Laser Diode Driver

LDD605

Revision 1.06

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Preface

The MOGLabs LDD Laser Diode Driver is a compact high-power laser diode driver. It provides up to 6 A at 5 V diode injection current with very low noise, and a temperature controller and 60 W Peltier TEC driver. It can be operated via front-panel controls, or using a computer communications interface (TCP/IP or USB) with simple text-based commands. It has been designed for tapered amplifier and broad area laser diodes commonly used in atomic physics research laboratories, where stability and low noise are essential.

We hope that the LDD meets and exceeds your expectations. Please let us know if you have any suggestions for improvement in the LDD or in this document, so that we can make life in the laser lab easier for all, and check our website from time to time for updated information.

MOGLabs www.moglabs.com

Safety Precautions

Safe and effective use of this product is very important. Please read the following safety information before attempting to operate your laser. Also please note several specific and unusual cautionary notes before using the MOGLabs LDD, in addition to the safety precautions that are standard for any electronic equipment or for laser-related instrumentation.

CAUTION – USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE

Laser output can be dangerous. Please ensure that you implement the appropriate hazard minimisations for your environment, such as laser safety goggles, beam blocks, and door interlocks. MOGLabs takes no responsibility for safe configuration and use of your laser. Please:

- Avoid direct exposure to the beam.
- Avoid looking directly into the beam.
- Note the safety labels and heed their warnings.
- When the laser is switched on, there will be a short delay of two seconds before the emission of laser radiation, mandated by European laser safety regulations (IEC 60825-1).
- The STANDBY/RUN keyswitch must be turned to RUN before the laser can be switched on. The laser will not operate if the keyswitch is in the STANDBY position. The key cannot be

removed from the controller when it is in the clockwise (RUN) position.

- To completely shut off power to the unit, turn the keyswitch anti-clockwise (STANDBY position), switch the mains power switch at rear of unit to OFF, and unplug the unit.
- When the STANDBY/RUN keyswitch is on STANDBY, there cannot be power to the laser diode, but power can still be supplied to the laser head for temperature control.

CAUTION Please ensure that the unit is configured for the correct voltage for your AC mains supply before connecting. The supply must include a good ground connection.

CAUTION To ensure correct cooling airflow, the unit should not be operated with cover removed.

WARNING The internal circuit boards and many of the mounted components are at high voltage, with exposed conductors, in particular mains supply to various sections of the power supply. The unit should not be operated with cover removed.

NOTE The MOGLabs LDD is designed for use in scientific research laboratories. It should not be used for consumer or medical applications.

Protection Features

The MOGLabs LDD includes a number of features to protect you and your laser.

Softstart A time delay (3 s) followed by linearly ramping the diode current (3 s max).

Circuit shutdown Many areas of the circuitry are powered down when not in use. The diode current supplies, and others may be without power when the unit is in standby mode, if an interlock is open, or a fault condition is detected.

Current limit Sets a maximum possible diode injection current.

Cable continuity If the laser is disconnected, the system will switch to standby and disable all laser supplies. If the laser diode, TEC or temperature sensor fail and become open-circuit, they will be disabled accordingly.

Short circuit If the laser diode, TEC or temperature sensor fail and become short-circuit, they will be disabled accordingly.

Temperature If the detected temperature is outside normal operating temperature, the temperature controller is disabled.

Internal supplies If one of the internal DC power supplies (+3.3, +5, ±12 V) is 1 V or more below its nominal value, the respective components are disabled.

Protection relay When the power is off, or if the laser is off, the laser diode is shorted via a normally-closed solid-state relay at the laser head board.

Emission indicator The MOGLabs controller will illuminate the current warning indicator LED immediately when the laser is switched on. There will then be a delay of at least 3 seconds before actual laser emission.

Mains filter Protection against mains voltage supply transient peeks.

Key-operated The laser cannot be powered unless the key-operated STANDBY switch is in the RUN position, to enable protection against unauthorised or accidental use. The key cannot be removed from the controller when it is in the clockwise (RUN) position.

Interlocks The main unit has an external interlock to allow the laser to be disabled via a remote switch, and a laser head cover interlock can be connected to disable laser output if the cover is removed.

Seed input A photodetector in the laser head can be used to detect proper seed of an amplifier.

Contents

1. Introduction

The MOGLabs LDD is a compact high-power laser diode driver, providing low-noise injection current for the diode, and a temperature controller with Peltier TEC output.

All connections are via a dual cable arrangement from the LDD to the laser diode, typically in a MOGLabs amplifier or high-power cateye laser. One cable provides the interface for the TEC and temperature sensor, the other for the laser diode. For use with non-MOGLabs laser products, please see appendix C for information on connecting the diode, thermoelectric Peltier cooler (TEC), and temperature sensor.

The front-panel controls and display (see figure 1.1) can be used to monitor and set the diode current, current limit, diode voltage, temperature, temperature setpoint, temperature limits, TEC current and TEC voltage.

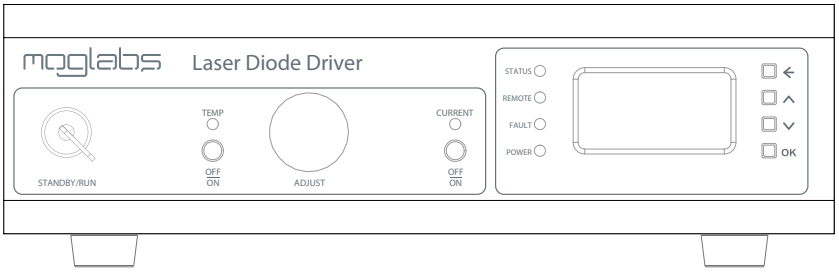
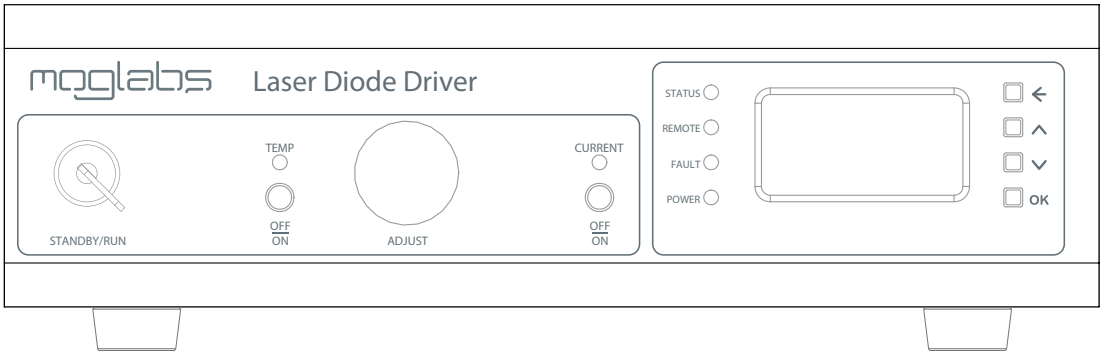


Figure 1.1: MOGLabs LDD front panel layout.

2. Connections and controls

2.1 Front panel controls



STANDBY/RUN

In STANDBY mode, the temperature controller is active, but the diode current is disabled.

In RUN mode, the laser current driver is active. The diode current is disabled until the laser enable switch is ON.

On first power-up and during the boot procedure the LDD will halt if the key is in the RUN position. This ensures the laser cannot be accidentally turned back ON if there is a power failure. The unit should be set to STANDBY and back to RUN to initiate user control. Place the unit back into STANDBY if further operation is not desired.

CURRENT OFF/ON

Diode current enable. The STANDBY/RUN key switch must first be in the RUN position. The temperature controller must also be on and operating.

If the unit fails to switch to RUN mode (current indicator does not show yellow or green), see appendix B.

ADJUST

The ADJUST rotary encoder allows variation of any editable value on the LCD display. The encoder can be pressed to rotate through

different digits of the value being edited, to allow for fine and coarse control.

TEMP OFF/ON Temperature control enable. If the unit fails to switch the temperature controller on (current indicator does not show green), see appendix B.

←, ↑ , ↓, OK Menu control buttons. These are used to navigate the menu system allowing users to go back one menu level (←), up and down between lines on any given menu (↑ or ↓) and to move forward in the menu system or to run system functions (OK). They also provide special functions described below.

2.2 Menu button special functions

Special functions can be accessed by holding two buttons down while powering up the unit. That is, with unit powered off, hold both buttons down, then turn power on.

← + ↑ Access firmware update mode. Normally not required; use `mogldd` Help/Update instead. Please contact MOGLabs if you have problems with updating firmware and need to use ← + ↑.

OK + ↓ Factory reset. The firmware will be restored to the original factory version using a stored image. Saved settings (stored in EEPROM) will also be restored to factory values: please check maximum allowed laser diode current, I_{lim}.

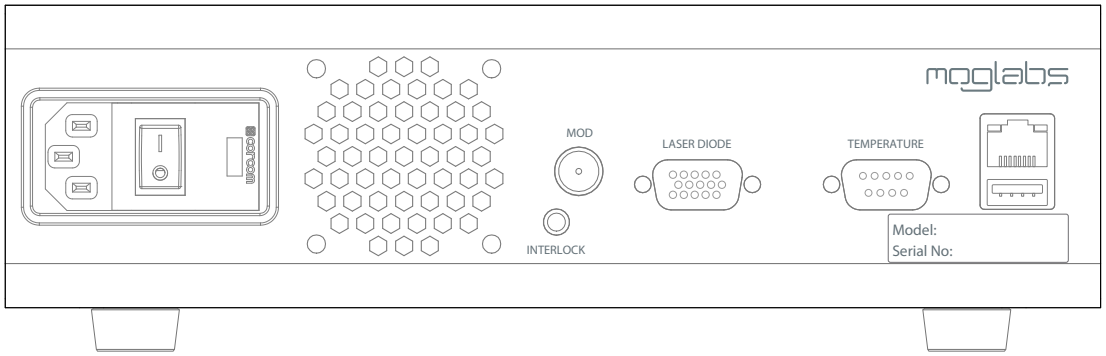
↑ + ↓ Start in separate controller mode. Current controller and temperature controller can be run separately; that is, the diode current can be enabled without enabling the temperature controller.

2.3 Front panel display

The LCD display provides status and control information in the following pages:

Main	Critical values and settings
Menu	Main menu structure
TEC	Temperature-related values and settings
Laser	Laser values and settings
Ethernet	Ethernet (TCP/IP) configuration
Advanced	Debug information
About	Model and serial numbers

2.4 Rear panel connections



IEC power in The unit should be pre-set for the appropriate voltage for your country. Please see appendix E if you need to change the power supply voltage.

Warning: The LDD uses an analogue power supply to achieve low noise. It does not automatically select the correct mains voltage. The mains voltage must be set to 120 or 240 V as required. See appendix E.

Fan The fan speed is temperature-controlled.

Interlock The LDD will not power on the laser unless the pins on this port is shorted. A standard 3.5 mm audio plug is provided.

MOD BNC connector. Control input for analogue diode current modulation. ±10 V input max, 10 mA/V sensitivity (modulation depth of 100mA) and bandwidth of 40 kHz.

LASER DIODE Female DE15 port to laser head. Provides diode current, I2C, 5 V and other control lines to the laser headboard.

TEMPERATURE Female DE9 port to laser head. TEC current and temperature sensor.

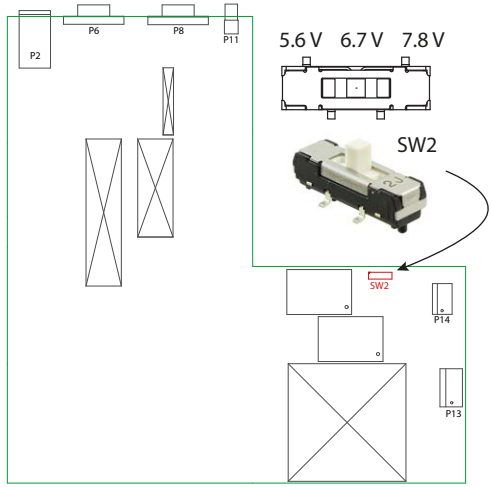
Ethernet RJ45 10/100 twisted pair ethernet port.

USB USB-A hi-speed (USB2) port.

2.5 Internal switches

CAUTION The cover should only be removed when the power switch is in the OFF position and the power cable has been removed.

Compliance voltage Switch 2 (SW2) located near the switch-mode power supply enables adjustment of the maximum compliance voltage to −5.6 V, −6.7 V or −7.8 V. To reduce internally dissipated power, use the lowest value that ensures adequate compliance potential at the diode, allowing for loss in the cable. These settings represent the voltage at the power supply and significant potential can be lost along the cable to the laser head when operating at high current.



2.6 Digital control

Located on the rear of the unit are both USB and ethernet ports to allow remote control via simple text commands. The USB connection appears on a computer as a COM port. Commands can be sent via ethernet using a simple telnet protocol. For a list of commands please refer to the command syntax, appendix F.

3. Menus

The MOGLabs LDD can be controlled via a detailed on-screen menu system. The intent is that these are self-explanatory but additional information can be found below.

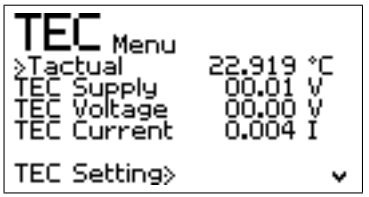
There are four pushbuttons to the right of the LCD display, to step through the menus. The large encoder knob can be rotated to change a value, and also acts as a push-button to change which character or digit is being changed, and can be used as OK to select a menu option.

3.1 Default

The default screen on power-up, showing firmware version number, diode set current, current limit, set temperature, actual temperature. The cursor shows that the LD current is selected for adjustment. Rotate the adjust knob to change the current; use the ↓ button to select a different parameter, or to move the cursor down to the Menu→ line and press OK or press the adjust knob to jump into other menus.

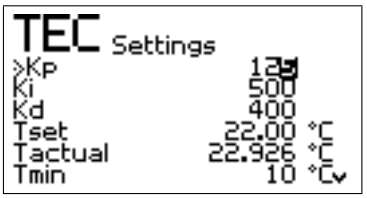
3.2 Main menu

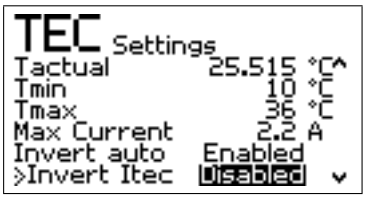
3.3 TEC



The TEC menu provides access to key operating parameters of thetemperature controller, and a sub-menu to change TEC settings.

3.4 TEC setting

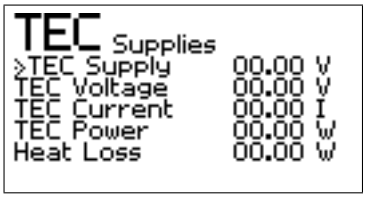




PID coefficients, current temperature, temperature set-point, and temperature minimum. T_{min} and T_{max} are limits; if the temperature falls outside this range, the temperature controller is disabled and current to the TEC is set to zero. *Max Current* sets an upper limit to the current to the TEC.

By default, the LDD will auto-detect the TEC polarity. Auto-polarity can be disabled and the polarity manually inverted with the *Invert Itec* menu option.

3.5 TEC supplies



TEC Supply and *TEC Voltage* are the TEC voltages at the LDD unit

and at the laser headboard. *Heat Loss* is the difference in those voltages, multipled by the TEC current, providing a measure of thermal loss in the cable.

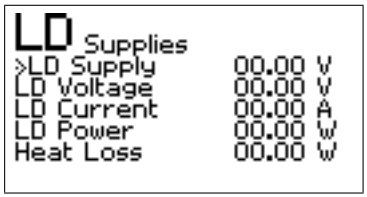
3.6 Laser menu

Laser Supply and *Laser Voltage* show the diode voltage measured at the LDD unit and at the laser headboard.

3.7 Laser settings

V_{max} is maximum voltage available to drive the diode, at the LDD and does not account for possible voltage drop along the cable to the headboard. The rear-panel and laser head cover interlocks can be disabled; if disabled, current to the laser diode is then possible even if either interlock connection is open-circuit.

3.8 LD supplies



Voltage for the laser diode at the LDD and at the laser headboard. *Heat Loss* is the difference between those two multiplied by the diode current; that is, the calculated thermal loss along the cable.

3.9 Headboard

The LDD communicates to the laser head, for example to measure voltages at the headboard rather than at the LDD, pusing serial communications adhering to the I^2C protocol. The headboard information screen shows the status of the I^2C connection, the number of hours of operation of the installed laser diode, and the time-averaged current. Values saved in EEPROM memory on the headboard can be loaded and saved via the menu options; this should only be attempted in consultation with MOGLabs.

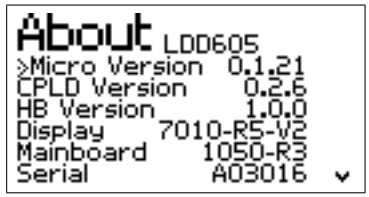
3.10 Ethernet

TCP/IP network parameters. Note that to save changes for the next power-cycle or reset, select the *Save* menu option which is initially off-screen at the bottom.

3.11 Advanced

The Advanced menu allows access to infrequently required information, including supply voltages for the main and display circuit boards, and the temperature on the main board near the main components driving the laser diode current and TEC. The *TEC Debug* and *Current Debug* menu options jump to the TEC Supplies and Laser Supplies information displays described above.

3.12 About



Provides information including serial number and revisions of the firmware and printed circuit boards.

4. Operation

The MOGLabs LDD should be connected to the laser diode and TEC using heavy gauge screened cables, one for each of the current and temperature functions.

To operate the LDD:

1. Ensure the rear power switch is on, and the STANDBY/RUN switch is in the STANDBY position. In this mode, the current controller is disabled. The TEMP LED should glow yellow indicating that the temperature controller is in standby waiting to be initialized. To start the temperature controller press the ON/OFF button below the TEMP LED. The LED should turn green indicating that the temperature controller is running.
2. Switch from STANDBY to RUN. The CURRENT LED should turn yellow indicating that the current supply can now be enabled. If the indicator is still off, this indicates that the temperature loop has not been enabled or that an interlock is not connected.
3. If the controller is switched back to STANDBY, the laser current will terminate but the temperature controller will continue to operate.
4. Turning off the temperature controller also disables the current controller. This can be done by pressing the TEMP ON/OFF button.
5. To adjust the temperature setpoint: using the buttons to the right of the display, move the cursor down to T_{set} and then use the rotatory encode (ADJUST) to vary the value. Push the rotary encoder knob to select the active digit for coarse or fine control.
6. Adjust the current setpoint and current limit by selecting I_{set} and I_{lim}. The diode current can never be set above the current

limit and the current limit can never be set below the diode current setpoint.

7. Switch the laser on. Press the CURRENT ON/OFF button will now enable the current supply. The LED below CURRENT will briefly turn blue indicating that the current supply is starting and after 3 seconds will ramp up to the setpoint. Once the current has hit the setpoint the LED will turn green.

Note that the temperature controller must be running, all interlocks enabled and no errors present for the laser current to be enabled.

5. MOGLDD application

The host software `mogldd` provides a graphical user interface that allows remote control of the LDD laser diode driver.

5.1 Device discovery

By default, a device discoverer (Figure 5.1) is initiated when `mogldd` is started. The discoverer broadcasts a UDP discovery packet on ethernet, and scans the USB ports of the host computer, looking for an LDD device. Starting the application is then as simple as selecting the device to communicate with and clicking *Connect*.

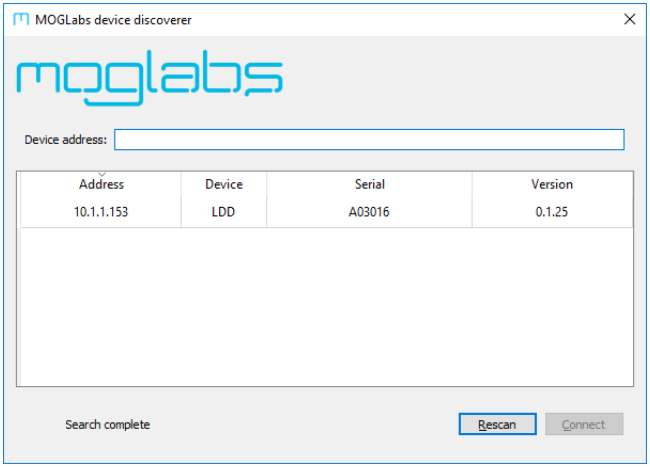
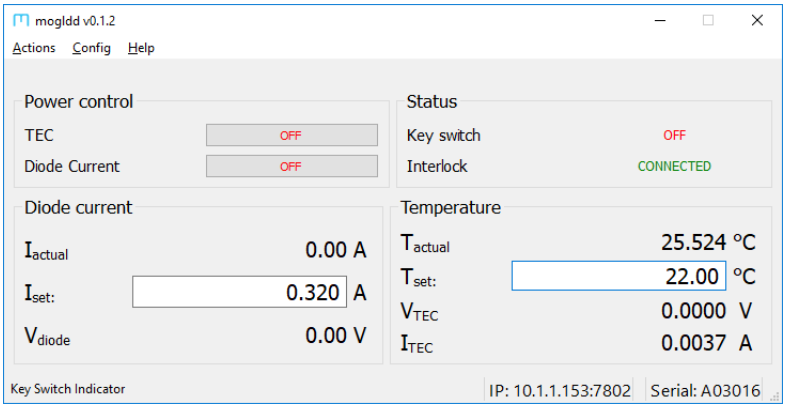


Figure 5.1: Example of the *device discoverer* window.

If the network does not permit device discovery and/or your LDD does not appear in the list, it is possible to enter the IP address of the unit in the *Device address* box and connect regardless.



5.2 Main display

Power control Two buttons allow control of the TEC and laser diode current and show their status.

TEC Activates the TEC output and temperature feedback control.

Diode current Activates the laser diode output with soft start: the current increases slowly after a short delay.

Status The front panel keyswitch and interlock status are displayed.

Temperature The measured temperature of the laser, and the current and voltage of the TEC, are displayed and updated periodically.

T_{actual} Measured temperature determined from the temperature sensor (thermistor or AD590).

T_{set} Displays the temperature setpoint value. The value can be edited to change the temperature setpoint. The device value is updated on Enter or TAB.

I_{TEC} Measured current through TEC.

V_{TEC} Measured voltage across TEC.

Diode current

I_{actual} Measured current through laser diode.

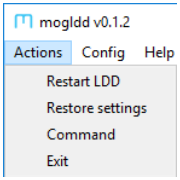
I_{set} Displays the current setpoint value. The value can be edited to change the current setpoint. The device value is updated on Enter or TAB.

V_{diode} Measured voltage across laser diode.

Status bar The status bar shows the device serial number, and the communications channel: IP address and port (if using ethernet) or USB port.

5.3 Menu

5.3.1 Action

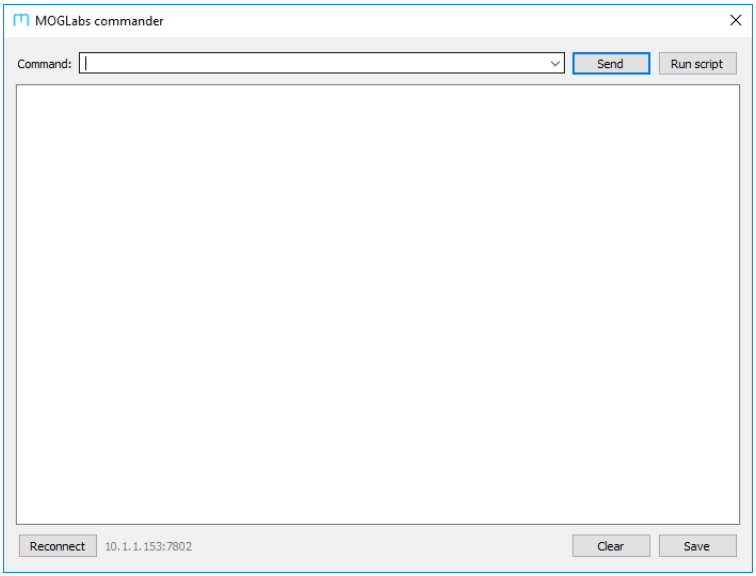


Restart LDD Resets the LDD device. Communications will be suspended. `mogldd` will attempt to reconnect to the device for up to 10 seconds.

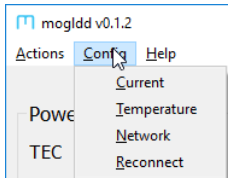
Restore settings Initiates restore of factory settings from EEPROM on the LDD device.

Command

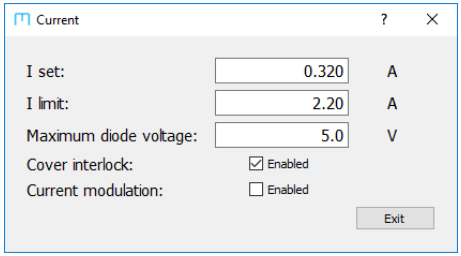
This opens a new dialogue for interactive command access to the device, similar to `telnet` but this approach will work via USB. Type a command into the command line window, and hit `Enter` to send that command to the device (see appendix F); the response will appear in the box below the command line window.



5.3.2 Config



Current



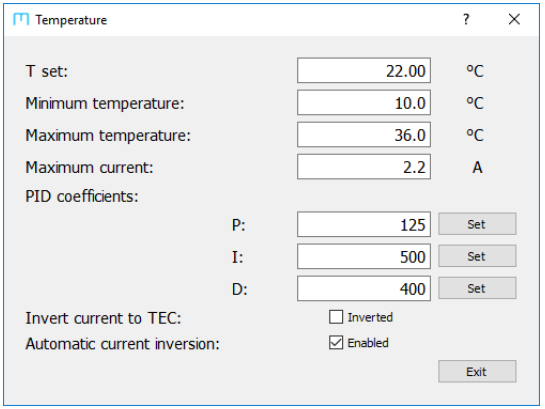
I set An alternative control for setting the desired laser diode current.

I limit Sets upper limit for the entered diode current on the LDD device.

Maximum diode voltage Sets upper limit on the diode voltage on the LDD device.

Current modulation Enables external analogue modulation of the laser diode current via the rear panel modulation input.

Temperature The temperature settings dialogue allows setting critical temperature controller parameters.



T set An alternative control for setting the desired temperature.

Minimum/Maximum temperature, Maximum current Define the limits to allowed setpoint temperature and the maximum TEC current.

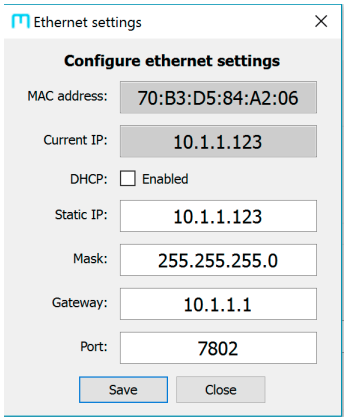
PID coefficients The LDD implements the feedback control via a standard PID (proportional integral differential) function:

$$u(t) = k_p e(t) + k_i \int_0^t e(\tau)d\tau + k_d \frac{de}{dt}.$$

$e(t)$ is the input error signal and $u(t)$ is the feedback response. k_p, k_i, k_d are scaled positive proportional (P), integral (I) and differential (D) gain coefficients. Typical values are $P = 80$, $I = 3$ and $D = 2$. New coefficients can be entered but are not activated until the adjacent Set button is pressed.

Inverted current to TEC Allows application of the LDD with a reverse polarity TEC.

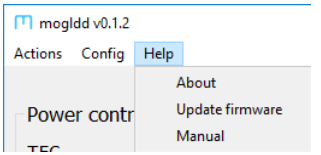
Network Allows configuration of network connection settings (IP address, mask, gateway and port). Particularly useful for configuring the network settings over USB. Note that changing the *Static IP* only has an effect if DHCP is disabled, or if DHCP name resolution fails. Note



that changing the ethernet settings will require the application to be restarted, and may also require the device to be rebooted. The port should be unchanged at 7802 to ensure that the `mogldd` suite of programs can continue to communicate with the device.

Reconnect Initiates attempt to reconnect to device if communication is broken.

5.3.3 Help



About Displays device information.

Update Initiates firmware update from binary file.

Manual Opens web browswer at the MOGLabs support website.

A. Specifications

Parameter	Specification
Current regulator	
Output current	0 to 6 A
Max diode voltage	5 V at full current
Display resolution	±1 mA
Noise	TBD (10 Hz – 1 MHz)
Stability	Warmup time: 15 minutes
Analogue mod	10 mA/V, ±10 V max, 40 kHz bandwidth

Temperature controller	
TEC current max	±5 A
TEC voltage max	±12 V
TEC power max	60 W
Stability	±10 mK/°C
Sensor	NTC 10 kΩ
Range	−20 to +80°C standard
Display resolution	±0.01°

Note

The TEC is controlled with a linear regulator, which may overheat if the current load is high and the TEC voltage is low. Choose a TEC with resistance of 2 to 3 ohms to optimise power to the device.

Parameter	Specification
Computer interface	
Ethernet	10/100 TP, RJ45
USB	USB2, plug type USB-A
Display type	2.4" 128 x 64 LCD display

Connectors	
Current	DE15 high density 15 pin female
Temperature	DE9 9 pin female

Protection	
External interlock	3.5 mm mono audio plug (provided)
Cover interlock	Laser head cover interlock
Key interlock	STANDBY/RUN
Delayed soft-start	3 s delay + 3 s ramp (to 6A)
Open circuit	Laser cable, TEC, temperature sensor
Diode current	Digital setpoint limit I_{lim}

Mechanical & power	
Fan	Dual 24 V DC ball-bearing Temperature controlled
IEC input	95 to 130 V 60Hz or 220 to 260 V 50Hz Replaceable fuse: radial can, anti-surge (slo-blo), 250V/200mA
Dimensions	WxHxD = 250 × 79 × 292 mm
Weight	2.4 kg (excluding cables, laser head board)
Power	18 W (standby) 30 W to 80 W (low/high diode/TEC load)

B. Troubleshooting

The MOGLabs LDD detects a wide range of fault conditions and deactivates related circuitry accordingly. The front-panel LEDs provide indication of the state of these functions.

B.1 CURRENT indicator

Colour	Status
DARK	Current controller off and blocked
RED	Current error
YELLOW	Current OFF – current standby mode Current ready to be enabled
BLUE	Current ramping up to setpoint
GREEN	Current at setpoint

B.2 TEMP indicator

Colour	Status
RED	Temperature controller error
YELLOW	Temperature controller OFF Temperature standby mode Temperature controller ready to be enabled
GREEN	Temperature control operating

B.3 STATUS indicator

Colour	Status
RED	The device is booting
YELLOW	Toggle key switch to continue
GREEN	The device has booted successfully

B.4 REMOTE indicator

Colour	Status
DARK	Remote mode is currently OFF
BLUE	Remote mode is currently ON

B.5 FAULT indicator

Colour	Status
DARK	No faults detected
RED	Error detected
YELLOW	Interlock open circuit

B.6 POWER indicator

Colour	Status
DARK	The device is switched off
RED	Power supply fault
GREEN	Power supplies normal

B.7 Error codes

If an error is detected, the LCD display will provide an explanatory message from the table below.

Error Message	Solution
TEC Temp too low	The temperature has fallen below the temperature minimum setpoint. This may indicate an issue with the polarity of the TEC.
TEC Temp too high	The temperature has risen above the temperature maximum setpoint. This may indicate an issue with the polarity of the TEC, or a failure of the TEC.
Laser over voltage	The voltage supplied to the laser diode has exceeded the voltage maximum setpoint.
No interlock	An interlock is open circuit. Make sure the rear-panel and laser head cover interlocks are connected and shorted.
PD error	The photodiode threshold has not been met. Disable this feature by enabling PD override in the TEC menu.
Laser open circuit	The laser diode is open circuit. Make sure the laser cable is connected correctly.
Laser short circuit	The laser diode is short circuit. Check laser cable and diode.
Toggle key to continue	The key needs to be turned off and on again before operation.

Error Message	Solution
IO error	Internal error, check power supplies and internal ribbon cables.
ADC error	Internal error, check power supplies and internal ribbon cables.
DAC error	Internal error, check power supplies and internal ribbon cables.
Turn off TEC first	The temperature controller must be turned off before you can complete that operation.
DHCP Failed	Ethernet DHCP failed, disconnect and reconnect Ethernet cable.

For additional support please contact MOGLabs.

C. Laser head board

A laser head interface board is available. The headboard allows convenient connection breakout to the laser diode, TEC, temperature sensor, and laser head interlock. It also includes a protection relay a passive protection filter and a laser-on LED indicator.

The default headboard provided with LDD controllers purchased with a laser is the B1048, which includes connections capable of 6A of diode current and 5A of TEC current.

Currently there is provision for a photodiode which can be used to verify proper laser diode output, so that the current supply can be reduced if the output is below expectations. Contact MOGLabs for further information.

C.1 B1048 headboard

The B1048 is a small circuit board that provides connection to a passive NTC thermistor temperature sensor, TEC, diode and photodiode, using Hirose DF59 "swing-lock" wire-to-board connectors.

Name	Description
P1	TEC current input
P6	Diode current input
PD	Photodiode connection
Therm	Thermistor input
Pelt1	Peltier connection 1 TEC
Pelt2	Peltier connection 2 TEC
Las A	Laser anode
Las K	Laser cathode

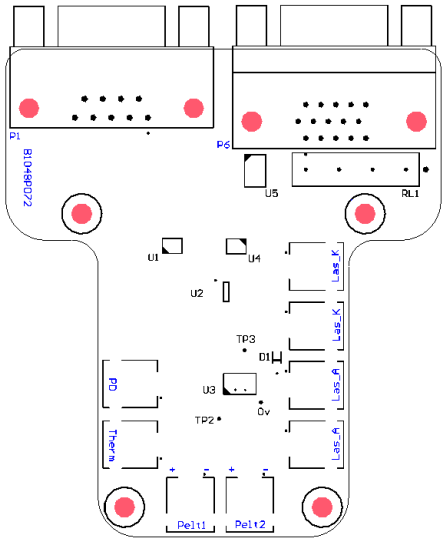


Figure C.1: B1048 laser head board.

D. Connector pinouts

WARNING: The CURRENT and TEMP connectors are intended for connection to a MOGLabs laser head board. They can provide high currents that may damage other devices. Considerable care should be taken if connecting to non-MOGLabs equipment.

Only high quality cables with 24 AWG or larger conductors should be used.

D.1 Temperature

Pin	Signal
1	Thermistor +
2	GND
3	TEC -
4	TEC +
5	TEC +
6	Thermistor -
7	TEC -
8	TEC -
9	TEC +

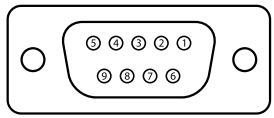


Figure D.1: Female DE9 TEMP connector on rear panel.

D.2 Current

Pin	Signal
1	Relay -
2	I2C SDA
3	Photodiode status
4	Diode cathode
5	Diode anode
6	GND
7	GND
8	GND
9	N/C
10	Diode anode
11	5v
12	I2C SCL
13	Diode cathode
14	Diode cathode
15	Diode anode

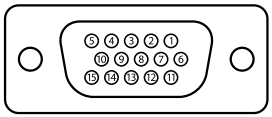


Figure D.2: Female DE15 CURRENT connector on rear panel.

E. 115/230 V conversion

E.1 Fuse

The fuse is a ceramic antisurge, 2.5A, 5x20mm, for example Littlefuse 021502.5MXP. The fuse holder is a red cartridge just above the IEC power inlet and main switch on the rear of the unit (Fig. E.1).

Figure E.1: Fuse catridge, showing fuse placement for operation at 230 Vac.

E.2 120/240 V conversion

The unit can be powered from AC 50 to 60 Hz, 110 to 120 V (100 V in Japan), or 220 to 240 V. To convert between 115 V and 230 V, the fuse cartridge should be removed, and re-inserted such that the correct voltage shows through the cover window.

Figure E.2: To change fuse or voltage, open the fuse cartridge cover with a screwdriver inserted into a small slot at the left edge of the cover, just to the left of the red voltage indicator.

When removing the fuse catridge, insert a screwdriver into the recess at the *left* of the cartridge; do not try to extract using a screwdriver at the sides of the fuseholder (see figures).

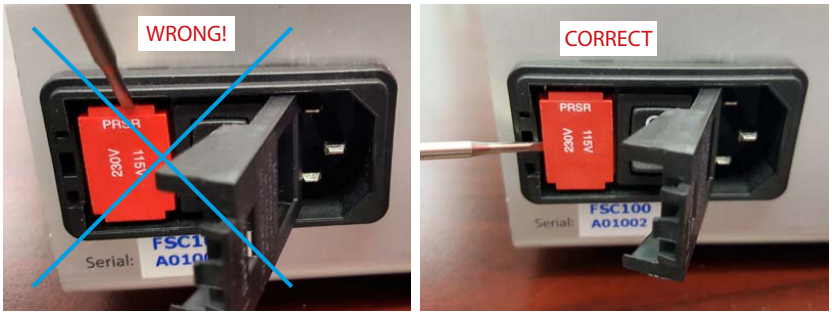


Figure E.3: To extract the fuse cartridge, insert a screwdriver into a recess at the *left* of the cartridge.

When changing the voltage, the fuse and a bridging clip must be swapped from one side to the other, so that the bridging clip is always on the bottom and the fuse always on the top; see figures below.

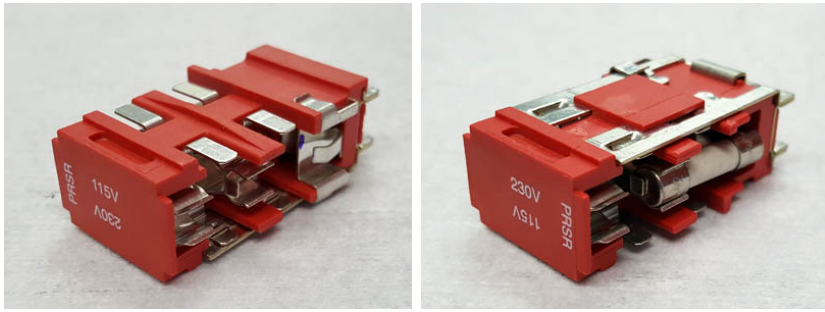


Figure E.4: 230 V bridge (left) and fuse (right). Swap the bridge and fuse when changing voltage, so that the fuse remains uppermost when inserted.

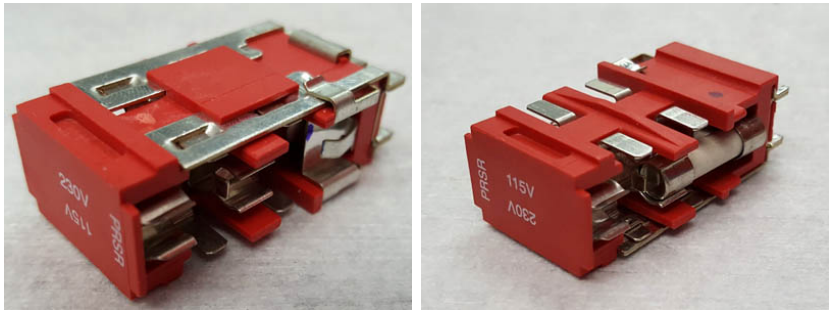


Figure E.5: 115 V bridge (left) and fuse (right).

F. Command language

The protocol for communicating with an LDD is described in Appendix G. Host software to interface with the unit is in development. The protocol follows a request/reply architecture: after sending a command, it is important to always wait for the response before sending the next command.

Please note: The command language is being continuously updated across firmware releases to improve functionality and add features. When upgrading firmware, please refer to the most recent version of the manual available at `http://www.moglabs.com`.

F.1 Arguments

Most commands accept a comma-separated list of parameters. Parameters shown in square brackets are optional, and most commands are treated as queries when called without a value.

Controlling commands respond with a string that begins with either "OK" or "ERR" to indicate whether it was successful. Value queries, such as requesting actual temperature, return a value with units.

The units used are as follows:

Temperature Degrees Celsius

Voltage Volts

Current Amperes

Most commands will return a message that includes the *actual* value, which may differ from the *requested* value due to parameter limits and will start with the "ERR" prefix.

F.2 General functions

AUTOTEC `AUTOTEC[,onoff]`
Enable/disable automatic determination of TEC polarity. `onoff` can be ON or OFF; reports AUTOTEC status if parameter absent.

BOARDTEMP Report measured board temperature.

CLEARERROR Clear errors remotely.

CLOSE Close communications.

CONTRAST Set LCD display contrast. Change to suit different viewing angles; valid values are from 0 to 64.

ETHINFO Report Ethernet settings.

EXIT Close communications.

FACTORYRST Restore EEPROM configuration from factory defaults. Note that this irreversibly overrides all user settings.

HELP, ? List available commands.

INFO Report information about the unit.

INTERLOCK Report interlock status.

KEY Report status of standby/run keyswitch.

REPORT Report most parameters including temperature and diode current values. Values are reported as a string label, a colon, and a value; for example
`CURRENT:OFF, TEC:OFF, TEMP:26.707,...`

RESET, RESTART Initiate microcontroller reset, causing unit to reboot. Note that all communication links will be immediately closed.

STATUS Report errors currently shown on the display.

TOGOVERRIDE Removes the need to toggle the key switch on boot.

UPDATE Initiate microcontroller update mode, causing unit to reboot. Note that all communication links will be immediately closed.

VERSION Report version of firmware currently running on device. Please include this information in any correspondence with MOGLabs.

VMON Report diagnostic monitoring information about power supplies.

F.3 Basic control

TEC `TEC[,onoff]`
Control temperature controller. `onoff` can be ON or OFF; reports temperature controller status if parameter absent.

CURRENT `CURRENT[,onoff]`
Control current controller. `onoff` can be ON or OFF; reports status of the current controller if parameter absent.

REMOTE `REMOTE[,onoff]`
Remote control lockout. `onoff` can be ON or OFF; reports remote lockout status if parameter absent.

F.4 Temperature control setting

INVERT `INVERT[,value]`
Invert current to TEC. `value` can be 0 or 1; reports status of current inversion if parameter absent.

ITEC `ITEC`
Reports TEC current.

PID `PID,{P, I, D}[,value]`
Set one of P, I or D constants or report their current value if no value specified. `value` will be rounded to the nearest whole number.

TCURRENT `TCURRENT[,value]`
Set the maximum TEC current or reports TEC current if no value specified. `value` will be rounded to one decimal place.

TEMP `TEMP`
Reports laser temperature.

TMAX `TMAX[,value]`
Set the temperature maximum or reports the current maximum if no value specified. `value` will be rounded to the nearest whole number.

TMIN `TMIN[,value]`
Set the temperature minimum or reports the current minimum if no value specified. `value`will be rounded to the nearest whole number.

TSET `TSET[,value]`
Set the temperature setpoint or report current setpoint if no value specified. `value` will be rounded to two decimal places.

VTEC `VTEC`
Reports TEC voltage.

F.5 Current control setting

ILD `ILD`
Reports laser diode current.

ILIM `ILIM[,value]`
Set or query the current limit. `value` will be rounded to two decimal places.

ISET `ISET[,value]`
Set or query the current setpoint. `value` will be rounded to three decimal places.

MODULATION `MODULATION[,value]`
Set or query current modulation. `value` can be 0 or 1.

PDOVERRIDE `PDOVERRIDE[,value]`
Set or query photodiode override. `value` can be 0 or 1.

VLD `VLD`
Reports laser diode voltage.

VMAX `VMAX[,value]`
Set or query the maximum laser voltage. `value` will be rounded to two decimal places.

F.6 Configuration settings

SET, GET Set and report EEPROM configuration values. Each `set` (`get`) command has a corresponding `get` (`set`) command; those listed as `get` cannot be set.

bid `GET,bid`
Get main board identification code.

dhcp `SET,dhcp,onoff`
Enable or disable DHCP. Set to non-zero to enable DHCP; zero to use internal IP address.

ipaddr `SET,ipaddr,"xxx.xxx.xxx.xxx"`
Set IP default address based on decimal dotted-quad string (for example "10.1.1.180"). The double-quotes are required.

ipgw `SET,ipgw,"xxx.xxx.xxx.xxx"`
Set IP gateway based on dotted-quad string (for example "10.1.1.1").

ipmask `SET,ipmask,"xxx.xxx.xxx.xxx"`
Set IP mask based on dotted-quad string (for example "255.255.255.0").

ipport `SET,ipport,port`
Set the TCP/IP port number for device communication.

mac `SET,mac,"xx:xx:xx:xx:xx:xx"`
Set hardware MAC address based on colon-separated hexadecimal numbers (for example "70:b3:d5:84:a0:00").

contrast `set,contrast,int`
Set LCD contrast; unsigned integer between 0 and 64. Values between 8 and 20 work well. Best value depends on viewing angle.

version `GET,version`
Returns firmware version as binary.

G. Communications

The LDD can be connected to a computer by USB or ethernet (TCP/IP). A host app`mogldd` is in development, to provide interactive access to most of the features, or communications can be integrated into existing control software. Examples of controlling the LDD in several languages are also in development.

G.1 Protocol

Communication follows a query/response protocol, where the user sends an ASCII string to the unit, and the unit sends an ASCII response to the originating source. The list of possible commands is detailed in Appendix F.

Messages must be CRLF-terminated. This means that all statements sent to the unit must end with the carriage return ('\r' = ASCII code 0x0D) followed by a new-line character ('\n' = ASCII code 0x0A). Most terminal applications and drivers provide the ability to automatically append these characters.

Responses from the unit are also CRLF terminated, and responses should be buffered until CRLF is received because some responses span multiple lines. For most applications buffering may not be required, but for reliability buffering is recommended.

Statements are either `commands` or `queries`. A command is a statement that causes some action to occur, and the unit will respond with either "`OK`" or "`ERR`" depending on whether the command succeeded or not. For example,

```
> CURRENT,ON
< ERR: The TEC needs to be ON to turn the Current ON.
> TEC,ON
< OK: The TEC is now ON.
```

```
> CURRENT,ON
< OK: The Current is now ON.
```

Note that the response typically describes the result of the request.

Queries are statements to return an internal value, and either return the value requested or a message beginning with "ERR". For example,

```
> TEMP
< ERR: Temperature sensor missing
```

```
> TEMP
< 22.635 C
```

It is strongly recommended that all software should wait for this response, and check whether it indicates an error. The `python` and `LabVIEW` bindings provided by MOGLabs take care of buffering and error checking automatically.

G.2 TCP/IP

When ethernet is connected, the LDD will attempt to connect to the network using saved values, which can be altered using the front-panel menu system. If DHCP is enabled the device will first try to obtain an IP address via DHCP. If DHCP fails, the static settings will then be used. In both cases, the current address will be shown. The TCP/IP port number is also displayed in this menu. This port can be connected to using a `telnet` application to execute commands, or the provided `mogldd` software suite.

G.2.1 Changing IP address

If your network does not use a DHCP server, you may need to manually change the IP address. This is easily done via the front-panel menu system.

G.3 USB

The LDD can be directly connected to a host computer using a USB cable (type A-male). The device will appear as a Virtual COM port - a fast serial port that behaves like an RS232 connection.

The STM32 Virtual COM Port Driver device driver for the Windows™ operating system is available from the MOGLabs website. Connecting the LDD will install a new COM port on the machine, which can be connected to and communicated with.

To determine the port number of the device, go to Device Manager (Start, then type `Device Manager` into the Search box). You should see a list of devices including "Ports" (Figure G.1).

The LDD can be identified as a COM port with the following name,

```
STMicroelectronics Virtual COM Port (COMxx)
```

where `xx` is a number (typically between 4 and 15). In the example

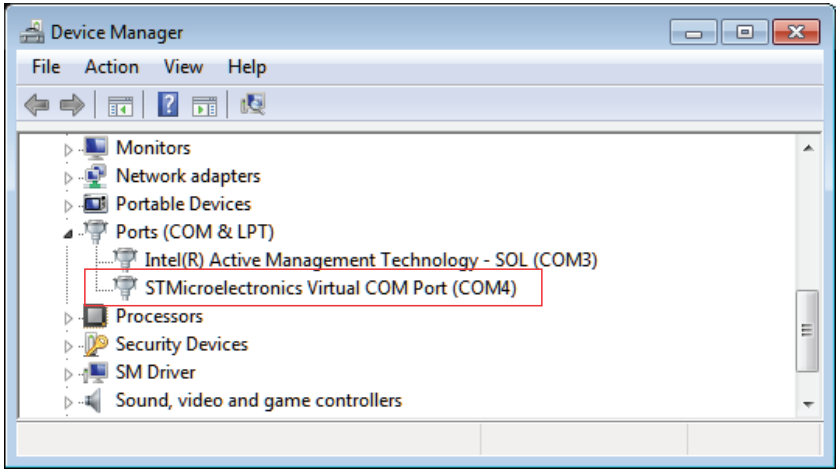


Figure G.1: Screenshot of Device Manager, showing that the LDD can be communicated with using COM4. The port number might change when plugging into a different USB port, or after applying a firmware update.

image, the device was installed as COM4.

Note that if the port appears in Device Manager with a different name, then the driver was not successfully installed. If this occurs, disconnect the LDD from the host computer, reinstall the device driver, then reconnect the USB cable.

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