



Laser Diode Controller

LDC4000 Series Operation Manual



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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 live up to your expectations and improve our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

Warning

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

Attention

Paragraphs preceded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

Note

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

Please read these advices carefully!

1 General Information

The LDC4000 series is a high power precision laser diode controller series with a USB2.0 interface for driving laser diodes up to 20A laser current.

Special highlights of the LDC4000 Series Laser Diode Controllers are:

- Operate with anode- or cathode-grounded lasers and photodiodes
- Current (photodiode) and voltage (thermopile) feedback inputs
- The laser diodes can be operated in constant current as well as in constant power mode
- CW mode with modulation up to 100kHz
- Internal DDS generator for sine, square, triangle waveforms
- External modulation input
- QCW mode with pulse width down to 100 μ s
- QCW trigger input and trigger output
- Interlock for automatic switch off by an external emergency switch or by cable interruption
- Laser Diode Enable input for temperature loop monitoring
- A wide variety of protection features safeguard the laser diode from damage
- USB interface for remote operation supporting the USBTMC protocol
- SCPI compliant command set
- VXI/vni Instrument Drivers for various programming environments including NI-LabVIEW™, NI-LabWindows™/CVI and MS-Visual Studio
- Power efficient by active power management

This part of the operation manual contains specific information on how to operate the LDC4000 Series Laser Diode Controller. A general description is followed by an explanation of how to operate the unit manually. The Series 4000 instruments provide a USB 2.0 Full Speed interface according to the USB 2.0 specification, the USBTMC specification and the USBTMC USB488 specification.

Related documents:

- TED4000 Series Operation Manual available at www.thorlabs.com
- ITC4000 Series Operation Manual available at www.thorlabs.com
- Series 4000 Programmers Reference Manual at www.thorlabs.com

1.1 Safety

Attention

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

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

The LDC4000 Series Operation Manual must not be operated in explosion endangered environments!

Do not obstruct the air ventilation slots in the housing!

Do not remove covers!

Do not open the cabinet. There are no parts serviceable by the operator inside!

This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

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

Attention

Prior to applying power to the LDC4000 Series Operation Manual, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

Ensure that the line voltage setting of the fuse holder at the rear panel agrees with your local supply and that the corresponding fuses are inserted. If not, please change the line voltage setting (see section [Line voltage setting](#)) and the mains fuses (see section [Replacing the mains fuses](#)).

To avoid risk of fire, only the appropriate fuses for the corresponding line voltage must be used.

All modules must only be operated with duly shielded connection cables.

Attention

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the respective accompanying documentation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Standard ICES-003 for digital apparatus. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/T.V. technician for help.

Users that change or modify the product described in this manual in a way not expressly approved by Thorlabs (party responsible for compliance) could void the user's authority to operate the equipment.

Thorlabs GmbH is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs GmbH. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.

The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

Attention

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

Warning

Laser modules can deliver up to several Watts 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.

Vous pouvez trouver les traductions françaises des paragraphes ayant trait à la sécurité d'utilisation de ce produit sur le lien suivant:

https://www.thorlabs.com/_sd.cfm?fileName=16407-D04.pdf&partNumber=LDC4005

En outre, vous pouvez soit scanner le QR code, soit vous référer à la section "Documents" sur la page web du produit.



1.2 Laser Diode Protection

To protect the user and the connected setup, the LDC4000 series includes the following protective features:

Key switch

The key switch will shutoff the laser output. This feature complies with the CDRH (Center for Devices and Radiological Health) requirements and prevents an unauthorized usage off the laser driver.

Switch on delay

The LDC4000 controllers are CDRH compliant with the user programmable switch on delay. The default setting is 3 seconds.

Softstart

The softstart function protects the laser diode against undesired peaks.

Laser current limit (hardware limit)

The maximum laser current can be adjusted by the laser current limit.. The threshold can be set in the LD Source Setup menu.

(Refer to chapter [Setting the LD source parameters](#))

Interlock

The interlock input realizes several protection functions simultaneously.

- Safety lock to prevent unintentional use
- Cable damage monitoring
- An external emergency switch may be connected
- To connect your external automatic protection equipment, e.g. for temperature monitoring
- Laser ON/OFF LED

(Refer to chapter [Connecting the interlock and LD ON monitoring](#)). The laser can only be operated with the interlock input being closed.

Open circuit detection for the laser diode

If the connection to the laser is interrupted even for a short time during operation, an immediate emergency switch off occurs. The open circuit threshold can be set via the "Voltage Protection" feature. (Refer to chapter [Laser Output Configuration](#))

Electronic short-circuit switch for the laser diode

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

Control LED for laser current ON

When the laser current is switched on, a green LED indicator in the LD ON switch lights up.

Temperature window protection of the laser diode

A laser operation in a specified temperature range can be realized in combination with a Thorlabs temperature controller TED4015 or TED 350 (Refer to chapter [Laser output configuration](#)). The laser output is switched off, if the temperature leaves the defined temperature window.

Overtemperature protection

The LDC4000 has an automatic overtemperature protection. If the allowed internal operating temperature should be exceeded, the laser output will be switched off. After a temperature drop of about 10 °C, the output of the LDC4000 can be switched on again.

Defined states after switch-on

When turning on the LDC4000 with the main switch, the laser current output remains switched off.

Line failure monitoring

In case of line failure / line interruption the LDC4000 will restart anew as if it has been turned on. So the laser output remains switched off.

Mains filtering

The installed power supply, with carefully dimensioned filters, provides low ripple and noise at the laser output.

1.3 Ordering Codes and Accessories

<u>Ordering code</u>	<u>Short description</u>
----------------------	--------------------------

LDC4005	Laser Diode Controller, LD current range 0 ... 5 A
LDC4020	Laser Diode Controller, LD current range 0 ... 20 A
CAB4005	Shielded cable to connect the laser diode controller to a Thorlabs LM14S2, LDM21 or TCLDM9 laser diode mount (male 13W3 mixed DSUB connector to male 9 pin DSUB connector). The rated LD current is 5A.
CAB4006	Shielded cable to connect the laser diode controller to a Thorlabs high power laser diode mount (male 13W3 mixed DSUB connector to male 13W3 mixed DSUB connector). The rated LD current is 20A.
CON4005	Connector kit for LDC4000 laser diode controllers, 20A: Mixed DSUB connector type 13W3 (male) with three 20A high current contacts (male)
CAL-LDC4000	Recalibration of a LDC4000 series controller

Please visit our homepage www.thorlabs.com for further information.

2 Getting Started

Inspect the shipping container for damage.

If the shipping container appears to be damaged, keep it until you have checked the contents and you have inspected the LDC4000 controller mechanically and electrically.

Verify that you have received the following items:

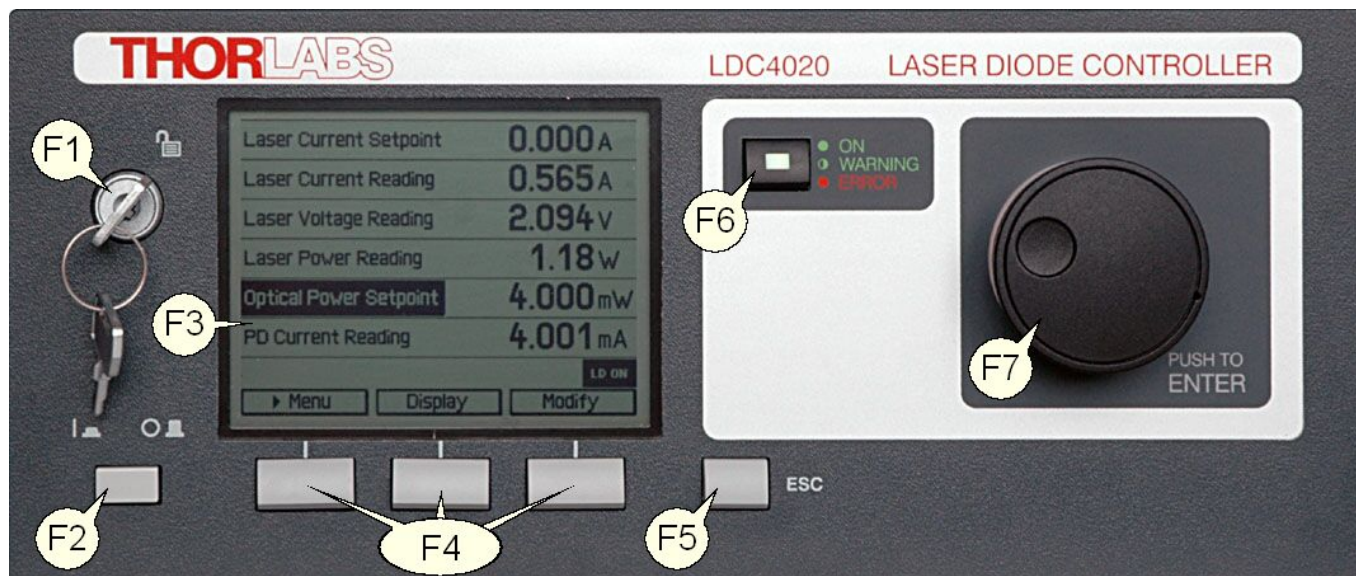
- 1 LDC4005 or LDC4020
- 1 power cord, connector according to ordering country
- 1 USB cable (A-B) 2 m
- 1 LDC4000 series operation manual
- 1 Series 4000 instrumentation CD (containing manuals, drivers, tools and software)
- With LDC4005: 1 CAB4005 shielded cable to connect the laser diode controller to a Thorlabs LM14S2, LDM21 or TCLDM9 laser diode mount (male 13W3 mixed DSUB connector to male 9 pin DSUB connector), rated laser current 5A
- With LDC4020: 1 CAB4006 shielded cable to connect the laser diode controller to a Thorlabs high power laser diode mount (male 13W3 mixed DSUB connector to male 13W3 mixed DSUB connector), rated laser current 20A
- 1 Connector Kit CON4005 for ITC4000 series, rated laser current 20A:
 - 1 Mixed DSUB connector type 13W3 (male) with 3 high current contacts (male)
 - 1 Mixed DSUB connector type 13W3 (female) with 3 high current contacts (female)

2.1 Preparation

Connect the mains connector (R10) of the unit to the line via the provided mains cable (refer to section [Operating elements at the rear panel](#)). An external optical setup can be connected to ground potential via the connector jack of the chassis ground (R12).

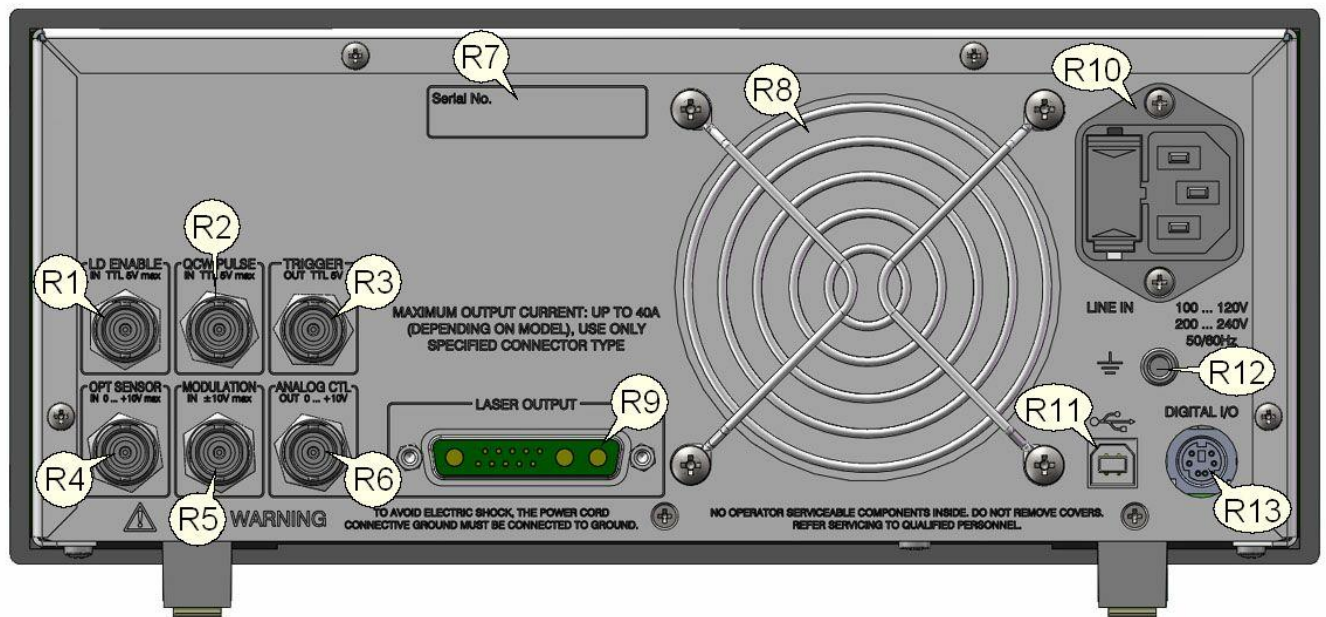
2.2 Operating Elements



Front Panel



- | | | |
|-----------|-----|----------------------------------------------------------------------------------|
| F1 | | Key switch (Locked/Unlocked) |
| F2 | | Line switch (On/Off) |
| F3 | | LC display |
| F4 | | Softkeys for menu navigation |
| F5 | ESC | Escape key |
| F6 | ON | LD On/Off button for the laser output with LD ON LED (green) and ERROR LED (red) |
| F7 | | Adjustment knob to change set values, push to enter |

Rear Panel



R1	LD ENABLE IN	Laser Enable input (high to enable laser ON), TTL 5 V max.
R2	QCW PULSE IN	Input for external trigger signal, TTL 5 V max.
R3	TRIGGER OUT	QCW pulse tracking output, TTL 5 V
R4	OPT SENSOR IN	Input for optical sensor, 0 ... +10 V max.
R5	MODULATION IN	Input for external modulation signal, -10 ... +10 V max.
R6	ANALOG CTL OUT	Output for laser current monitoring, 0 ... +10 V
R7	Serial No.	Serial number of the unit
R8		Cooling fan
R9	LASER OUTPUT	Laser diode output and optical sensor input (13W3 mixed DSUB jack)
R10	LINE IN	Mains connector and fuse holder
R11		USB connector
R12		4 mm banana jack for chassis ground
R13	DIGITAL I/O	MiniDin-6 jack for 4x digital I/O, I/O supply voltage (internal +12V) and GND

2.3 First Operation

Warning

Prior to switching on your LDC4000, please read the safety instructions in chapter [Safety](#) carefully.

Turn on the unit by means of the line switch (F2 - see section [Operating elements at the front panel](#)).

After switching on the unit, the backlight of the display (F3) must get visible and the backlight behind the adjustment knob (F7) must light up.

If nothing is shown on the display, please check the line voltage (see chapter [Line Voltage Setting](#)) and the mains fuses (see chapter [Replacing the mains fuses](#)).

The LDC4000 series is immediately ready to use after turning on. The rated accuracy is reached, however, after a warming-up time of approx. 30 minutes.

After switching on the unit, the graphics display will show the device status, followed by the measurement screen.

By using the softkeys (F4) you can select the menu items, the set values and the measurement readings to be displayed. You can change the set values by pressing the **Modify** button or the adjustment knob and then turning the adjustment knob (F7). Push this knob or the **Done** key to enter the adjusted value. If several menu items are displayed, you can select them also by turning and then pressing the adjustment knob.

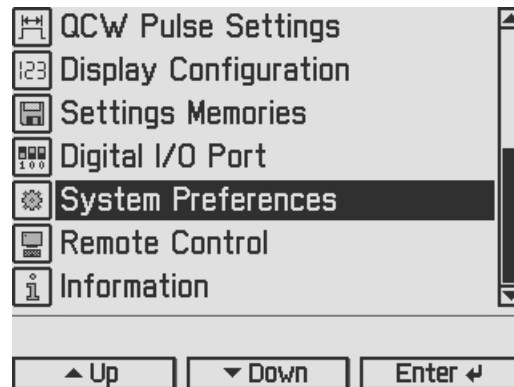
If changing a parameter isn't permitted in the actual operating mode, or you reach the end of a parameter number range, entering is declined and a short beep is audible.

From any menu level, you can navigate to the next higher menu level using the **ESC** key (F5). The highest level is the measurement screen.

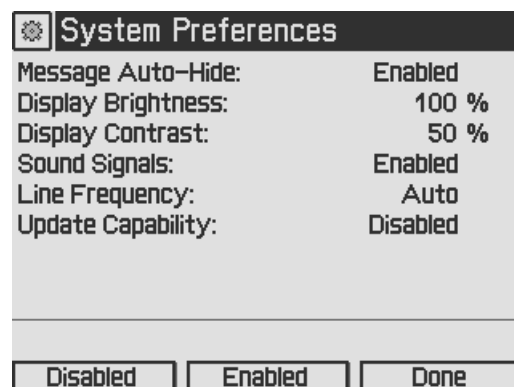
To leave the measurement screen and to enter the menu, press the **Menu** key or the **ESC** key.

2.4 System Preferences

In the System Preferences menu you can select different settings concerning your LDC4000 system configuration, including Message Handling, Display Brightness, Display Contrast, Sound Signals, and Update Capability. To get into the System Preferences menu, turn the adjustment knob or press **Up / Down** until System Preferences is highlighted. Press **Enter** or the adjustment knob to confirm.



Turn the adjustment knob or press **Up / Down** and select your desired menu item by pressing the **Modify** key or the adjustment knob. Make your necessary changes and confirm with the **Enter** key or by pressing the adjustment knob.



Message Auto-Hide:

Message and error conditions which force the Laser output to switch off may disappear after a short time. So it may be preferable to keep the error messages displayed. You can choose the following settings:

Enabled (auto-hide): Error popup messages disappear after 10 seconds, you can close them instantly by pressing the ESC button (F5).

Disabled: Messages are displayed until they will be confirmed by pressing the ESC button.

Display Brightness, Display Contrast:

Both display parameters can be changed from 0% to 100%. The brightness value also determines the illumination brightness of the adjustment knob.

Note

Please take care not to reduce the contrast value to a level making it impossible to read the display.

Sound Signals:

Here you can disable or enable the audibility of the error beeps and the menu navigation click response.

Line Frequency:

According to the mains properties, the line filter frequency can be set to 50 Hz or 60 Hz to suppress unwanted readout aliasing effects. The "Auto" function detects the line frequency automatically.

Update Capability:

Firmware updates can be performed by the user via the USB interface. Three options are available:

Enabled: Firmware can be updated at any time.

Enabled once: Firmware can be updated once, afterwards this setting changes to disabled.

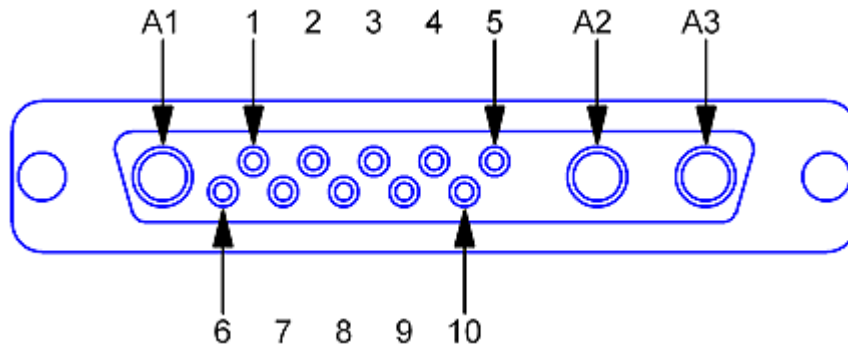
Disabled: Firmware update is inhibited (default setting).

For more information please refer to chapter [Firmware Update](#).

3 Operating the LDC4000 Series

3.1 Connecting Components

3.1.1 Pin Assignment of the Laser Output Jack



Pin assignment of the 13W3 DSUB laser output jack (rear panel view)

Pin Connection

Interlock and Status Indicator:

- 5 Output for interlock and status indicator "LASER ON/OFF" (+)
- 6 Ground pin for interlock and status indicator "LASER ON/OFF" (-)

Monitor Input / Power Feedback Source:

- 1 (Thermo) voltage sensor input (+)
- 2 (Thermo) voltage sensor ground (-)
- 7 Photo current sensor input
- 8 Photo current sensor ground

Laser Voltage Measurement:

- 4 Laser diode anode (+)
- 10 Laser diode cathode (-)

Laser Diode:

- A1 Laser diode ground
- A2 Laser diode cathode (with polarity AG) (-)
- A3 Laser diode anode (with polarity CG) (+)
- 3, 9 Not connected

Attention

The maximum output current for the LDC4020 is 20A. Use only the specified connector type: 13W3 mixed DSUB plug with high power contacts A1, A2, and A3 rated for at least 20A current. For wiring of A1, A2, and A3 use only wires rated for at least 20A current.

If Thorlabs laser diode mounts like TCLDM9, LDM21, or LM14S2 are used, the easiest way to connect them using a shielded cable CAB4005 (rated Laser current is 5A).

For use of other equipment's, a shielded cable with two 13W3 mixed DSUB plugs, CAB4006, (20A Laser current rating) is also available.

If using a custom-made cable, we recommend to use a shielded cable for the sensor inputs with twisted pairs. Use a separate shielded cable for the Laser current and Laser voltage measurement lines. The Laser current lines should be as short as possible and as close together as possible (e.g. twisted) to minimize inductance.

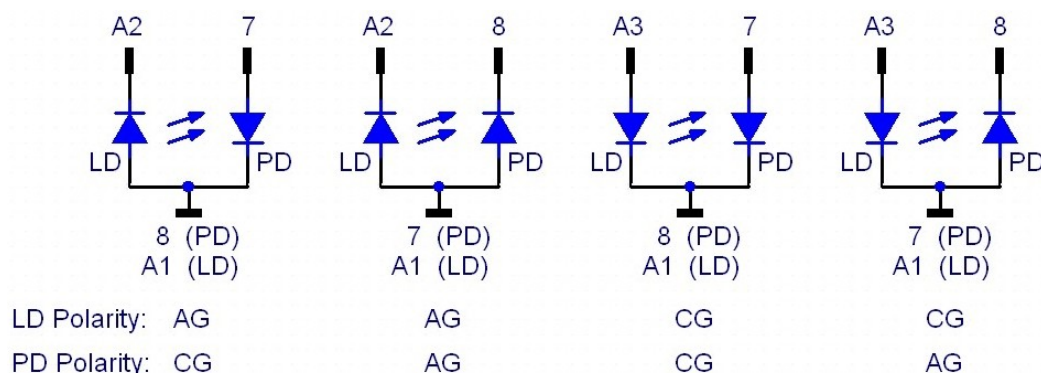
3.1.2 Connecting the Laser Diode

For CG polarity connect the laser diode with anode to A3 and with cathode to A1 (ground). For AG polarity, connect the laser diode with cathode to A2 and with anode to A1 (ground). Please refer to section [Pin assignment of the laser output jack](#).

Attention

Take care to select the proper polarity for the connected laser diode. A wrong polarity may damage the laser diode.

We recommend using separate shielded lines drilled in pairs (twisted pair) for laser diode current and laser voltage measurement, as well as for the sensor inputs. Some laser modules have a common ground pin for laser and photodiode. Figure 6 shows four wiring configurations for these modules.



3.1.3 Connecting an Optical Sensor as a Feedback Source

The LDC4000 Laser Diode Controllers support optical current sensors (e.g. photodiodes) and optical voltage sensors (e.g. thermopiles) for monitoring the laser power output. Both sensor types can be used as a feedback source for a constant power loop to stabilize the laser output power.

3.1.3.1 Connecting a Photodiode

The photodiode input circuit design is a trans-impedance amplifier with virtual ground (input impedance $\sim 0 \Omega$).

The photodiode can be connected to the 13W3 DSUB jack "LASER OUTPUT" (R9) pins 7 and 8 or to the BNC jack "OPT SENSOR IN" (R4) at the rear panel of the ITC4000 (please refer to section [Operating elements at the rear panel](#)).

For more information about connecting modules with common laser and photodiode ground please refer to section [Connecting the Laser Diode](#)

The photodiode input parameters like input route, polarity, current range, BIAS state, BIAS voltage and response can be set via [Setting the Photodiode Input Parameters](#).

We recommend using shielded "twisted pair" wiring for the monitor diode current measurement.

Attention

Input voltage / current must not exceed 10V / 20mA!

3.1.3.2 Connecting an Optical Voltage Sensor

An optical voltage sensor (like thermopile) can be connected to the 13W3 DSUB jack "LASER OUTPUT" (R9) or to the BNC jack "OPT. SENSOR IN" (R4) at the rear panel (please refer to section [Operating elements at the rear panel](#)). Sensor amplifiers or power meters with voltage output can be connected here as well.

Attention

Prior to connecting an optical voltage sensor to the BNC jack "OPT. SENSOR IN", make sure that the thermopile sensor input route is set to rear panel BNC (refer to [Setting the Thermopile Parameters](#)).

The voltage sensor input parameters like input route, voltage range and response can be set via [Setting the Thermopile Parameters](#).

We recommend using shielded "twisted pair" wiring for the thermopile voltage measurement.

Attention

Input voltage must not exceed 10V!

3.1.4 Connecting the Laser Voltage Measurement

The LDC4000 controllers offer laser voltage measurements with standard accuracy or enhanced accuracy. Without additional wiring, the laser voltage is measured at the "LASER OUTPUT" jack (R9) at the rear panel of the unit (two terminal measurement). This leads to a measurement error due to the voltage drop along the "current" lines to the laser diode, so a slightly increased voltage will be displayed.

For an enhanced laser voltage measurement, two additional lines must be connected as close as possible to the laser diode pins (four terminal measurement). Connect the laser diode anode to pin 4 and the laser diode cathode to pin 10 of the "LASER OUTPUT" jack (R9) at the rear panel of the unit.

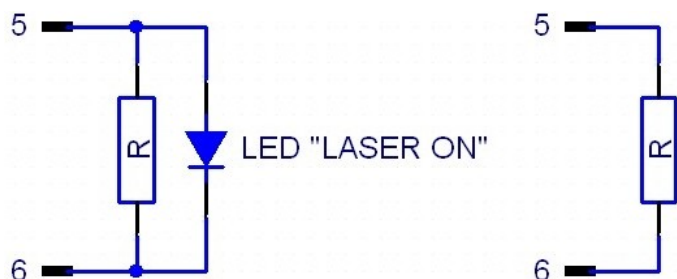
Attention

If the laser voltage measurement contacts (pin 4 and pin 10 of the "LASER OUTPUT" jack) are not used, they must be left unconnected to any other potential, otherwise the overvoltage protection may not work properly.

We recommend using separate shielded "twisted pair" wiring for the Laser voltage measurement to minimize noise in the current- or voltage feedback measurement.

3.1.5 Connecting Interlock and LD ON Monitoring

The interlock function is realized using two pins that must be connected to each other as a pre-condition for switching on the laser. These are pin 5 and pin 6 of the 13W3 DSUB "LASER OUTPUT" jack (R9) at the rear panel of the unit.



Connecting the Interlock with and without monitoring LED

Pin 5 and pin 6 must be connected externally by a wire (total resistance $<430\Omega$). If this connection is opened while the laser is switched on, there will be an acoustic signal and the laser will be switched off immediately. If the two pins are not connected, the laser cannot be switched on.

Furthermore the red LED in the "LD-ON" key (F6) on the front panel of the LDC4000 and a corresponding error message on the display will indicate that the interlock is open.

A LED can be connected in parallel to a resistor ($<430\Omega$) between pin 5 and pin 6. This LED lights up when the laser current is switched on (Laser ON indicator).

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 accomplished simultaneously via the interlock.

Examples of various protective interlock functions:

- An external emergency key (opener) is connected to the two pins of the interlock or in series to other interlock switches.
- 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 a certain temperature range is to be monitored a suitable (fast) thermo switch can be used.
- 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.
- If the interlock line is led in parallel to the laser current line a cable damage monitoring can be realized.

3.1.6 Control Outputs

Trigger Out:

The LDC4000 Trigger Output jack (R3) provides a tracking of the QCW pulse, preselected in QCW pulse settings. The output level is TTL5V.

Analog Control Out:

An Analog Control output (R1, see section [Operating elements at the rear panel](#)) is provided at the rear of the unit for monitoring purposes, e.g. to watch the settling behavior of the constant power control loop by means of an oscilloscope. At this jack, a voltage proportional to the actual driven laser current, scaled to the maximum laser current of the unit is available. The voltage ranges from 0 V to +10 V.

The voltage formula is:

$$U_{\text{out}} = 10\text{V} \times \frac{I_{\text{act}}}{I_{\text{max}}}$$

3.1.7 Laser Protection "LD Enable" Input

The LDC4000 has a "LD Enable" input for additional laser safety. Using this input, the laser diode can be switched off by an external TTL signal. Please connect this external "safety signal" to the BNC input jack "LD ENABLE IN" (R1) at the rear of the unit. The external signal should be low, in case of an error, to switch off the laser output.

The input is high active with an internal pull-up resistor, therefore, if no cable is connected, the input is at high level and the laser output is enabled.

In the Laser Output Configuration you can change the LD Enable functionality (please refer to chapter [Laser Output Configuration](#) for more information).

For example, if the LDC4000 is used together with a temperature controller (TED4015 or TED350), you can use the BNC jack "LD ENABLE IN" (R1) as a temperature window input, to switch off the laser current, if the temperature leaves a predefined window.

Attention

The LD ENABLE Input voltage must not exceed TTL level (5V)

3.2 Power-Up

Warning

Prior to switching on your LDC4000, please read the safety instructions in chapter [Safety](#) carefully.

Turn on the unit by means of the line switch (F2 - see section [Operating elements at the front panel](#)).



After switching on the unit, the graphics display will show the device status, followed by the measurement screen shown below. In the device status window, device specific information like device name, serial number, the installed firmware versions, and the calibration date will be shown. If any system error has occurred (refer to chapter [Error Messages](#)), the LDC4000 display will stay in the device status window. You can switch to the measurement screen window by pressing the ESC key.

LD Current Setpoint	0.0000 A
LD Current Reading	0.0001 A
LD Voltage Reading	0.001 V
TP Voltage Reading	0.000 V
▶ Menu Display Modify	

In the display configuration menu, the display can be configured to show two, four or six values. Factory setting is the four value screen.

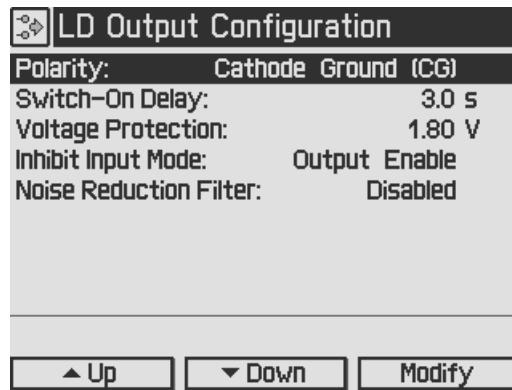
To change a setpoint displayed on the screen, select it using the softkeys or turning the adjustment knob. Press the **Modify** button or the adjustment knob to get into the entry mode. Adjust the value by turning the adjustment knob. The entry position to be changed can be selected by the **Coarse** or **Fine** buttons. Confirm your entry by pressing the **Done** button or the adjustment knob again.

Please refer to chapter [Display Configuration](#) for more information about selecting setpoints and measurement readings.

Switch into the menu by pressing the **Menu** button or the ESC key. In the LDC4000 menu you can change different LDC4000 settings described in the following chapters.

For a complete menu item listing, please refer to chapter [Menu structure overview](#).

3.3 LD Output Configuration



In the Laser Output configuration you can set the polarity of the driven laser diode, the switch on delay time, the laser voltage protection and the inhibit input mode of the "LD Enable" input.

Polarity:

The laser polarity can be chosen between anode grounded (AG) and cathode grounded (CG).

Attention

Take care to select the proper polarity for the connected laser diode. A wrong polarity may damage the laser diode.

Switch-On Delay:

With the CDRH Compliant Switch-On Delay option you can choose the time delay between pressing the "LD-ON" key and the point in time the laser output is switching on. A time delay from 0s to 60s is selectable. The default value is 3 seconds. This feature is required to conform several government requirements like the CDRH US21 CFR 1040.10.

Voltage Protection:

The voltage protection is an additional protection feature for the laser diode. It is recommended to set the voltage protection about 0.5V higher than the nominal laser voltage. If the protection voltage is reached the laser output will be switched off. Protection voltages from 1 V to 11 V can be set.

Inhibit Input Mode:

The Inhibit input mode predefines the behavior of your LDC4000 when using the "LD ENABLE IN" BNC jack as an error signal input.

You can choose between:

None	no action
Output enable	the laser output is switched off during a failure and will be switched on automatically, when the error condition will be fixed
Protection	the laser output is switched off and can only be switched on by pressing the "LD ON" key again

Noise Reduction Filter

The noise reduction filter is a low pass that can be enabled to significantly decrease the laser current noise.

Enabled	The filter is enabled, LD current noise is reduced.
Disabled	No filter.

Note

- The noise reduction filter is available only in LDC4005.
- Enabling the NR filter, the constant current modulation bandwidth decreases!

3.4 LD Source Setup

LD Source Setup	
Operating Mode:	Constant Current CW
Laser Current Limit:	20.200 A
Photodiode Current Limit:	20.00 mA
Thermopile Voltage Limit:	10.000 mV
Optical Power Limit:	20.00 W
Constant Power Mode Feedback Loop	
Source:	Photodiode Input
Speed:	0.1 %
<input type="button" value="▲ Up"/> <input type="button" value="▼ Down"/> <input type="button" value="Modify"/>	

Setting the operating mode:

In the LD Source Setup menu you can change the operating mode of your LDC4000 between Constant Current mode and Constant Power mode. In Constant Current mode an internal current loop to the laser will be closed. You can set the laser output current in Ampere, read back and display the actual laser current. In Constant Current mode a preselected pulse regime enabled in chapter [QCW Pulse Settings](#) may work together with the internal laser current loop. In Constant Power mode a control loop will be closed via an external feedback source (current or voltage). A laser current depending on the feedback value will be driven. The optical output power can be set and displayed in Watts, when the response of the connected feedback sensor is known and entered. Additionally you can set the corresponding feedback current for photodiodes or the feedback voltage for voltage sensor like thermopile.

Setting the laser current limit:

In the LD Source Setup menu, the laser diode current limit can be set. This limit is active in the constant current mode and in the constant power mode, and protects the laser diode against excessive laser current. This value can be set from 5mA to 5.05A for an LDC4005 and from 20mA to 20.2A for an LDC4020.

Setting the photodiode current limit:

The feedback photo current will be limited to this preselected value, so the optical output power will be clipped by a hardware circuit. This feature protects the optical setup against excessive optical power. If the photodiode range is switched from the high to the low range, the photodiode current limit will be constrained to the maximum value of the low range (if higher than the maximum before). When switching back to the higher range, the constrained value will remain and has to be increased if necessary.

Setting the thermopile voltage limit:

The feedback voltage will be limited to this preselected value, so the optical output power will be capped by a hardware circuit. This feature protects the optical setup against excessive optical power. If the thermopile voltage range is changed from a higher to a lower range, the thermopile voltage limit will be constrained to the maximum value of the lower range (if higher than the maximum before). When switching back to the higher range, the constrained value will remain and must be increased if necessary.

Setting the optical power limit:

The optical power limit can be set if the responsivity of the connected sensor is known and entered. The resulting photodiode current or thermopile voltage will be calculated by the LDC4000 Firmware.

Note

The photodiode current, the thermopile voltage, and the power limit values shouldn't be set to zero, otherwise the laser current may be limited by these power limits in constant current mode. If a power limit gets active in constant current mode, the operation mode changes over to constant power mode.

The response time of these limits is dependent on the control rate of the power feedback loop. If the feedback loop speed is adjusted to a very low level, the limit reaction will be accordingly slow. If a quick reaction is desired, the feedback loop speed should be optimized as described below. In any case, the laser current limit should be set to an appropriate value as an additional safeguard for the laser.

The maximum limit values are dependent on the connected sensor and the selected range for this sensor:

Optical sensor type	Measurement range	Limit range
current	2mA	0 to 2.02 mA
current	20mA	0 to 20.2 mA
voltage	10mV	0 to 10.1 mV
voltage	100mV	0 to 101 mV
voltage	1V	0 to 1.01 V
voltage	10V	0 to 10.1 V

Setting the constant power feedback loop:

In this menu topic, the feedback source for the constant power loop (photodiode or thermopile) can be set. In addition, the feedback loop speed can be limited to minimize oscillation and overshoots. For DC operating laser diodes, the speed should be set to the minimum value (0.1%). For modulated laser applications with a photodiode as sensor, the optimum feedback loop speed can be identified by using an internal square wave modulation (100Hz 20% modulation depth). With an oscilloscope connected to the ANALOG CTL OUT jack, the resulting waveform can be evaluated. Increasing the feedback loop speed as long as no overshoots are visible at the square wave, should result in an optimized setup. When using a thermopile sensor, a quite slow feedback loop speed may be necessary to obtain a stable constant power control.

3.5 LD Source Setpoints

LD Source Setpoints	
Constant Current Mode Setpoint	
Laser Current:	0.020 A
Constant Power Mode Setpoints	
Photodiode Current:	0.000 mA
Thermopile Voltage:	0.150 mV
Optical Power:	0.150 W
<input type="button" value="▲ Up"/> <input type="button" value="▼ Down"/> <input type="button" value="Modify"/>	

You can change the set point values for constant current or constant power mode depending on the selected operating mode. To select the operating mode please refer to chapter [Setting the LD source parameters](#).

For constant current mode, only the laser current can be adjusted. This value can also be changed from the measurement screen, if one of the displayed values is the laser current set point.

In constant power mode you can adjust the photodiode current or the thermopile voltage depending on the power feedback source selected in chapter [Setting the LD source parameters](#). If you have entered the response of your feedback source in mA/W (photodiode) or mV/W (thermopile) you can use the optical power set point to change the optical output power.

Note

In constant current mode, the constant power mode set points are ignored. In constant power mode, the laser current set point is ignored. Only the set point for the selected power feedback source will be effective.

3.6 Setting the Power Feedback Source Parameters

To select the power feedback source please refer to chapter [Setting the LD source parameters](#). Additional settings according to the selected sensor are described in the following two sub items.

3.6.1 Photodiode Input Settings

Photodiode Input	
Polarity:	Cathode Ground (CG)
Input Route:	DSUB connector
Range:	20mA
BIAS State:	Off
BIAS Voltage:	0.00 V
Response:	0.00100 A/W

▲ Up ▼ Down Modify

For current sensors like photodiodes the following parameters can be set:

Parameter	Selection	Description
Polarity	CG or AG	grounding of the used photodiode: CG: cathode grounded AG: anode grounded
Input Route	DSUB connector or Rear Panel BNC	configures which input connector is used
Range	2mA or 20mA	depending on nominal current of the used photodiode
BIAS State	On or Off	an applied reverse bias voltage is used to reduce the response time of the photodiode
BIAS Voltage	0 to ± 10 V	reverse bias voltage value. The sign is depending on the selected polarity
Response	entered in mA/W	is used to display a calibrated power value

For using photodiode sensors in the constant power loop please choose photodiode input as power feedback source (please refer to chapter [Setting the LD source parameters](#)).

Polarity:

The polarity in the Photodiode Input configuration menu can be chosen between anode grounded (AG) and cathode grounded (CG). For connecting the photodiode please refer to chapter [Connecting a photodiode](#)

Attention

Take care to select the proper polarity of the connected photodiode. A wrong polarity may damage the photodiode, if a bias voltage is applied.

Input Route:

The Input Route determines the used photodiode input. The Input Route will be the contacts 7 and 8 of the 13W3 Mixed DSUB jack "LASER OUTPUT" (R9) or the BNC jack "OPT SENSOR" (R4) on the rear panel. For using the 13W3 "LASER OUTPUT" please select DSUB connector. Otherwise please select Rear panel BNC.

Note

If the thermopile sensor is configured to the Rear Panel BNC a settings conflict will be shown. In this case set the thermopile input route to DSUB connector.

Range:

The LDC4000 features two photo current input ranges. Please choose the 20mA range for higher photo currents and the 2mA range for higher sensitivity.

BIAS State:

The BIAS State switches the adjusted BIAS voltage On or Off. A BIAS voltage offers a shorter response time of the connected photodiode. For the maximum permitted reverse voltage please refer to the data sheet of the used photodiode.

BIAS Voltage:

The BIAS voltage can be adjusted from 0 to +10V with CG polarity and from 0 to -10V with AG polarity.

Response:

The photodiode responsivity value is used for a calibrated power adjustment. The adjustment range is 0.01mA/W to 10 A/W. With this parameter set correctly, the optical output power can be displayed in Watts. The resulting photodiode current setpoint will be calculated automatically by the LDC4000.

3.6.2 Thermopile Input Settings

Thermopile Input	
Input Route:	Rear panel BNC
Range:	10mV
Response:	2.084 mV/W

▲ Up ▼ Down Modify

For voltage sensors like thermopiles the following parameters can be set:

Parameter	Selection	Description
Input Route	DSUB connector or Rear Panel BNC	configures which input connector is used
Range	10mV, 100mV, 1V or 10V	depending on nominal voltage of the used voltage sensor
Response	entered in mV/W	is used to display a calibrated power value

For using thermopile sensors please choose thermopile input as power feedback source described in chapter [Setting the LD source parameters](#).

Input Route:

The Input Route determines the used thermopile input. The Input Route will be the contacts 1 and 2 of the 13W3 Mixed DSUB jack "LASER OUTPUT" (R9) or the BNC jack "OPT SENSOR IN" (R4) on rear. For using the 13W3 DSUB jack "LASER OUTPUT" please select DSUB connector. In other case please select Rear Panel BNC.

Note

If the photodiode input route is set to the Rear Panel BNC a settings conflict will be shown. In this case set the photodiode input route to DSUB connector.

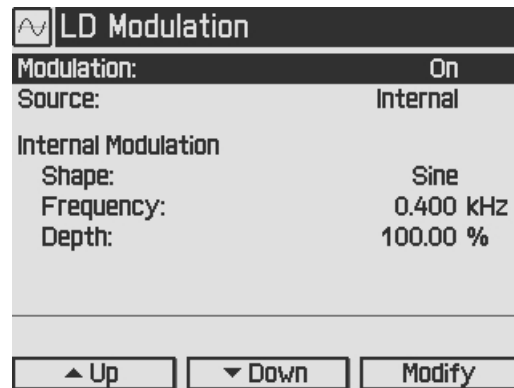
Range:

Four voltage ranges from 10mV to 10V are offered. For thermopile sensors, the 10mV or 100mV ranges are recommended. For other voltage sensors, sensor amplifiers or power meters, you can also use the 1V or 10V ranges depending on the maximum output voltage.

Response:

The thermopile responsivity value is used for a calibrated power adjustment. The adjustment range is 0.01mV/W to 500 V/W. With this parameter set correctly, the optical output power can be displayed in Watts. The resulting sensor voltage setpoint will be calculated automatically by the LDC4000.

3.7 LD Modulation Settings



The LDC4000 provides a modulated operation of laser diodes in constant current and constant power mode. The modulation signal can be generated internally or by an external source.

An internal function generator offers an AC coupled sine, triangle or square signal. The modulation frequency range is 20 Hz to 100 kHz for the LDC4005 and 20 Hz to 50 kHz for the LDC4020. The modulation depth can be set from 0.1% to 100%. In constant current mode, this percentage means the peak to peak value of the output current in relation to the nominal maximum current of the laser diode controller.

Example: A DC current of 10 A (LDC4020) is modulated from 8A to 12 A with 20% modulation depth.

In constant power mode, the bandwidth may be limited by the constant power loop characteristics (for optimizing the speed of the constant power loop, please refer to chapter [Setting the LD source parameters](#)). In this mode, the percentage refers to the peak to peak value of the optical power in relation to the selected power range.

The external modulation input allows a precision power level control or a wavelength tuning of the laser.

When using an external modulation source, please connect the external source to the "MODULATION IN" BNC jack (R5) on rear of your LDC4000 and switch the modulation source to External. The modulation signal is DC coupled and added to the current setpoint (in constant current mode) or to the power setpoint (in constant power mode).

The resulting values for the laser current " I_{LD} ", the photodiode current " I_{PD} " and the thermopile voltage " U_{TH} " are calculated as:

$$I_{LD} = I_{LDset} + I_{LDmax} * U_{MOD} / 10V \text{ (in constant current mode)}$$

$$I_{PD} = I_{PDset} + I_{PDmax} * U_{MOD} / 10V \text{ (in constant power mode, photodiode sensor)}$$

$$U_{TH} = U_{THset} + U_{THmax} * U_{MOD} / 10V \text{ (in constant power mode, thermopile sensor)}$$

with:

- I_{LDmax} : maximum laser current (e.g. 5A for a LDC4005)
- I_{PDmax} : maximum photodiode current (depending on selected range)
- U_{THmax} : maximum thermopile voltage (depending on selected range)
- I_{LDset} : set value in constant current mode
- I_{PDset} : set value in constant power mode, photodiode as sensor
- U_{THset} : set value in constant power mode, thermopile as sensor
- U_{MOD} : modulation voltage at "MODULATION IN BNC" jack (R5)

For example; you can add a bipolar ($0 \dots \pm 5V_{max}$) modulation to an internal adjusted 50% current / power value or a unipolar modulation ($0 \dots 10V$) if the internal adjusted "DC" value is zero. The laser current can be monitored at the "ANALOG CONTROL OUT" jack (R6) at the rear panel.

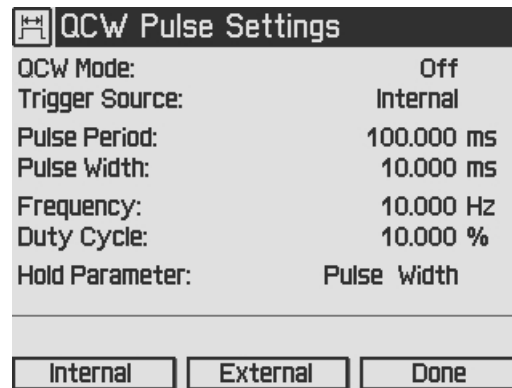
Note

If the laser current or the laser power reaches the adjusted limits, the status indicators "I LIMIT" or "P LIMIT" are shown and the green "LD ON" LED is flashing. The modulation will be clipped to the adjusted limit values.

Attention

The input voltage at the "Modulation Input" BNC jack must not exceed $\pm 10V$!

3.8 QCW Pulse Settings



The Quasi Continuous Wave (QCW) mode allows the laser output to be pulsed with an internal or an external trigger source. All necessary pulse parameters can be set in the QCW pulse settings menu.

QCW Mode

Off sets the LDC4000 to "CW" (continuous wave) mode. This is the default setting.

On enables the "QCW" (quasi continuous wave) mode. Changes in the state of the QCW mode (On/Off) are only possible if the laser output is switched off.

The QCW mode can only be enabled in constant current mode. Otherwise the error message "Wrong LD Source Operating Mode" will be shown. In this case please set the LD operating mode to constant current. (please refer to chapter [Setting the LD source parameters](#))

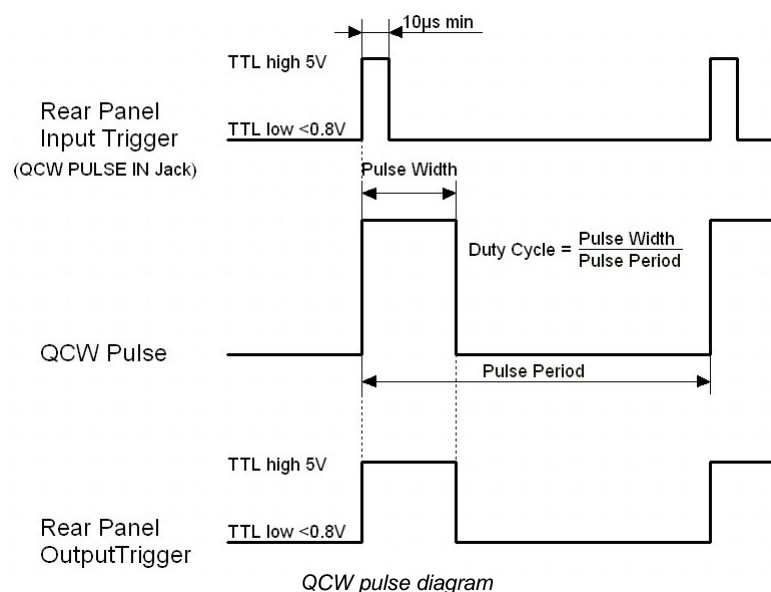
Trigger Source

This parameter specifies the QCW pulse trigger source.

Internal: current pulses are generated regularly with the specified period / frequency.

External: a single current pulse is generated each time a rising edge is detected at the QCW Pulse input (R2) at the rear of the unit.

The parameters shown in the QCW pulse settings menu are dependent on the trigger source used. The upper screenshot shows the parameters for internal triggering.



Pulse frequency / Pulse period

This is the pulse repetition rate in case of internal triggering. Pulse frequency is the reciprocal value of the pulse period. If you change one value the other will be readjusted automatically. The pulse period can be changed from 1ms to 5s, the pulse frequency accordingly from 1 kHz to 0.2 Hz.

Duty cycle

Means the duration of the QCW pulses in relation to the pulse period. It can be set from 0.002% to 99.999% depending on the used pulse period.

Pulse width

Means the duration of the QCW pulse and can be set from 100 μ s to 1s pulse width.

Hold parameter

Sets the parameter to be held constant when the pulse period or the frequency changes. The hold parameter can be the duty cycle or the pulse width. If the trigger source is set to external, the following parameters will be shown.

QCW Pulse Settings	
QCW Mode:	Off
Trigger Source:	External
Minimum Pulse Period:	100.000 ms
Pulse Width:	10.000 ms
Pulse Frequency:	---
▲ Up	
▼ Down	
Modify	

Minimum pulse period

The minimum pulse period indicates the minimum permitted time between the rising edges of two trigger pulses. Trigger pulses following after a time interval shorter than the minimum pulse period will be ignored.

Pulse width

Corresponding to the internal triggering the QCW pulse width can be changed from 100 μ s to 1s.

Pulse frequency

With an external trigger source, the pulse frequency is a measured value and therefore can't be set.

3.9 Display Configuration

The display can be configured to show two, four or six values on the screen. Factory setting is the four value screen.

Laser Current Setpoint 18.000 A	LD Current Setpoint 0.0000 A	Laser Current Setpoint 18.000 A
Laser Current Reading 18.000 A	LD Current Reading 0.0001 A	Laser Current Reading 18.000 A
	LD Voltage Reading 0.001 V	Laser Voltage Reading 10.819 V
	TP Voltage Reading 0.000 V	Laser Power Reading 194.75 W
		PD Current Setpoint 0.200 mA
		PD Current Reading 0.198 mA
LD ON		LD ON
Menu Display Modify	Menu Display Modify	Menu Display Modify

You can select your favorite measurement screen by pressing the **Display** button or in the Display Configuration menu. Press the **Menu** button, scroll to the Display Configuration and press the **Enter** button or the adjustment knob. You get the following display configuration:

123 Display Configuration
Display: 6 Value Screen
1: LD Current Setpoint
2: LD Current Reading
3: LD Voltage Reading
4: LD Power Reading
5: Thermopile Voltage Reading
6: Optical Power Reading via Thermopile
▲ Up ▼ Down Modify

In the **Display configuration** menu you can select the favorite screen configuration with two, four or six values. For each value number (depending on selected values per screen), you can choose one of the following setpoints or readings:

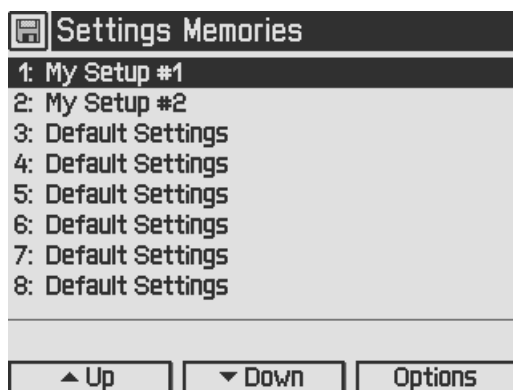
- Source Setpoint; shown value dependent on selected operating mode (LD Current Setpoint if constant current mode or LD Optical Power Setpoint if constant power mode)
- LD Current Setpoint
- LD Optical Power Setpoint
- Photodiode Current Setpoint
- Thermopile Voltage Setpoint
- LD Current Reading
- LD Voltage Reading
- LD Power Reading
- Photodiode Current Reading
- Optical Power Reading via Photodiode
- Thermopile Voltage Reading
- Optical Power Reading via Thermopile

For choosing the desired values please select the appropriate line by turning the adjustment knob. Then press **Modify** or the push button on adjustment knob and choose your desired value. For confirmation press **Done** or the adjustment knob again.

3.10 Settings Memory

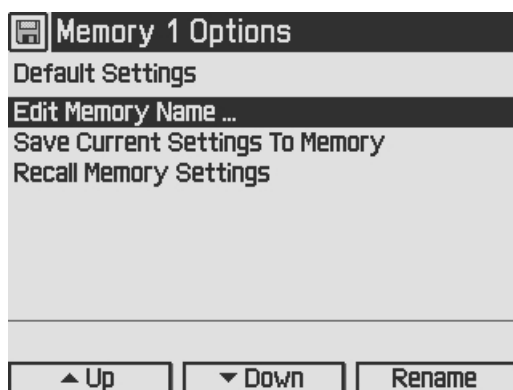
With the exception of the “LD ON” state, all settings will be saved when the LDC4000 series is powered down.

Additionally, the **Settings Memories** menu can be useful in saving several sets of specific settings like: current limit, power limits, polarities, sensor input settings etc. for the connected laser setup. Consequently, you can reload the saved setup parameters from one of the eight memory spaces in the **Settings Memories** menu.

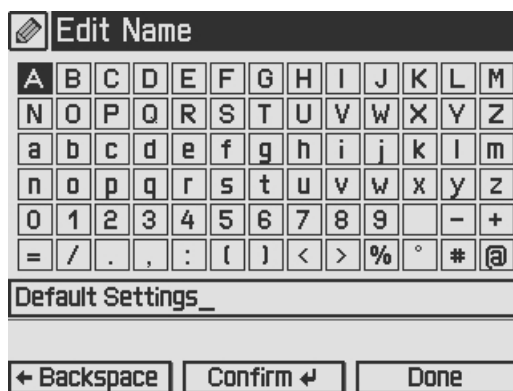


Select the desired data set by turning the adjustment knob or by pressing **Up / Down**. Enter the menu for the respective data set by pressing the **Options** key or the adjustment knob.

In the **Edit Memory Name...** menu

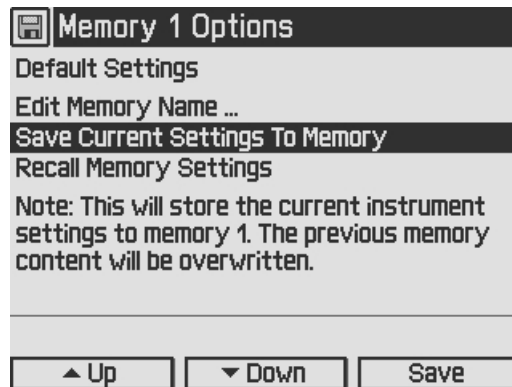


you get a table of characters.



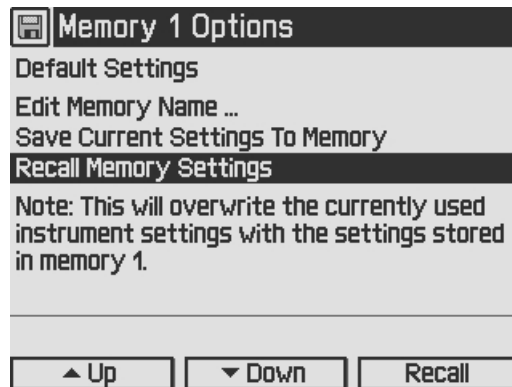
Select a character by turning the adjustment knob (F7) and then press **Confirm**. The selected character will be inserted in the text field. Delete mistyped characters by pressing **Backspace**. When you are finished, confirm with **Done**.

Save Current Settings To Memory allows to save all current laser controller settings. Note that this will overwrite the settings stored in the selected data set.



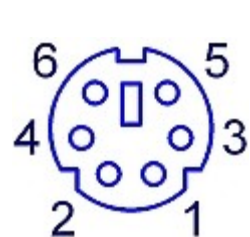
Via **Recall Memory Settings** you can load a saved laser setup. Note that this will overwrite your currently used instrument settings.

Before recalling data from the memory, the Laser output must be switched off (if on) by means of the LD ON button (F6, see section [Operating elements at front panel](#)).



3.11 Digital I/O ports

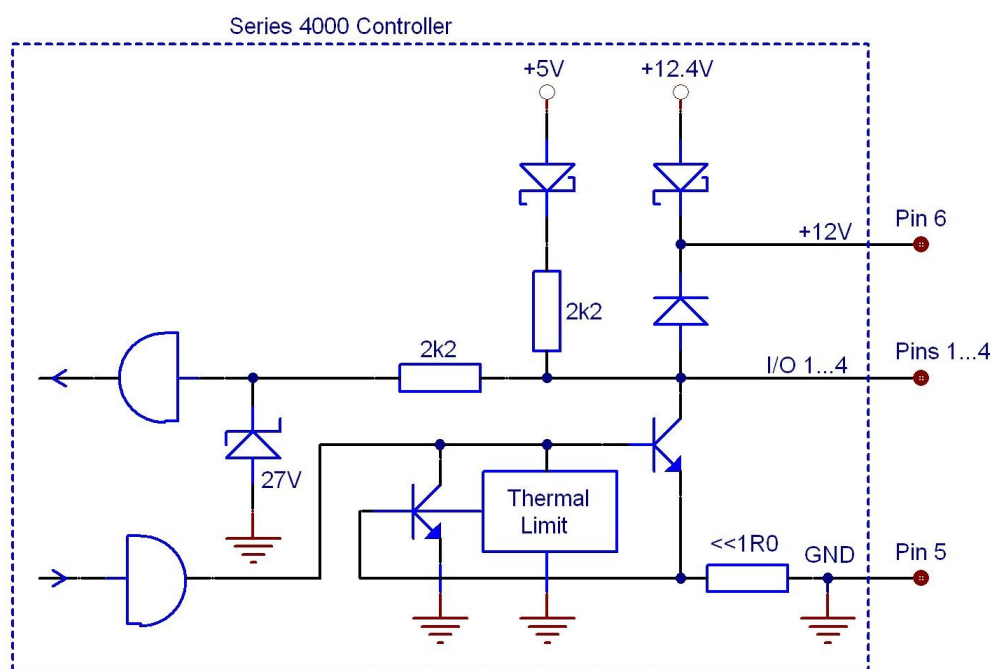
The laser diode controllers of the LDC4000 series have a very versatile digital port providing four separately configurable Input / Output lines. This feature allows control of external circuitry from the unit, or control of the unit from external circuitry (via PC software). Figure 58 shows the pin layout of the 6 pin Mini-DIN jack (R13, see section [Operating elements at the rear panel](#)).



Digital I/O jack (Mini-DIN 6, female, rear panel view)

Pin	Connection
1	I/O1
2	I/O2
3	I/O3
4	I/O4
5	GND
6	I/O Supply voltage (+12 V from internal or higher external voltage up to +24 V)

The figure below shows the I/O port basic circuit (applicable for each channel).



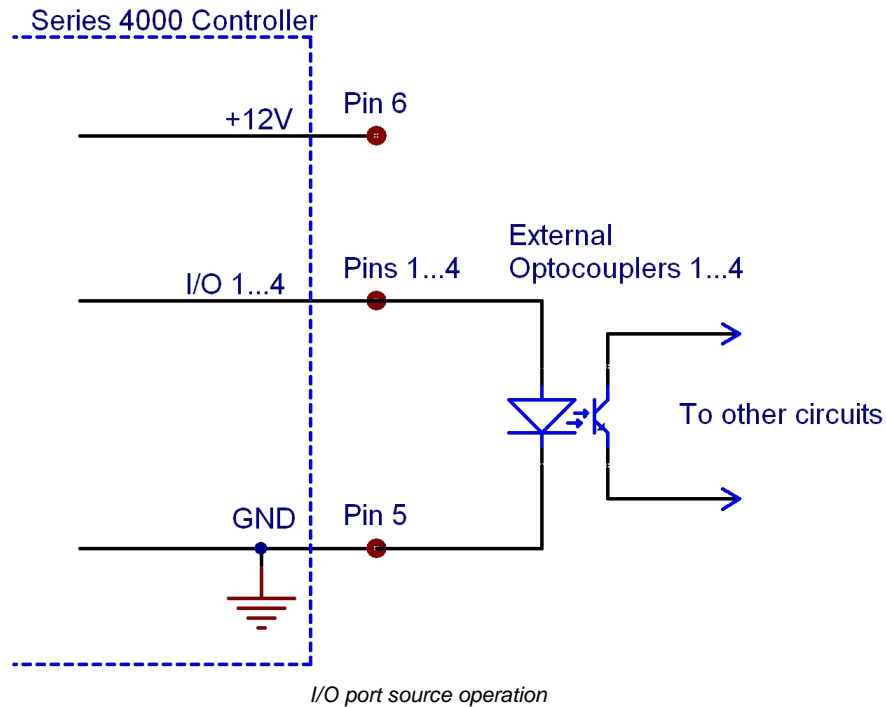
Any I/O line configured as input accepts TTL levels (0 V / +5 V) and is tolerant of higher voltages up to +24 V. When the input is left open, an internal +5 V pull-up resistor in series with a diode shifts the input to high level.

Any I/O line configured as output can source up to 2 mA when high (+5 V) and sink up to 400 mA when low.

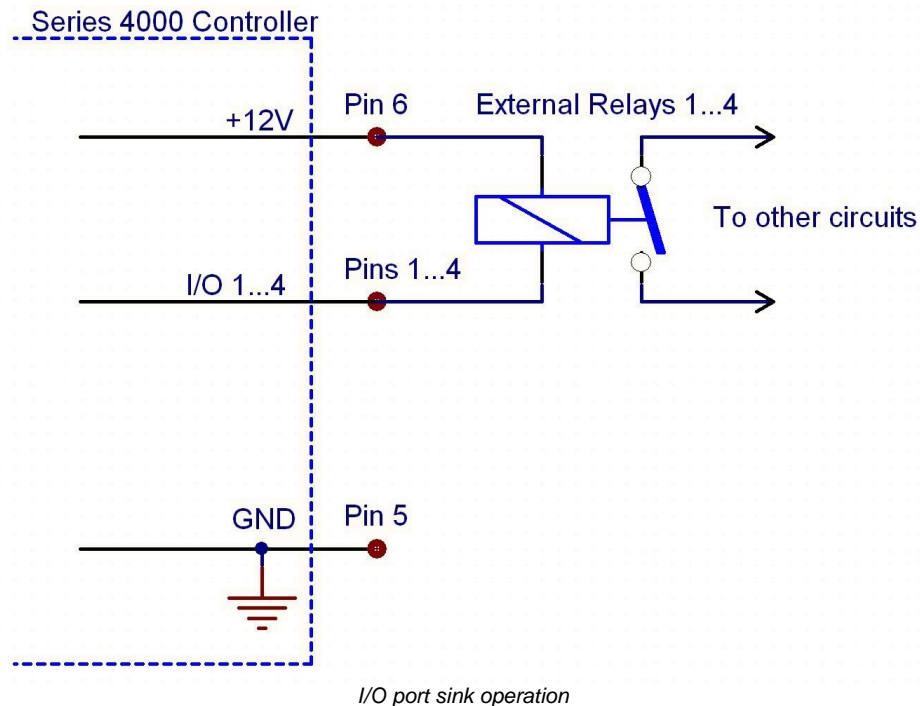
The outputs are current-limited and infinitely short-circuit proof.

Additionally a +12 V supply output is provided to drive a relay or other external circuitry. The maximum output current is 500 mA. This supply output is current-limited and infinite short-circuit proof.

The following figures show three typical output configurations.



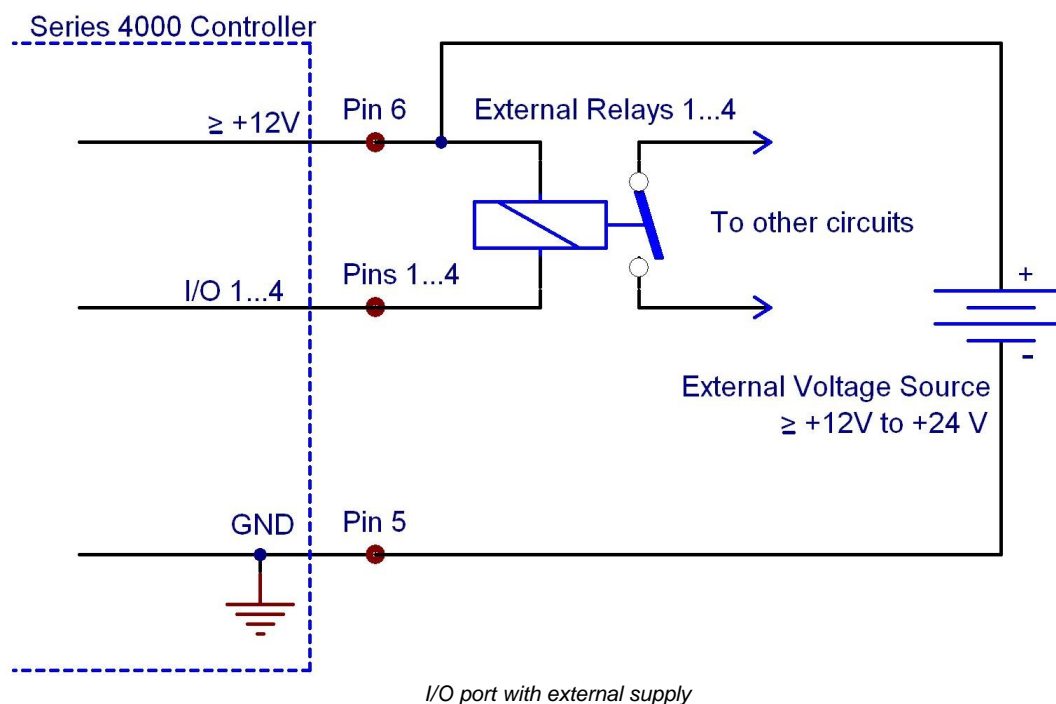
In above circuit, the output drives an optocoupler in source operation. This component may be replaced by a LED or a switching transistor. To switch the connected device to on-state, the output level of the digital I/O line must be set HIGH. The maximum source current is 2 mA.



In above schematic, the output drives a relay in sink operation. Note that the external relay coil is connected between the digital I/O line (pins 1 ...4) and +12 V (pin 6).

To energize the external relay, the output level of the digital I/O line must be set LOW. The maximum sink current is 400 mA.

If a lower supply voltage is required for the relay, a standard voltage regulator may be inserted between pin 6 and the relay coil contact.



In the figure above, the output drives a relay in sink operation using a higher external voltage supply ($\geq +12\text{V}$ to $+24\text{V}$). To energize the external relay, the output level of the digital I/O line must be set LOW. The maximum sink current is 400 mA.

When driving a relay, connect your external supply voltage also to pin 6 of the digital I/O jack in order to connect the internal de-spiking clamping diode in parallel to the relay coil. The internal $+12\text{V}$ supply (which passes a serial diode) is overridden and non-effective in this case.

In **Digital I/O Port** menu the direction of each port can be set to input or output.

Digital I/O Port				
	I/O 1	I/O 2	I/O 3	I/O 4
Direction	Output	Output	Input	Input
Out Level	High	Low		
Pin Level	High	Low	High	High
Note: 'Pin Level' monitors the actual level of the I/O pins.				
<div style="display: flex; justify-content: space-between; width: 100%;"> ◀ Previous Next ▶ Modify </div>				

In addition the output level of each I/O port can be set, if configured as output. The actual pin level of each port pin is monitored and displayed in the third line.

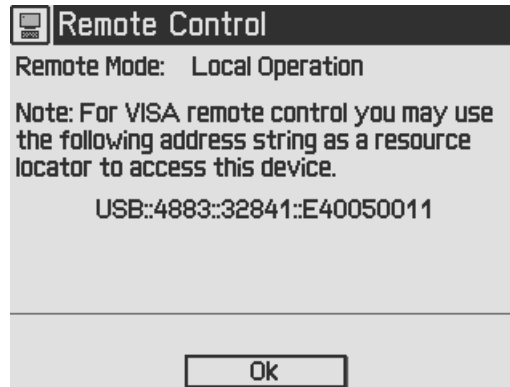
For enhanced controlling, please use the remote control interface from an external PC or Laptop. See the Thorlabs "Series 4000 Programmers Reference Manual" on the included "Series 4000 Instrumentation CD".

3.12 System Preferences

The System Preferences menu allows to select different settings concerning your LDC4000 system configuration, including Message Handling, Display Brightness, Display Contrast, Sound Signals, and Update Capability.

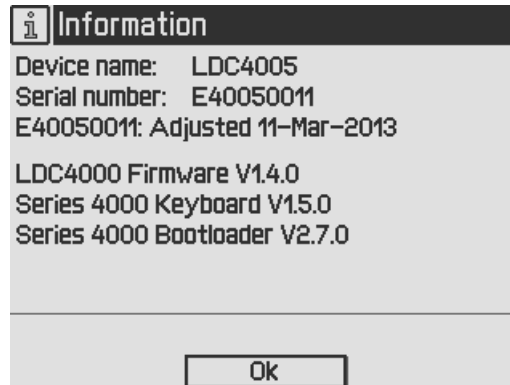
For detailed explanations please see section [Getting Started - System Preferences](#).

3.13 Remote Control



This menu displays the remote control state of the device.

3.14 Information



The last menu topic displays important information on the unit, such as type, serial number, date of last calibration and software versions.

4 Computer Interface

4.1 Using the USB Interface

The instrument provides a USB 2.0 Full Speed link according to the USB 2.0 specification, the USBTMC specification and the USBTMC USB488 specification. It allows sending commands from a host computer to the instrument. The connection to the PC is accomplished by a USB cable with a type 'A' connector at the PC side and a type 'B' connector on the instrument side.

When connecting the instrument to the PC the first time, on Windows systems the "New Hardware Found" wizard will be displayed. Proper installation requires a VISA library with USBTMC support to be installed on your system in advance (e.g. NI-VISA available at the National Instruments website www.ni.com or from the data carrier that comes with the instrument. Allow the installation and follow the dialog instructions).

Via the instrument's USB interface you may easily connect to third party data logging, data acquisition and data analysis software (e.g. MATLAB, NI LabVIEW Signal Express, Agilent VEE). For basic instrument communication you may also use the *Thorlabs Instrument Communicator 2 Software* from the accompanying data carrier. Please see also the *SCPI Programmers Reference Manual* for a detailed description of the instrument's command set.

When receiving a command, the ITC4000 will enter its **Remote** mode. This will be indicated by the REMOTE Symbol in the Status Bar. The right softkey (F4) will serve as a Local button, which switches back from Remote mode to Local operations mode. In Remote mode, the front panel setup of the instrument is disabled to avoid accidental entries and settings conflicts. This also includes the LD ON key.

Optical Power Setpoint	3.000 mW	
Laser Current Reading	0.2878 A	
Laser Voltage Reading	1.426 V	
Laser Power Reading	0.41 W	
PD Current Reading	3.000 mA	
TP Voltage Reading	0.0000 V	
	REMOTE LD ON	
▶ Menu	Display	Local

4.2 Instrument Driver Installation

The software package that comes with the device contains a VXIpnP instrument driver. This instrument driver library simplifies the instrument control and reduces test program development time. It is suitable for various programming environments including NI-LabVIEW, NI-LabWindows/CVI and MS-Visual Studio.

Prior to connecting the instrument to a PC, please check if a VISA engine is installed on the PC, otherwise install the NI-VISA engine that is available for free from the National Instruments website www.ni.com or from the included data carrier.

Note

To complete the installation of the LDC4000 USB driver successfully, you must have Administrator privileges on the PC on which you are performing the installation.

After successfully installing the drivers connect the LDC4000 to a USB port of your PC. The PC will find a test and measurement device. Please follow the instructions of the dialog screens and allow the installation.

Various programming examples demonstrate how to use the instrument driver and how to communicate successfully with your instrument. The examples are installed with the instrument driver and may be found in the drivers installation directory.

4.3 Firmware Update

Firmware upgrades can be accomplished by the user via the USB interface using the software "Thorlabs DFU Wizard".

Note

To install the Thorlabs DFU wizard successfully, you must have Administrator privileges on the PC, and the instrument must be powered down or disconnected from the USB.

Follow the instructions below to upgrade your instrument:

- Install the Thorlabs DFU Wizard on your PC.
- Download the new Firmware file from the Thorlabs web site (www.thorlabs.com).
- Switch on your instrument and connect it to a USB port of your PC.
- Make sure the Update Capability is "enabled" or "enabled once" in the System Preferences Menu (refer to chapter [System preferences](#)),
- Launch the DFU Wizard from the start menu. Follow the DFU Wizard instructions.



- During the process a new DFU capable device will be recognized by the PC. Make sure to install this device properly.
- If the following error message appears, click "Yes" to retry finding the device and continue the installation of the new firmware.



Note

Do not switch off the instrument or disconnect the USB cable during the firmware download.

5 Maintenance and Service

5.1 General Remarks

LDC4000 laser diode controllers do not need regular maintenance by the user. They do not contain any modules that could be repaired by the user himself. If a malfunction occurs, the whole unit has to be sent back to Thorlabs. Do not remove covers!

If any disturbances in function occur, please refer first to chapter [Troubleshooting](#).

If you don't find the error source by means of the trouble shooting list please first contact *Thorlabs* before sending the LDC40xx laser diode controller for checkup and repair to *Thorlabs* (refer to section [Thorlabs Worldwide contacts](#)).

To ensure best accuracy, it is recommended to have the LDC4000 factory recalibrated every 24 months.

General care

Protect the unit from adverse weather conditions. The LDC4000 laser diode controllers are not water resistant.

Attention

To avoid damage to the LDC4000 laser diode controllers, do not expose it to spray, liquids or solvents!

Cleaning

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

5.2 Line Voltage Settings

The LDC4000 series laser diode controllers operate with line voltages of 100 ... 120 V AC and 200 ... 240 V AC $\pm 10\%$. The line frequency range is 50 ... 60 Hz.

Thus it can be operated worldwide without any adjustment or voltage setting.

5.3 Replacing the Mains Fuses

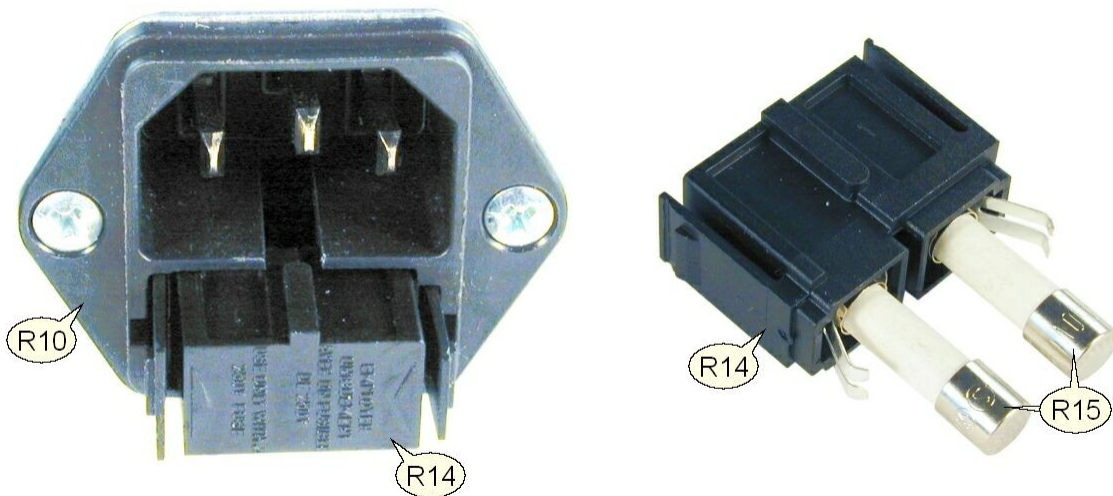
The two power input fuses are externally accessible. If they have blown due to line disturbance or other influences from the outside, they can be replaced at the rear panel without opening the unit.

Warning

To avoid fire hazard, replace the two mains fuses with fuses of the specified type and rating only. Fuse Type: IEC60127-2/1 (High breaking capacity!), F10 H 250V, fast acting (F) 10 Amperes, size 5 x 20 mm

Instructions:

1. Power off the LDC4000 and disconnect the mains cable.
2. The fuse holder (R14, see Figure 34) is located below the 3-terminal power connector of the mains jack (R10). Release the fuse holder by bending its two plastic retainers with the aid of two small screwdrivers. The retainers must be pressed towards the center of the fuse holder.
3. Replace the defective fuses (R15). We recommend changing both fuses, even if only one fuse has opened.
Press in the fuse holder into the mains jack until locked on both sides.
4. Switch on the unit. If it cannot be switched on, please contact your supplier or [Thorlabs](http://Thorlabs.com).



5.4 Troubleshooting

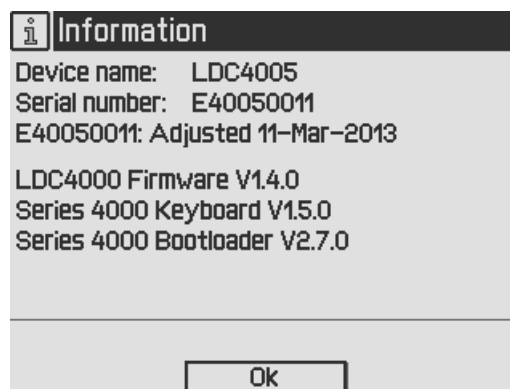
In case that your LDC4000 shows malfunction, please check the following items:

➤ Unit does not work at all (nothing is shown on the display at the front):

- Is the LDC4000 connected to the mains properly?
- Is the LDC4000 turned on?
- Check the fuses on the rear panel (see chapter [Replacing the mains fuses](#)). If blown, please replace the fuses by the correct type.
- Check via SCPI interface if the unit works (see chapter [Computer Interface](#)). If you can connect to the unit properly, please check display settings via remote control (brightness and contrast).

➤ The display works, but you don't get the desired operation current or power:

- Have the corresponding hardware limits been set correctly? Please refer to chapter [Setting the LD source parameters](#)
- Has the laser diode setup been connected to the [13W3 DSUB jack](#) on the rear panel correctly?
- Has the interlock circuit been closed? Please refer to chapter [Connecting Interlock and LD ON Monitoring](#).
- Has the Voltage Protection been set to a value greater than the nominal laser forward voltage? Please refer to chapter [Laser Output Configuration](#).
- Please check all cables and the polarity settings. Please refer to chapter [Connecting components](#), to chapter [Laser Output Configuration](#) and to chapter [Setting the Photodiode Parameters](#).
- The optical output power in constant power mode is oscillating. Please check the bandwidth setting for the constant power feedback loop. Please refer to chapter [Setting the LD source parameters](#).
- If you don't find the error source by means of the trouble shooting list please first contact *Thorlabs* before sending the LDC40xx laser diode controller for checkup and repair to *Thorlabs* (refer to section [Thorlabs Worldwide contacts](#)).
- Please check the error messages before calling.
- For additional information about the installed firmware, please check the current firmware versions on the Information screen before calling:.



6 Appendix

6.1 Technical Data

	LDC4005	LDC4020
Laser Current Control (Constant Current Mode)		
Laser diode current range	0 to 5 A	0 to 20 A
Compliance voltage	12 V	11 V
Setting and Measurement resolution ¹	1 mA / 80 μ A	1 mA / 320 μ A
Current accuracy	$\pm(0.1\%$ reading + 2 mA)	$\pm(0.1\%$ reading + 8 mA)
Ripple and noise, w/o Noise Reduction Filter (10 Hz to 10 MHz, rms, typ.)	< 250 μ A	< 10 mA
Ripple and noise, with Noise Reduction Filter (10 Hz to 10 MHz, rms, typ.)	< 50 μ A	n.a. (no Noise Reduction Filter)
Drift, 24 hours ITC4001 (0 -10 Hz, typ., at Constant Ambient Temperature)	< 300 μ A	< 1 mA
Temperature coefficient	≤ 50 ppm/ $^{\circ}$ C	
LD Current Limit		
Setting range	5 mA to 5 A	20 mA to 20 A
Setting resolution ¹	1 mA / 80 μ A	1 mA / 320 μ A
Accuracy	$\pm(0.12\%$ reading + 3 mA)	$\pm(0.12\%$ reading + 12 mA)
Power Monitor Input - Photodiode		
Photo current measurement ranges	0 to 2 mA / 0 to 20 mA	
Photo current measurement resolution, 2 mA range ¹	1 μ A / 32 nA	
Photo current measurement resolution, 20 mA range ¹	10 μ A / 320 nA	
Photo current accuracy, 2 mA range ¹	$\pm(0.08\%$ reading +0.5 μ A)	
Photo current accuracy, 20 mA range ¹	$\pm(0.08\%$ reading +5 μ A)	
Photodiode reverse BIAS voltage	0 to 10 V	
Photodiode input impedance	~ 0 (Virtual Ground)	
Power Monitor Input - Thermopile		
Voltage Measurement Ranges	0 to 10 mV / 0 to 100mV / 0 to 1V / 0 to 10V	
Voltage Measurement Resolution, via front panel	1 μ V / 10 μ V / 100 μ V / 1mV	
Voltage Measurement Resolution, via remote control	0.16 μ V / 1.6 μ V / 16 μ V / 160 μ V	
Voltage Measurement Accuracy	$\pm(0.1\%$ reading + 10 μ V / + 100 μ V / + 1 mV / + 5 mV)	
Voltage Input Impedance	1 M Ω	
Laser Power Control (Constant Power Mode)		
Photo current setting resolution, 2 mA range ¹	1 μ A / 32 nA	
Photo current setting resolution, 20 mA range ¹	10 μ A / 320 nA	
Thermopile voltage setting resolution, 10 mV range ¹	1 μ V / 0.16 μ V	
Thermopile voltage setting resolution, 100 mV range ¹	10 μ V / 1.6 μ V	

	LDC4005	LDC4020
Thermopile voltage setting resolution, 1 V range ¹	100 μ V / 16 μ V	
Thermopile voltage setting resolution, 10 V range ¹	1 mV / 0.16 mV	
Power Limit (Constant Power Mode)		
Photo current limit setting ranges	5 μ A to 2 mA / 50 μ A to 20 mA	
Photo current limit resolution 2 mA range ¹	1 μ A / 128 nA	
Photo current limit resolution 20 mA range ¹	10 μ A / 1.28 μ A	
Photo current limit accuracy 2 mA / 20 mA range	\pm 20 μ A / \pm 200 μ A	
Thermopile voltage limit setting ranges	1 μ V to 10 mV / 10 μ V to 100mV / 100 μ V to 1V / 1 mV to 10V	
Thermopile voltage limit accuracy	\pm 10 μ V / \pm 100 μ V / \pm 1 mV / \pm 10 mV	
Thermopile voltage limit resolution 10 mV range ¹	1 μ V / 0.73 μ V	
Thermopile voltage limit resolution 100 mV range ¹	10 μ V / 7.3 μ V	
Thermopile voltage limit resolution 1 V range ¹	100 μ V / 73 μ V	
Thermopile voltage limit resolution 10 V range ¹	1 mV / 0.73 mV	
Laser voltage measurement		
Measurement principle	4-wire	
Measurement range	0 to 14 V	
Measurement resolution ¹	1 mV / 160 μ V	
Measurement Accuracy	\pm 20 mV	
Laser overvoltage protection		
Setting range	1 to 12 V	1 to 11 V
Resolution	1mV	
Accuracy	\pm 50 mV	
Laser Current Monitor Output		
Load resistance	>10 kOhm	
Transmission coefficient	2 V/A \pm 5%	500 mV/A \pm 5%
External Modulation Input		
Input impedance	>10 kOhm	
Small signal 3dB bandwidth, CC mode, without Noise Reduction Filter	DC to 100 kHz (1 Ω load)	DC to 50 kHz (0.2 Ω load)
Small signal 3dB bandwidth, CC mode, with Noise Reduction Filter	DC to 6 kHz (1 Ω load)	n.a. (no Noise Reduction Filter)
Modulation coefficient, CC mode	500 mA/V \pm 5%	2 A/V \pm 5%
Modulation coefficient, CP mode, Current Sensor ²	200 μ A/V / 2 mA/V \pm 5%	
Modulation coefficient, CP mode, Voltage Sensor ²	1 mV/V / 10 mV/V / 100 mV/V / 1V/V \pm 5%	
Internal laser modulation		
Waveforms	Sine, Square, Triangle	
Frequency range	20 Hz to 100 kHz	20 Hz to 50 kHz
Modulation depth	0.1 to 100%	

	LDC4005	LDC4020
QCW Mode		
Pulse width range	0.1 ms to 1 s	
Pulse width resolution	1 μ s	
Repetition rate range	1 ms to 5 s (0.2 to 1000 Hz)	
Repetition rate resolution	10 μ s	
Trigger		
Input	rising edge triggered, starts QCW pulse with internal adjusted width	
Input level	TTL or 5 V CMOS	
Output	active high, tracks pulse width	
Output level	TTL or 5 V CMOS (open collector with internal pull-up resistor 2 k Ω)	
Dead time to next pulse	>10 μ s	
Digital I/O port		
Number of I/O lines	4 (separately configurable)	
Input level	TTL or CMOS, voltage-tolerant to max.24 V	
Output level (source operation)	TTL or 5 V CMOS, 2 mA max.	
Output level (sink operation)	open collector, up to 24 V, 400 mA max.	
Interface		
USB 2.0	according to USBTMC/USBTMC-USB488 specification Rev. 1.0	
Protocol	SCPI compliant command set	
Drivers	VISA VXIppn™, MS Visual Studio™, MS Visual Studio.net™, NI LabView™, NI LabWindows/CVI™	
Connectors		
Connector for Laser, Photodiode, Interlock & Laser On Signal	13W3 mixed DSUB jack (female)	
Connectors for LD Enable, QCW Pulse, Trigger Out, Opt. Sensor In, Modulation In, Analog CTL Out	BNC	
Chassis ground connector	4 mm Banana jack	
Connector for USB interface	USB type B	
Connector for Digital I/O	Mini DIN 6	
Mains input	IEC 60320	
Safety features		
Switch ON delay	0 to 60 s	
Keylock switch	yes	
Interlock	yes	
Overtemperature protection	yes	
Inhibit Input (LD Enable)	yes	
Laser current and power limits	yes	
Adjustable overvoltage protection	yes	

	LDC4005	LDC4020
Soft Start	yes	
Short circuit when laser off	yes	
Temperature Window Protection	only in combination with TED4015	
General Data		
Line voltage	100 to 120V $\pm 10\%$ and 200 to 240V $\pm 10\%$	
Line frequency	50 to 60 Hz $\pm 5\%$	
Maximum power consumption	200 VA	600 VA
Mains Supply Overvoltage	Category II (Cat II)	
Operating temperature (non condensing)	0 to +40°C	
Storage temperature	-40 to 70°C	
Relative humidity	max. 80% up to 31°C, decreasing to 50% at 40°C	
Pollution degree (indoor use only)	2	
Operation altitude	< 2000 m	
Warm-up time for rated accuracy	30 min	
Weight	5.5 kg	
Dimensions (WxHxD) without operating elements	263 x 122 x 307 mm ³	
Dimensions (WxHxD) with operating elements	263 x 122 x 345 mm ³	

¹ via front panel / remote control

² depending on selected measurement range

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

6.2 Menu Structure Overview

Menu topic	description
LD Output Configuration	Laser diode polarity, laser diode voltage protection, switch on delay, and inhibit input mode can be set
LD Source Setup	Operating mode, laser current limit, photodiode current limit, thermopile voltage limit, power feedback loop settings can be set
LD Source Set Points	changes of different set points like the laser current (in constant current mode) or photodiode current, thermopile voltage, and optical power (in constant power mode) can be made
Photodiode Input	the photodiode parameters like input route (13W3 DSUB jack or BNC jack), current range, BIAS state, BIAS voltage and response can be set
Thermopile Input	the voltage sensor parameters like input route (13W3 D-Sub jack or BNC jack), voltage range or response can be set
LD Modulation	the modulation source (internal or external) and the settings for the internal modulation like shape, frequency and depth can be changed
QCW Pulse Settings	the trigger source and the QCW pulse parameters can be changed
Display Configuration	two, four or six value measurement screen can be picked and the displayed set points or readings can be changed
Settings Memories	8 different Laser setups can be saved or reloaded
Digital I/O Port	the direction and the levels of the digital I/Os can be read or written
System Preferences	the system settings like message handling, display brightness and contrast, sound signal on/off, line frequency and update capability can be changed.
Remote Control	contains the address string for use of VISA remote control
Information	contains device specific information like device name, serial number, calibration date, and the current firmware version

6.3 Factory Settings for LDC40xx

Set Value	Factory Setting
LD Polarity	cathode grounded (CG)
Switch On Delay	3 seconds
LD Voltage Protection	1.0 V
Inhibit Mode	Protection
Laser Current Limit	5 mA (LDC4005) / 20 mA (LDC4020)
Laser Current set point	0 A
PD Range	20 mA
PD Polarity	CG
PD Input Route	DSUB connector
PD Sensitivity	1 A/W
PD Current Limit	2 mA
PD Current set point	0 mA
PD BIAS State	Off
PD BIAS Voltage	0 V
Thermopile Voltage Range	10 V
Thermopile Input Route	DSUB connector
Thermopile Sensitivity	1 V/W
Thermopile Voltage Limit	1 V
Thermopile Voltage set point	0 V
Feedback Source	Photodiode
Feedback Loop Speed	0.1%
Modulation	Off
Modulation Source	Internal
Shape	Sine
Frequency	1 kHz
Depth	5 %
QCW Trigger	internal
QCW Pulse Period	20 ms
QCW Pulse Width	1 ms
Display	4 value screen
Display Value 1	LD Source set point

Set Value	Factory Setting
Display Value 2	LD Current Reading
Display Value 3	LD Voltage Reading
Display Value 4	Photodiode Current Reading
Display Brightness	100 %
Display Contrast	65 %
Sound Signals	Enabled
Line Frequency	Auto
Update Capability	Disabled

6.4 Error Messages

6.4.1 LED Status Messages

LD ON switch LED	Description
Green	LD output ON
Green flashing	<ul style="list-style-type: none">• Switch On Delay active• I-Limit / P-Limit• Inhibit Input Mode (Output Enable) active*• Temp. Protection Mode (Output Enable) active*
Red	Critical errors: <ul style="list-style-type: none">• Keylock• LD open• Interlock• Inhibit Input Mode (Protection)*• Temperature Protection (Protection)*
Red flashing	Internal device overtemperature (OTP)

* Refer to section [Laser Output Configuration](#)

6.4.2 Status Indicators

The LDC4000 has various status indicators in the displays bottom line.

Laser Current Setpoint	0.0500 A					
Laser Current Reading	0.0004 A					
Laser Voltage Reading	Underrun					
Laser Power Reading	Overflow					
PD Current Reading	0.008 mA					
Optical Power (PD)	0.008 mW					
KEY	INTERL	I LIMIT	P LIMIT	INHIB. OTP	REMOTE ERROR	LD ON
▶ Menu	Display	Local				

The meanings are:

Status indicator	Description
KEY	The key switch is in locked position to prevent unauthorized usage of the laser driver.
INTERL	The interlock is open because of an open safety switch or an incorrect wiring or an open safety switch; the laser output can't be switched on.
I LIMIT	The laser current is limited because the adjusted laser current limit value (adjusted in the LD Source Setup menu) is reached
P LIMIT	The optical laser power is limited because one of the sensor limits is reached (photo current limit, voltage limit, or power limit, adjusted in the LD Source Setup menu).
INHIB.	The LD-ENABLE input level is in disable state (low). The effect on the laser output is dependent on the selected Inhibit input mode in the LD Output configuration menu.
OTP	The unit is internally overheated. The laser output is switched off and can be switched on again after a temperature drop of about 10 degrees
REMOTE	The unit is in remote operation
TMC-ID	The unit is in TMC identification (via remote)
LOCK	The unit is in remote operation and a local operation is locked.
ERROR	Interface error indicator. There are errors stored in the device's error queue. Thea can be read using the <code>syst:err?</code> command.

6.4.3 Instrument Errors

Switch Off / Output Protection Errors

Error	Description
The instrument is too hot	The laser output and the TEC output were switched off because the instrument is internally overheated
LD output switched off due to Key switch	The laser output was switched off because the key switch was moved to "locked" position
Open interlock circuit detected	The laser output was switched off because the interlock connection was opened
LD inhibit input was tripped	The laser output was switched off because the level of the "LD ENABLE IN" input was changed to LOW
LD temperature protection detected	The laser output was switched off because the temperature protection was tripped
LD output voltage protection was tripped	The laser output is switched off. This can be caused by a too low laser voltage threshold or an incorrect laser diode wiring. Please check polarity, wiring, and the laser voltage protection

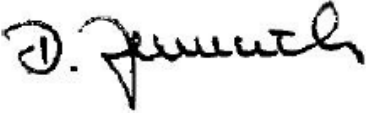

Other Instrument Errors

Error	Description
Instrument is overheated	The units internal temperature is too high. The laser output and the TEC output are switched off and can be switched on again after a temperature drop of about 10 degrees.
Not permitted with LD Output on	Operation is not allowed while the laser output is switched on. This applies to the laser current limit, the used sensor limits, and the sensor ranges.
Interlock circuit open	Operation is not allowed while the interlock protection is tripped. This can be caused by an incorrect wiring or an open external safety switch.
Key switch is in locked position	Operation is not possible, when locked by the front panel key switch. This avoids an unauthorized usage of the laser driver
LD inhibit is active	The Laser output is temporarily switched off until the status level on "LD ENABLE IN" jack will be switched to high level
Not permitted with photodiode BIAS on	Operation is not allowed while the photodiode BIAS is switched on.
Not permitted with QCW mode on	The constant power mode is not allowed if the QCW mode is switched on, please set the QCW mode to off before using constant the power mode

Error	Description
Wrong LD source operating mode	The QCW mode is not allowed in constant power mode, please switch the operating mode to constant current before using the QCW mode.
Settings conflict	Only one feedback sensor (photodiode or thermopile) can be switched to the BNC jack "OPT SENSOR IN". If this message is shown please set the unused feedback sensor to the DSUB connector.
Value is not editable	The selected display item (e.g. measurement reading) can't be adjusted
Not editable with LD output on	Laser current limit, photo current limit, thermopile voltage limit, and power limit can't be set if the Laser output is on.
Value is out of range	A sent numerical value in remote mode is out of range, check the allowed min/max values for the parameter to be changed
Value minimum/maximum reached	Occurs when the range limits of the set points are reached
Operation is not applicable	Occurs in Edit Name menu if characters can't be deleted (with backspace) anymore
FPGA configuration error	A FPGA configuration failure has occurred during the boot procedure, please switch the unit off and on again. If this error is shown again contact the Thorlabs Hotline
Nonvolatile checksum error	A general EEPROM checksum error has occurred, please switch the unit off and on again. If this error will be appeared again contact the Thorlabs Hotline
General keyboard bootloader error	The keyboard bootloader is not running after the boot procedure, please switch the unit off and on again. If this error is shown again contact the Thorlabs Hotline
Hardware error	A device internal hardware error has occurred, please switch the unit off and on again. If this error continues contact the Thorlabs Hotline
Calibration memory lost	The calibration data in the EEPROM is invalid, please switch the unit off and on again. If this error is still present contact the Thorlabs Hotline
Save/recall memory lost	The saved user setup data in the EEPROM is invalid, please switch the unit off and on again. If this error is shown again contact the Thorlabs Hotline
Configuration memory lost	The last saved setup before power down is invalid, please switch the unit off and on again. If this error is still present contact the Thorlabs Hotline

Error	Description
Self test failed	The device self test procedure has failed, please switch the unit off and on again. If this error continues contact the Thorlabs Hotline

6.5 Certifications and Compliances

<h3><i>EU Declaration of Conformity</i></h3> <p><i>in accordance with EN ISO 17050-1:2010</i></p>		
We:	Thorlabs GmbH	
Of:	Hans-Boeckler-Str. 6, 85221 Dachau/München, Deutschland	
<i>in accordance with the following Directive(s):</i>		
2014/35/EU	Low Voltage Directive (LVD)	
2014/30/EU	Electromagnetic Compatibility (EMC) Directive	
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)	
 <i>hereby declare that:</i>		
Model:	LDC4xxx	
Equipment:	Benchtop Laser Diode Controller	
<i>is in conformity with the applicable requirements of the following documents:</i>		
EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
 <i>and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:</i>		
does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive		
 <i>I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.</i>		
Signed:		On: 29 January 2016
Name:	Dorothee Jennrich	
Position:	General Manager	
		
<small>EDC - LDC4xxx -2016-01-29</small>		

This product was tested for and complies with the following standards:

- CAN/CSA-C22.2 No. 61010-1-04
- ANSI/UL 61010-1-2004

6.6 Warranty

Thorlabs warrants material and production of the LDC4000 Series Operation Manual for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs. The customer will carry the shipping costs to Thorlabs, in case of warranty repairs Thorlabs will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

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

Restriction of Warranty

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

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

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

6.7 Exclusion of Reliability and Copyright

Thorlabs has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

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

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

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6.8 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 below)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

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

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

Waste treatment on your own responsibility

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

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS Directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE Directive is to enforce the recycling of WEEE. A controlled recycling of end-of-life products will thereby avoid negative impacts on the environment.



*Crossed out
"Wheelie Bin" symbol*

6.9 List of Acronyms

AC	Alternating Current
AG	Anode Grounded
CC	Constant Current
CG	Cathode Grounded
CP	Constant Power
CW	Continuous Wave
DC	Direct Current
DDS	Digital Direct Synthesizer
ILD	I (current) of Laser Diode
IPD	I (current) of Photodiode
I/O	Input / Output
LD	Laser Diode
LDC	Laser Diode Controller
LED	Light Emitting Diode
OTP	Overtemperature Protection
PC	Personal Computer
PD	Photodiode
QCW	Quasi Continuous Wave
RF	Radio Frequency
RMS	Root Mean Square
TEC	Thermo Electric Cooler
USB	Universal Serial Bus
UTH	U (voltage) Thermopile

6.10 Thorlabs Worldwide Contacts

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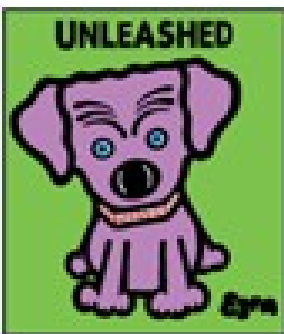
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