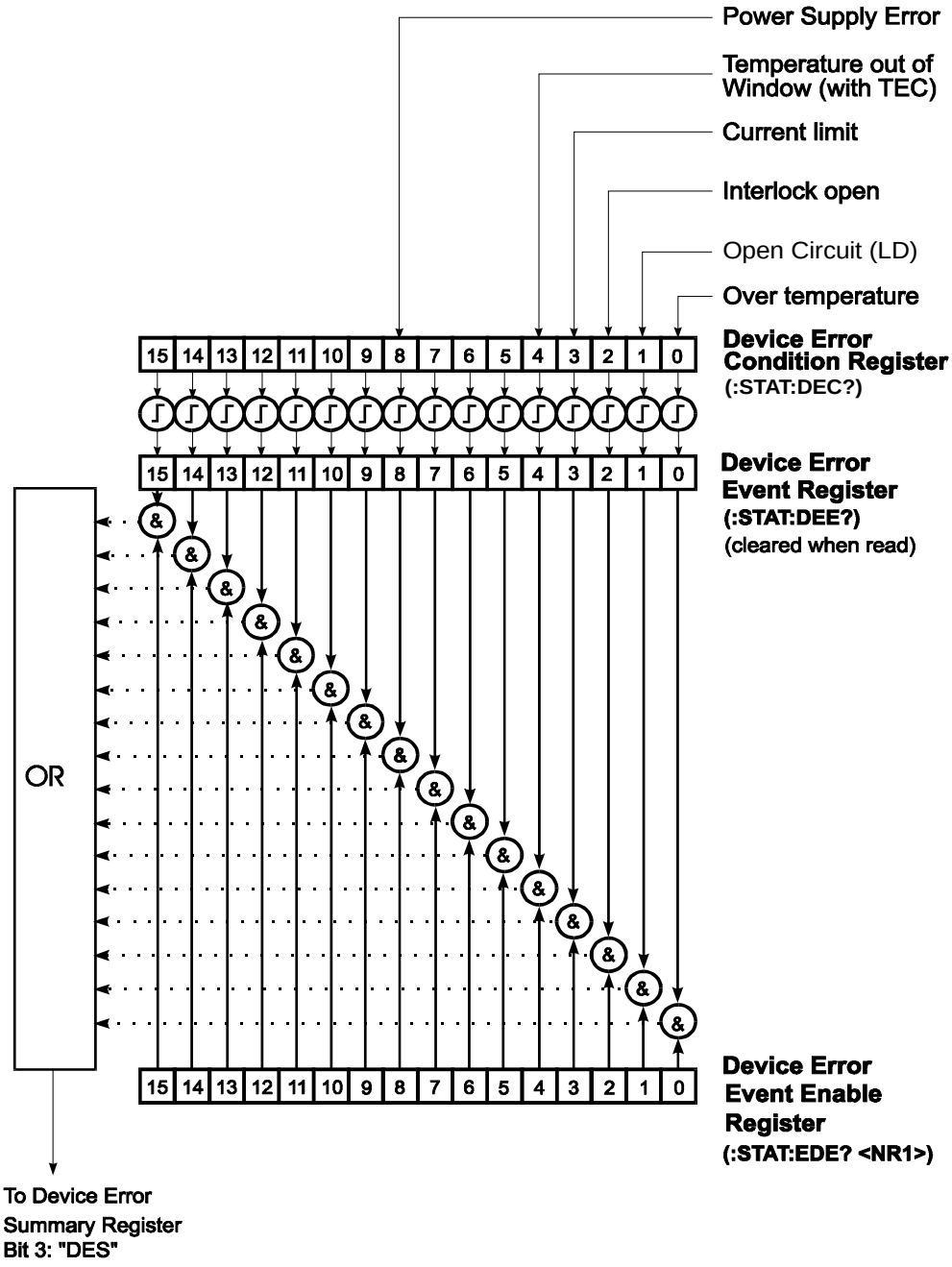


Figure 4 The status registers "DEC", "DEE" and "EDE"

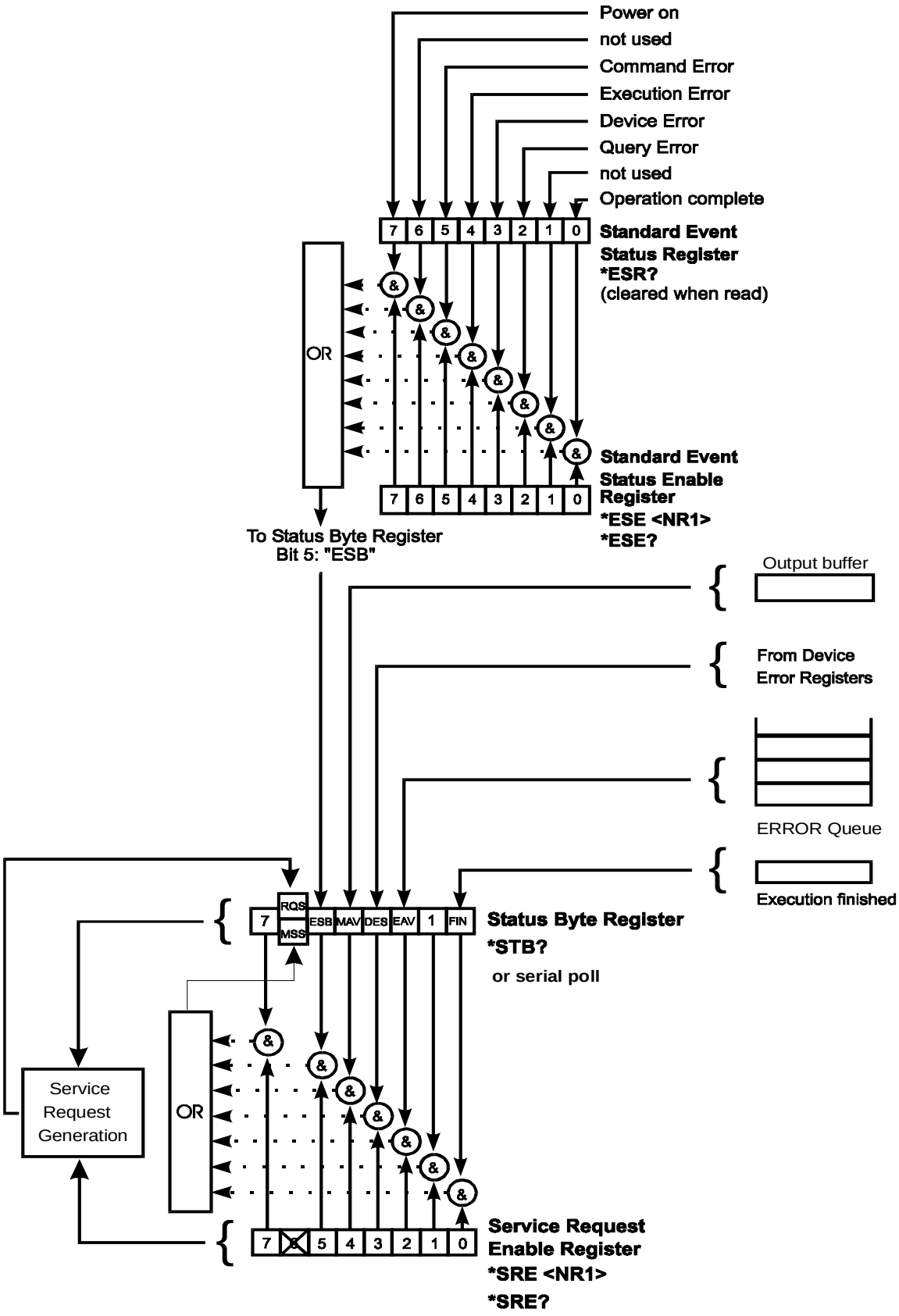


Figure 5 The status registers "ESR", "ESE", "STB" and "SRE"

4.9.1 Standard event status register (ESR)

The bits of this register mirror the following standard events:

Power on	This event bit indicates, that an off to on transition has occurred in the power supply. So it is high after switching on the device for the first time.
User request	(Not used)
Command error	A command error occurred.
Execution error	An execution error occurred.
Device error	A device dependent error occurred.
Query error	A query error occurred.
Request control	(Not used)
Operation complete	Can be set with **"*OPC"**

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

The bits are active high.

4.9.2 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.

4.9.3 Status byte register (STB)

The bits of this register are showing the status of the LDC340.

RQS RQS: Request service message: Shows, that this device has asserted SRQ (red via serial poll).

MSS Master summary status: Shows that this device requests a service (read via **“*STB“**).

MAV (message available) This bit is high after a query request, as a result "waits" in the output queue to be fetched. It is low, if the output queue is empty.

DES (device error status) This bit is high after a device error occurred. Which device errors shall set this bit is defined with the EDE.

EAV (error available) This bit is high as long as there are errors in the error queue.

FIN (command finished) This bit is high, after a command has finished and all bits of the STB have been set.

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

All bits except bit 6 of the STB can be used to assert a service request (SRQ) (Please refer to 4.9.5). Alternatively the SRQ can be recognized using the command **"*STB?"** (Please refer to 4.9.6) or by serial poll (Please refer to 4.9.7).

4.9.4 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.

4.9.5 Reading the STB by detecting SRQ

If an SRQ is asserted (see 4.9.5) bit 6 of the STB is set to logical 1, so that the controller can detect by auto serial polling, which device asserted the SRQ.

4.9.6 Reading the STB by *STB? command

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

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

4.9.7 Reading the STB by serial poll

If the controller does not "listen" to SRQs at all, the service request can also be detected via serial poll.

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

4.9.8 Device error condition register (DEC)

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

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

For an LDC340 bits 0 ... 4, 8 are used:

(0) Over temperature	Internal temperature too high. Wait until the LDC340 has cooled down. Maintain proper air flow.
(1) Open circuit	Cable to the laser diode has opened. Compliance voltage not high enough
(2) Interlock open	Interlock line is open.
(3) Current limit	The current limit is reached and the protection circuit is active now. Noise and drift specs are not valid any more.
(4) Temperature window	The temperature module detected a temperature window violation.
(8) Power supply error	Internal power supply error.

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

4.9.9 Device error event register (DEE)

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

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

4.9.10 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.

4.10 Hints for setting up control programs

The following flowcharts show the communication sequences between a control computer and a LDC340 using the IEEE488 interface. Use this sequences to ensure a fast and secure communication.

Flowchart for writing device commands

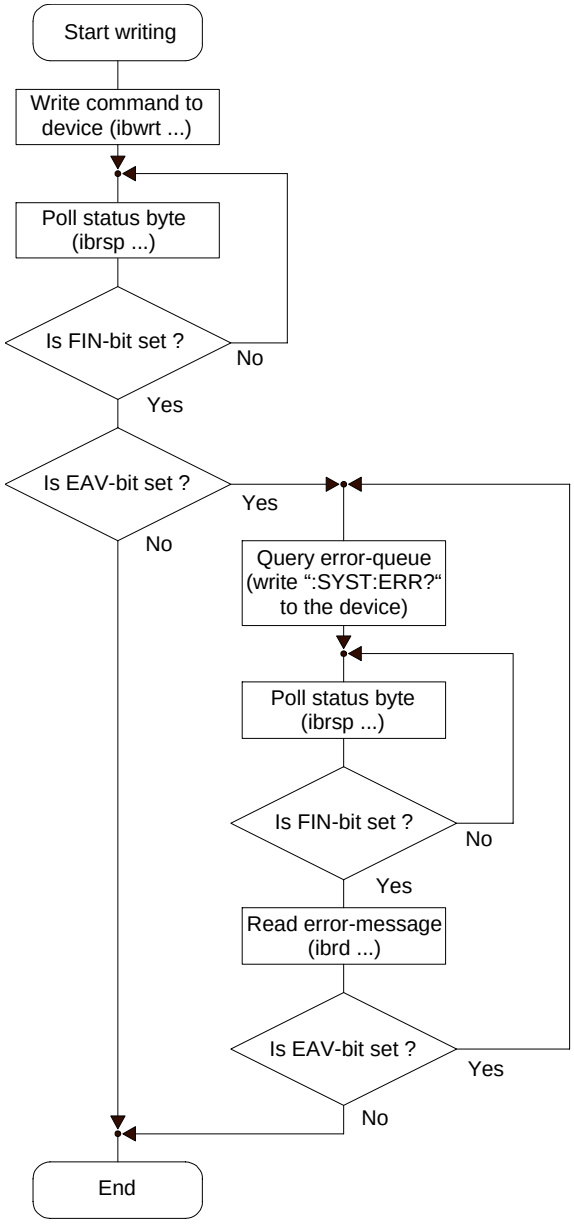


Figure 6 Writing device commands

Flowchart for querying device messages

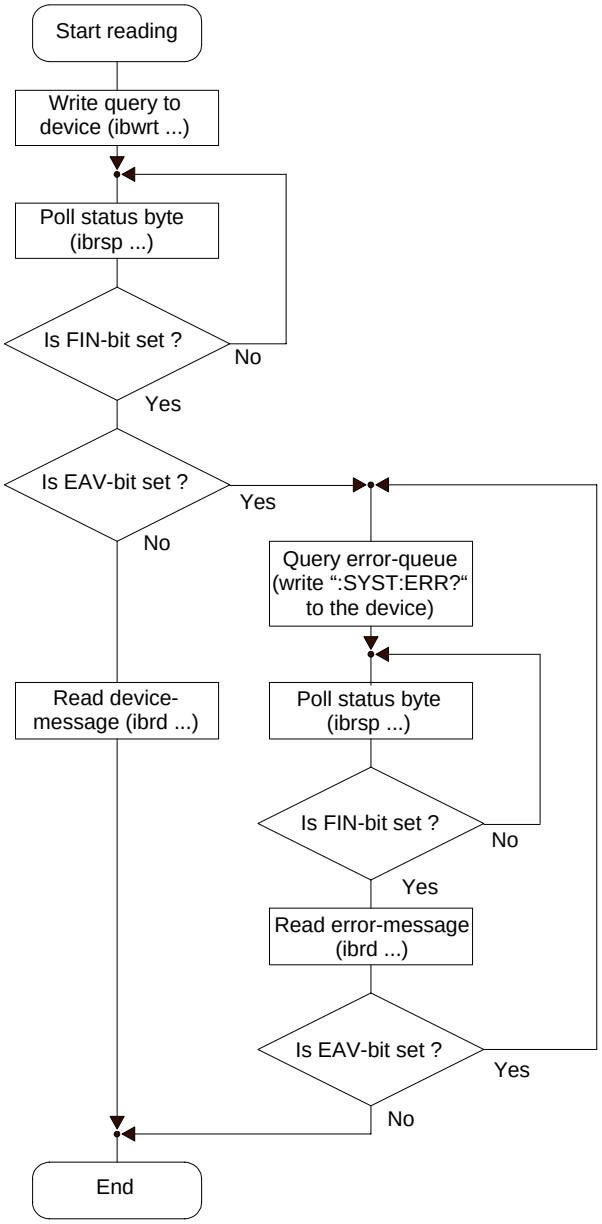


Figure 7 Querying device messages

NOTE

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

NOTE

The producer of the interface card of the control computer will provide communication functions for both directions between PC and LDC340 for all common software packages. These will be embedded into the programming text and accomplish the data transfer between control computer and LDC340. We recommend to build these write and read back commands into separate functions and then use these functions for the data transfer.

In these functions a globally to set flag should be requested that would determine whether the write or read back communication is to be read out together with talker and listener address at IEEE488 systems additionally into a data file or on the printer. When communication problems occur at the bus or in case of error messages that cannot be explained the evaluation of the data transfer between the LDC340 and the control computer will then be possible without much effort.

This also applies in programming the RS232C interface

5 Maintenance and repair

5.1 Maintenance

Protect the LDC340 from adverse weather conditions. The LDC340 is not water resistant.

☝ Attention ☝

To avoid damage to the LDC340, do not expose it to spray, liquids or solvents and do not use any abrasive or chemical cleaning agents.!

The LDC340 does not need a regular maintenance.

If necessary the unit and the LCD display can be cleaned with a cloth dampened with water.
You can use a mild 75% Isopropyl Alcohol solution for more efficient cleaning.

To guarantee the specifications given in chapter 6.3 over a long period it is recommended to have the unit calibrated by *Thorlabs GmbH* every two years.

There are no user serviceable modules inside. Any service must only be done by qualified service personnel.

The LDC340 does not contains any components to be repaired by the user. If any disturbances in function occur please first contact the *Thorlabs GmbH* technical hotline (refer to section 6.7, "Addresses" on page 83) before sending the device to *Thorlabs GmbH* for repair.

5.2 Selecting the line voltage

The line voltage can be selected with the line voltage selector on the rear of the LDC340. The LDC340 can be operated with 100 V 115 V or 230 V.

5.3 Exchanging the line fuse

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

☝ Attention ☝

To avoid fire hazard only the appropriate fuse for the corresponding line voltage is to be used:

100 V / 115 V : T4H250V
230 V : T2H250V
(IEC 60127-2/V, 5 x 20mm, 250 V, slow response)

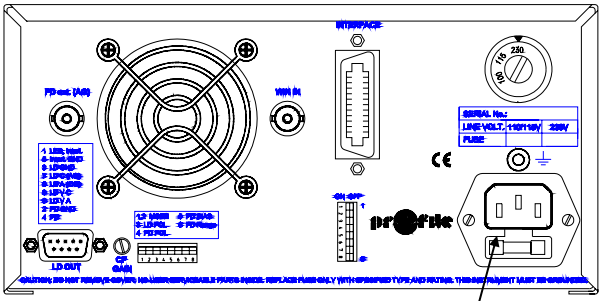


Figure 8 Rear view of the LDC340

- Switch off the LDC340 and remove the mains cable from the mains jack.

- Remove the cover of the fuse holder by means of a screwdriver. A small drawer will open up. If available first the replacement fuse is visible. The active fuse is located at the rear part of the drawer.

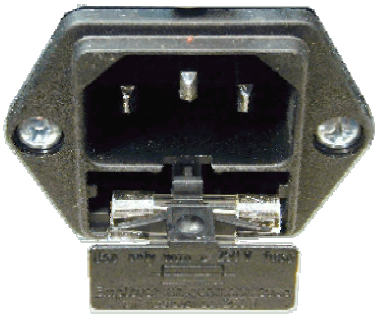


Figure 9 Exchanging the mains fuse

- Remove the fuse holder completely and exchange the blown fuse. We would recommend to check the same time if a replacement fuse is provided and if this fuse is still useable.

- Put the fuse holder back until is has snapped in.

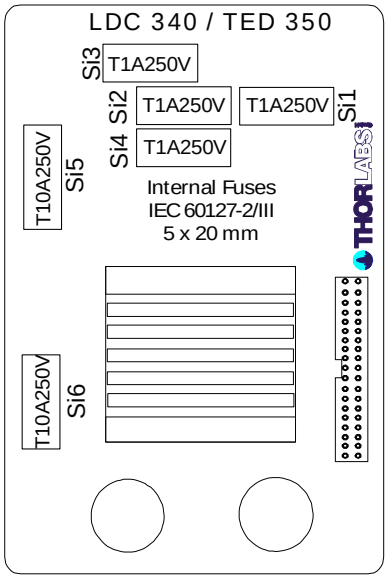
- Execute a function test of the LDC340 by switching it on. In case the LDC340 could not be switched on despite the correct fuse being inserted please contact your supplier or the *Thorlabs GmbH* technical hotline.

5.4 Exchange of internal fuses

Disconnect Power. To avoid electrical shock, first switch off the LDC340 power, and then disconnect the power cord from the mains power.

With the LDC340 turned over, remove the two screws that secure the cover to the chassis.

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



Replace the defective fuse, and reattach the cover.

5.5 Troubleshooting

In case that your LDC340 system shows malfunction please check the following items:

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

- ➢ Mainframe LDC340 connected properly to the mains?
  - ▪ Connect the LDC300 to the power line, take care of the right voltage setting of your mainframe.

- ➢ Mainframe turned on?
  - ▪ Turn on your LDC340 with the key mains-switch.

- ➢ Control the fuse at the rear panel of the LDC340 mainframe.
  - ▪ If blown replace the fuse by the correct type

◆ 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 3.2.2, "Using the interlock input" on page 16)

- ➢ Do you have turned on the laser output?
  - ▪ Set all necessary parameters and push the "LD ON" key or use the command "**:LASER ON**"

- ➢ Is the hardware limit $I_{LD\ LIM}$ or $I_{PD\ LIM}$ set to 0?
  - ▪ Adjust the hardware limits by means of the potentiometer on the front panel to appropriate values.

- ➢ Is the output power in CP mode or output current in CC mode set to 0?

Adjust the output power (or the output current) with the tuning knob or with the command "**:ILD:SET <NR3>,**"**:POPT:SET <NR3>**"or "**:IMD:SET <NR3>**"" depending on the operation mode.

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

- Is the laser diode polarity set correctly?
  - If not change the polarity.

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

- Is the photo diode polarity set correctly?

If not (negative current on display) change the polarity in the setup field on the front panel or with the command "**:PDPOL CG**" or "**:PDPOL AG**"

- Is the correct photo diode efficiency set (A/W)?
  - Calibrate the diode with the P_{LD} potentiometer on the front panel or with the command "**:CALPD:SET <NR3>**"

- Do you have connected a TEC-module but the laser temperature is out of window?
  - Disconnect the TED 350
  - or wait for the laser to reach the window temperature

If you don't find the error source by means of the trouble shooting list or if more modules work erratic please first contact the *Thorlabs GmbH – Hotline (profile@thorlabs.com)* before sending the whole LDC340 system for checkup and repair to *Thorlabs GmbH* -Germany.

➔ (Refer to section 6.7, "Addresses" on page 83.)

6 Appendix

6.1 Warranty

Thorlabs GmbH warrants material and production of the LDC340 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 fault 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 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.

6.2 Certifications and compliances

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions[1,2,3] and Immunity.[1,2,4]
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion C)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion B) [5]
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance criterion C)
	IEC 61000-4-5	Power Line Surge Immunity (Performance criterion C)
	IEC 61000-4-6	Conducted RF Immunity (Performance criterion 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.

[2] Compliance demonstrated with CAB400 cable installed at the LD Output port.

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

[4] Minimum Immunity Test requirement.

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

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC	
	EN 61010-1/A2:1995	Safety requirements for electrical equipment for measurement control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1	Standard for electrical measuring and test equipment.
	ANSI/ISA S82.01:1994	Safety standard for electrical and electronic test, measuring, controlling, and related equipment.
Canadian Certification	CAN/CSA C22.2 No. 1010.1	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC61010-1/A2:1995	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Equipment Type	Test and measuring	
Safety Class	Class 1 (as defined in IEC 61010-1, Annex H) - grounded product	

6.3 Technical data

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

General Data

Line voltage		100 V / 115 V / 230 V (-10%, +15 %) (fixed)
Line frequency		50 ... 60 Hz
Max. power consumption		125 VA
Supply mains overvoltage		Category II (Cat II)
Operating temperature		0 ... + 40 °C
Storing temperature		- 40 °C ... + 70 °C
Relative Humidity		Max. 80% up to 31 °C, decreasing to 50% at 40 °C
Pollution Degree (indoor use only)		2
Operation altitude		< 3000 m
Warm up time for rated accuracy		≤ 10 min
Weight		< 7 kg
Dimensions (W x H x D)	including operating elements	220 x 120 x 376 mm^3
	without operating elements	220 x 110 x 351 mm^3

Current control

Low range of laser diode current	0 ... ± 1 A
High range of laser diode current	0 ... ± 4 A
Compliance voltage	> 6 V
Setting resolution (manual / remote control)	1 mA / 70 µA
Measurement resolution (manual / remote control)	1 mA / 15 µA
Accuracy	± 4 mA
Noise without ripple (10 Hz ... 10 MHz, rms), typ.	< 30 µA
Ripple (50/60 Hz, rms), typ.	< 6 µA
Transients, typ.	< 4 mA
Drift, 24 hours, typ. (0 … 10 Hz, without changing the ambient temperature)	< 300 µA
Temperature coefficient	≤ 50 ppm/°C

Power control

Low range of photo current 1	5 µA ... 2 mA
High range of photo current 1	50 µA... ≥10 mA
Setting resolution photo current 1 (manual control)	0.1 µA / 1 µA
Setting resolution photo current 1 (remote control)	0.03 µA / 0.3 µA
Measurement resolution photo current 1 (manual control)	0.1 µA / 1 µA

Measurement resolution photo current 1 (remote control)	0.01 µA / 0.1 µA
Accuracy of photo current 1	± 2 µA / ± 20 µA
Display optical power 1	0 ... 2 W
Resolution optical power 1	100 µW
Bias voltage photo diode 1	0 ... 10 V
Control range of photo current 2	5 µA ... 2 mA
Setting resolution photo current 2 (manual control)	0.1 µA
Setting resolution photo current 2 (remote control)	0.03 µA
Measurement resolution photo current 2 (manual control)	0.1 µA
Measurement resolution photo current 2 (remote control)	0.01 µA
Accuracy of photo current 2	±2 µA
Bias voltage photodiode 2	n.a.

LD Current limit

Setting range	0 ... ≥ 4 A
Measurement resolution (manual / remote control)	1 mA / 0.1 mA
Accuracy	± 10 mA

PD Current limit

Setting range	0 ... ≥ 2 mA / 10 mA
Measurement resolution (manual control)	0.1 µA / 1 µA
Measurement resolution (remote control)	10 nA / 100 nA
Accuracy	± 20 µA / ± 200 µA

Laser voltage measurement

Measurement principle	4-wire
Measurement range	0 ... 10 V
Measurement resolution (manual / remote control)	1 mV / 100µV
Accuracy	± 10 mV

Analog modulation input (MOD IN)

Input impedance	10 kΩ
Max. input voltage	±10 V
Small signal 3 dB bandwidth (CC)	DC ... 50 kHz
Laser diode modulation coefficient (CC)	400 mA/V ± 5%
Laser diode modulation coefficient (CP)	0.2 mA/V ± 5% / 2 mA/V ± 5%

Analog control output (ANALOG OUT)

Load resistance	≥ 10 kΩ
Output voltage for 0 ... $I_{LD\ MAX}$	0 ... ± 10 V[1)]
Transmission coefficient	2.5 V/A ± 5%

Computer Interface (LDC340-IEEE)

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

1 sign depends on selected polarity

2 in High Resolution mode, at reduced measurement speed

6.4 Thorlabs “End of Life” policy (WEEE)

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

This offer is valid for Thorlabs electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see Figure 10)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

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

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

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

6.4.1 Waste treatment on your own responsibility

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

6.4.2 Ecological background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.
The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of live products will thereby avoid negative impacts on the environment.

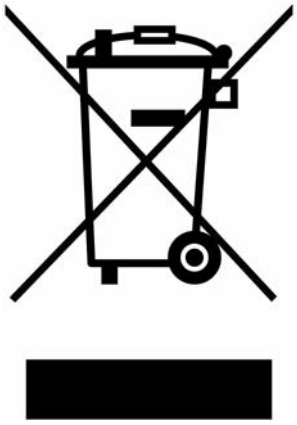


Figure 10 Crossed out “wheelie bin” symbol

6.5 List of acronyms

AC	Alternating Current
ADC	Analog to Digital Converter
AG	Anode Ground
ASCII	American Standard Code for Information Interchange
CC	Constant Current
CG	Cathode Ground
CLR	CleaR
CP	Constant Power
CR	Carriage Return
CRD	Character Response Data
CW	Continuous Wave
DAC	Digital to Analog Converter
DC	Direct Current
DCL	Device CLear
DEC	Device Error Condition Register
DEE	Device Error Event Register
DES	Device Error Summary Bit
DIN	Deutsche Industrie Norm
DIP	Dual In-line Package
EAV	Error Available Bit
EDE	Enable Device Error Event Register
EN	Europa Norm (European Standard)
EOI	End Or Identify
ERR	ERRor
ESE	Standard Event Status Enable Register
ESR	Event Status Register
FIN	Command FINished Bit
GET	Group Execute Trigger
GTL	Go To Local
IEEE	Institute for Electrical and Electronic Engineering
ILD	I (current) Laser Diode
IPD	I (current) Photo Diode
LD	Laser Diode
LDC	Laser Diode Controller
LED	Light Emitting Diode
LF	Line Feed

LLO	Local Lockout
NR1	Numeric Response data of type 1
NR2	Numeric Response data of type 2
NR3	Numeric Response data of type 3
MAV	Message Available Bit
MSS	Master Summary Status
N.C.	Not Connected
OTP	Over TemPerature
PC	Personal Computer
PD	Photo Diode
RF	Radio Frequency
RMS	Root Mean Squared
RQS	ReQuest Service Message
SDC	Selected Device Clear
SEL	SELect
SRE	Service Request Enable Register
SRQ	Service ReQuest
STB	STatus Byte Register
TEC	Thermo Electric Cooler (Peltier Element)
TRG	TRiGger

6.6 List of figures

6.7 Addresses

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

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