Compact Laser Diode Driver
Version 2.4
cLDD User’s Guide
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1. General information

1.1. Safety

**WARNING** - Laser diodes are susceptible to damage as a result of electrostatic discharge (ESD). Ensure that you take proper precautions when handling these devices.

**WARNING** - Depending on the type of laser used, the laser diode modules may deliver several hundreds of mW of invisible laser radiation. To avoid injuries follow the laser diode manufacturer and standard laser safety instructions.

**WARNING** - Always power off the Compact Laser Diode Driver (cLDD) unit before replacing the laser diode. Configure the cLDD laser diode parameters with the CLDD Control Application software before operating the cLDD unit.

1.2. Product overview

The Compact Laser Diode Driver (cLDD) combines a laser mount with built-in laser current and TEC drivers in a single unit. The cLDD is optimized for driving laser diodes, SLEDs, or SOAs, with integrated TECs.

The cLDD is configurable as a 0.5 Amp, 1 Amp or 2 Amp laser diode current driver, with up to 4 Amp of TEC current.\(^1\) The cLDD is provided with a 14-pin butterfly mount or with a DIL mount depending on the option selected.\(^2\) Mounts may be acquired separately. Please refer to product brochure or contact Innolume for further details.

The cLDD has a Java computer control application to set and monitor various driver parameters such as laser diode current, output power, temperature, mode of operation, and several warnings and alarms. Connection to the computer is through a USB communications interface. Once configured, the cLDD may be operated stand-alone (disconnected from the computer) and operating parameters may be changed with the cLDD keypad.

The cLDD integrates several protective functions including slow start-up of the laser diode current, laser current limit, TEC current limit and temperature limit detection. Threshold values for various warning and alarm conditions may be defined by the User.

By changing a laser diode Pin-routing board, laser diodes of different pin-out assignments may be utilized with the same cLDD unit. Refer to the pin-assignment table to check the Pin-routing board to use with your laser diode. Pin-routing boards for different laser diode packages can be provided on request.

Custom OEM modules may be provided. Please contact us with your requirements.

This User’s Guide applies to cLDD version 2.4 only.

---

\(^1\) TEC current is up to 4 Amp in transient regime and rated 3 Amp in permanent operation.

\(^2\) The DIL mount is rated 1 Amp continuous current.
2. Technical Data

2.1. Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>0.5 A</th>
<th>1.0 A</th>
<th>2.0 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current range (user configurable)</td>
<td>0.5 A</td>
<td>1.0 A</td>
<td>2.0 A</td>
</tr>
<tr>
<td>Current control range</td>
<td>15 mA to 0.5 A</td>
<td>30 mA to 1.0 A</td>
<td>60 mA to 2.0 A</td>
</tr>
<tr>
<td>Current limit (user configurable)</td>
<td>0.2 A to 0.5 A</td>
<td>0.2 A to 1.0 A</td>
<td>0.2 A to 2.0 A</td>
</tr>
<tr>
<td>Current reading resolution</td>
<td></td>
<td>0.1% full scale</td>
<td></td>
</tr>
<tr>
<td>Compliance voltage</td>
<td></td>
<td>&gt; 4.8 V</td>
<td></td>
</tr>
<tr>
<td>Photodiode current control ranges (user configurable)</td>
<td>5 μA to 0.25 mA; 10 μA to 0.5 mA; 20 μA to 1.0 mA; 50 μA to 2.5 mA; 100 μA to 5 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEC current – transient</td>
<td></td>
<td>4.0 A</td>
<td></td>
</tr>
<tr>
<td>TEC current – permanent rating a)</td>
<td></td>
<td>3.0 A</td>
<td></td>
</tr>
<tr>
<td>TEC current limit (user configurable)</td>
<td></td>
<td>0.4 A to 4 A</td>
<td></td>
</tr>
<tr>
<td>Mode of operation</td>
<td></td>
<td>Constant average current; Constant average output power; External Analog Modulation;</td>
<td></td>
</tr>
<tr>
<td>Temperature control Kp and Ti parameters (user configurable)</td>
<td>Kp from 0.02 to 4870</td>
<td>Ti from 0.01s to 229s</td>
<td></td>
</tr>
<tr>
<td>External analog current modulation</td>
<td></td>
<td>-3dB high freq. cut-off &gt; 500kHz</td>
<td></td>
</tr>
<tr>
<td>External power supply b)</td>
<td>DC, 5V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption d)</td>
<td></td>
<td>typical &lt; 25 W</td>
<td></td>
</tr>
<tr>
<td>Dimensions d)</td>
<td></td>
<td>135 mm x 200 mm x 55 mm</td>
<td></td>
</tr>
<tr>
<td>Computer controlled operation – via provided Software Control Application</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand-alone operation – via local keypad and display</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Specifications are subject to change without notice.

a) DIL mount is rated 1A permanent operation;
b) 5VDC to center pin, 0V external;
c) Power consumption and power supply current depend on operating conditions. Typical values are a power supply of 5 A, 25 W for a 500 mA laser diode operated at room temperature;
d) Without brackets, with butterfly adapter.
2.2. Panels description

2.2.1. Top panel

The cLDD Top Panel has an LCD display, two status LEDs and four control buttons:

- **LCD DISPLAY**: displays values of applied laser current, laser output power, laser temperature and mode of operation;
- **ENABLE LED** – indicates cLDD status of operation (see table below for details);
- **ERROR LED** – indicates a warning or error status (see table below for details);
- **ENABLE button** – controls cLDD status of operation:
  - Pressing once toggles cLDD between ENABLED and DISABLED status of operation.
  - Continuous pressure for about three seconds sets cLDD to HIBERNATED status.
- **SET button** – controls the cLDD display status and allows modification of cLDD operation parameters:
  - Press button once to enter SETTING status,
  - Press button several times until desired field blinks on the display,
  - Use **UP** and **DOWN** buttons to change field values,
  - Press **SET** button again to save the values into memory,
  - To exit SETTING status press **SET** button until there is no field blinking.
- **UP** and **DOWN** buttons – change the values of the selected field on the LCD display.
  - Pressing down the button once makes the values change incrementally (at unit steps),
  - Holding the button down makes the values change faster (at steps of ten).

The following table summarizes the LED color codes and corresponding cLDD status:
<table>
<thead>
<tr>
<th>ENABLE LED</th>
<th>ERROR LED</th>
<th>cLDD status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Off</td>
<td>The cLDD unit is powered OFF.</td>
</tr>
<tr>
<td>Blinking Red</td>
<td>Off</td>
<td>cLDD unit is powered ON and ready for operation; Laser current drivers and TEC are disabled.</td>
</tr>
<tr>
<td>Blinking Green</td>
<td>Off</td>
<td>cLDD unit is ENABLED. Laser current and TEC drivers are active and in the process of locking the control loops - may take a few seconds.</td>
</tr>
<tr>
<td>Green</td>
<td>Off</td>
<td>cLDD unit is ENABLED; Laser current and TEC drivers are active and locked.</td>
</tr>
<tr>
<td>Red</td>
<td>Off</td>
<td>cLDD unit is DISABLED; Laser current driver is disabled; TEC driver is still active and locked.</td>
</tr>
<tr>
<td>Fast blinking Red</td>
<td>Off</td>
<td>cLDD unit is HIBERNATED. All drivers are disabled for minimum power consumption. cLDD ready for power OFF.</td>
</tr>
<tr>
<td>XX</td>
<td>Yellow</td>
<td>Warning alarm – a non-fatal alarm has been detected.</td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
<td>Fatal alarm – a fatal alarm has been detected on the Laser current driver. TEC driver is active. The cLDD is DISABLED.</td>
</tr>
<tr>
<td>Fast blinking Red</td>
<td>Red</td>
<td>Fatal alarm – a fatal alarm has been detected. All drivers are disabled. The cLDD is HIBERNATED.</td>
</tr>
</tbody>
</table>

2.2.2. Rear panel

The back panel has the power supply connector, the external modulation connector and the communications interface connector:

- Power supply connector: 2.1 mm internal diameter and 6.3 mm external diameter DC male connector; mates with 2.1 mm internal diameter and 5.5 mm external diameter female connector; +5 V DC to positive central pin; 0 V DC external.
  - External power supply requirements depend on the laser diode being used. For a typical 500 mA laser diode a 3 to 4 Amp peak current power supply is required. Maximum power rating 5.5 V/ 5 A.
  - The cLDD is powered ON and OFF by connecting and disconnecting the power at this rear panel power connector.
- External modulation connector: male SMB connector
  - DC modulation voltage (voltage gain = 1).
- Communications interface connector: USB socket type B.
2.3. Device mount and Pinout assignment

2.3.1. Devices with 14-pin butterfly packages

14-pin butterfly mount

14-pin butterfly packaged laser diodes are mounted on the cLDD with the butterfly mount assembled. The butterfly mount consists of an aluminum base with two 7-pin ZIF (zero-insertion-force) butterfly connectors, together with the necessary screws. The aluminum base has M2 threaded holes to accommodate footprints with mounting hole spacing of 26 mm x 9 mm as well as 32.7 mm x 9 mm.

To assemble the butterfly mount, first screw down the aluminum base using M3 screws. Then close the 7-pin butterfly connectors, carefully align the connector pins with the corresponding cLDD socket, gently push the connector all the way down, and fix the connector onto the cLDD using the M2 screws.

The two 7-pin ZIF connectors are attached using M2 screws with 1.5mm hex head. The aluminum heatsink base is attached using two M3 screws with 2.0mm hex head. Use M2 screws to fix the laser diode device to the aluminum base.

14-pin butterfly pin assignments

Check that the pin assignment of your device is compatible with the pin assignment of the Type I or Type II Pin-routing boards:
### TYPE I PIN ASSIGNMENT OF THE 14-PIN BUTTERFLY CONNECTOR

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thermoelectric Cooler Positive (TEC+)</td>
</tr>
<tr>
<td>2</td>
<td>Thermistor</td>
</tr>
<tr>
<td>3</td>
<td>Monitor Photodiode Anode</td>
</tr>
<tr>
<td>4</td>
<td>Monitor Photodiode Cathode</td>
</tr>
<tr>
<td>5</td>
<td>Thermistor a)</td>
</tr>
<tr>
<td>6</td>
<td>Not connected</td>
</tr>
<tr>
<td>7</td>
<td>Monitor Photodiode Cathode</td>
</tr>
<tr>
<td>8</td>
<td>Monitor Photodiode Anode</td>
</tr>
<tr>
<td>9</td>
<td>Laser Diode Cathode a)</td>
</tr>
<tr>
<td>10</td>
<td>Laser Diode Anode b)</td>
</tr>
<tr>
<td>11</td>
<td>Laser Diode Cathode a)</td>
</tr>
<tr>
<td>12</td>
<td>Not connected</td>
</tr>
<tr>
<td>13</td>
<td>Case</td>
</tr>
<tr>
<td>14</td>
<td>Thermoelectric Cooler Negative (TEC-)</td>
</tr>
</tbody>
</table>

### TYPE II PIN ASSIGNMENT OF THE 14-PIN BUTTERFLY CONNECTOR

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thermistor a)</td>
</tr>
<tr>
<td>2</td>
<td>Thermistor</td>
</tr>
<tr>
<td>3</td>
<td>Laser Diode Cathode a)</td>
</tr>
<tr>
<td>4</td>
<td>Monitor Photodiode Anode</td>
</tr>
<tr>
<td>5</td>
<td>Monitor Photodiode Cathode</td>
</tr>
<tr>
<td>6</td>
<td>Thermoelectric Cooler Positive (TEC+)</td>
</tr>
<tr>
<td>7</td>
<td>Thermoelectric Cooler Negative (TEC-)</td>
</tr>
<tr>
<td>8</td>
<td>Case</td>
</tr>
<tr>
<td>9</td>
<td>Case</td>
</tr>
<tr>
<td>10</td>
<td>Not connected</td>
</tr>
<tr>
<td>11</td>
<td>Not connected</td>
</tr>
<tr>
<td>12</td>
<td>Not connected</td>
</tr>
<tr>
<td>13</td>
<td>Laser Diode Anode b)</td>
</tr>
<tr>
<td>14</td>
<td>Not connected</td>
</tr>
</tbody>
</table>

a) Connected to GND within the cLDD;
b) If connected to case, see WARNING below.

**WARNING:** If the device has the Anode connected to Case then the device case must be electrically isolated from the aluminum mount using an insulating sheet or mica and nylon screws. Please refer to the pin assignment tables.

The cLDD comes with a factory installed Type I pin routing board unless otherwise specified at the time of purchase. A Type II pin routing board and a Custom routing board are also provided. The Custom routing board allows the user to wire a user-defined pin-out assignment.

To change routing boards first disconnect the power supply from the cLDD, remove the laser diode or device (if mounted), remove the back plate of the cLDD, and carefully pull out the routing board applying an even pull on both sides of the board. Then align the desired routing board with the cLDD sockets, confirm that the arrows marked OUTSIDE are pointing to the outer side of the cLDD, and gently push the routing board all the way down. Re-assemble the back plate.

**WARNING:** The use of an inappropriate routing board may damage the device and the cLDD.
To mount the laser diode device it is recommended to first place the device on the connectors, check that the pins are properly aligned and the device is centered on the connectors, close the connectors, and screw down the device onto the aluminum base using M2 screws. Refer to the figure below for position of pin 1.

To remove the device from the mount it is recommended to first unscrew the device from the aluminum base, then press down the connectors and unlatch them, and finally carefully remove the device.

2.3.2. Laser diodes with 14-pin DIL packages

DIL mount

14-pin DIL packaged laser diodes are mounted on the cLDD with the DIL mount, as shown in the next figure. The DIL mount consists of an aluminum heatsink block and a PCB with a 14-pin ZIF (zero-insertion-force) DIL connector.

If the butterfly mount was being used before, first remove the butterfly connectors and aluminum base.

To assemble the DIL mount, first carefully align the PCB pins with the corresponding cLDD socket, check that the holes on the PCB are on the outer side of the cLDD, and gently push the PCB all the way down. Fit the heatsink aluminum block over the DIL connector and screw it down to the cLDD using the M3 screws. (see figure below).

**Warning** - The DIL adapter is to be used with Type I Pin-routing board only. The use of another type of Pin-routing board may result in damage to the laser diode and the cLDD unit.

First insert the PCB with the 14-pin DIL connector onto the cLDD sockets. Fit the aluminum heatsink block over the DIL connector. Attach the mount to the cLDD with two M3 screws (2.0mm hex head).
Check that the pin assignment of your laser diode is compatible with the pin assignment described in the following table.

### PIN ASSIGNMENT OF THE 14-PIN DIL CONNECTOR

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thermoelectric Cooler Positive (TEC+)</td>
</tr>
<tr>
<td>2</td>
<td>Not connected</td>
</tr>
<tr>
<td>3</td>
<td>Not connected</td>
</tr>
<tr>
<td>4</td>
<td>Not connected</td>
</tr>
<tr>
<td>5</td>
<td>Laser Diode Anode b)</td>
</tr>
<tr>
<td>6</td>
<td>Not connected</td>
</tr>
<tr>
<td>7</td>
<td>Monitor Photodiode Cathode</td>
</tr>
<tr>
<td>8</td>
<td>Monitor Photodiode Anode</td>
</tr>
<tr>
<td>9</td>
<td>Laser Diode Cathode a)</td>
</tr>
<tr>
<td>10</td>
<td>Not connected</td>
</tr>
<tr>
<td>11</td>
<td>Thermistor a)</td>
</tr>
<tr>
<td>12</td>
<td>Thermistor</td>
</tr>
<tr>
<td>13</td>
<td>Not connected</td>
</tr>
<tr>
<td>14</td>
<td>Thermoelectric Cooler Negative (TEC-)</td>
</tr>
</tbody>
</table>

a) Connected to GND within the cLDD;  
b) If connected to case, see WARNING below.

**WARNING:** If the device has the Anode connected to Case then the device case must be electrically isolated from the aluminum mount using an insulating sheet or mica and nylon screws. Please refer to the pin assignment tables.
2.4. cLDD operation modes

The cLDD may operate in three different modes as shown in the next table.

The user can select the mode of operation using the cLDD Control Application or local buttons (see section 2.2.1). The user can also switch between modes of operation during laser operation.

<table>
<thead>
<tr>
<th>Mode of Operation</th>
<th>Feedback Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Average Current</td>
<td>Laser Diode Current</td>
</tr>
<tr>
<td>Constant Average Power (Monitor Photod.)</td>
<td>Internal Monitoring Photodiode</td>
</tr>
<tr>
<td>External Analog Modulation</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

**Constant Average Current** – In this mode of operation the laser diode current is maintained at a constant set point. This set point is defined using the software control application (see section 4.3.3) or the cLDD control buttons (see section 2.2.1).

**Constant Average Power** – In this mode of operation the laser diode is set to a constant optical output power. The feedback signal is provided by the monitoring photodiode integrated in the laser diode module. The set point is defined using the software control application (see section 4.3.3) or the cLDD control buttons (see section 2.2.1).

**External Analog Modulation** – In this mode of operation the laser diode is controlled directly thru the SMB connector. The limits to the laser diode current and the corresponding alarms remain valid, but the current/power setpoint set via the software control application or the local keyboard is inactive (see section 3.5).

**WARNING** - To operate the laser in Constant Power mode, the user must first define the calibration parameters of the monitoring photodiode (internal to the laser diode housing) using the cLDD Computer Control Application (see section 4.3.3). The use of inappropriate calibration parameters in Constant Average Power mode may result in device damage, will result in inaccurate power information and may affect the cLDD performance.

**ATTENTION** – Operating the cLDD unit in Constant Average Power mode when the laser diode is close to laser threshold may result in laser current instability, and the cLDD unit may not be able to lock.

**ATTENTION** – When operating the cLDD unit in Constant Current mode with low currents (see section 2.1 for typical values) the cLDD unit may not be able to lock.
3. Operation

This section describes how to get started with the cLDD unit, how to operate the cLDD unit in stand-alone or computer-controlled modes, how the cLDD unit and the cLDD Control Application are synchronized, and how to modulate the laser diode current using an external DC voltage modulation signal.

3.1. Getting Started

When using for the first time a laser diode with the cLDD unit, it is necessary to configure the cLDD settings using the cLDD Control Application software. Once the cLDD unit has been configured it may be operated stand alone (disconnected from the computer).

Follow the instructions below to configure the cLDD.

1) Install the cLDD drivers and Control Application software from the cLDD CD. Refer to section 4.1 and 4.2 for details.

2) Verify if the laser diode pin-out is compatible with the Pin-routing board (see section 2.3.1 or 2.3.2 for details). Make sure the power supply is disconnected from the cLDD unit.

3) Place the laser diode on the Socket. To obtain a good thermal contact between the laser diode case and the mount you may use thermal conductive paste or thermal pad and fix the laser diode onto the mount using the given screws. Close the laser diode Socket.

4) Power ON the cLDD by connecting the external power supply (see section 0). After being powered up the cLDD enters the RESET state (shown by a blinking red Enable LED) and the message “system ready for operation ...” appears on the LCD display. In this state the laser diode and the TEC driver are DISABLED.

**WARNING:** Do not press the Enable button on the cLDD before configuring the unit! Operation of the laser diode without first configuring the unit may result in permanent damage to the laser diode.

5) Connect the cLDD to the computer using the provided USB Type A to Type B cable. Start the cLDD Control Application. A Configuration Wizard will start automatically. Follow the instructions to configure the cLDD unit according to your laser diode parameters and desired operation conditions. You may find a detailed description of the Configuration Wizard in section 4.3. Configuration and operation parameters may be changed at a later time. If you are connecting the cLDD unit to a computer USB port for the first time, a Found New Hardware window will appear. Follow instructions given at section 4.5.

The cLDD unit is now ready to drive the laser diode. The cLDD unit may be operated either in stand-alone or computer controlled operation. Please refer to sections 3.2 and 3.3 for further details.

**ATTENTION** – Make sure you follow steps 2 to 5 every time you change the laser diode.
3.2. Stand-alone operation

**WARNING**: If you have changed the laser diode on the cLDD unit, in order to prevent laser diode damage reconfigure the cLDD unit. See section 3.1.

Once the CLDD has been configured, as described in section 3.1, it may be operated stand-alone (with no USB cable connected).

1) Power ON the cLDD by connecting the external power supply (see section 0). After being powered up the cLDD enters the RESET state (shown by a blinking red Enable LED) and a “system ready for operation ...” message appears on the LCD display. In this state the laser diode and the TEC driver are DISABLED.

2) ENABLE the cLDD by pressing the **Enable** button on the top panel. After being enabled, the cLDD starts locking the laser diode temperature and current (signaled by a blinking green **Enable** LED). Once locked the driver is operating at the defined settings (signaled by a stable green **Enable** LED). The LCD display shows the laser diode current, the laser diode output power (if the monitor photodiode option is active), the laser diode temperature and the mode of operation.

3) To change the laser diode temperature, lasers diode current (or power) or mode of operation values press the **Set** button once to get into SETTING state, then press several times the **Set** button until the desired field to change is blinking on the LCD display. Press the **Up** and **Down** buttons to obtain the desired value (or mode). Pressing the **Up** or the **Down** buttons continuously makes the value change faster. Press the **Set** button again to save settings. To leave the SETTING state press several times the **Set** button until no field is blinking. The **Enable** LED may start blinking Green while the drivers are being locked to the specified values.

4) To DISABLE laser emission press the **Enable** button on the top panel of the cLDD unit. The laser diode current is turned off but the TEC driver and all other electronics remain active. The DISABLED state is signaled by a stable red **Enable** LED.

5) To HIBERNATE the cLDD press the **Enable** button continuously for about three seconds. On this state both laser diode current and the TEC drivers are turned off. This state requires minimal electrical consumption and is signaled by a fast-blinking red **Enable** LED on the top panel of the cLDD unit. To recover from this state press the **Enable** button once.

6) To turn OFF the cLDD unit, first press the **Enable** button continuously for about three seconds to enter HIBERNATED state and then shut down the power supply or remove the power cable to the cLDD.

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### 3.3. Computer Controlled Operation
The cLDD unit may be operated while connected to the computer allowing remote continuous monitoring and control of the laser diode.

Once the cLDD with a mounted laser diode has been configured, as described in section 3.1, a control screen similar to the following is showed.

[Image of control screen]

A detailed description of all commands and information provided in this window is given in section 4.4.

1) The user may define/change the laser diode mode of operation at the Laser setpoint Operation Mode field of Main cLDD control window. Constant power mode is available only if the User enabled it during laser configuration. Laser configuration can be changed at any time by pressing the Wizard icon on the toolbar. Please refer to section 4.3 for more details.

2) TEC can only be operated at Constant temperature mode.

3) Set the operating current and temperature by filling the corresponding fields in the Main cLDD control window. These values can be changed during laser and TEC ENABLED states. If the cLDD is ENABLED the Enable LED, located at bottom right corner, will be blinking while the drivers are being locked to the specified values (a message will also be shown at left bottom corner).

4) ENABLE the cLDD by clicking over the Laser enable button on the screen. After being enabled, the cLDD starts locking the laser diode temperature and current to the defined values (signaled by a blinking green Enable LED). Once locked the driver is operating at defined settings (signaled by a stable green Enable LED). The displays show the laser diode real time operating current and the laser diode output power (if correctly calibrated during the configuration procedure), together with the laser diode temperature and TEC current values.
5) To DISABLE laser emission click over the Enable button. The laser diode current is turned off but the TEC driver and all other electronics remain active. The DISABLED state is signaled by a stable red Enable LED.

6) To HIBERNATE the cLDD press the Power icon on the toolbar. On this state both laser diode current and the TEC drivers are turned off. This state requires minimal electrical consumption and is signaled by a fast-blinking red Enable LED. To recover from this state press the Restart button once.

7) To turn OFF the cLDD unit, first press the Power icon to enter HIBERNATED state and then shut down the power supply or remove the power cable to the cLDD.

3.4. cLDD unit synchronization

After the cLDD unit is configured, the user may exit the cLDD Control Application at any time, or remove the connecting USB cable to the cLDD unit. The user may re-connect the cLDD unit to the computer at a later time, or even connect a different computer (with the cLDD Control Application installed) to the cLDD unit.

The Configuration Wizard is started whenever the connection is interrupted or when the cLDD Control Application is re-started. The user may then select which cLDD unit to control, and when the connection is re-established the user may proceed and reconfigure the cLDD unit or cancel without changing the configuration.

**NOTE:** The cLDD Control Application reads the existing configuration from the cLDD unit. This configuration is compared to the configuration on the cLDD Control Application. If the cLDD unit is enabled the user may skip the other configuration steps and press Finish to exit the Wizard.

The cLDD Control Application displays the real-time values of laser diode current and output power (if properly configured) together with temperature and TEC current.

3.5. External modulation

**WARNING** - Before applying any modulation signal, make sure you configure the cLDD unit in accordance to the laser diode manufacturer datasheet.

**WARNING** - To avoid damaging the laser diode, turn off the cLDD unit before connecting the electrical cable from the external modulation signal generator to the SMB connector of the cLDD unit.

**WARNING** – Make sure the GND of the external modulation source and that of the cLDD are the same

**ATTENTION** - User-defined limits and alarm thresholds apply to the modulation voltage and corresponding current.

The cLDD modulation circuitry is a voltage unitary gain circuit with DC-coupled input and 1 MOhm input impedance. The DC modulation voltage applied to the laser diode is a replica of the external modulation signal (gain = 1), thus a sinusoidal input signal with 1 mV amplitude would correspond to a
sinusoidal voltage modulation of 1 mV amplitude. The exact electrical current modulation of the laser diode is dependent on the specific voltage-current characteristic of the mounted laser diode and on the frequency of the modulation signal. The -3 dB cut-off modulation frequency is greater than 500 kHz for a typical laser diode.

**Protections**

- Laser current limit is defined by the User using the Configuration Wizard of the Control Application software (see section 4.3).
- Alarms (warning and fatal) are defined by the User using the Configuration Wizard of the Control Application software (see section 4.3). Alarm thresholds apply to the sum of the AC and DC currents. If a fatal alarm threshold is detected the cLDD is DISABLED (for a laser current or power fatal alarm) or HIBERNATED (for a TEC fatal alarm).
- The modulation voltage swing is limited to the 0V to 5V range
4. Reference Guide to the Java cLDD Control Application

This section describes the computer system requirements for the CLDD Control Application, the installation instructions and a general overview of the cLDD Control Application.

4.1. System requirements

The following computer systems requirements are needed to install the cLDD Control Application:

- Microsoft Windows™ operating system (version 98, ME, 2000, or XP);
- USB port;
- Graphic card capable of a minimal resolution of 800x600 and 256 colors;
- Minimum of 32 MB of system RAM (64 MB recommended).

4.2. Installation instructions

To install the cLDD drivers and Control Application follow the next steps:

1) Close all running applications before proceeding. Disconnect the computer from the internet. Do not connect the cLDD unit to the computer yet. Insert the cLDD CD provided with the unit into the computer. The cLDD installer should start automatically. If the cLDD installer does not start, locate and run the file Setup.exe on the root folder of the CD drive.

2) Follow the instructions on the screen. The cLDD Control Application requires the Java 2 Runtime Environment. The setup will ask if you wish to install a compatible version of the Java RE if it is not already installed on your computer.

3) Once the cLDD Control Application is installed, you will be prompted to proceed with the cLDD unit configuration.

4.3. Configuration Wizard

The Configuration Wizard is a step-by-step guide to configure the laser diode parameters required by the cLDD unit, as well as the alarm configurations and operation set points. The Wizard allows you to create new configurations for the first time operation of a laser diode, or recall/edit previously saved laser diode configurations.

The Configuration Wizard may be started selecting the Configuration Wizard command from the File menu or by clicking over the wizard button on the upper toolbar of the cLDD Control Application main window. The Configuration Wizard starts automatically when the cLDD Control Application is started or when there is an interruption in the communications with the cLDD unit. This is a safety measure to prevent the user from running a laser diode with incorrect parameters.
4.3.1. Starting screen

The starting screen informs the user of three configuration steps required.

![Starting screen](image)

4.3.2. Communications configuration

The application detects all cLDD units connected to USB ports of the computer. After the user selects the desired USB port (or cLDD unit), the wizard reports the name and serial number of the cLDD unit found at the selected USB port.

**NOTE:** the cLDD Unit name may be changed at the System information window. Refer to section 4.4.1.

![Communications configuration](image)

The wizard reports an error if no cLDD unit is found. In this case make sure the cLDD unit is powered and the USB cable is properly connected. Press the **Re-scan ports** button to detect cLDD units connected.

**NOTE:** If you have plugged the communications cable to a different USB computer port, Windows will start the Found New Hardware Wizard. See section 4.5 for details.
4.3.3. Laser Parameters and Alarms Configuration

The name of the configuration currently loaded on the cLDD unit is shown on the Selected laser configuration box, together with a Description of the configuration.

The user may select and edit the cLDD loaded configuration or any other of the locally saved configurations from the list provided.

To import a list of configurations go to the Import Configurations command of the File menu and select to open the Laser_configs.cfgs file of the Cfgs folder from the CD.

**WARNING**: If you have changed the laser diode on the cLDD unit or are connecting the computer to a different cLDD unit, in order to prevent laser diode damage you should create and save a new configuration according to the mounted laser diode parameters.

- The New button starts a new configuration screen;
- The Edit button loads the Selected laser configuration to be edited;
- The Delete button deletes the Selected laser configuration.
Editing the Laser Diode Configuration

The following window exemplifies the edition of an existing laser diode configuration. To save a configuration with a different name it is required to create a new configuration.

The user may recall the configuration settings present in the cLDD unit (download values from the cLDD unit) by pressing the Read cLDD Configuration button.

The Cancel button takes the user to the previous screen. No modifications are saved.

After filling the required parameter fields, click the OK button to save the configuration.

The Parameters sheet allows configuring the cLDD unit with the laser diode parameters according to the laser diode manufacturer datasheets.

**Laser Parameters:**

- **Current Limit:** user defined current limit in mA. The laser driver will not provide current over this limit. This is a required field.

**WARNING** – Make sure you input the laser current limit according to the laser diode manufacturer datasheet. Running a laser diode over the specified current limit may result in permanent damage to the laser diode.

- **Current range:** configures the maximum current of the cLDD unit.

- **Enable Constant power operation mode:** Enables operation of the mounted laser diode in the Constant power operation mode. This mode uses the monitoring photodiode on the laser diode to keep the output power at the requested operation set point. The value of the monitoring photodiode current (in mA) and the corresponding laser diode output optical power (in mW) are required parameters (if the Constant power mode of operation is enabled). The User may select Constant power or Constant current operation mode at main window.
• **Photodiode Current Range**: user-selectable photodiode current range. Defines the usable photodiode current in user selectable range in Constant power operation mode. The power reading is not reliable when the photodiode current falls off the selected range.

**WARNING** - The use of inappropriate calibration parameters will result in inaccurate power information and may affect cLDD operation.

**TEC Parameters:**

• **Maximum Current**: this setting limits the current on the TEC driver. This is a required field.

**WARNING** – Make sure you input the TEC current limit according to the laser diode manufacturer datasheet. Running a TEC over the specified current limit may result in permanent damage to the laser diode.

• **Thermistor Parameters**: The parameters of the laser diode thermistor are needed for an accurate temperature control. If thermistor parameters are not set, the CLDD Control Application assumes a **Thermistor resistance** of 10000 Ohm at 25°C and a **Beta** of 3750 K.

**WARNING** - The use of inappropriate thermistor parameters will result in inaccurate temperature information, may result in damage to the laser diode and may affect cLDD performance.

• **Control Parameters**: These are the Proportional and Integral gain parameters of the TEC control loop. Typical values are 80% for Proportional and 30% for Integral.

**ATTENTION** - The cLDD is shipped from factory with TEC control loop parameters that satisfy most devices. It is possible that for some particular devices the TEC control loop is not able to stabilize, as the design of the laser diode (SLED or SOA) heatsink and the TEC vary depending on the device manufacturer and on the required heat dissipation. In case the TEC current is unstable refer to section 4.4.6 for an adjustment procedure.
The **Alarm thresholds** sheet allows setting of thresholds for two types of alarms:

- **Warning alarms**: User defined. If a parameter exceeds a warning alarm threshold, the condition is indicated by the corresponding yellow LED on the Control Application screen. The laser current driver and the TEC drivers remain active;

- **Fatal alarms**: User defined. If a parameter exceeds a fatal alarm threshold, the condition is indicated by the corresponding red LED on the Control Application screen. The laser current driver is **DISABLED** if a current driver fatal condition is detected. All drivers are **DISABLED** if a different fatal condition is detected.

**WARNING** – If the user selects the operation point of the cLDD unit too close to a fatal alarm threshold, the cLDD may not be able to operate as a fatal condition is immediately triggered.

The alarm threshold values are optional. Alarms will only be reported if corresponding threshold values are enabled using the corresponding checkboxes.

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**Laser alarm thresholds:**

- **Current**, in mA: an alarm will be given if the laser diode current exceeds the indicated thresholds;

- **Power**, in mW: an alarm will be given if the output optical power of the laser diode exceeds the indicated thresholds. This alarm is available only if the Constant power operation mode was enabled by the user on the Parameters sheet.

**TEC alarm thresholds:**

- **Current**, in Amp: an alarm will be given if the absolute value of the TEC current exceeds the indicated thresholds;
• **Temperature**, in °C: an alarm will be given if the laser diode temperature exceeds the indicated threshold.

### 4.3.4. Laser and TEC Operation Set Points

The laser may be operated in either Constant current mode or in Constant power mode. The former requires a laser current setting (in mA) and the latter requires a laser output power setting (in mW). The Constant power mode is only available if the Enable constant power operating mode checkbox in the Laser parameter configuration window is selected (see section 4.3.3). In Constant power operation mode the laser output power is kept at a constant power. Default values are 50 mA for Constant current mode and 20 mW for Constant power mode.

The TEC can be set to different operating temperatures. Default value is 25 °C.

![CLDD Configuration Wizard](image.png)

### 4.3.5. Final screen

The user is required to press **Finish** to apply the configuration. Applying the configuration writes the configuration onto the cLDD unit memory. The cLDD is now ready to operate. The cLDD may be operated stand-alone or computer-controlled.
4.4. Main cLDD Control Window

Once the cLDD with a mounted laser diode has been configured, as described in section 4.3, a control screen is shown, similar to that of next figure.

The menu bar on this window gives access to all commands including configuration, import/export file operations, system configuration, and system enable/disable and reset.

- **Configuration**: shows the active configuration name. A summary of the configuration is provided by pressing on the underlined configuration name. See next figure for an example.
• The large numeric displays show real time readings of Laser and TEC parameters.

• Alarms LEDs show yellow for warning alarms and red for fatal alarms.

• The lower half of the screen allows for control of the Laser and TEC operation modes and set points. These settings are applied once modified.

• Data logging allows logging to a file of the selected parameters at a desired sampling rate.

• Timer Control allows disabling or hibernating the cLDD after a user-defined period of time.

• Laser enable toggles the laser emission ON or OFF.

• A status message is displayed on the lower left corner of the screen.

4.4.1. Menu description

The menu bar gives access to several commands described as follows:

File Menu
• Configuration Wizard command: Executes the Configuration Wizard. See section 4.3 for details;

• Import Configurations command: Imports laser diode configuration data from a previously exported file;

• Export Configurations command: Creates a configuration data file with all the laser diode configurations the user has entered to data. The file can be used for back-up purposes or transferred to another computer;

• Exit command: exits the application.

System Menu
• Enable laser command: enables laser emission. Same as pressing the Laser enable button when the laser is disabled. The command is only visible if the laser is disabled;

• Disable laser command: disables laser emission. Same as pressing the Laser enable button when the laser is enabled. The command is only visible if the laser is enabled;

• Hibernate command: enters the HIBERNATED state, disables the laser and TEC drivers, and shuts down most electronics. This is the closest to doing a remote shut-down to the cLDD unit;

• Restart command: exits the HIBERNATED state, executes a soft reset to the cLDD unit, and enters the RESET state as signaled by a blinking red Enable LED. The command is only available if the cLDD is in HIBERNATED state;

• Data Logging: opens the data logging window to setup and run cLDD parameter acquisition. Same as pressing the Data Logging button on the lower left corner of the window.
• **Timer Control**: opens the timer control window to setup and run the laser enable timer. Same as pressing the Timer Control button on the lower left of the window.

• **View alarm log**: opens an alarm log text file.

• **Display configuration**: opens a control window that allows adjustment of the brightness and contrast of the cLDD unit display. It also allows the enabling/disabling of the unit's display and LEDs. See section 4.4.5 for details.

• **System information**: opens an information window about the cLDD unit. The cLDD unit device name may be changed at this window.

• **PI configuration**: opens a control window that allows adjustment of the temperature control loop Proportional and Integral parameters. See section 4.4.5 for details.

• **Update Firmware ...**: initiates the procedure of firmware update.

**Help Menu**

• **About ...**: information about the current software version.

**4.4.2. Toolbar icons**

The toolbar icons allow immediate access to a few selected commands:

- Laser Enable/Disable
- Configuration Wizard (refer to section 4.3)
- Data logging (refer to section 4.4.3)
- Timer control (refer to section 4.4.4)
- Display adjustment (refer to section 4.4.5)
- Hibernate
4.4.3. Data Logging window

The data logging window allows the logging, to a text file, of selected parameters.

The Sampling time and the Duration of the logging are user defined.

To obtain a time-delayed start time check the Enable Start Time tick box and input a starting time (in 24h format). The computer clock is used as reference for the delayed start time.

To disable the laser at the end of logging check the respective tick box.

Press the Start Task button to start logging.

Press Cancel to exit the window without making any modifications.

4.4.4. Timer Control window

The timer control window allows disabling or hibernating the cLDD after a user-defined period of time.

The timer Duration is user defined.

To obtain a time-delayed start time check the Enable Start Time tick box and input a starting time (in 24h format). The computer clock is used as reference for the delayed start time.

Select between Hibernate unit? or Disable laser? to select the action to be executed when the time ends.

Press the Start Task button to start the timer. If the time-delayed start is not selected, pressing the Start Task button will enable the laser.

Press Cancel to exit the window without making any modifications.
4.4.5. Display configuration window

The display configuration window allows control of contrast and brightness of the cLDD unit’s LCD display. It also allows the enabling/disabling of the unit’s display and LEDs.
4.4.6. Temperature control loop adjustment

The PI configuration window allows control of Proportional and Integral parameters of the temperature control loop. If the cLDD cannot keep the device at a constant temperature (under reasonable environmental temperature and set temperature) or the TEC current display is changing back and forward from a large positive value to a large negative value, then the TEC loop parameters of your cLDD need to be adjusted to the particular device you are using. Please refer to section 5.1 for the adjustment procedure.
4.5. USB drivers – USB Hubs and USB ports

The cLDD can be connected to different USB ports of a computer or even through a USB hub. The first time you connect the cLDD unit to a USB port Windows will detect the presence of the cLDD unit as new hardware and start the Found New Hardware Wizard.

NOTE: The setup of the cLDD Control Application installs the required USB driver on the USB port

The following Windows XP screen shots will guide you to appropriately install the required USB driver.

Select ‘No, not this time’ and click Next.

Select to ‘Install the software automatically’ and press Next.
Select 'Continue Anyway'.

The wizard installs the FTDI driver.
Click Finish to close the wizard.

The cLDD Control Application can now connect to the cLDD unit.
5. Troubleshooting

5.1. Temperature Control Loop

The cLDD is shipped from factory with temperature control parameters that satisfy most devices. It is possible that for some particular devices the TEC control loop is not able to stabilize, as the design of the laser diode (SLED or SOA), its heatsink and its TEC vary depending on the device and on the required heat dissipation.

If the cLDD cannot keep the device at a constant temperature (under reasonable environmental temperature and set temperature) then user intervention is required. Starting on version v2.3, the cLDD control electronics allows for the adjustment of the gain parameters of the TEC control loop using the cLDD Control Application. The adjustable parameters are the Proportional gain and the Integration time. These parameters can be modified through the System menu, PI configuration command.

Adjustment procedure

If the temperature displayed on the cLDD is changing more than 0.1°C, and the TEC current display is changing back and forward from a large positive value to a large negative value, then the TEC loop parameters of your cLDD need to be adjusted to the particular device you are using. Please follow the described procedure.

1. Place the laser diode device on the cLDD unit, connect the cLDD unit to the computer and run the cLDD Control Application Software. Use the Configuration wizard in order to properly configure the maximum settings according to your device manufacturer’s information (refer to section 4.3.3). Enter a Maximum current that is safely below the maximum allowed. Then press the button OK, and on the following screens press Next, Next and Finish.

2. Enable the cLDD and disable it again. This will leave the cLDD unit in DISABLE state (driver current off, TEC control on). If the TEC control loop is unstable the displayed TEC current will
be oscillating between large negative and large positive values. Go to System menu, to the PI Configuration command. The following window will appear.

3. Set the Kp to minimum and the Ti to minimum. Then, while observing the TEC current on the main window, gradually increase the Kp value, press Apply and observe the TEC current. In some cases the oscillation period may be over one second. Keep applying changes to the Kp value until you observe no more TEC current oscillations.

4. Apply changes to the Temperature setpoint up and down (e.g., with steps of 10 C) and observe if you see oscillations and if the temperature stabilizes. If the temperature is still unstable further increase the Kp parameter.

5. Observe the actual temperature (select Temperature display or observe the unit’s display) to check if the desired temperature has been reached to within ± 0.1C. If the offset is larger, increase the Integral parameter until the offset is within tolerance.

6. As you increase the Ti parameter you may need to further adjust the Kp parameter to obtain a stable behaviour with reasonable overshoot and small offset.

7. Once the TEC loop is adjusted, enable the device emission and observe the stability with the device operating. If needed perform further fine adjustments.

The TEC control parameters are saved to the laser configuration together with the remaining configuration parameters.
5.2. Power supply

When a large electric current is requested from the power supply, depending on the specific power supply being used, the supply voltage may drop below 5V. Large transient currents may be required when the cLDD is powered on, when the TEC circuitry is turned on, when a large step of laser diode current is applied, or when a large step in temperature is applied. In these situations and if the voltage supply drops below 5V, the cLDD may fail to start appropriately (the welcome message does not appear correctly on the local display) or communications with the computer may be lost. This is because the cLDD incorporates digital control and communication circuits that require the power supply voltage to be maintained close to 5 V. Also, the LCD screen may lose some brightness.

If the cLDD does not start appropriately, restart the cLDD by unplugging and plugging the power supply cable to the cLDD. If communications is lost after enabling the cLDD, first set the laser diode current to a lower value, enable the cLDD, and then increment the laser diode current to the desired value. If communications is lost after applying a large step in current or temperature, apply smaller steps until reaching the desired value.

In alternative utilize a 5V DC power supply with a higher current rating.
6. Service Information

If you would like to get more information regarding Innolume’s Compact Laser Diode Driver, the Java cLDD Control Application, or if you have any comments, suggestions or questions, please contact us.

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