

## WL-LDC10D

# High Speed Laser Diode / SOA / BOA Controller Operator's Manual

### Features

- Analog bandwidth **DC to 15MHz**
- Up to **1A** output drive current
- Adjustable output current limit **200mA to 1A**
- Laser diode reverse current protection
- Current monitor output
- TTL modulation (2 arbitrary currents)
- Integrated **TEC Controller** (1.5A max.)
- Adjustable TEC regulator parameters
- Adjustable TEC current limit
- USB interface (virtual COM port)
- Affordable pricing

### Applications

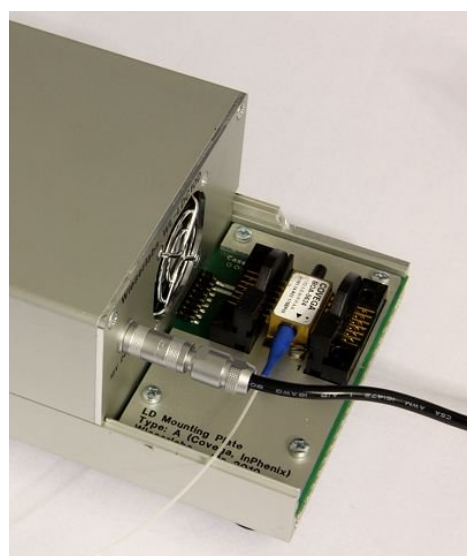
- FDML laser: sweep amplitude shaping
- SOA/BOA/LED modulation and switching

### General Description

The WL-LDC10D is a high speed laser diode driver especially designed to drive SOAs and BOAs in the near infrared range. It features an analog input which sets the laser current anywhere between 0 and 1A at frequencies from DC to 15MHz. This combination of high output drive and high slew rate (50A/μs) makes the WL-LDC10D well suited for switching as well as analog modulation applications. A digital TTL input allows digital switching between two arbitrary current settings.

The WL-LDC10D features an adjustable current limit, reverse current protection and an integrated thermal overload protection. It provides an internal digital control loop as TEC controller with adjustable temperature and current limit. All parameters can be adjusted at the frontpanel and via the built-in USB interface.

### Typical Application



The laser diode is mounted directly at the back of the WL-LDC10D. Different slot-in mounts for different pinouts are available.

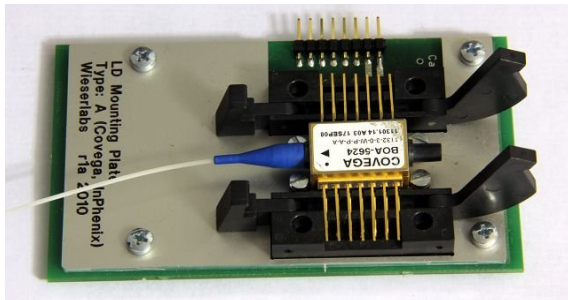
## Mounting the Laser Diode

The laser diode is mounted on a slot-in module at the back of the LDC10D. Follow these steps to mount the laser diode in butterfly package:

1. Switch off the device.
2. Slide back the LD mounting module (image) and then completely remove it.

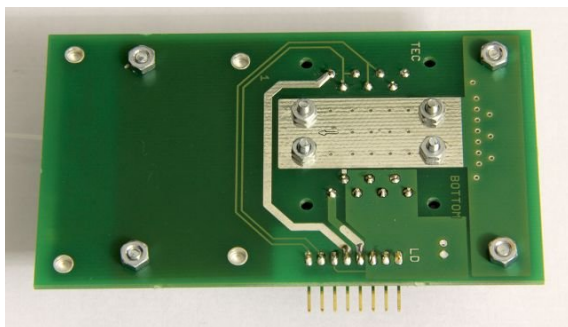


3. Open the butterfly mount and insert the laser diode (SOA, BOA) in butterfly package. Ensure the pin 1 is on the correct side. Pin 1 is marked on the mounting plate and usually also on the butterfly mount. (Note: There are different mounting plates for different pinouts.) Put the 4 fixing screws through the holes of the butterfly package and the mounting plate. The screws supplied with the LDC10D are standard metric 2.5mm screws (M2.5). In some cases, it may



help to first put the screws through the butterfly package and then put the package with the screws on the mounting plate.

4. Close the butterfly mount. With the help of a



screw driver, mount the nuts from the bottom side onto the screws and fix them firmly.

5. Slide the LD mounting plate onto the LDC10D again. The laser diode is now mounted.



Note: The screws ensure that the butterfly package has good thermal contact with the aluminum LD mounting plate for heat sinking.

**NOTE:** It is highly recommended to perform an **LD current calibration** whenever changing the laser diode. See the chapter „LD Controller“.

## Pinout of the Connector

For reference, this is the pinout of the back connector at the LDC10D.

Pin	Description
1	LD+ (Laser diode Anode)
2	LD- (Laser diode Cathode)
3	GND
4	TEC- (Peltier element negative connection)
5	TEC+ (Peltier element positive connection)
6	PRESENCE_DETECT (Presence detect; connected to pin 3 on the mounting plate)
7	Therm- (10k Thermistor)
8	Therm+ (10k Thermistor)

In this list, pin 1 refers to the pin farthest away from the back fan. Pin 8 is the pin directly below the center of the back fan.

## Basic Operation



## Menu Interface

The LDC10D has a menu-driven interface. The meaning of the 4 pushbuttons (8) is displayed in the last line of the LC display (9). The rotary knob (2) is used to change values and scroll menus. The rotary knob also has push-button functionality most easily described as „enter key“.

To navigate the menu, turn the rotary knob (2). To enter a menu item, press the rotary knob (2). To change certain settings in the menu, press the rotary knob (2), rotate the knob to adjust the setting and press the rotary knob again.

The meaning of the 4 push buttons (8) is denoted by the last line in the display:

- **Mode:** Select LD mode (CW, TTL modulation, analog modulation).
- **TEC, LD:** Show TEC and LD main screen.
- **Conf:** Show configuration menu of current screen.
- **Menu:** Show main menu.
- **LASER:** Switch laser emission on/off.
- **OnOff:** (TEC screen) Switch TEC controller on/off.

Except in TEC main screen, the red pushbutton is always the laser emission switch. Active laser emission is shown by the red emission LED (1).

## Getting Started (for the impatient)

After mounting the laser diode and connecting the power supply on the back: Switch on the LDC10D using the main power switch (3). Press the second pushbutton (8) named „TEC“. Press the red „OnOff“ pushbutton and watch how the actual temperature converges against the setpoint (Tset).

NOTE: If the temperature diverges away from the setpoint, the TEC polarity may be reversed. Try with opposite polarity („Conf“ -> „Reg.polarity“).

BTW, you can configure the device to automatically start the TEC once powered up („Conf“ -> „Pwr on state“, then save settings in the main menu)

Next, push the „LD“ button and set the desired current with the rotary knob (2). To switch on the laser, press the red „LASER“ emission knob.

During emission, the current can be changed via the rotary knob (2). In the display „Act“ shows the actual laser current and voltage.

## TEC Controller

The LDC10D features a fully digital built-in TEC PID controller with adjustable current limit and safety window function.

The TEC main screen displays the most important TEC settings:

```
TEC: Reg ON          ▲
  Tset=25.00C -0.12V
  Act: 25.00C -0.05A ▼
Menu Conf LD OnOff
```

„Reg ON“ or „Reg OFF“ show whether the TEC controller is switched on or not.

„Tset=“ displays the temperature setpoint in °C. This can be changed using the rotary knob.

„Act:“ shows the actual temperature measured with the thermistor inside the butterfly mount of the laser diode.

The right paragraph shows the TEC voltage and current (in the image above: -0.12 Volt and -0.05 Ampere).

The 4 pushbuttons can be used to access the main menu („Menu“), the TEC configuration menu („Conf“; also reachable via „Menu“ -> „TEC Config“) and the laser diode driver main screen („LD“). The red pushbutton is used to switch the regulator on/off (when in regulator mode).

## TEC Configuration Menu

- **TEC opmode:** Operation mode.
  - „Reg“: standard setting for TEC regulator.
  - „Mon“: Merely monitor temperature, no TEC current is applied.
  - „Off“: Disable TEC controller.
  - „Mon“ and „Off“ are mainly useful for laser diodes without TEC.
- **I limit:** Sets the TEC current limit in Ampere.
- **Reg.polarity:** Sets the regulator polarity. If the TEC element in the laser diode is reversed, also reverse the regulator polarity. When switching on the TEC controller and the actual temperature diverges instead of converging, try reversing the polarity.
- **P gain, I gain, D gain:** Sets the proportional, integral and differential gain of the PID regulator.

- **Off mode:** Whether the TEC element in the laser diode is open or shorted when the TEC is controller switched off.
- **Soft win, Timeout:** Soft temperature window. If the TEC interlock is enabled (default), then the laser emission will be switched off for safety reasons if the actual temperature deviates from the setpoint by more than the specified window (in °C) for more than the specified timeout (in seconds). The window can be switched off by turning to the lowermost temperature. Only active in regulator mode (see TEC opmode).
- **Hard win:** Hard temperature window. Like soft window (above) except that no timeout applies. Only active in regulator mode (see TEC opmode). Can switch off the TEC controller as well when the temperature falls outside the window.
- **Hard Tmin, Hard Tmax:** Hard minimum and maximum temperature. Active in all modes. Can be disabled by turning to the lowermost temperature. If the hard min/max temperature is exceeded, the laser and the TEC controller are switched off.
- **Pwr on state:** If set to „on“, the TEC controller will be automatically enabled when the LDC10D is powered on using the main switch (3).

Note: Use the „Save Settings“ menu to store configuration settings permanently.

## TEC Controller Operation

The TEC controller is a digital PID controller. The device measures the LD temperature and adjusts the TEC current such that the temperature is regulated towards the setpoint.

Soft and hard window functionality (see above) can be used as safety measure to switch off the laser if the temperature exceeds a defined limit. The soft limit merely switches off the laser diode if the TEC interlock is enabled. The hard window can switch off the TEC controller as well. It tries to be intelligent about temperature change and tries to not switch off the TEC controller as long as the actual temperature converges towards the setpoint, even if the actual temperature is outside the hard limit. This allows to switch on the TEC controller even if the laser diode is initially outside the hard limit.

## LD Controller

The LDC10D's laser diode current controller allows to run diodes continuously with a defined current (CW), to modulate the current digitally between two arbitrary values (TTL modulation) and to apply any current waveform present at the external analog modulation input (EXT analog mod.). This operation mode can be changed in the „Mode“ menu by pressing the first pushbutton („Menu“) and then again the first pushbutton („Mode“). The laser diode controller also features an adjustable current limit and a TEC interlock for safety.

The main screen of the LD controller displays the most important settings. Different main screens are shown for different modulation modes.

The 4 pushbuttons can be used to access the main menu („Menu“), TEC controller's main screen („TEC“) and the LD configuration menu („Conf“; also reachable via „Menu“ -> „LD Config“). The red pushbutton is used to switch the laser emission on/off. The red emission LED (1) always shows whether emission is on or off.

### CW Mode

```
LD: CW          T= 23C ▲
  Iset= 152mA
  Act: 152mA 1.1V ▼
Menu TEC Conf LASER
```

The main screen in CW mode displays the current setpoint („Iset“) as well as the actual current through the laser diode and the voltage at the laser diode (here: 152mA and 1.1V).

The value in the right top displays the case temperature inside the LDC10D in °C.

**NOTE:** To prevent damage to the LDC10D, the case temperature should never exceed 50°C.

Use the rotary knob (2) to change the LD current.

The current setpoint („Iset“) is displayed either in mA or in bits. If an LD current calibration has been performed and the calibration is enabled for CW mode (for both: see configuration menu), then the current can be set in mA units. Otherwise, the current can be set in mA units as long as the emission is off. When switched on, the current is set in „bits“ which is the smallest available current

unit and allows to adjust the current most precisely.

### TTL Modulation Mode

In TTL modulation mode, the TTL input (5) is used to switch between two arbitrary laser diode currents.

```
LD: TTL          T= 24C ▲
  I0/1= 0/ 125mA  ←
  Act: 0mA 0.2V  ▼
Menu TEC Conf LASER
```

The main screen in TTL mode displays the current setpoints for TTL LOW and HIGH levels („I0/1“) as well as the actual average current through the laser diode and the average voltage at the laser diode (here: 0mA and 0.2V).

The value in the right top displays the case temperature inside the LDC10D in °C.

**NOTE:** To prevent damage to the LDC10D, the case temperature should never exceed 50°C.

To change the two current setpoints, use the rotary knob (2). By pushing the rotary knob, you can toggle between I0 (TTL low current) and I1 (TTL high current). Which of these two currents is active at any time depends on the input level of the BNC TTL input (5). The input accepts a standard 5V TTL signal.

The current setpoint („I0/1“) is displayed either in mA or in bits. If an LD current calibration has been performed and is enabled for TTL modulation mode (see configuration menu), then the current can be set in mA units. Otherwise, the current is set in „bits“ which is the smallest available current unit and allows to adjust the current most precisely.

The current monitor output (6) can be connected to a 50 Ohm terminated oscilloscope to check the actual laser diode current over time.



## External Analog Modulation Mode

```
LD: EXT      T= 24C
  External (0..5V)
  Act:      0mA 0.0V
Menu TEC  Conf LASER
```

When in external analog modulation mode, the LDC10D accepts an analog modulation waveform (0V to 5V max) at the analog modulation input (7). The analog input has internal 50 Ohm termination. The analog input has a slightly non-linear voltage-to-laser current relation and features a laser dependent offset of several hundred mV.

Therefore, it is highly recommended to measure the actual laser diode current by attaching a 50 Ohm terminated oscilloscope to the current monitor output (6).

For advanced modulation purposes other than on-off modulation, it is recommended to use a feedback loop and adjust the modulation waveform to the actual laser output on a point-by-point (in time) basis.

The actual average laser diode current and voltage are displayed in the third line (here: 0mA and 0.0V).

The value in the right top displays the case temperature inside the LDC10D in °C.

**NOTE:** To prevent damage to the LDC10D, the case temperature should never exceed 50°C.

## LD Configuration Menu

- **HW limit:** Sets the hardware current limit. This limit should be set to the highest permissible current of the attached laser diode to prevent damage to the laser. The limit can be switched off by tuning to the highest setting.  
Note: See also: Errata (below)
- **Soft limit:** Software limit in mA. Only active when the LD current calibration is used and only affects currents adjusted with the rotary knob in mA units (not in „bits“). Prevents to set currents with the rotary knob above the limit. The soft limit can be switched off by tuning to the highest setting.
- **TEC interlock:** If enabled („on“), the laser diode can only be switched on if the TEC controller allows this. For a TEC controller in regulator mode, this ensures that the TEC

controller is running and within the soft temperature window whenever the laser diode is running.

- **CW current unit:** Sets the current unit for CW mode to „bit“ or „mA“.
- **I calibrat.:** This is the current calibration.  
„No“: No current calibration available.  
„OK“: Current calibration available.  
„Go!“: Perform current calibration (switch to „Go!“ and press rotary knob)  
„Clr“: Clear current calibration.  
See below for details on current calibration.
- **I max:** Maximum current to be used for current calibration.
- **Use for CW:** Whether the current calibration should be used for CW mode. If „Yes“, this enables to specify currents in mA instead of „bits“ in CW mode.
- **Use f. TTL:** Whether the current calibration should be used for TTL mode. If „Yes“, this enables to specify currents in mA instead of „bits“ in TTL mode.

Note: Use the „Save Settings“ menu to store configuration settings permanently.

## Current Calibration

Current calibration is a procedure where the LDC10D internally measures the current in mA corresponding to different bit values in the internal digital-to-analog converters. This allows the LDC10D to convert mA into „bits“ so that the user can conveniently set the current in mA units.

**NOTE:** Since **this bits-to-mA conversion depends on the attached laser diode**, it is highly recommended to either clear or **repeat the current calibration whenever the attached laser diode is changed**.

An outdated current calibration will cause the actual current to deviate from the setpoint specified in mA!

To perform the current calibration set the „I calibrat.“ menu entry of the LD configuration menu to „Go!“ and press the rotary knob.

The current calibration is stored when saving the settings in the toplevel „Save Settings“ menu.

## Current Monitor Output

The current monitor output (6) reflects the current

through the laser diode at any time (as long as the LDC10D is switched on). The monitor output has a bandwidth higher than the modulation bandwidth of the LDC10D so that all current modulation features can be accurately detected and visualized on an oscilloscope.

**The current monitor output is calibrated to 1V/A output voltage when connected to a 50 Ohm load. For a high impedance load, the calibration is 2V/A.**

It is highly recommended to use a 50 Ohm load termination inside or directly in front of an attached oscilloscope to prevent ringing and reflections within the cable that connects the LDC10D to the oscilloscope.

**NOTE:** When switching off modulation current quickly, the current monitor can display a ringing undershoot. This usually does not impair modulation and is usually not visible in the laser intensity. In order to prevent the undershoot, the modulation can be chosen in a way to not switch off the diode to zero but to some small offset slightly above zero. Use the current monitor output to adjust the modulation in the desired way.

## System Settings Menu

The system settings menu is accessed from the main menu.

- **Fan PWM:** Case fan PWM (pulse width modulation) percentage: Should be set such that the case temperature does not exceed the limit (50°C).  
Note: See also: Errata (below)
- **Fan PWM min:** Minimum fan speed. (Feature will be useful after next firmware update.)
- **LCD Bright:** Change the LC display background brightness.
- **Contrast:** Adjust the LC display contrast.
- **Error Beep:** Enable the emission of an audible beep tone in case of error (TEC window error,...)
- **Enable USB:** Whether the USB interface (4) is enabled.
- **FW Version:** Firmware version. (Display only)
- **FW Update:** Firmware update via USB. To perform a firmware update, switch to „Go!“, press the rotary knob and follow the procedure on the display. Firmware updates require a USB cable connection to a computer and a new firmware binary.
- **USART0, USART1:** Communication status display. For debugging purpose only.

## Save Settings Menu

The save settings menu is accessed from the main menu. It allows to store all configuration and calibration settings permanently. The permanently stored settings are automatically loaded when powering on the LDC10D.

- **Save all:** Save all configuration and calibration settings? To save settings permanently, switch to „Yes“ and press the rotary knob.
- **Load all:** Load the current settings. This happens automatically upon powerup.
- **Ld defaults:** Load factory default settings. In order to permanently set factory defaults, use „Save all“ after „Ld defaults“.



## USB Interface

The USB interface can be used to remotely control certain aspects and to perform firmware updates.

The USB uses an FT232R USB-to-serial converter. On most operating systems, drivers are either pre-installed (any recent Linux) or will install automatically when plugging in (Windows).

The USB will register itself at the operating system as virtual COM port (Linux: /dev/ttyUSBx, Windows: COMx). In order to use it, it has to be configured for a baud rate of 38400, no parity, 8 bits, 1 stop bit (commonly called „38400 8N1“).

## USB Commands

The USB interface uses a line-oriented text based protocol. Each command is terminated by a newline.

You can open a serial connection using a terminal program such as PuTTY (Windows) or minicom (Linux) for testing. However, normally, to use the USB one would have dedicated control software that talks to the LDC10D and not an interactive shell.

Hence: Please note that characters you type into the terminal window will not be echoed back. It looks like you are typing „blind“. This is to ease integration into dedicated control software. After pressing the return key (or sending a CR or LF character), any typed command will be executed.

As of version 0.8a, the USB supports the following commands:

- **:tec:sp *NNN*** – Set the TEC setpoint to the specified temperature *NNN* in 0.1°C. E.g. to set 25°C, use „:tec:sp 250“.
- **:version** – Query firmware version.

After each command, a status message is sent back. Only issue one command at a time and wait for the status message before sending another command. The following status messages exist:

- OK – command understood
- E:TMA – too many arguments
- E: MA – missing argument
- E:OOR – argument out of range
- E:CMD – unknown command

## Firmware Update via USB

In order to perform a firmware update, you need the firmware file called **ldc10d.cfb**

Perform the following steps:

- Connect USB cable between LDC10D and computer.
- Power on the LDC10D. For safety, switch any attached laser off.
- Launch the firmware update utility on the computer.

The firmware update takes about 30 to 60 seconds. The red emission LED on the front panel will blink during the update procedure. When complete, the LDC10D will re-start itself immediately. **Do not turn off the device while the firmware update is in progress!**

## Errata: Known Problems and Bugs

- **Case temperature:** The LDC10D features an adjustable case fan and a case temperature sensor. However, the case fan is not regulated according to the case temperature. However, the device is shut down in case of excessive case temperature.  
Solution: Increase the fan PWM value in the system settings menu if the device runs too hot (>50°C).  
Fix: Will be fixed in a future firmware update.
- **Hardware current limit:** Hardware current limit may be lower than specified. Especially for SOAs in the 1050nm range.  
Solution: Increase the hardware current limit and use the displayed actual current to judge the settings.  
Fix: Will be fixed in a future firmware update.
- **USB interface:** The USB interface currently only supports firmware updates. A future firmware release will support changing all values accessible from the menus via USB as well.

### Old errata fixed in current firmware:

- **Current calibration:** Occasionally, the LD current calibration fails.  
Solution: Try current calibration a couple of times. If it does not work, do not use current calibration.  
Fix: Fixed in firmware version 0.6d and above.

(blank)