Sepia PDL 810

Computer Controlled Picosecond Diode Laser Driver

PicoQuant GmbH

Table of contents

1. General Safety Information

⚠ CAUTION

Before using this device, make sure that you have read and understood the content of this user manual. Store this documentation in a safe and easily accessible place for future reference.

Incorrect handling of this product may result in personal injury or physical damage. The manufacturer assumes no responsibility and cannot be held liable for any injury/damages resulting from operating the device outside of the normal usage defined in this manual.

1.1 Warning Symbols and Conventions

The following symbols and conventions will be used throughout this manual. Please take time to familiarize yourself with their meaning before proceeding.

Label	Explanation
	The **general safety alert symbol** is used to alert you to hazards that may lead to personal injury or physical damage. Follow all associated safety instructions to avoid possible injury or death.
	A **high voltage warning symbol** is used to indicate the presence of un-insulated, dangerous voltage inside the enclosure. Note that this voltage may be sufficient to constitute a risk of shock.
	The **laser radiation warning symbol** alerts you that the device can generate laser radiation. Follow all applicable laser safety instructions to avoid injury or damages.
	The device's susceptibility to electrostatic discharge (ESD) is indicated by the **ESD warning symbol**. Ensure that you follow proper ESD protection rules to avoid damaging the device.
⚠ CAUTION	Indicate a hazardous situation which, if not avoided, could result in minor or moderate injury.
⚠ WARNING	Indicate a hazardous situation which, if not avoided, **could** result in death or serious injury.

Label	Explanation
DANGER	Indicate a hazardous situation which, if not avoided, **will** result in death or serious injury.
NOTICE	Important tips and information for device operation that do not include a risk of injury or damage are prefaced with the “**NOTICE**” label.
	This symbol indicates that an earth terminal shall be connected to the ground (to avoid risks of electrical shock).
	Disconnect the power cord from the electrical outlet.

1.2 Electrical Safety Instructions

WARNING

To avoid electric shock, the power cord’s protective grounding conductor must be connected to the ground. This device and laser heads do not contain any user serviceable components. Do not remove covers! Servicing of internal components is restricted to qualified personnel.

Only use dedicated power supply.

CAUTION

Disconnect the power cord from the electrical outlet before performing any maintenance.

Never connect or disconnect any cable while the system is powered ON. Before plugging or unplugging any interconnection between laser driver and laser head, switch off all components using the ON/OFF switch at the rear panel. Charged cables can damage electronic devices!

1.3 Laser Safety Instructions

⚠ WARNING **Visible and invisible laser radiation**

- Diode laser heads from the *LDH* series and *LDH-FA* series are available at different wavelengths and intensities.
- Some lasers can emit infrared or ultraviolet laser light. Both are invisible to the eye!
- Some laser modules can emit laser light of up to class 3B / IIIB.
- Please refer to the labels affixed to the laser head for information on classification.

Avoid exposure to beam!

Lasers can be hazardous and have unique safety requirements. Permanent eye injury and blindness is possible if lasers are used incorrectly. Pay close attention to each safety related CAUTION and WARNING statement in the user manual. Read all instructions carefully BEFORE operating this device.

The *Sepia PDL 810* laser driver as well as laser diode heads of the *LDH* series and *LDH-FA* series are manufactured according to the International Laser Safety Standard IEC 60825-1 and comply with the US law 21 CFR §1040.10 and §1040.11.

1.3.1 Required Laser Safety Measures

Please observe the laser safety measures for class 3B / IIIB and class 3R / IIIR (depending on the laser) in accordance with applicable national and federal regulations. The owner / operator is responsible for observing the laser safety regulations.

1.3.2 What does the Owner/Operator have to observe?

- The owner/operator of this product is responsible for proper and safe operation and for following all applicable safety regulations.
- The owner/operator is fully liable for all consequences resulting from the use of the laser for any purposes other than those listed in the operating manual. The laser may be operated only by persons who have been instructed in the use of this laser and the potential hazards of laser radiation.
- The owner/operator is responsible for performing and monitoring suitable safety measures (according to IEC/EN 60825-1 and the corresponding national regulations).
- The owner/operator is also responsible for naming a laser safety officer or a laser protection adviser.
- The room in which the laser is installed must be labeled as a laser area.

- When using lasers of class 3B / IIIB or class 3R / IIIR, it is required to wear special eye protection (laser safety goggles).

⚠ WARNING

The following security instructions must be followed at all times.

⚠ CAUTION

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure!

1.3.3 General Safety Instructions for Operation

- Never look directly into a laser beam or a reflection of the laser beam. Avoid all contact with the laser beam.
- Do not introduce any reflective objects into the laser beam path. This includes jewelry, watches, etc.
- Every person involved with the installation and operation of this device has to:
    - Be qualified
    - Follow the instructions of this manual
- As it is impossible to anticipate every potential hazard, please be careful and apply common sense when operating the *Sepia PDL 810* laser driver and its associated diode laser heads. Observe all safety precautions relevant to class 3B / IIIB or class 3R / IIIR, respectively.
- For safety reasons, you should periodically check (on a monthly basis) the function of the emission indicators, remote interlock, and key switch on the laser driver, as well as verify that no scattered radiation can escape the collimator (e.g., by missing screws).
- **Do not dismantle the modules or laser heads** under any circumstances! There are no user serviceable parts inside.

1.4 Laser Safety Labels

Laser heads from the *LDH* and *LDH-FA* series use various types of housings depending on the model type. The following sections provide an overview of the individual housing types and the respective positions of the laser safety and classification labels as well as the aperture warnings (with an arrow pointing in the direction of the aperture).

The laser safety label states the information about the classification of the laser product, its certification, its power, and the wavelength range relevant to its classification. An overview of the laser safety labels by model type can be found in the table in the *Appendix*.

NOTICE

This list is not exhaustive and includes *Sepia PDL 810* - compatible laser heads that were available at the time of publication of this manual.

Please refer to the *laser delivery report* provided with each ordered laser head for information on the central emission wavelength, maximum achievable optical output power, and pulse shape of the delivered *LDH* laser heads. If the delivery report is not available, please contact: **support@picoquant.com**.

1.4.1 Short Cylindrical Heads (*LDH* Series)

Figure 1: Position of the laser warning, aperture indicator, certification, and laser marking label on laser heads built with short cylindrical housings (LDH-D-C-640S is used here as an example)

1.4.2 Long Cylindrical Heads (*LDH* Series)

Figure 2: Position of the laser safety, warning labels and aperture indicator on a long cylindrical laser head (LDH-D-TA-530 is used here as an example)

1.4.3 Flat Cuboid Heads (*LDH-FA* Series)

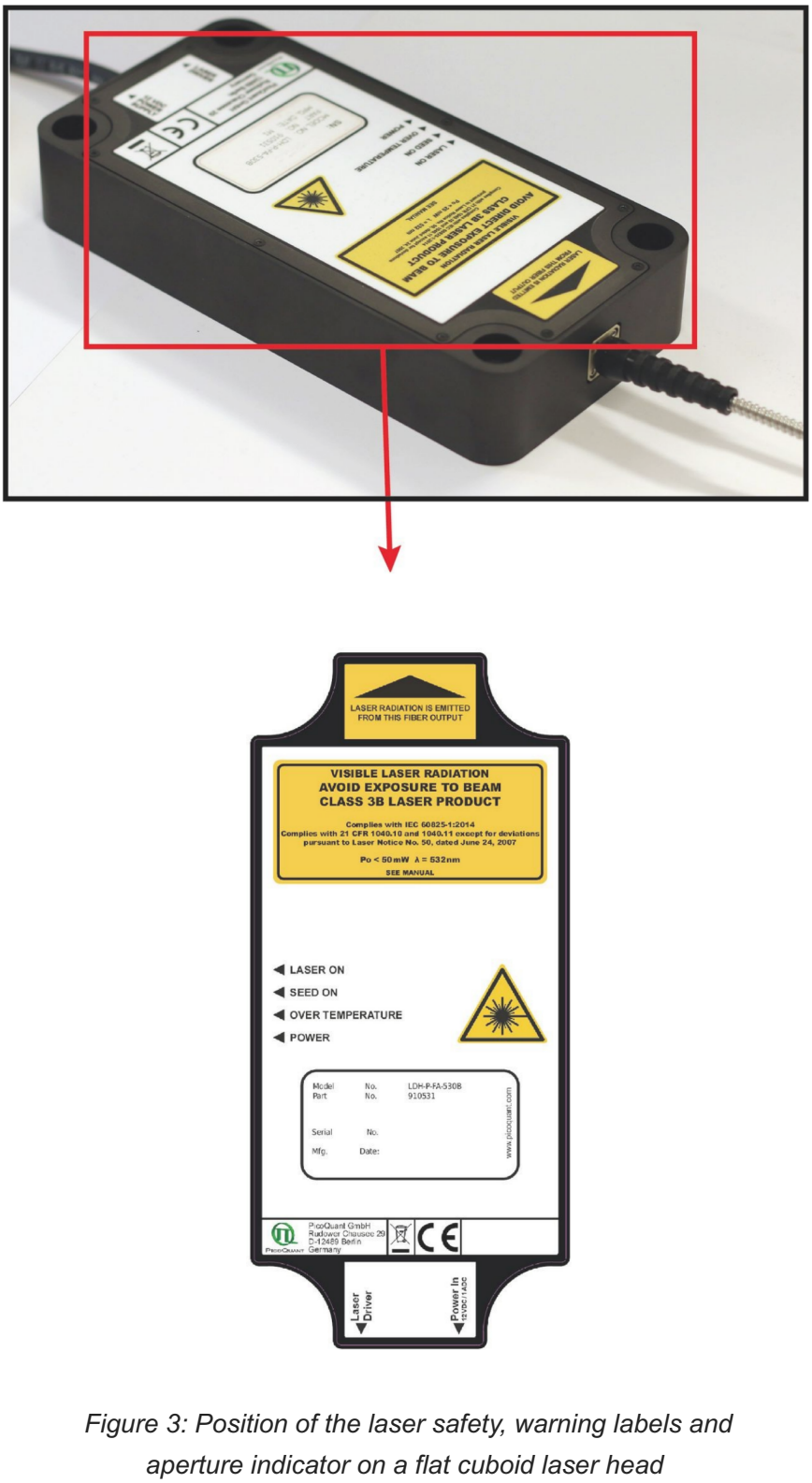


Figure 3: Position of the laser safety, warning labels and aperture indicator on a flat cuboid laser head (LDH-P-FA-530B is used here as an example)

1.4.4 Tall Cuboid Heads (*LDH-FA* Series)

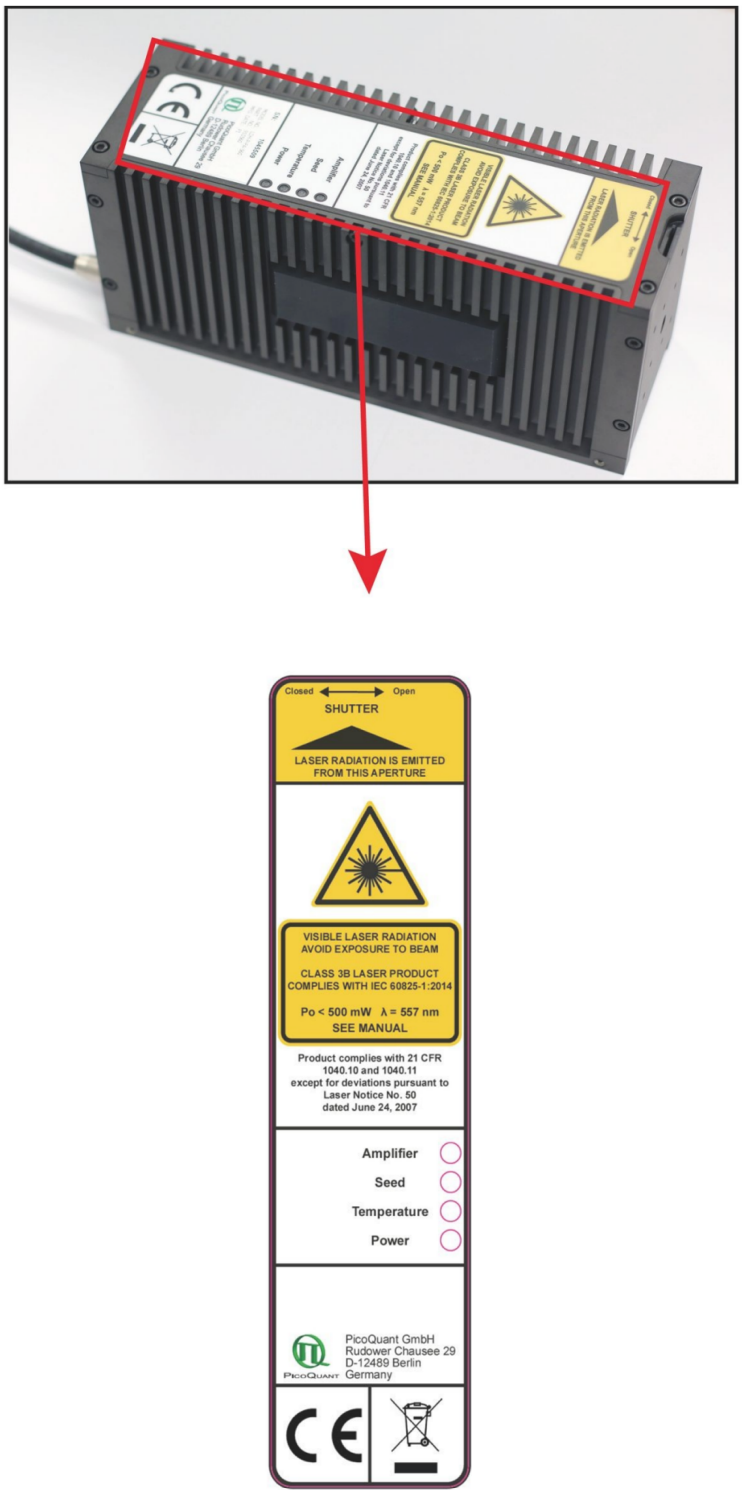


Figure 4: Position of the laser safety, warning labels and aperture indicator on a tall cuboid laser head (LDH-P-FA-560 is used here as an example)

1.5 Remote Interlock Connector

The *Sepia PDL 810* has a remote interlock connector on the front panel as a hardware interlock. Removing the green interlock connector (LEMO plug) or breaking the interlock circuit will immediately deactivate the power supply of the laser.

⚠ CAUTION

The *Sepia PDL 810* will resume laser emission as soon as the remote interlock circuit is closed or once power is restored after a power loss. Note that there is no indication of the status of the interlock. However there is an additional buzzer that always buzzes briefly when the laser radiation is switched on.

The green remote interlock connector (LEMO plug) is located on the front panel as shown in Fig. 5.

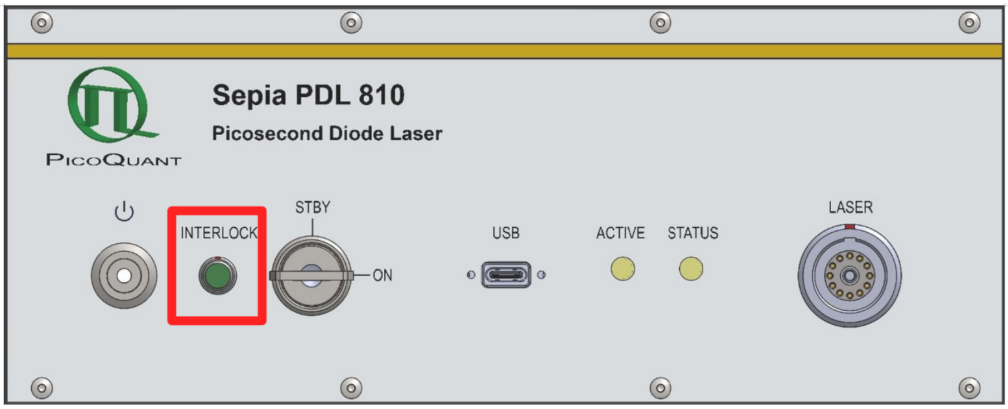


Figure 5: Position of the remote interlock connector on the front panel of the Sepia PDL 810 (highlighted with a red box)

NOTICE

In order to meet laser safety regulations, you may need to install a remote interlock, e.g., a door switch, to deactivate the power to the laser when the door to the laser area is opened.

Pin assignment for the interlock

The interlock is a 4 pin LEMO EGG.00.304.CLL female connector as shown in Fig. 6. In order to activate laser emission, **pins 2 and 3** need to be bridged using a suitable adapter.

Do **NOT** apply any voltage.

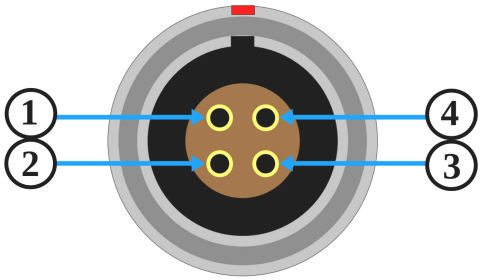


Figure 6: remote interlock connector

⚠ CAUTION

A green LEMO plug is delivered with the laser driver, which bridges pins 2 and 3. Using this bridging plug is NOT intended for everyday use of the laser driver.

The bridging plug cannot act as a functional remote interlock circuit, since it has no capability to react to e.g., a door switch.

1.6 Third-Party Lasers

Only compatible laser heads (*LDH* or *LDH-FA* series) or pulsed LEDs (*PLS* series) manufactured by PicoQuant can be operated with the *Sepia PDL 810* laser driver. **Do NOT connect any laser heads that were not supplied by PicoQuant to the *Sepia PDL 810*.**

PicoQuant declines any responsibility and cannot be held liable for any direct or indirect damages to the users and/or instrumentation resulting from the connection of non-approved third-party laser devices by the end user.

2. Introduction

The *Sepia PDL 810* system is a single channel pulsed diode laser driver system that allows operating a connected laser head in either pulsed or continuous wave (CW) mode. It supports laser heads from the *LDH* and *LDH-FA* series as well as pulsed LEDs (*PLS* series).

The *Sepia PDL 810* driver can trigger the laser autonomously via its integrated crystal oscillator or, if a more complex triggering scheme is required, it can also be triggered by an external signal.

All output frequencies from single shot (with external triggering) up to 80 MHz are supported.

The operating parameters are configured entirely via a computer using USB, enabling quick setup and easy storage of predefined settings. Stand-alone operation is possible, if no changes to the parameter set-up is required.

A Broad Selection of Light Sources

Users can choose from a wide range of pulsed light sources with wavelengths ranging from ultra-violet (266 nm) to infrared (1990 nm). For some wavelengths, the laser head can also be optimized for maximum power or shortest pulse duration. Currently, more than 30 laser head and pulsed LED models are available, and the selection is constantly being expanded.

3. Installation and Quick Start

This section contains information about installing the device's hardware and software, as well as a quick start guide.

3.1 Hardware Installation

When placing the *Sepia PDL 810*, please ensure a sufficient air flow from the fan at the rear panel by keeping a distance of 10 cm to any obstacle. The venting slots at the bottom must not be covered.

- Environmental conditions: +10°C - +35°C, relative humidity 20% – 80%
- Power input: 100 – 240 V, 50/60 Hz AC, power consumption <45 W
- The *Sepia PDL 810* is controlled from a PC using a USB 2.0 connection, see item 4 in Fig. 7
- The device can be operated stand-alone at fixed parameters. Changes to the operating parameters require the use of the computer interface.
- Before making any connections, be sure that all of the following conditions are met:
    - Main power switch (item 12 in Fig. 8) on the back panel is in the “0” (OFF) position
    - Key switch (item 3 in Fig. 7) is set to the “STBY” (vertical) position

Remote Interlock

In order to meet laser safety regulations, it might be necessary to install a remote interlock, e.g., a door switch, to deactivate power to the laser when the door to the laser area is opened. A remote interlock connector is provided for this purpose. See also chapter 1.5 for more details on the interlock connector.

Heat Dissipation

Ensure free air circulation. Do not cover the fan on the back or the ventilation slots on the device housing (especially those on the bottom of the housing).

Laser Diode Heads

Securely fasten the laser head. Ensure that it is not aligned in such a way that the laser light emitted by the collimator could pose a risk to eye safety.

⚠ CAUTION

Before connecting heads to the driver, please note that all applicable laser safety regulations must be observed (see section 1.3).

⚠ WARNING

Before unplugging a laser head from your laser driver, make sure that the **laser driver is fully switched OFF**! LED and Laser heads from the *PLS* and *LDH* series (and their respective drivers) do not support “hot-plugging”.

Use only laser heads of the *LDH*, *LDH-FA* or the *PLS* series supplied by PicoQuant. Connect the laser head via the large connector on the front panel of the *Sepia PDL 810*, see item 7 in Fig. 7.

Heat dissipation in temperature-controlled laser heads

The *LDH-...-C* and *LDH-FA* series laser heads contain an active thermoelectric cooling device. This produces, depending on the ambient temperature, a considerable amount of heat. Sufficient air circulation must be ensured to prevent an overheating of the laser head.

3.2 Software Installation

Before installing and using the *Sepia PDL 810*, please make sure to have:

- A solid base onto which the *Sepia PDL 810* can be placed (e.g. an optical table).
- A computer to install and run the operation software. The computer needs to have a free USB slot as well as a Windows operating system.

Place the *Sepia PDL 810* on its dedicated place, insert the power cord and connect the *Sepia PDL 810* to the host computer using the delivered USB cable.

The control software *“PQLaserDrv.exe”* for your *Sepia PDL 810* and other laser drivers manufactured by PicoQuant needs to be set-up by an installer. The control software can be downloaded from our website: www.picoquant.com/downloads. Installing the software is straightforward and performed by a step-by-step installation wizard.

NOTICE

In order to future-proof the software, a switch to a new USB driver architecture is required **starting with software version 1.2.xx.636** (changing from PQUSB to WinUSB). The two driver architectures are **NOT** compatible with each other. This means that once the new drivers have been installed and they have registered the PicoQuant laser driver(s), software packages relying on the other drivers will no longer be able to “see” or connect to these USB device. The reverse is also true: i.e. a software package relying on the newer drivers will not be able to discover or communicate with laser drivers registered to the older USB driver architecture. An important consequence of this is that both the PQLaserDrv package as well as any software package requiring a connection to a PicoQuant laser driver (i.e. SymPhoTime 64 or EasyTau) should be fully updated together.

NOTICE

The *Sepia PDL 810* should not be turned on before the control software is installed on the host computer!

To install the software:

- Download the control software from our website: www.picoquant.com/downloads.
- Launch the program: *PQLaserDrv_Setup.exe*
- Follow the instructions on the screen
- Accept the License agreement and click *Next* when requested
- Define the destination folder for the installation of the software
- Select the components to be installed (availability of which can change depending on product releases or discontinuations)

NOTICE

The PicoQuant Laser Driver Software can control not only the *Sepia PDL 810* but also other *Sepia* devices from PicoQuant. In case you need to control multiple lasers, then it is necessary to install all relevant components.

- Select which launcher icons will be generated

NOTICE

It is recommended to choose at least one of the suggested icon options. For each icon option chosen, the installer automatically creates two software launchers corresponding to the “Bright” and “Dark” PicoQuant color themes. For more details about the software color themes please refer to section 5.2.

- Validate your choices by clicking on *Next* and then click on the *Install* button to start the installation
- Click *Next* to start the installation of the drivers. It is possible that a *Windows Safety Warning* window pops up. In that case confirm the installation when requested in order to continue with the installation.
- Click *Next* when requested to complete the installation
- Click *Finish* to close the Installation Wizard

Once the software is installed, the *Sepia PDL 810* can be switched on, see chapter 3.3.1. When the laser is powered on for the first time, Windows will detect a new device and installs the necessary device drivers.

3.3 Quick Start Guide

Before proceeding with the quick start guide, please read chapter 1.3 and follow all required laser safety instructions.

⚠ CAUTION

Before powering the *Sepia PDL 810* on, ensure that the key-switch is in the secure “STBY” position (vertical)!

Before actually using the laser driver, the device has to be configured (see further sections of this manual). After configuration or if the system has been configured before, the lasers can be unlocked with the key switch.

3.3.1 System Start-Up

Fig. 7 shows the indicators and controls available on the front panel of a *Sepia PDL 810*.

- Ensure that the key switch 3 is in the vertical position (STBY).
- Switch on the main power using the switch on the back panel of the device, see item 12 in Fig. 8. The controller will then perform some internal checks, initialize the modules and finally enable the laser drivers. This will take no longer than 45 seconds.
- The STATUS indicator 6 should light up and flash red, then yellow and finally green. After approx. 15 seconds the STATUS indicator should permanently show green. The device is now ready for use. If the STATUS indicator shows red for more than 2 seconds, refer to chapter 8.1. and 8.2. for error diagnosis.
- Start the control software by double-clicking on the corresponding desktop icon.
- Turn the key switch 3 to the horizontal position (ON).
- Check the *Soft Lock* feature in the GUI. Clicking the button switches the control that locks the laser. This is important if the laser needs to be switched off quickly via the software.

NOTICE

Start the GUI only when the STATUS indicator shows continuously green.
Close the GUI before switching off the *Sepia PDL 810*.

- Get familiar with the GUI and its global functions. Detailed explanations of the GUI can be found in chapter 5.2.:
    - All parameter fields normally display the currently active values.
    - It is possible to change one or more parameters by entering new values, but the changes will not be effective until they are transferred to the *Sepia PDL 810* using the *Apply* button. Values that have been changed but not yet submitted to the hardware modules are highlighted with an orange box.
    - It is possible to undo changes in the GUI that are not yet transferred to the driver’s hardware by clicking the *Discard* button.

3.3.2 GUI Control Panel “Laser Driver”

⚠ CAUTION

Do not connect or disconnect any laser head unless the *Sepia PDL 810* is completely powered down and the Laser ACTIVE indicator is off.

The GUI shows the control panel for the installed laser driver as shown in Fig. 11, item **18**.

“Trigger Source”

The pulse repetition rate of the *Sepia PDL 810* can be derived either from its internal crystal oscillator or from an externally supplied trigger signal. The triggering source can be selected from the drop down menu labeled *“Trigger Source”*, see item **20** in Fig. 17. It is possible to select one of the 6 internal frequencies (2.5 MHz to 80 MHz) or to select external triggering at either rising or falling edge.

NOTICE

Synchronizing the detection system should be done directly from the Sync Output of the laser driver.

“Intensity”

The intensity (optical output power) can be set by the spin edit field *“Intensity”*, see item **21** in Fig. 17. Note that the percentage displayed has no linear relationship to the output power, e.g. setting the percentage to 50% does not mean that the laser head will provide 50% of its maximal optical output power, see section 5.2.5.

NOTICE

Always use only as much power as needed for your application to prolong the lifetime of the laser diode / LED.

“Pulsed Mode”

Laser diode heads of the *LDH-D-C-xxx* series can also be operated in continuous wave emission mode. This mode can be enabled by unticking the *“Pulsed Mode”* check box, see item 22 in Fig. 17. Unchecking this box for laser heads from the *LDH-P-xxx*, *LDH-P-C-xxx*, *LDH-P-FA-xxx* or *PLS* series will disable their laser emission.

4. Hardware Description

4.1 Laser Driver

The laser driver generates all of the signals and supply voltages for the picosecond laser heads and subnanosecond LED heads provided by PicoQuant. Only laser heads supplied by PicoQuant can be used with this laser driver. A direct connection of other types of laser diodes to the driver is not supported. The laser heads contain a unique circuit that matches the laser diodes to the driving electronics. Please contact us in advance if you have special laser diodes that need to be operated in picosecond pulsed mode.

The *Sepia PDL 810* also supports *LDH-D-C* laser heads allowing for CW operation of these laser diodes.

4.2 Front Panel

NOTICE

The front panel of the *Sepia PDL 810* does not feature any manual controls for the setting of operation parameter such as laser intensity, trigger source, internal repetition rate or operation mode. These parameters must be set via software. Full details on how to set these parameters with the standard operating software using the graphical user interface (GUI) can be found in chapter 5.2. or in the separate manual covering the programming library (API).

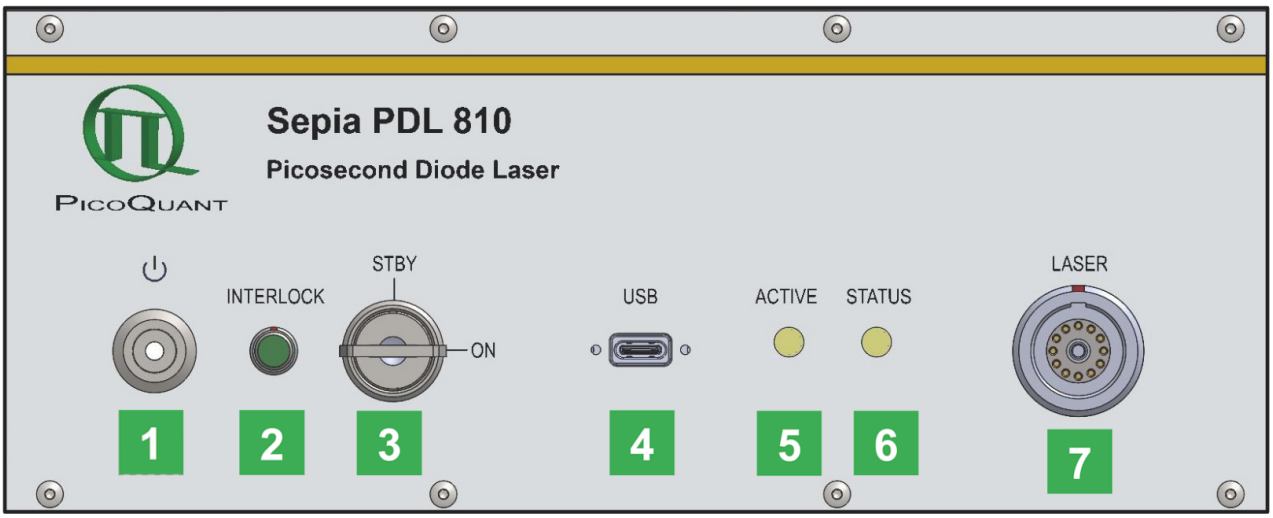


Figure 7: Sepia PDL 810 Front panel

1	**Power button** and indicator. In general use, it is recommended to turn off the *Sepia PDL 810* by using this button (power standby). The LED inside of the button lights up in red when the laser driver is in standby mode (main power switch is in the ON position). The LED turns off when the device is turned on.
2	**INTERLOCK** connector
3	**Key switch** for laser lock. Turning the key to the vertical position (STBY) puts the *Sepia PDL 810* into standby mode, in which the laser emission of the connected head is deactivated. Turning the key to the horizontal position (ON) activates the laser emission.
4	**USB-C** connector to interface the *Sepia PDL 810* with the PC
5	Laser **ACTIVE** indicator is a white LED. Lights up as soon as the power supply is on.

⚠ CAUTION

Laser radiation can be emitted when the white ACTIVE LED is on. Refer to chapter 1.3 for laser safety instructions and chapter 3 for installation information. Turn the key switch to “STBY” (vertical position) to deactivate the laser output of the connected laser head.

6	**STATUS** indicator is a green / yellow / red LED. A blinking sequence with various colors displays the device status during check-up and operation of the device.
7	**LASER** connector. The laser or LED head must be connected to this port via its cable. Ensure that the red markings on both the cable connector and the output port match.

⚠ CAUTION

Do NOT connect or disconnect a laser head unless the *Sepia PDL 810* is in power standby mode (i.e. the red LED in the power button is lit and the ACTIVE LED is off)!

4.3 Back Panel

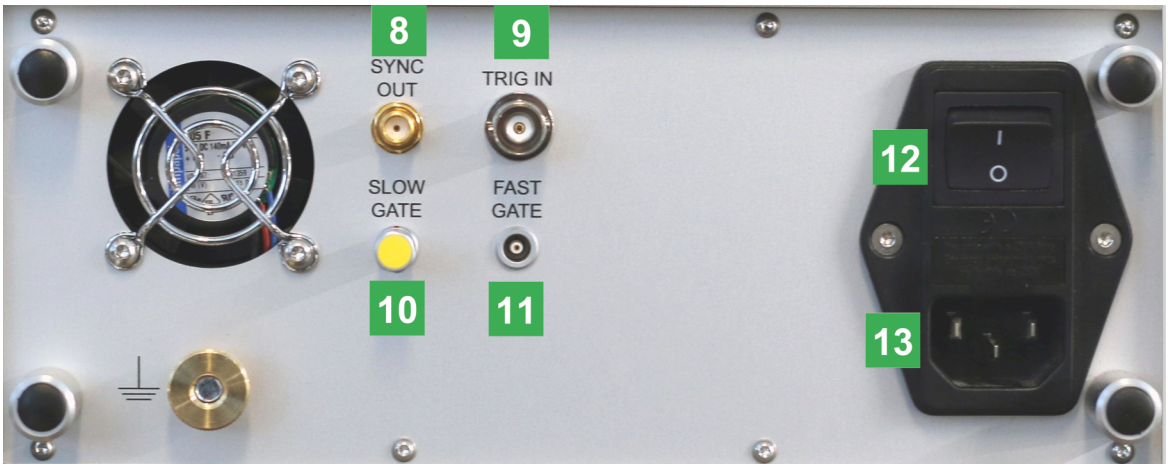


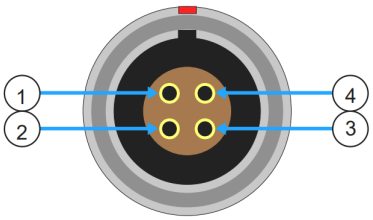
Figure 8: Sepia PDL 810 Back panel

8 **SYNC OUT** delivers a NIM compatible electrical signal synchronized to each laser pulse. This output is active in all triggering modes.

9 The **TRIG IN** is used to trigger laser pulses by an external NIM compatible signal.

10 **11** **SLOW GATE / FAST GATE:** Gating inputs can be used to disable the laser output through a TTL signal. Note that the SLOW GATE input cannot be left open: The yellow tipped 4-pin LEMO (00.304 Series) stub connector (provided with the device) needs to be plugged in if no other source is connected to the SLOW GATE.

The SLOW GATE input is isolated by an opto-coupler and a voltage of 5 V between pin 1 and pin 2 of the connector must be fed into the input to unblock the SLOW GATE. The pin assignment of the LEMO connector is shown in Fig. 9. Alternatively you can use an external generator delivering 5 V signal into 500 Ω (approx. 10 mA).



Pin #	*Function*
1	Anode
2	Cathode
3	Ground
4	+5 Volts

Figure 9: Pin assignment of the SLOW GATE input port

.

12 **13** **Main Power Switch** and **Main Power Socket**. Between these two is a replaceable fuse behind a cover. The fuse type is indicated on the label on the back panel.

4.4 Laser Locking Behavior

- The key switch 3 interrupts the laser power supply when it is in the vertical position. The key can be removed only in this position. It's a good practice to keep the key switch locked unless the connected laser heads can be operated according to safety regulations.
- The remote interlock 2 shuts the laser power supply off when the loop current is interrupted.
- To comply to the laser safety regulations, all lasers are locked off for at least the first 10 seconds after the main power has been switched on.
- The controller holds the laser locked off as long as it checks its hardware while powering up.
- The controller keeps the device locked off, if it detects any abnormal operating conditions.
- The controller can be instructed from the GUI or from any software using the programming library (API DLL) to hold the laser locked off regardless of the position of the key switch. Refer to chapter 5 and the separate API manual for more information on soft locking.

⚠ CAUTION

Soft locking the lasers does not ensure eye safety!

4.5 Operation Mode and Triggering

The *Sepia PDL 810* laser driver can be operated in either pulsed mode (triggered by an internal oscillator or via an external trigger) or in CW mode.

4.5.1 Internal Trigger or CW Mode

- The laser driver can be triggered from its internal local oscillator at six user-selectable frequencies: 80 MHz, 40 MHz, 20 MHz, 10 MHz, 5 MHz or 2.5 MHz.
- The synchronization output of the laser driver, see item 8 in Fig. 8, delivers a synchronization signal along with each laser pulse. This synchronization output is particularly helpful in independent operation. It can be connected to the detection electronics such as, e.g., a TCSPC module from PicoQuant. A suitable LEMO-SMA or LEMO-BNC adapter cable can be obtained from PicoQuant. The shortest possible pulse width can be achieved in this configuration and the drift between synchronization signal and optical pulse will be at its lowest.

- Another independent mode of operation is the **continuous (CW) mode**. It can be used with any CW mode compatible laser heads from PicoQuant, such as the ***LDH-D-C*** series.

4.5.2 External Triggered Operation

- Each *Sepia PDL 810* can be triggered externally by a suited NIM compatible trigger signal connected to the trigger input *TRIG. IN*, see item 9 in Fig. 8.
- The *Sepia PDL 810* triggers at a fixed trigger level of approx. -0.3 V from either edge. Triggering on the falling edge of the NIM signal is recommended for best results. The Maximum repetition rate is 80 MHz.

4.5.3 External Triggering with Other Types of Trigger Signal (e.g., TTL)

- It is **not** recommended to connect any other type of signal (e.g., TTL) directly to the external trigger input of the *Sepia PDL 810*. Even though this should in principle not cause any significant damage, it will lead to an unstable triggering or no triggering at all.
- PicoQuant recommends to use a TTL to NIM converter as e.g. the *SIA 400*. Please contact PicoQuant or your local PicoQuant distributor for more information about this.

NOTICE

The maximum user selectable frequency might exceed the maximum pulse repetition frequency (PRF) supported by some laser heads. This could result in overheating of the laser head. Although PicoQuant laser heads are protected against damages caused by excess PRF, it is strongly recommended to avoid such situations. Refer to the delivery report of your laser head for its individual maximum PRF.

4.6 Emission Intensity

The emission intensity cannot be changed via the front panel, but only via the GUI software. A detailed description of this topic can be found in section 5.2.5.

4.7 Gating Functions

For special applications, such as in scanning devices, the *Sepia PDL 810* has two gating functions allowing suppression of laser emission by an external signal.

FAST GATE

The fast gate function affects the trigger input line **TRIG. IN**, see item 9 in Fig. 8. It is thus only effective when the module is being triggered from an external source. The FAST GATE gate input will have no effect if either the internal oscillator is active or if the laser is operated in CW mode.

The gating function can perform the on/off transition within nanoseconds. It can therefore switch the laser state between two pulses, even at high repetition rates.

To use this gating mechanism, connect a active-low TTL signal to the “FAST GATE” connector, see 11 in Fig. 8. The input has an internal pull-up resistor to “High” level.

SLOW GATE

The SLOW GATE function modulates the laser activity by switching the output power voltage to zero. This method will be effective regardless of the trigger source and will also minimize drift effects. However, this method is a comparably slow modulation with respect to high repetition rates of the laser.

The SLOW GATE input is isolated by an opto-coupler and a current must be fed into the input to activate the laser. When this gating function is not used, the yellow LEMO connector stub (included with the device) must be plugged into the “SLOW GATE” connector, see 10 in Fig. 8 to keep the laser always active.

4.8 Temperature Control of the *LDH–…–C* Models

The only user adjustable part of the laser head is the set-point for the thermoelectric (TE) cooler. Since the output power at a given potentiometer setting depends slightly on the temperature of the diode element, the set-point should only be changed if absolutely necessary, e.g., if the ambient temperature is too high.

The thermoelectric (TE) cooler maintains the temperature of the diode element and collimating optics at a constant level. The factory pre-set value is approximately 20°C. The desired temperature can be set using the potentiometer for setting the temperature setpoint, which is located inside the *LDH-...-C*, see Fig. 10. For temperature adjustments a non conductive potentiometer adjustment tool is required.

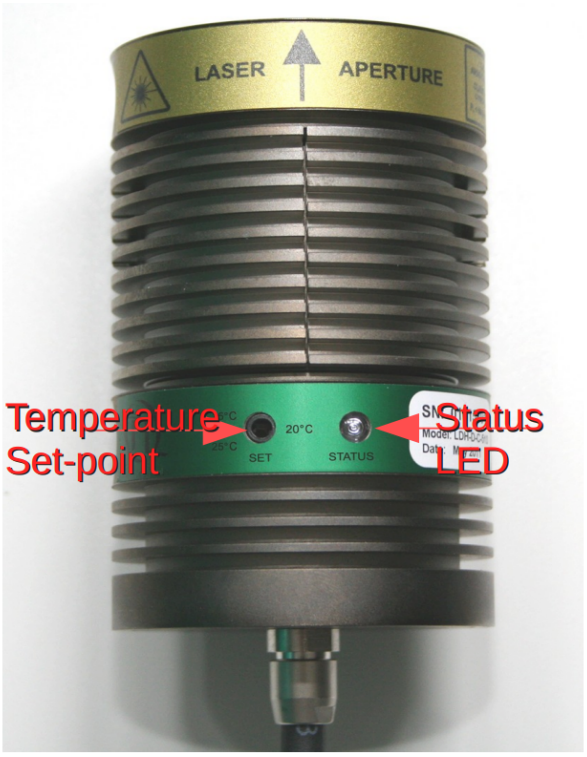


Figure 10: Top-view of a LDH-C series laser head

⚠ WARNING

Do NOT look into the laser optics when the laser is switched ON, which is indicated by the “ACTIVE” LED, see Fig. 7!

⚠ CAUTION

Please note that adjusting the set-point temperature is not meant to be a “daily” process. Constantly changing the temperature set-point will wear out the plastic adjustment potentiometer. Only change the set-point value if the temperature in your laboratory is regularly above (or below) +20°C.

NOTICE

The temperature level can be set from +15 to +25°C. The temperature should be chosen with respect to the ambient temperature and humidity conditions. The outer case acts as a heat sink. To prevent overheating, the temperature should not be set to the lowest value if the ambient temperature is higher than 30°C. Also, if the ambient humidity is high, water may condense on the collimator. Switch the laser OFF and look at the silver colored collimator holder to determine whether condensation is forming.

The temperature of the diode element needs to reach the set-point temperature for stable operation. At startup the “STATUS” LED on the laser head may be red. The laser head will switch off if the LED is red and the diode element is warmer than approx. 28°C. Under normal conditions, allow about 2 to 5 minutes after start-up for the TE cooler to reach the set-point temperature. The STATUS LED will change to green when the set-point temperature has been reached.

Check the temperature control “STATUS” LED on the laser head. If it is:

- **green** – the laser diode element is operating at the set-point temperature,
- **red** – the temperature is not at its set-point, if it is too high, the laser will be shut off.

Check the STATUS LED periodically. If it is red, the TE cooler is operating but not able to maintain the diode element temperature below 28°C. In this case, switch the laser OFF and wait until the laser head has cooled down. Then, adjust the temperature set-point to a higher value, reduce the ambient temperature or increase the ventilation near the diode laser housing.

NOTICE

At higher operating temperatures the diode laser can provide approximately 10% more output power, but the diode element lifetime will be much longer if operated at a lower temperature.

5. Operation

5.1 Startup Check

At power up, the *Sepia PDL 810* performs some basic checks on its hardware before the system is ready for operation. Once these tests are successfully completed, the “STATUS” indicator 6 emits constant green light and the laser driver will operate according to its last settings.

If the check fails, the device may be become blocked and the “STATUS” indicator 6 will show approx. 15 sec. red light. Refer to chapter 8.1. and 8.2. for details on error diagnosis.

5.2 Setting Operating Parameters with *PQLaserDrv* Graphical User Interface

NOTICE

The *Sepia PDL 810* must be turned on and the initialization process completed, before the software can be started!

The *Sepia PDL 810* GUI is available in three different **color schemes**: PicoQuant bright scheme, PicoQuant dark scheme and a standard Windows scheme. The latter can be customized using the standard Window control panel.

The dark scheme is intended for light sensitive set-ups and experiments such as, e.g., photon counting and single molecule sensitive spectroscopy set-ups, where ambient light perturbation should be minimized as far as possible. However, for better readability, all screen shots in this manual correspond to the PicoQuant bright color scheme.

The color scheme is applied by the command line parameter “/style=<scheme>” where the placeholder <scheme> could be one of the legal values “dark”, “bright” or “windows”.

During the installation setup of the software, the installer can optionally generate separate desktop as well as quick launch icons for the respective bright and dark schemes, see chapter 3.2.

In the interest of ergonomics, all relevant active controls (button, edit box, etc.) change color when the mouse pointer hovers above them.

An overview of the GUI with all control elements is shown in Fig. 11.

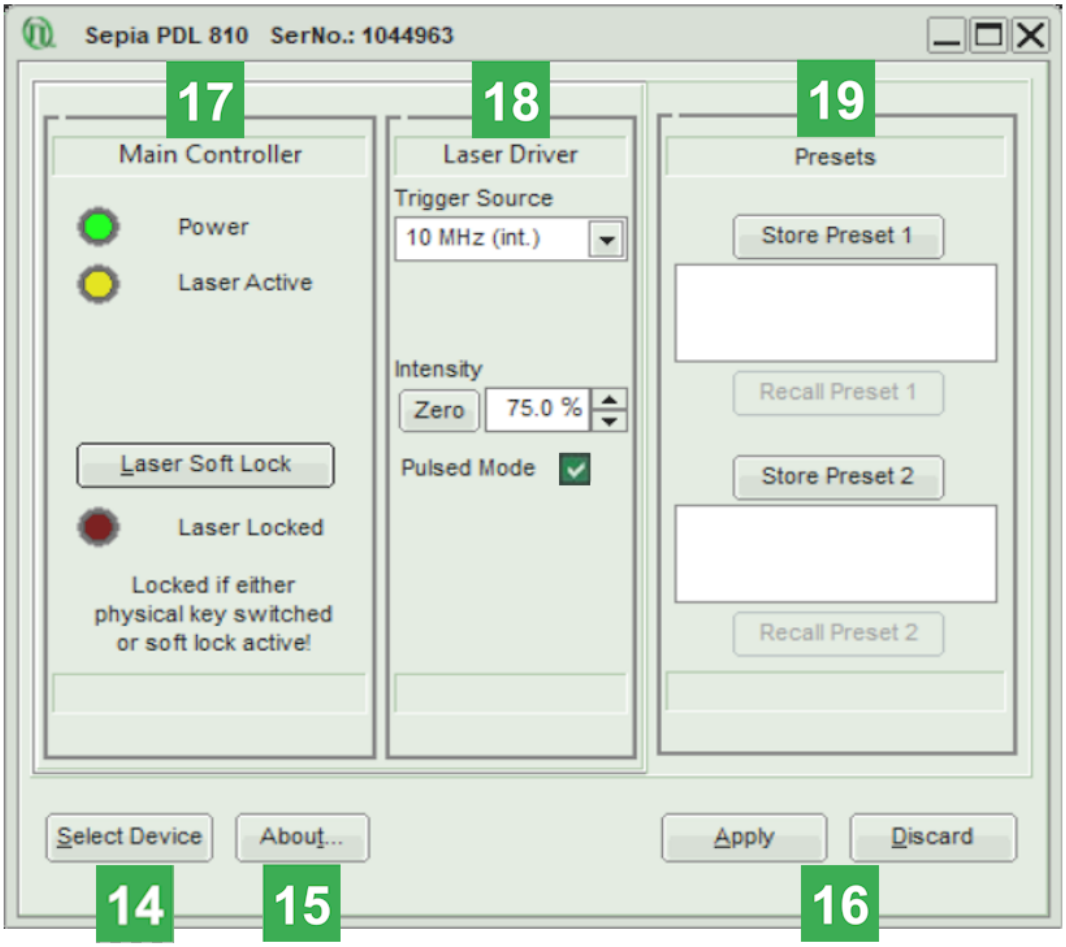


Figure 11: Sepia PDL 810 GUI

5.2.1 “Select Device” Button

The *Select Device* function 14 is useful if more than one *Sepia PDL 810* (or any other USB laser device from PicoQuant) are connected to the same host computer.

A mouse click on the *Select Device* button will start a scan for supported devices connected to the PC.

A modal dialogue with an *OK* and *Cancel* button presents a list box with the currently connected devices, see Fig. 12. When opening the list box, all detected devices are listed by their serial number. The currently selected device is marked with an asterisk “*”.

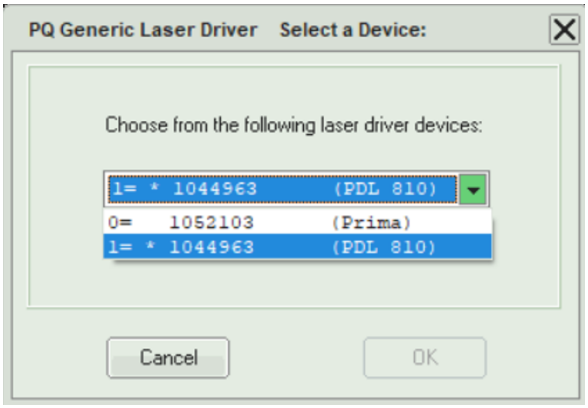


Figure 12: Select device

Cancel	Back to the main window without any changes.
OK/ Reconnect	Change to the newly selected device. Note that this might lead to changes in the GUI, if a device of different type or configuration is selected. The serial number of the currently selected device is always displayed in the title bar of the software. The “Select Device” button can also be used to restore the USB connection to the device if it is lost for any reason during operation. In this case, the label of the *OK* button changes to *Reconnect*.

5.2.2 “About...” Button

Extended information about the device, including hardware version, serial number, operating hours, software and firmware version etc. can be brought up by clicking on the button labeled *About…*, see item 15 in Fig. 11.

For every support request its is recommend to save the entire information by clicking on the button labeled *Copy Support Infos*, see Fig. 13, save the information as a plain text file, and send it per mail to **support@picoquant.com**.

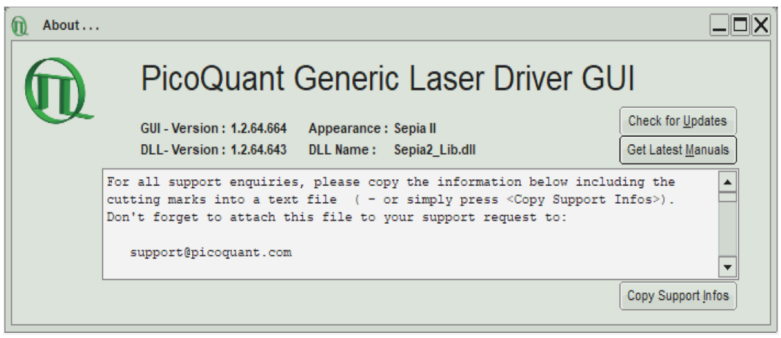


Figure 13: The “About...” window includes extended information about the status of the device

It is also possible to search for possible software updates by clicking on the button labeled *Check for Updates*. If an update is available, a download link to the latest version will be provided. The button labeled *Get Latest Manuals* will also check online if newer versions of applicable manuals are available. An example of such a search result is shown in Fig. 14.

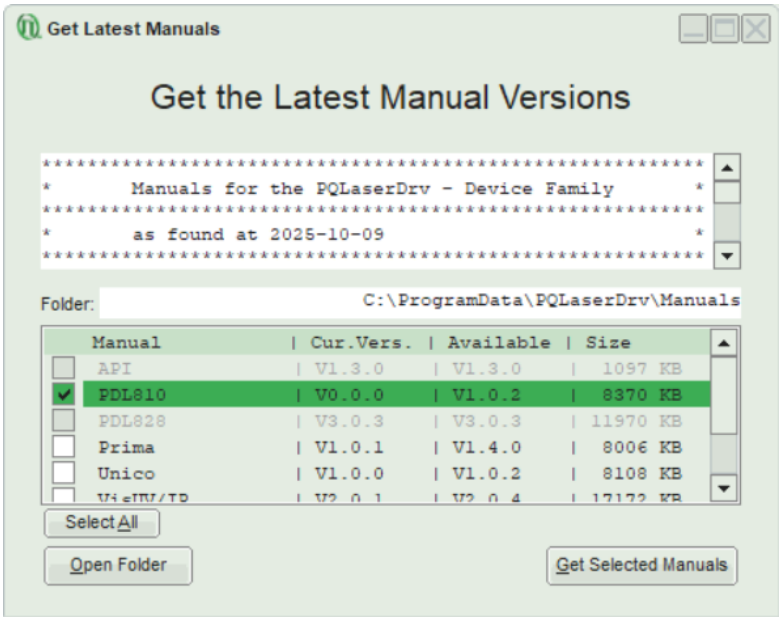


Figure 14: A potential result screen after searching for latest manual versions

Lines corresponding to manuals that are up-to-date will be greyed out. Manuals that are currently not installed are listed as v0.0.0 in the column *Cur. Vers.*

To download the latest version of one or more manuals, tick the corresponding check-boxes and click on *Get Selected Manuals*.

5.2.3 “Apply” and “Discard” Buttons

The *Apply* and *Discard* buttons 16 must be used to confirm or discard the configuration changes made in the GUI. In the example shown in Fig. 15, changes have been made to the parameters of the *Trigger Source*. The *Laser Driver* label and the *Apply* button are therefore highlighted in orange and remain highlighted until the changes are either applied or discarded.

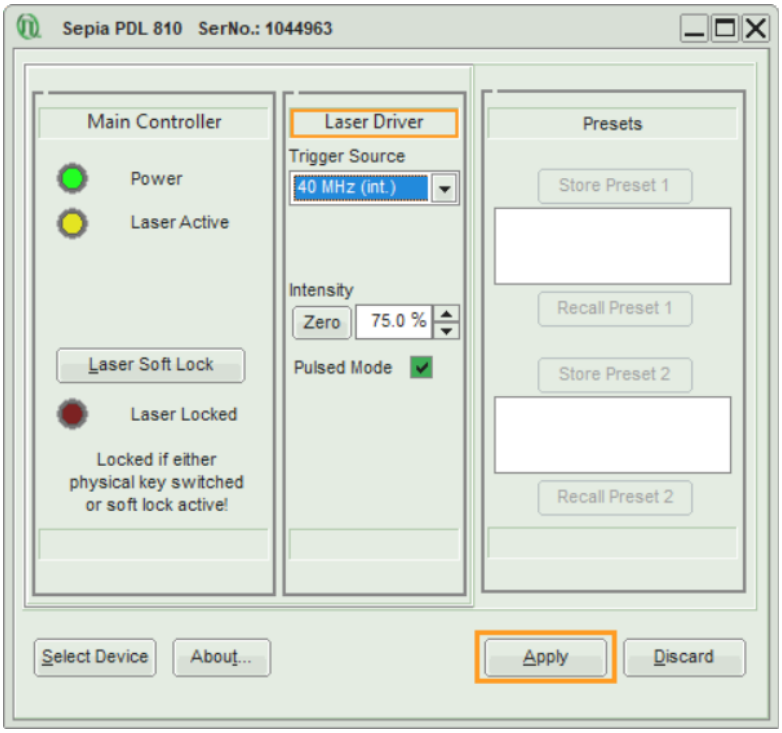


Figure 15: Elements highlighted in orange indicate a recent change of parameters

5.2.4 “Main Controller” Control Panel - Soft Lock and Unlock

The *Sepia PDL 810* can be locked (no laser light emission) and unlocked (laser ligth is emitted) not only with the hardware key switch on the front panel, but also via the GUI by clicking on the button labeled ***Laser Soft Lock / Laser Soft Unlock*** (see item 17 in Fig. 11) which is located in the controller frame on the left side of the software window.

⚠ WARNING

Soft locking the laser does not ensure eye safety!
Before unlocking the laser, please refer to chapter 1.3 for laser safety instructions.

⚠ CAUTION

Allow about 3 – 5 minutes warm-up time after unlocking the laser to reach a stable output power.

The ***Laser Unlocked*** state is recognizable in the software by the ***Laser Locked*** indicator turning dark red, see Fig. 16, left.

The ***Laser Locked*** state is recognizable in the software by the ***Laser Locked*** indicator turning bright red. The button text could be either ***Laser Soft Lock*** in case the system was hard locked by key switch or remote interlock circuit, see Fig. 16, middle, or ***Laser Soft Unlock***, see Fig. 16, right, in case the system was soft locked (this even masks a hard lock state).

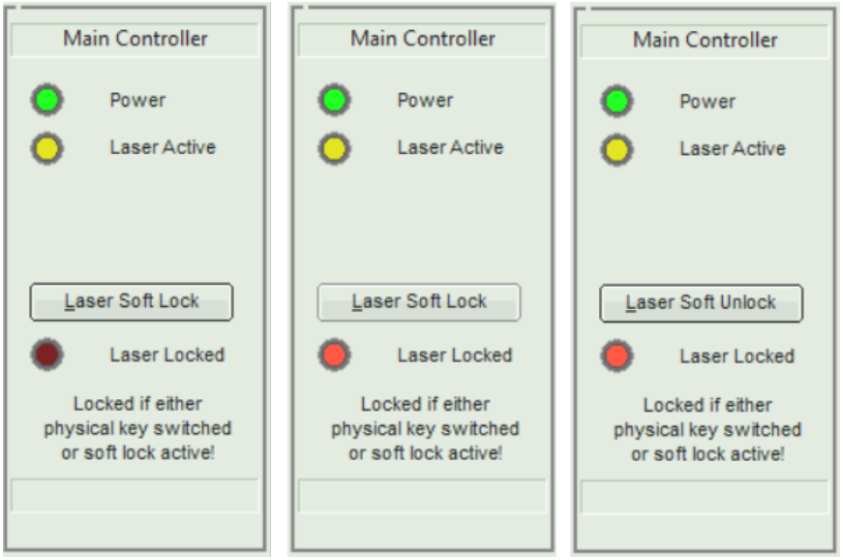


Figure 16: Locking status indicator in the GUI: laser unlocked (left), laser hard locked via key switch (middle), laser soft locked (right)

NOTICE

The lock state indicated in the GUI may refresh with a slight delay (<1 s). **Consider**: The soft lock state is not persistently stored in the system; it is lost after power down / power up.

5.2.5 “Laser Driver” Control Panel

The control elements of the “Laser Driver” control panel, see item 18 in Fig. 11 for the *Sepia PDL810* are shown in Fig. 17.

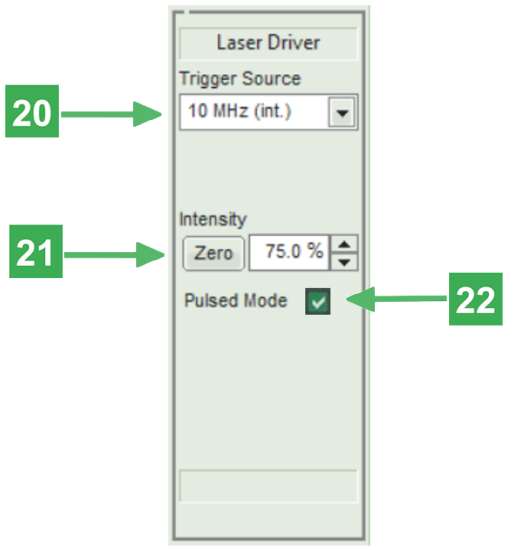


Figure 17: Laser Driver control panel in the GUI

“Trigger Source” 20

- 5 user selectable internal repetition rates of 80, 40, 20, 10, 5 or 2.5 MHz
- 2 external trigger input settings: *rising* or *falling*

“Intensity” 21

- The intensity of the laser head can be set on a freely adjustable scale from 0 to 100% in steps of 1‰ of its full scale value. This is controlled via an internal voltage change.
- The *Zero* button provides an easy toggle between any intensity value and zero intensity. This is useful in case a laser needs to be switched off quickly. The button memorizes the intensity previously set. Pressing it again restores this intensity setting (and vice versa).

NOTICE

Please note that the optical output power of a laser head does not correlate linearly with the intensity scale. Each laser head has a particular threshold value for laser emission, a particular slope and a particular maximal power value.

NOTICE

Some high-powered laser heads may only operate at very high levels of the intensity control. For long-term stability of the output power, allow the laser to warm-up for at least 20 minutes. This is especially important for temperature stabilized laser heads.

The emission pulse shape varies noticeably with increasing output power. Typically, the shortest pulses (without any “tails” or after pulses) can be achieved at output power settings slightly above the lasing threshold. Increasing the power results in higher pulse energy but also broader pulses. It depends on the application and particularly on the detector whether shorter pulses or higher power will be needed. Changing the repetition rate may change the shape of the pulses, too. In some cases, these changes can be compensated for by adjusting the intensity control.

There are also minimal variations in the output characteristics for each laser driver module (typically <1%). For laser heads with very steep transfer functions, the maximum power or output at a given intensity setting may, however, differ by up to 10%.

Please keep in mind that operating the laser at high power decreases the lifetime of the laser diode. To ensure safer working conditions and to prolong the lifetime of the laser, reduce the laser intensity to the lowest possible value supported by your experiment. Full laser power should only be selected when absolutely necessary.

“Pulsed mode” 22

This check box permits to deactivate the pulsed mode. If pulsed mode is deactivated, laser heads that support the Continuous Wave mode (e.g., from the *LDH-D-C*, *LDH-D-TA*, and *LDH-D-FA* series) will emit in Continuous Wave mode (CW emission).

⚠ WARNING

While most “pulsed only” laser heads that do NOT support the Continuous Wave mode (e.g., from the *LDH-P*, *LDH-P-C*, and *LDH-P-FA* series) will shut down if switched to CW operation, some laser heads, especially if manufactured before 2006, might turn into an undefined state. Unchecking Pulsed Mode does therefore not guarantee that a “pulsed only” laser head will behave safely!

5.2.6 “Presets” Control Panel

Two working configurations can be saved and recalled under in the frame labeled *Presets*, see item 19 in Fig. 11. Each preset stores all working parameters of the device. The currently applied configuration can be saved by clicking on the *Store Preset 1* or *Store Preset 2* button, see Fig. 18.

Figure 18: Save a configuration

A pop up window *Inquire Preset Comment:* gives the possibility to include a short comment with a maximal length of 64 characters for each stored configuration Fig. 19.

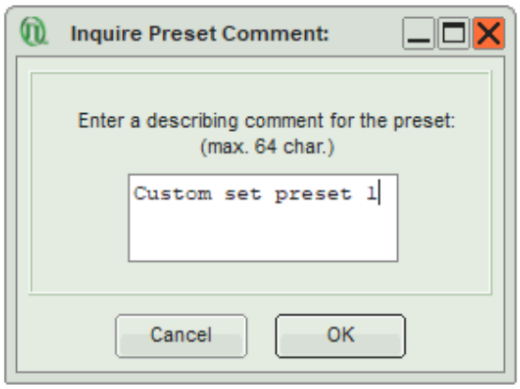


Figure 19: Edit comment for a preset

A stored configuration can simply be recalled by clicking on the button labeled *Recall Preset 1* or *Recall Preset 2* in the *Presets* window, see Fig. 18.

NOTICE

The presets are stored in the internal memory of the device and not on the host computer. They can therefore also be recalled if the device is connected to a different host computer.

NOTICE

Clicking on a *Recall Preset* button leads to an immediate configuration change without the need to manually apply the changes! The process itself can, however, take some time depending on the difference between current and recalled settings!

6. Application Hints

6.1 Choosing the Correct Laser Intensity

To ensure safer working conditions and to prolong the lifetime of the laser element, select a lower power setting (approx. 35% of full power). Full laser power should not be used unless it is absolutely needed. This applies especially to laser diodes in the ultraviolet to blue region, which still have a shorter lifetime than red or infrared laser diodes. It is recommended to switch these lasers off by disabling the trigger or by the key switch whenever possible.

6.2 Side Effects of Laser Settings

- An increased Laser **Intensity** affects:
  - **Pulse shape**: Pulses with a higher amplitude but a broader base will be produced. After-pulsing may occur.
  - **Pulse position**: The peak shifts to an earlier time (arrives sooner) in relation to the SYNC signal.
  - **Wavelength shift**: Shift of the emitted light to a shorter or longer wavelength (depending on the laser material).
- The **repetition rate** can slightly change the **pulse energy**. Consequently slight variations caused by laser intensity changes are possible. At repetition rates of 10 MHz or less, the pulse energy remains fairly constant.

7. Technical Data / Specifications

Power and Dimensions	
Power supply	110/120 or 220/240VAC, 50/60 Hz, max. 45 Watts
Size (w x l x h)	(237 × 310 × 97) mm
Laser Driver	
Inputs	1 trigger (NIM), 2 gating (TTL)
Output	1 synchronization (NIM)
Operation modes	pulsed or continuous-wave (CW)
Master oscillator frequency	80 MHz
Repetition frequency	80, 40, 20, 10, 5, or 2.5 MHz (user-selectable)
Gating Inputs	
Slow Gate	Transition time < 100 ms (pulsed and cw operation) Internal impedance: >500 Ω Signal type: TTL (5 V) Connector type: 4-pin LEMO socket – 00.304 series (Example of connector: FGG.00.304.CLA)
Fast Gate	Transition time typically 10 ns (pulsed only) Internal impedance: 50 Ω Signal type: TTL (5 V) Connector type: 1-pin LEMO socket – 00.250 series (Example of connector: FFA.00.250.NTA)
Computer	
Operating system	Windows™11
PC interface	USB 2.0

8. Trouble Shooting

If you have another laser head from PicoQuant, you can perform a comparison to determine whether the laser head or the laser driver is faulty.

8.1 Checklist – Device can’t Power Up

Please check:

- Is the power cord correctly inserted in the power socket 13?
  - If answer is **NO**: Attach the power cord correctly
  - If answer is **YES**: Continue with the next question
- Is the main power switch 12 in ON position?
  - If answer is **NO**: Turn the power switch to the ON position
  - If answer is **YES**: Continue with the next question
- Is the power button 1 lit red?
  - If answer is **NO**: Check whether the fuse has blown. The fuse is between 12 and 13.
    - If answer is **NO**: Contact PicoQuant’s support
    - If answer is **YES**: Replace fuse, see label at backside of device for type of fuse
  - If answer is **YES**: Push the power button 1. Does the device response by switching the red LED 1 to OFF and the ACTIVE LED 5 to ON?
    - If answer is **NO**: Contact PicoQuant’s support
    - If answer is **YES**: Connect the device with PC and start *PQLaserDrv*

8.2 Checklist - No Laser Emission

⚠ WARNING

Under no circumstances look directly into the laser!

Please check:

- Is the shutter open? (only for laser and LED heads with shutter)
  - If answer is **NO**: Open the shutter
  - If answer is **YES**: Continue with the next question
- Is the key switch 3 in ON position?
  - If answer is **NO**: Turn the key switch 3 in ON position
  - If answer is **YES**: Continue with the next question
- Is the Interlock 2 closed?
  - If answer is **NO**: Attach the green stub connector (for testing purposes only)
  - If answer is **YES**: Continue with the next question
- Is the Softlock unlocked (see section 5.2.4)?
  - If answer is **NO**: Unlock Softlock using *PQLaser Drv*
  - If answer is **YES**: Continue with the next question
- Is the yellow stub connector attached to SLOW GATE 10?
  - If answer is **NO**: Attach the yellow stub connector to SLOW GATE 10
  - If answer is **YES**: Continue with the next question
- Is the laser head cable correctly attached to the laser driver connector 7?
  - If answer is **NO**: Power of the device and reattach the laser head properly
  - If answer is **YES**: Continue with the next question
- Is the laser head correctly detected by the laser driver? If this is so, the term ‘LASER’ should appear in GUI.
  - If answer is **NO**: Contact PicoQuant’s support
  - If answer is **YES**: Set driver to the pulsed mode and select the highest possible repetition rate for the attached laser head

9. Support

Should you encounter problems that require sending the device in for inspection / repair, please contact us first at: **https://support.picoquant.com** or **support@picoquant.com** and request an RMA number before shipping the device. Please include the serial number of your device. Observe precautions against static discharge under all circumstances during handling, packaging and shipping. Use original or equally protective packaging material. Inappropriate packaging voids any warranty.

10. Legal Terms

10.1 Copyright

10.2 Trademarks

Other products and corporate names appearing in this manual may or may not be registered trademarks or subject to copyrights of their respective owners. PicoQuant GmbH claims no rights to any such trademarks. They are used here only for the purposes of identification or explanation and to the owner's benefit, without intent to infringe.

Retraction of Old Devices

Waste electrical products must not be disposed of with household waste. This equipment should be taken to your local recycling center for safe treatment. WEEE–Reg.–No. DE 96457402

11. Further Reading

11.1 PicoQuant Bibliography

PicoQuant maintains a database of publications mentioning PicoQuant devices. It can be found at our website **https://www.picoquant.com/scientific/references**. It is a valuable source if you would like to know which laboratories are using PicoQuant products or how broad the field of various applications is.

11.2 Download of Technical Notes, Application Notes

PicoQuant, along with our customers, continuously writes and publishes short documents about techniques, methods and applications that are possible with our hardware or software. The download section can be found at **https://www.picoquant.com/scientific/technical-and-application-notes**

12. Appendix

12.1 Abbreviations

API	Application Programming Interface
BNC	British Naval Connector or Bayonet Nut Connector or Bayonet Neill Concelman
CW	Continuous Wave
DLL	Dynamic Link Library
FWHM	Full Width at Half Maximum
GUI	Graphical User Interface
IEC	International Electrotechnical Commission
LDH	Laser Diode Head
LED	Light Emitting Diode
NIM	Nuclear Instrumentation Methods
PRF	Pulse Repetition Frequency
RMA	Return Merchandise Authorization
SMA	Sub-Miniature version A (Connector Type)
TCSPC	Time-Correlated Single Photon Counting
TTL	Transistor-Transistor Logic
WEEE	Waste Electrical and Electronic Equipment

12.2 Firmware Start-Up Diagnosis

After power up, several phases during the self test sequence can be distinguished:

phase id.	start up phase	Duration	Status light(s)
	booting the controller	approx. 5.0 sec	off
00	checking controller hardware	approx. 0.5 sec	continuously red
10	initialize device mapping	min. 4.0 sec	blinking yellow (or red *and* green)
20	device mapping		
30	checking frame	depends on configuration of the Sepia PDL 828	blinking green
40	checking modules		
50	checking configuration		
60	modules' calibration		
70	modules' initialization		
80	successfully up and free running, ready to release laser soft lock	until error detection or power down	continuously green
??	on error	repeating sequence …. until power down	long red interval, pause, yellow blink code…, pause, long red interval, pause, …

If a device from the *Sepia* family remains blocked by a failure, the error may be further diagnosed by software. Start e.g., **"ReadAllDataByDelphi.exe"** from the demo section of the programming library. This program will help to dentify the reasons. Please refer to separate manual for the API for details.

NOTICE

In order to ensure a safe shutdown, the controller of the *Sepia PDL 810* has an internal capacitor. This capacitor can supply the controller with electricity for a short period of time. For this reason we recommend to unplug the *Sepia PDL 828* from the main power supply and to wait for ca. 3 minutes to ensure a complete reset of the device.

⚠ CAUTION

An error may also occur during the operation if a laser head was removed or added without powering off the device. The best way to avoid this situation is to **power OFF the *Sepia PDL810* bevor removing or attaching a laser head**.

12.3 Naming scheme

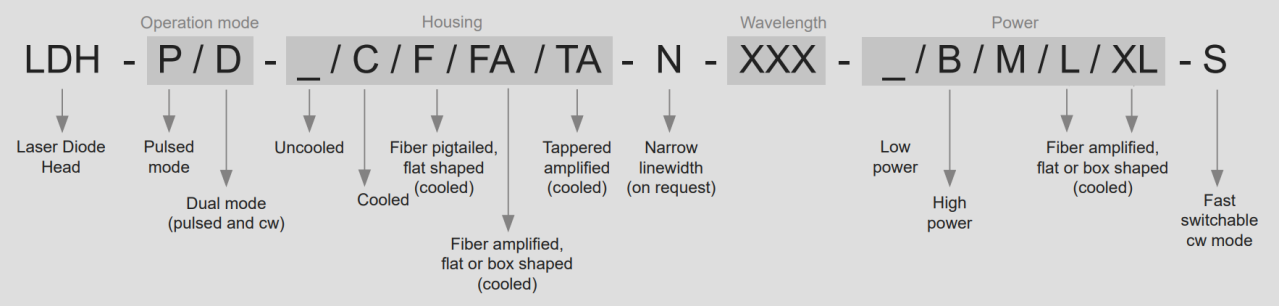


Figure 20: PicoQuant laser head naming convention

12.4 Overview of Laser Warning Labels by Model Type

The table in this section provides an overview of laser warning labels by model type. Note that this list ist not exhaustive and encompasses *Sepia PDL 810* compatible laser heads available at the time this manual was released.

Further specifications can be found at:

12.4.1 *LDH* Series

Figure 21: Warning label for LDH lasers with 315-400 nm, P_0 <500 mW

Figure 22: Warning label for LDH lasers with 400-700 nm, P_0 <5 mW

Figure 23: Warning label for LDH lasers with 400-700 nm, P_0 <500 mW

Figure 24: Warning label for LDH lasers with 700-1700 nm, P_0 <500 mW

Figure 25: Warning label for LDH lasers with blank nm, blank mW

Figure 26: Warning labels for Model type LDH-D-TA-532

Figure 27: Warning labels for Model type LDH-D-TA-560

Figure 28: Warning labels for Model type LDH-D-TA-595

12.4.2 *LDH-FA* Series

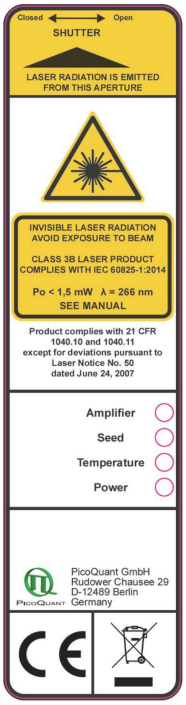


Figure 29: Warning label for Model type LDH-P-FA-266

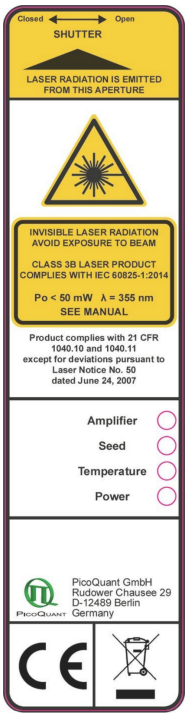


Figure 30: Warning label for Model type LDH-P-FA-355

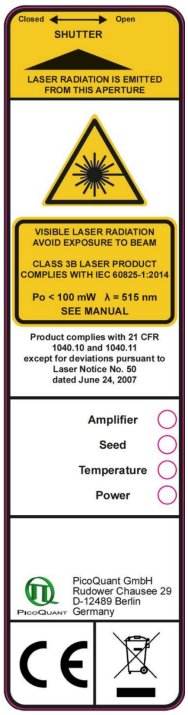


Figure 31: Warning label for Model type LDH-P-FA-515L

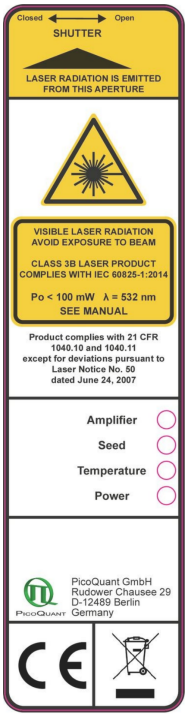


Figure 32: Warning label for Model type LDH-D-FA-530L

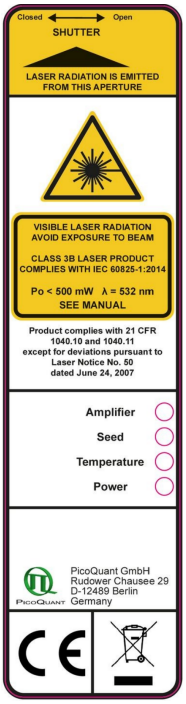


Figure 33: Warning label for Model type LDH-P-FA-530XL

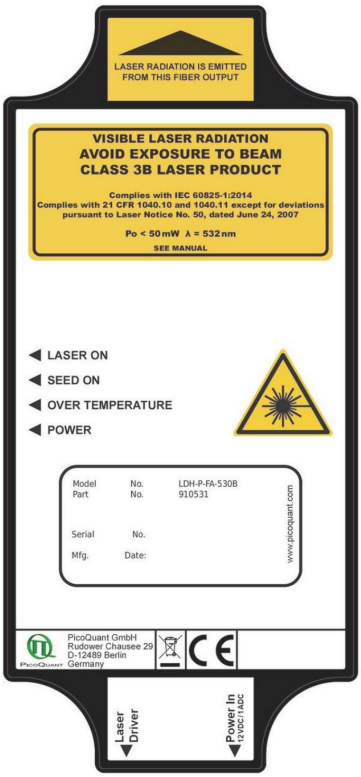


Figure 34: Warning label for Model type LDH-P-FA-530B

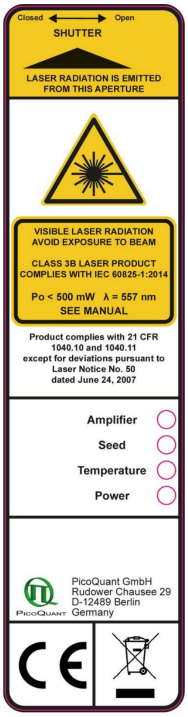


Figure 35: Warning label for Model type LDH-P-FA-560

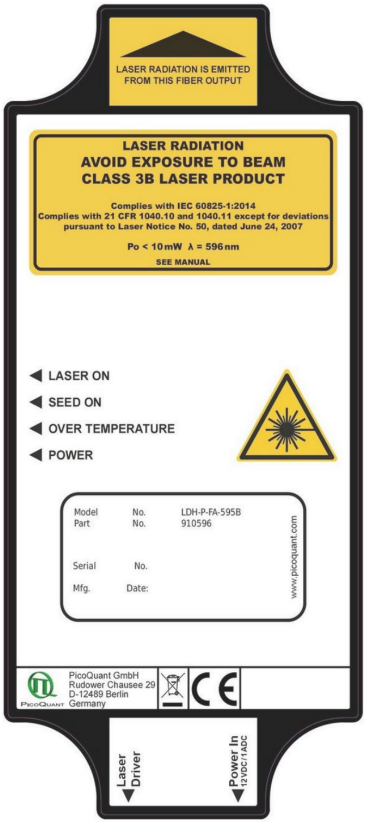


Figure 36: Warning label for Model type LDH-P-FA-595B

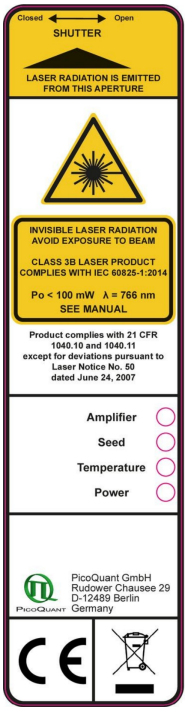


Figure 37: Warning label for Model type LDH-D-FA-765L

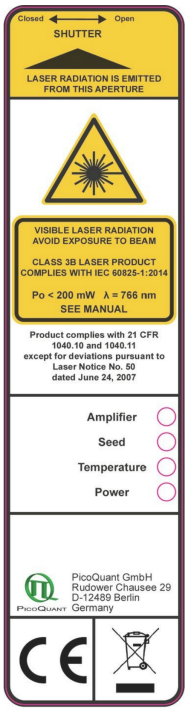


Figure 38: Warning label for Model type LDH-P-FA-765XL

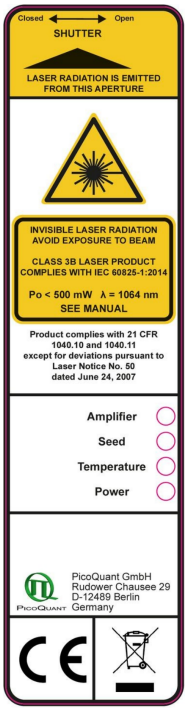


Figure 39: Warning label for Model type LDH-P-FA-1060 and LDH-P-FA-1060XL

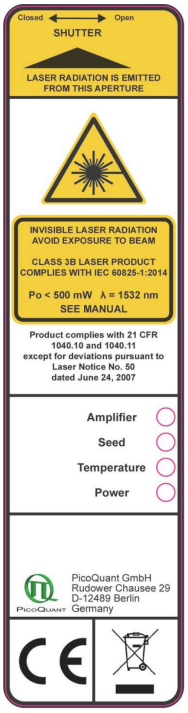


Figure 40: Warning label for Model type LDH-P-FA-1530XL

12.5 Drafts and Dimensions of *LDH* Laser Heads

12.5.1 *LDH* Freespace

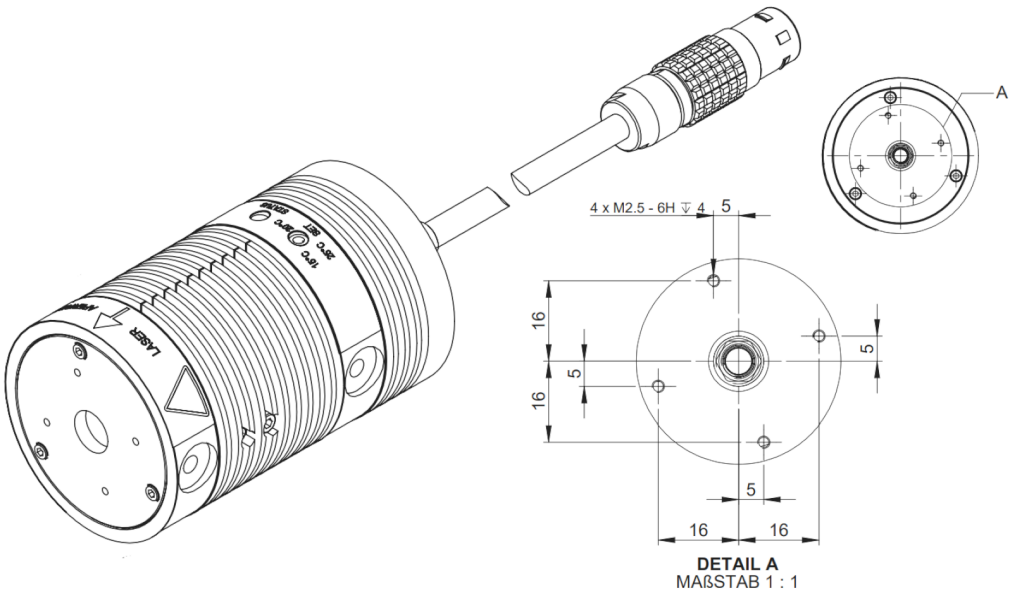


Figure 41: Front view of an freespace LDH laser head

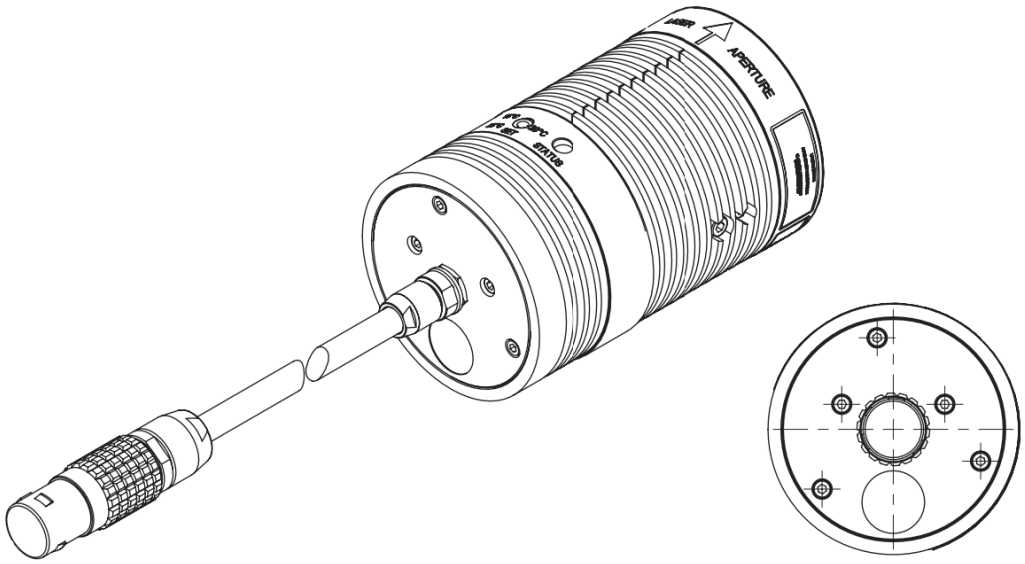


Figure 42: Back view of an freespace LDH laser head

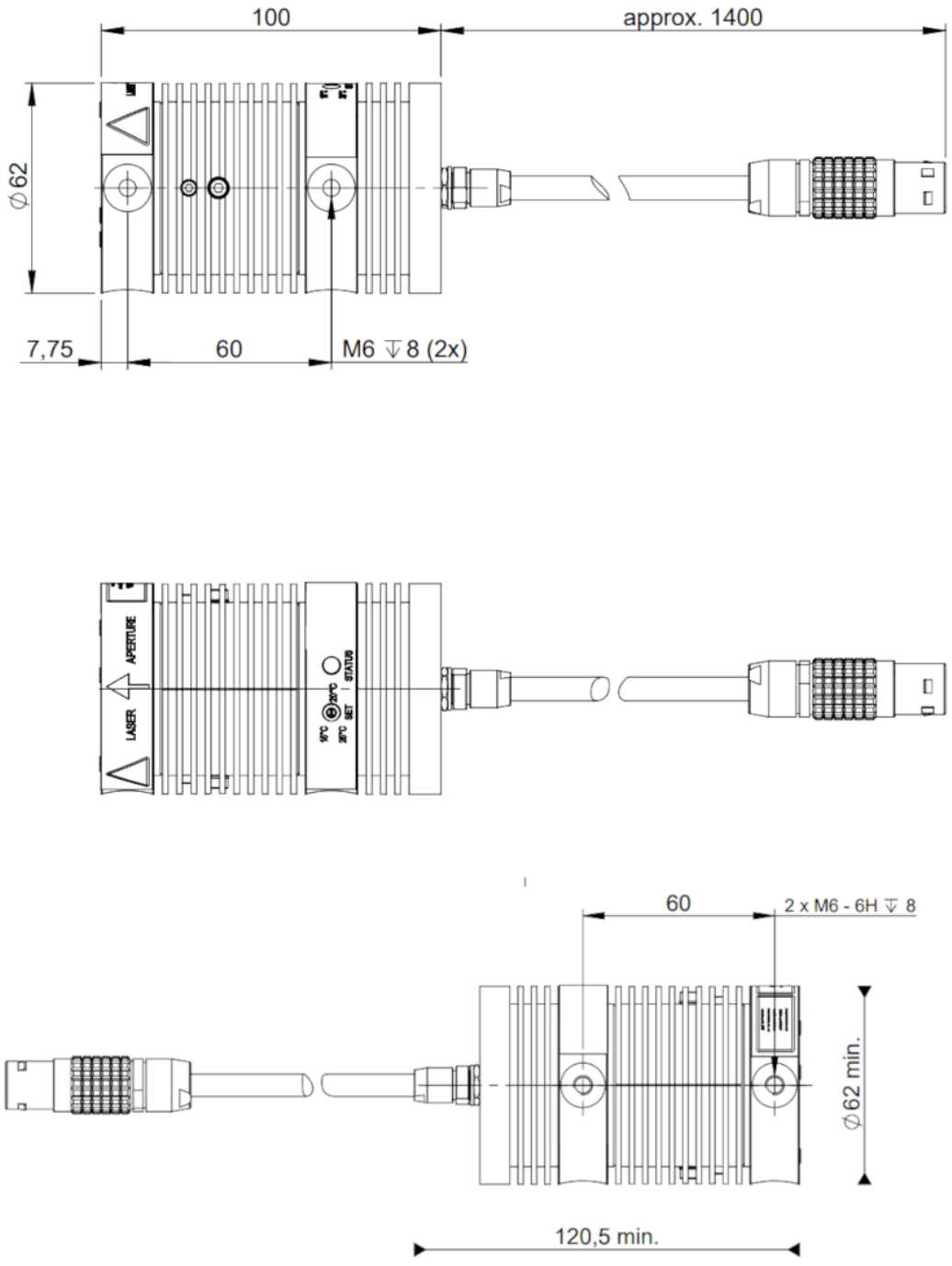


Figure 43: Dimensions of an freespace LDH laser head

12.5.2 *LDH* with Mounting Plate and Fiber Cable

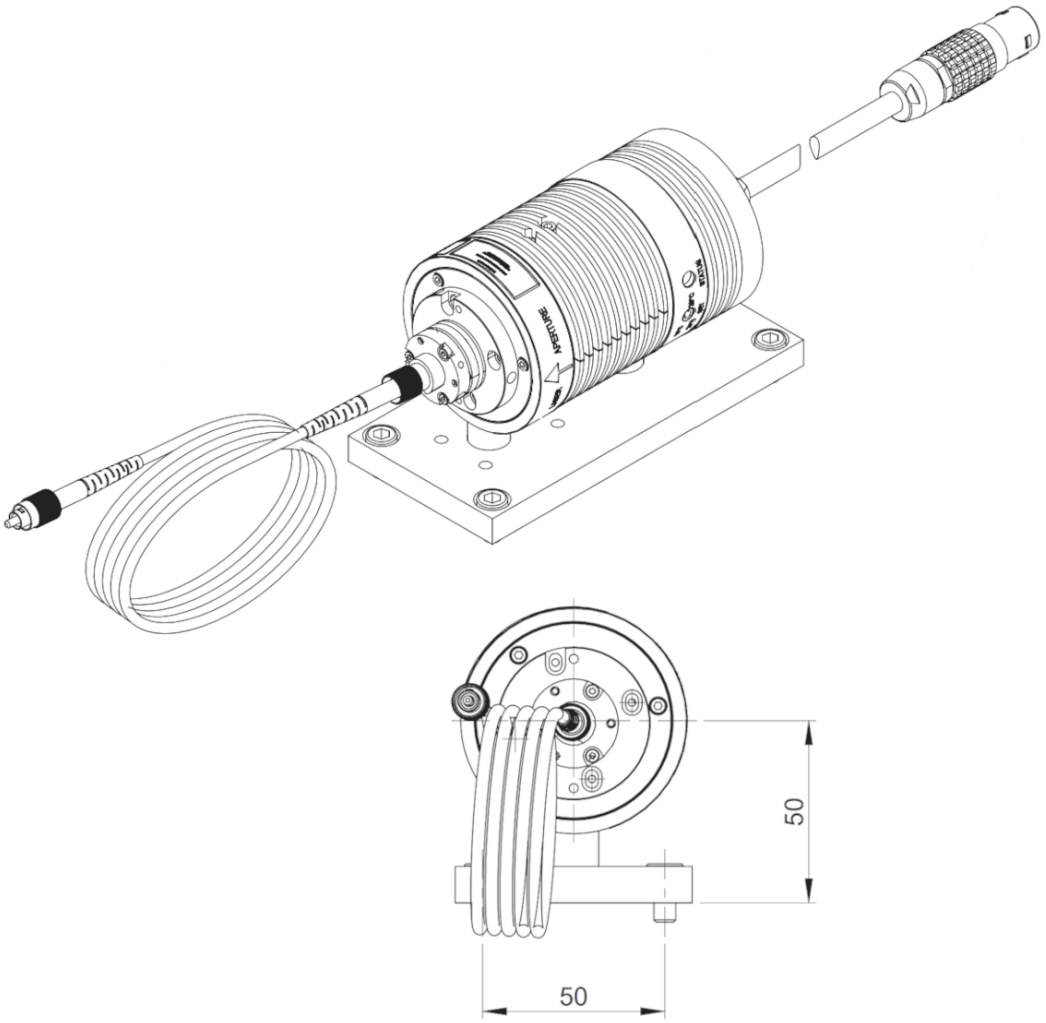


Figure 44: Front view of an LDH laser head with mounting plate and fiber cable

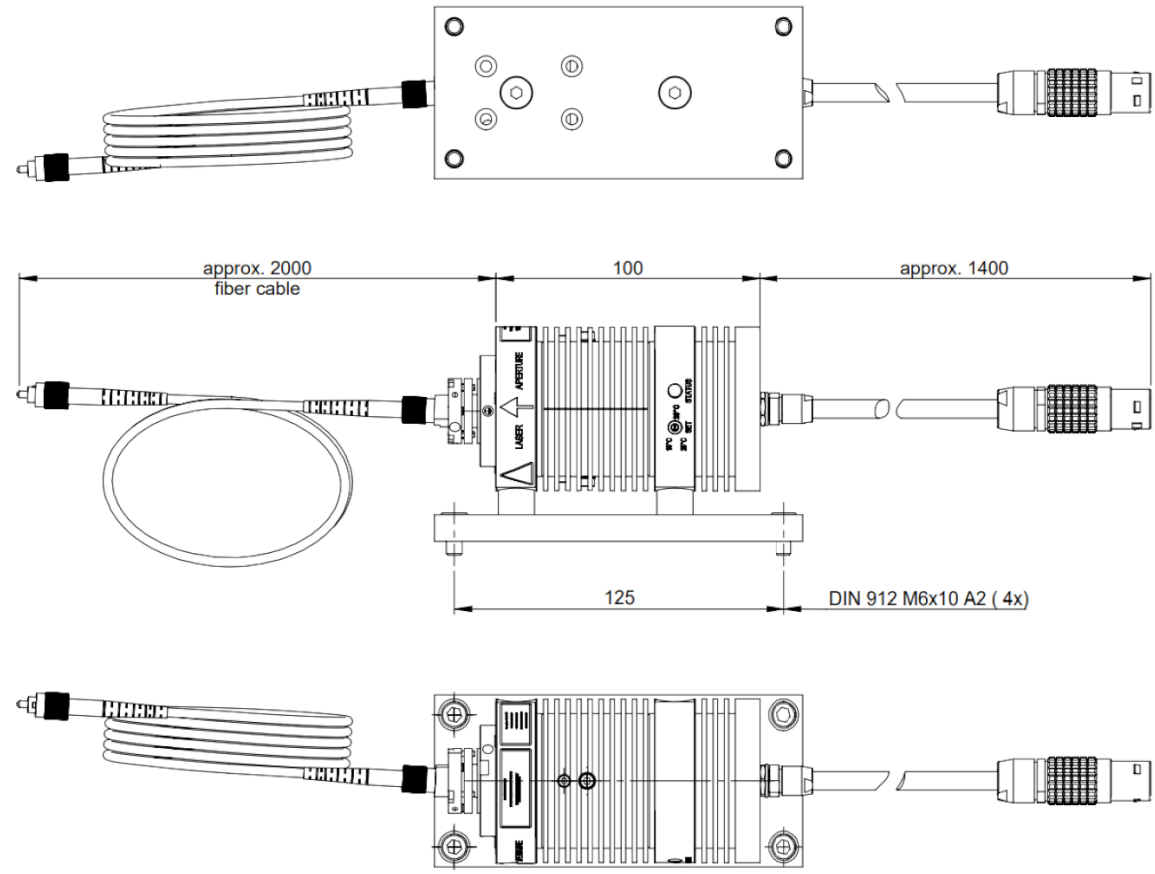


Figure 45: Dimensions of an LDH laser head with mounting plate and fiber cable

12.5.3 *LDH* with Mounting Plate and Filter Holder

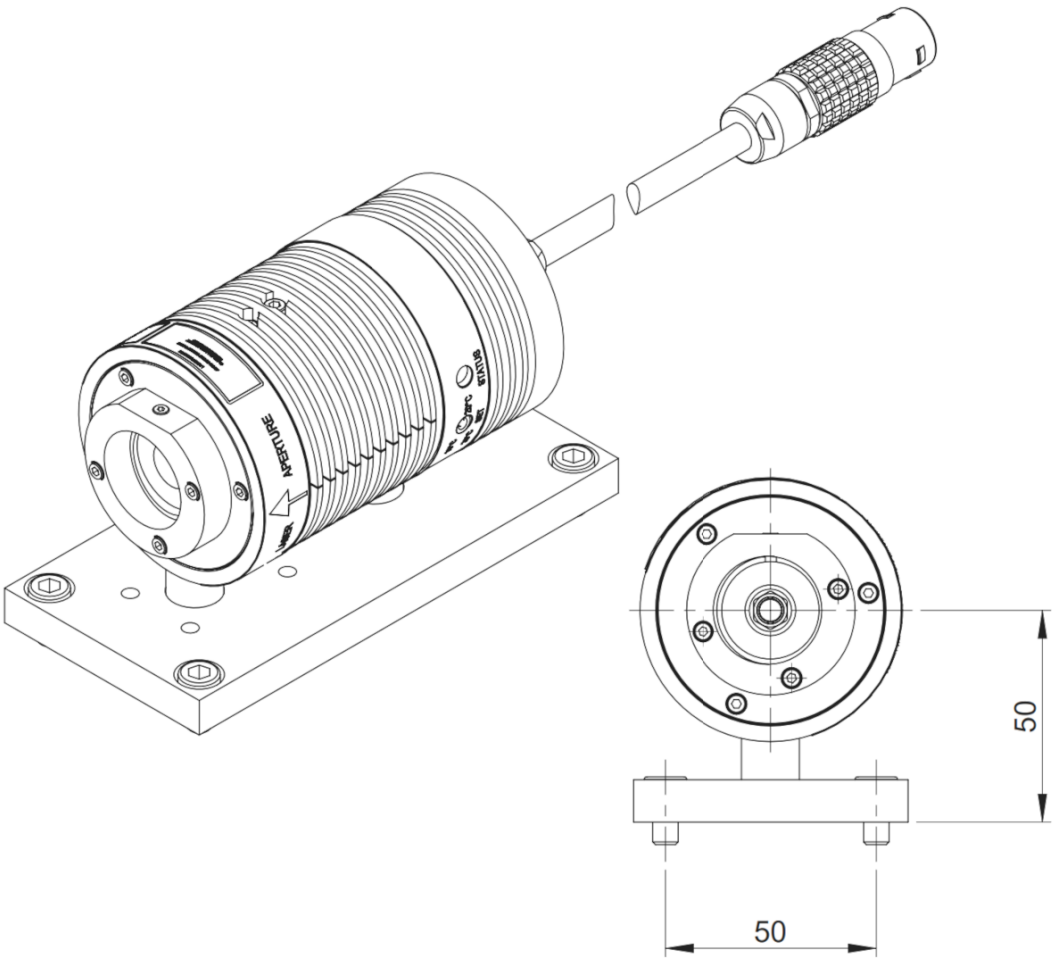


Figure 46: Front view of an LDH laser head with mounting plate and filter holder

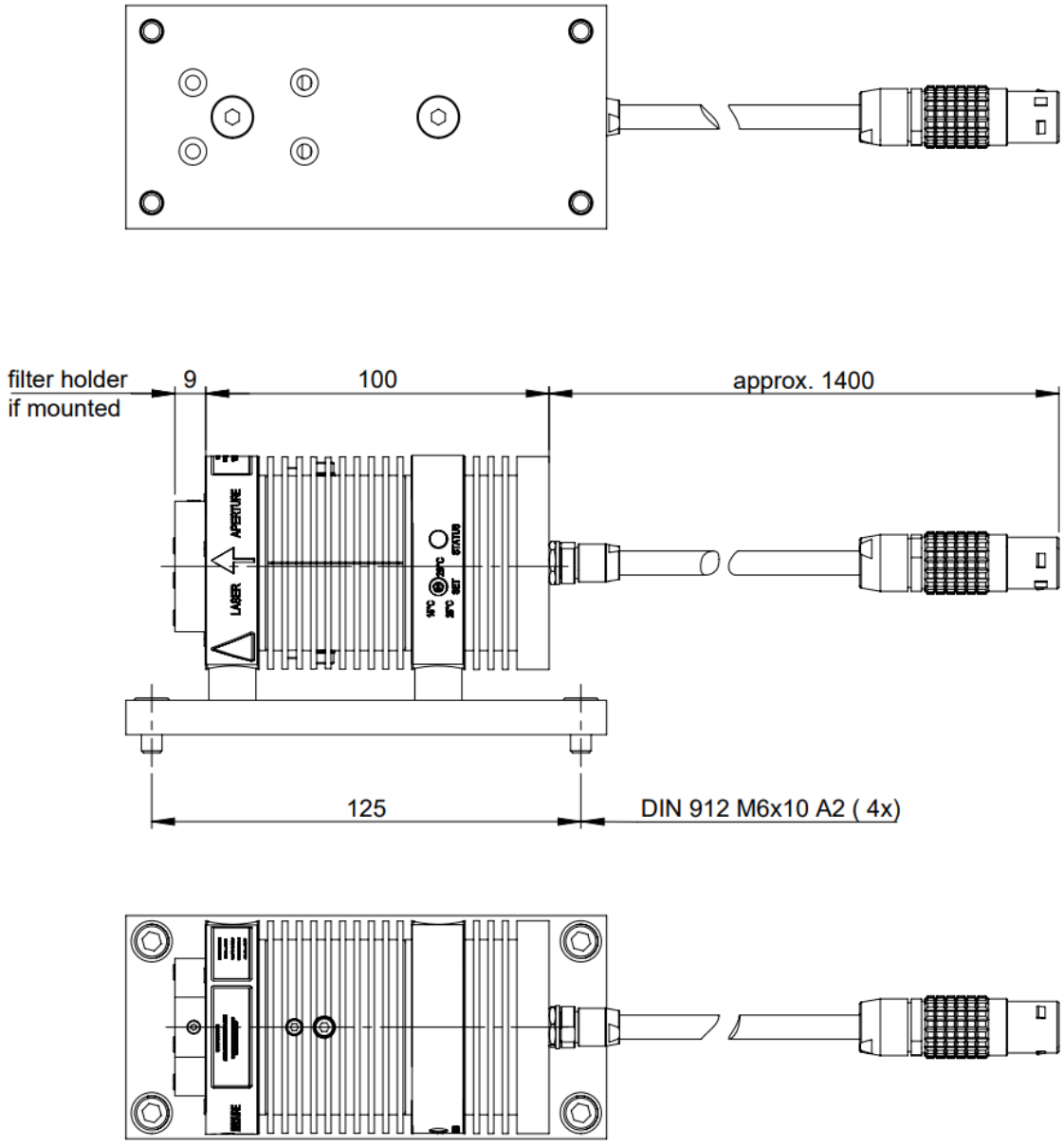


Figure 47: Dimensions of an LDH laser head with mounting plate and filter holder

12.6 Drafts and Dimensions of *LDH-FA* Laser Heads

12.6.1 Overview of Dimensions by Model Type

LDH-P-FA-...	**Dimensions (l × w × h)**
530B / 595B / 765B / 775B / 1030 / 1060 / 1530	(200 × 100 × 35) mm (without fiber)
515L / 530L / 530XL / 1060XL / 1530XL	(214 × 74 × 100) mm
560 / 765L / 765XL	(223 × 74 × 100) mm
266 / 355	(272.6 × 74 × 100) mm (incl. clean-up filter)

12.6.2 *LDH-FA* with Flat Housing and Fiber

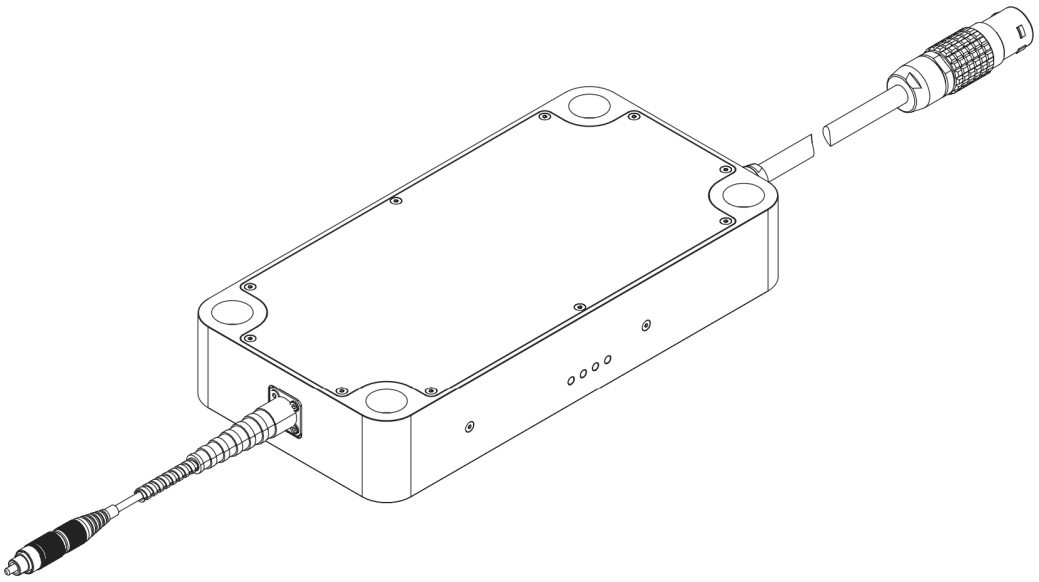


Figure 48: Front view of an LDH-FA laser head with flat housing and fiber

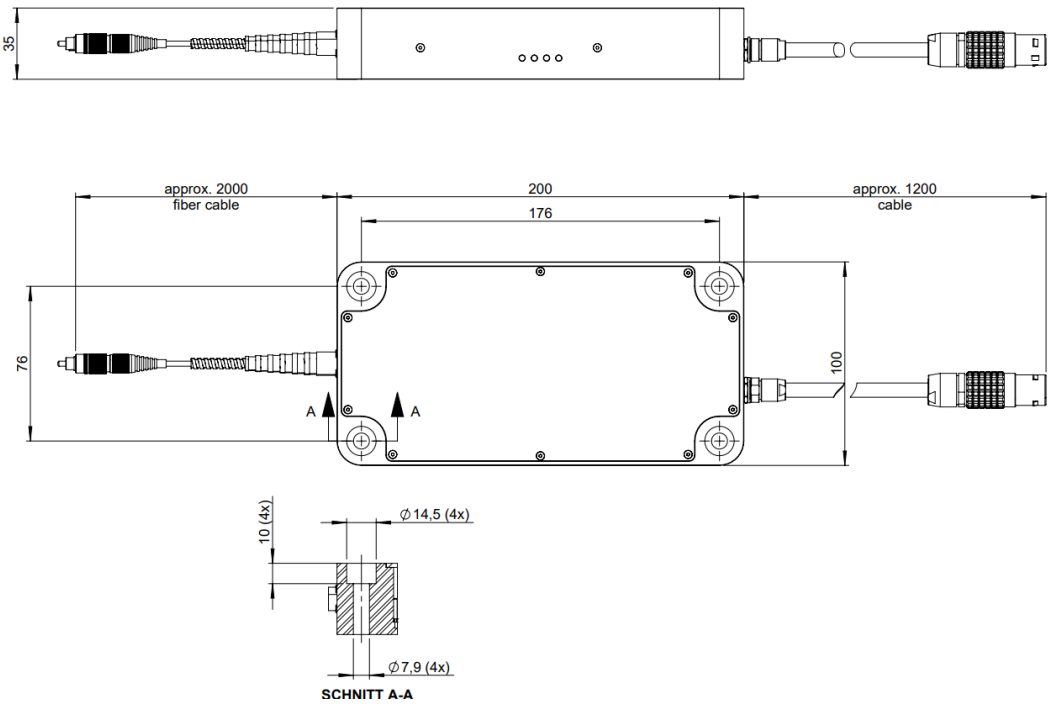


Figure 49: Dimensions of an LDH-FA laser head with flat housing and fiber

12.6.3 *LDH-FA* with Bulk Housing and Fiber

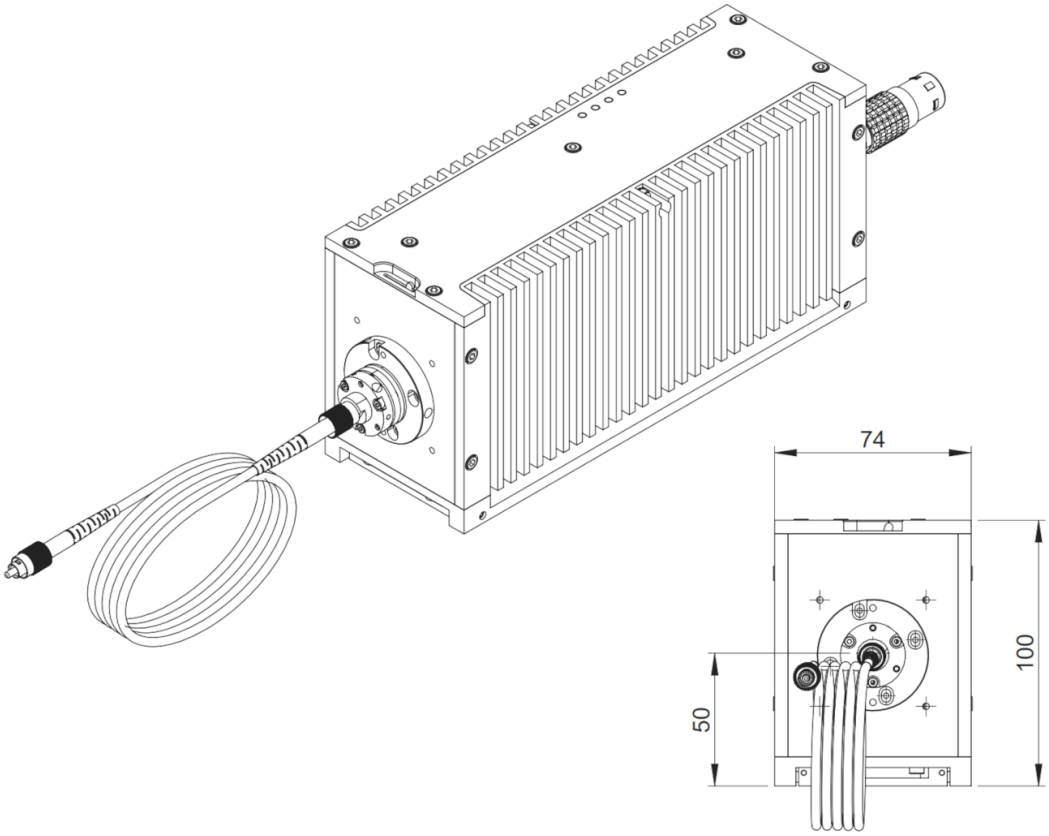


Figure 50: Front view of an LDH-FA laser head with bulk housing and fiber

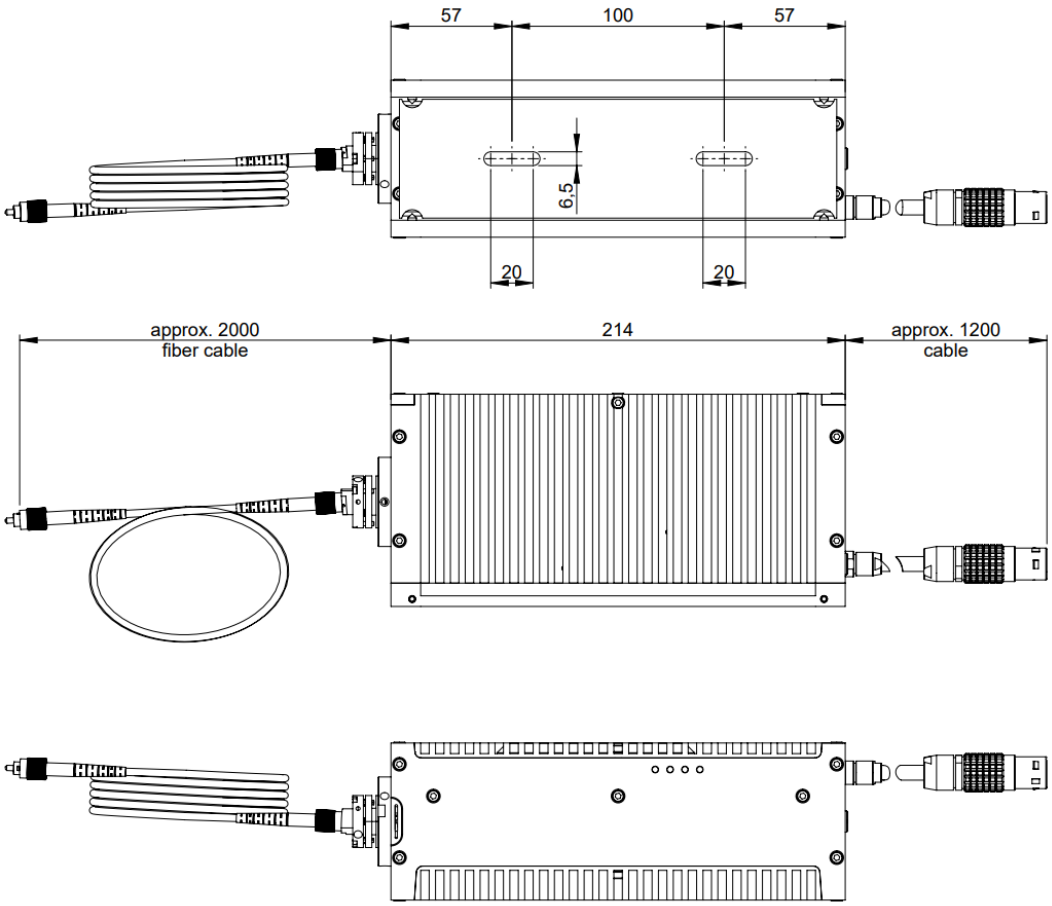


Figure 51: Dimensions of an LDH-FA laser head with bulk housing and fiber

12.6.4 *LDH-FA* with Bulk Housing, Freespace

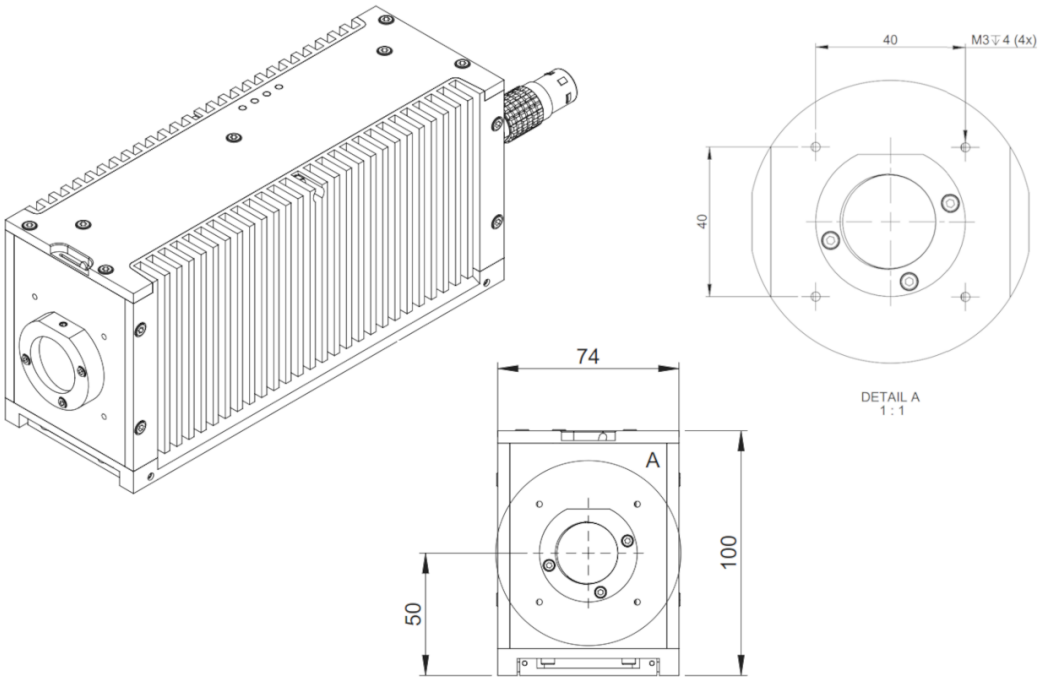


Figure 52: Front view of an freespace LDH-FA laser head with bulk housing

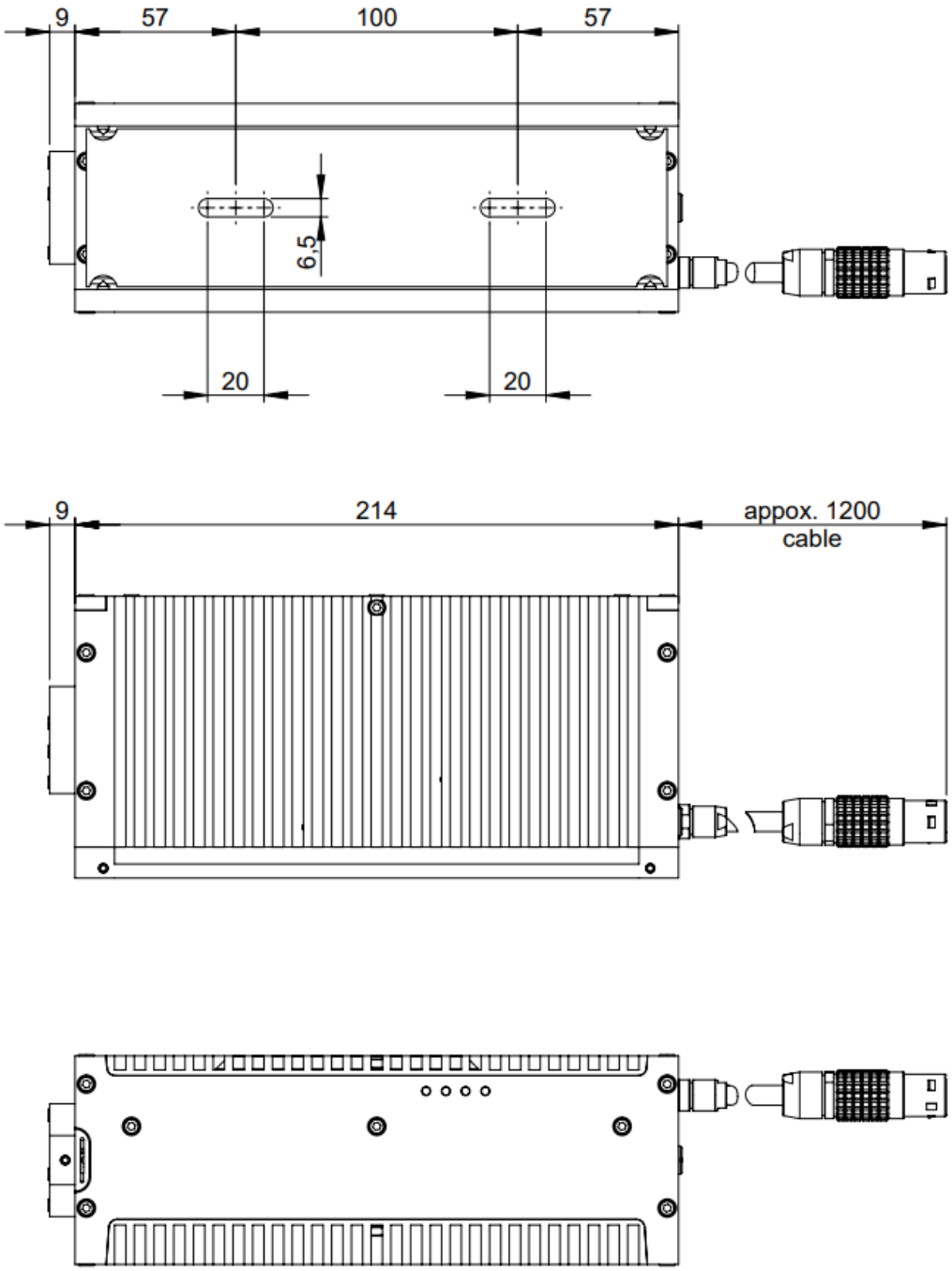


Figure 53: Dimensions of an freespace LDH-FA laser head with bulk housing

12.6.5 *LDH-FA* with Clean-Up Filter

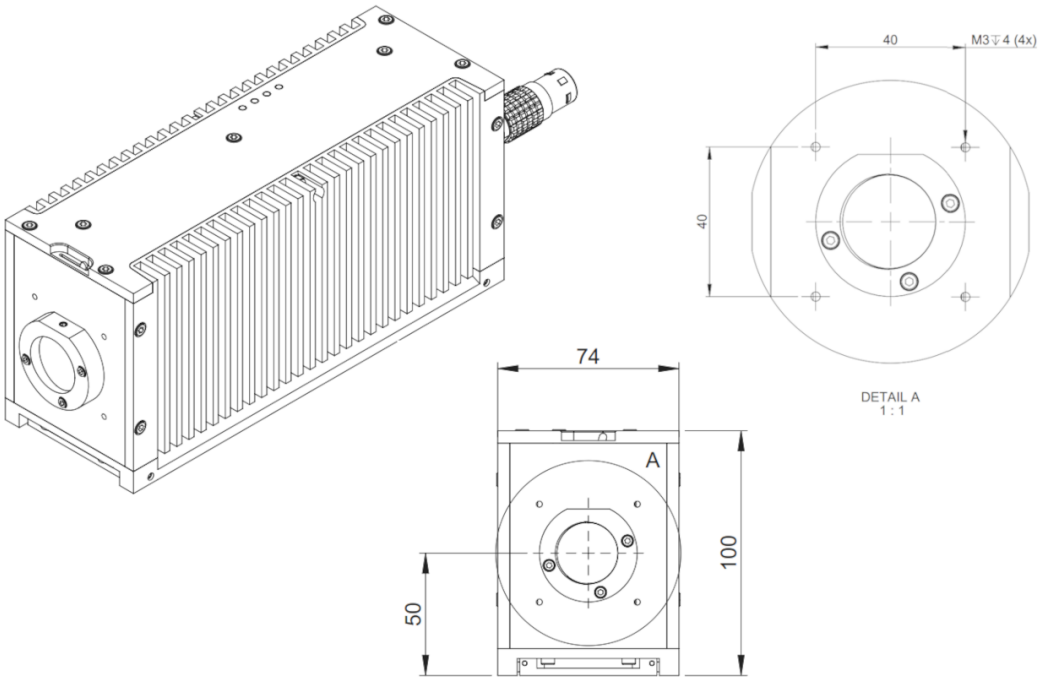


Figure 54: Front view of an freespace LDH-FA laser head with bulk housing and cleanup-filter

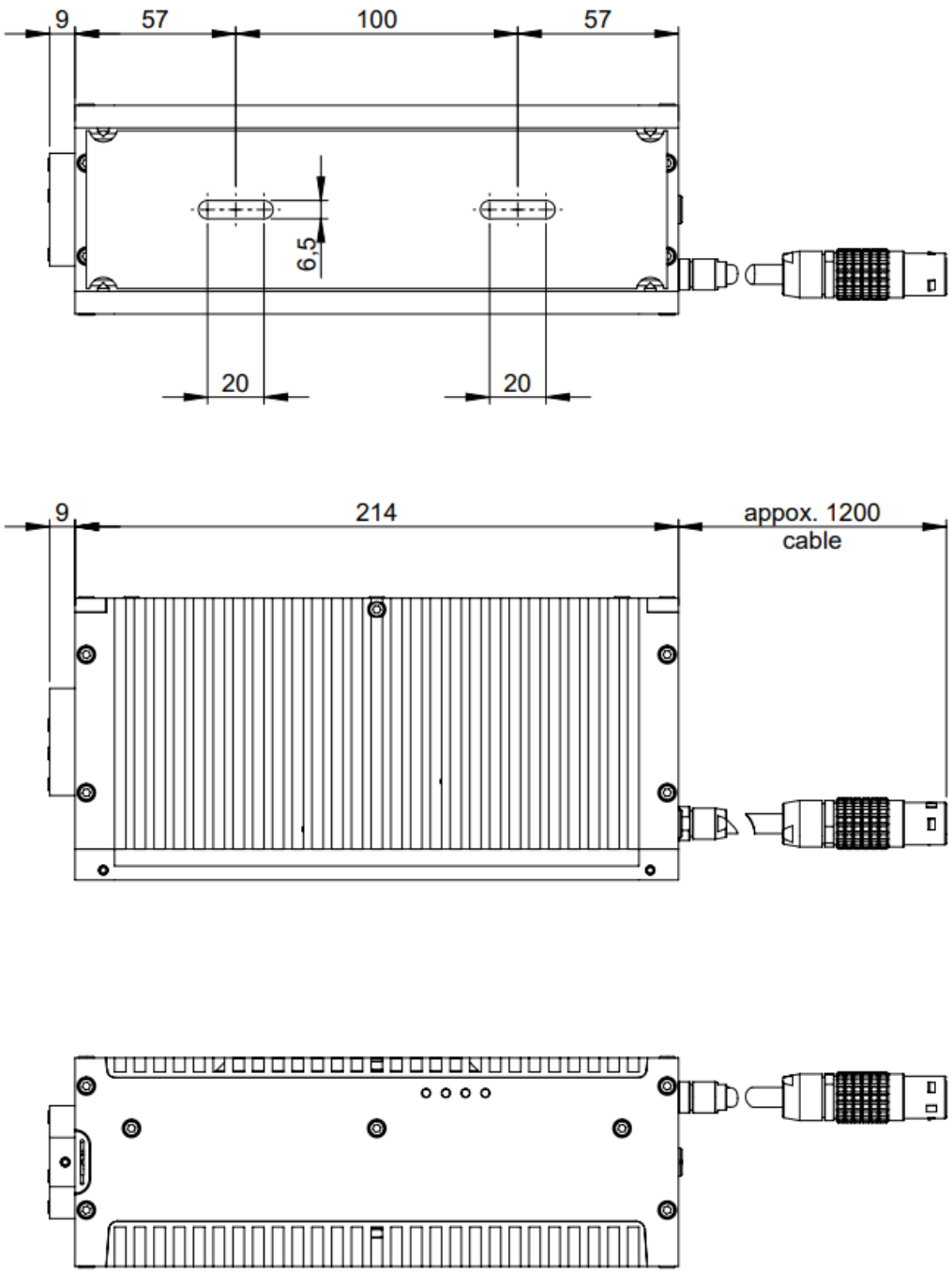


Figure 55: Dimensions of an freespace LDH-FA laser head with bulk housing and cleanup-filter

12.7 Draft and Dimensions of *PLS* LEDs, Freespace

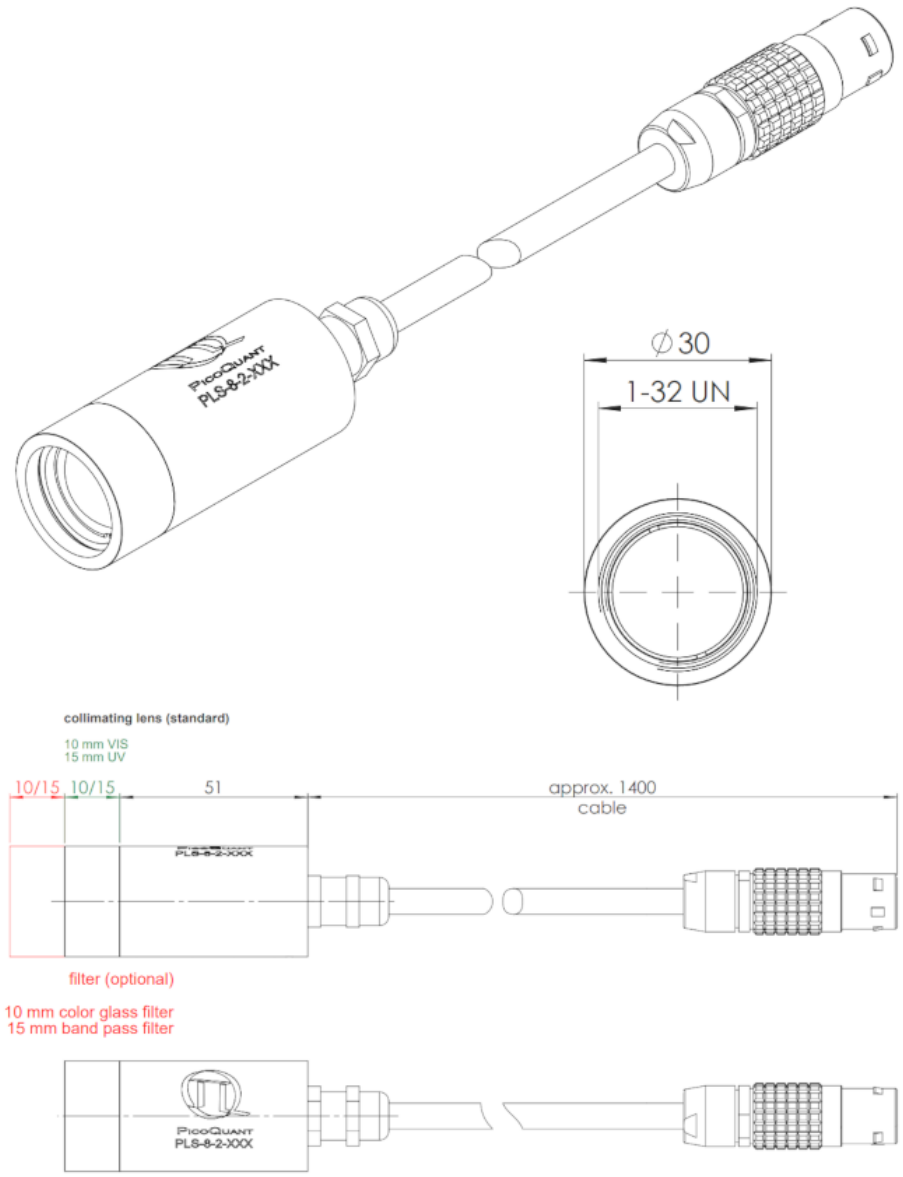


Figure 56: Draft and dimensions of freespace PLS LEDs

All information given here is reliable to our best knowledge. However, no responsibility is assumed for possible inaccuracies or omissions. Specifications and external appearances are subject to change without notice.

PicoQuant GmbH
Rudower Chaussee 29 (IGZ)
12489 Berlin
Germany

P +49-(0)30-1208820-0
F +49-(0)30-1208820-90
info@picoquant.com
www.picoquant.com

