

Prima

**3-Color Picosecond Pulsed, CW and fast switched laser
with variable operating wavelength**



PicoQuant GmbH

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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.
	Indicate a hazardous situation which, if not avoided, could result in minor or moderate injury.
	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



To avoid electric shock, the power cord's protective grounding conductor must be connected to the ground. This device contains no user serviceable components. Do not remove covers! Servicing of internal components is restricted to qualified personnel.

Only use dedicated power supply.



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

1.3 Laser Safety Instructions



Class 3B Laser - visible and invisible laser radiation

Avoid exposure to beam

The *PRIMA* can be equipped with laser diodes that can emit visible, infrared, or UV light. Infrared or UV light is not visible to the eye! The *PRIMA* laser module can emit laser light of up to class 3b / IIIB. Please refer to the labels affixed to the laser for information on classification.

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 *PRIMA* laser products 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 lasers 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 (according to the standard IEC/EN 60825-1: "Safety of laser products, Part 1: Classification of systems, requirements and user guidelines" and the respective national regulations).
- When using lasers of class 3B/IIIB, it is required to wear special eye protection (laser safety goggles).
- The room in which the system is installed must be labeled as a laser area.

⚠ 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 laser unit. Observe all safety precautions relevant to Class 3b / IIIb lasers.

1.4 Laser Safety Labels

On the Laser Device

The safety labels are affixed to the top and side of the laser module housing, with an arrow pointing towards the laser emission aperture (highlighted by red boxes in Fig. 1). The label states the laser product classification, certification, power, and wavelength range relevant for the classification.

Please refer to the *laser delivery report* provided with each ordered laser for information on the central emission wavelengths, maximum achievable optical output powers and pulse shapes of your *PRIMA* laser module.

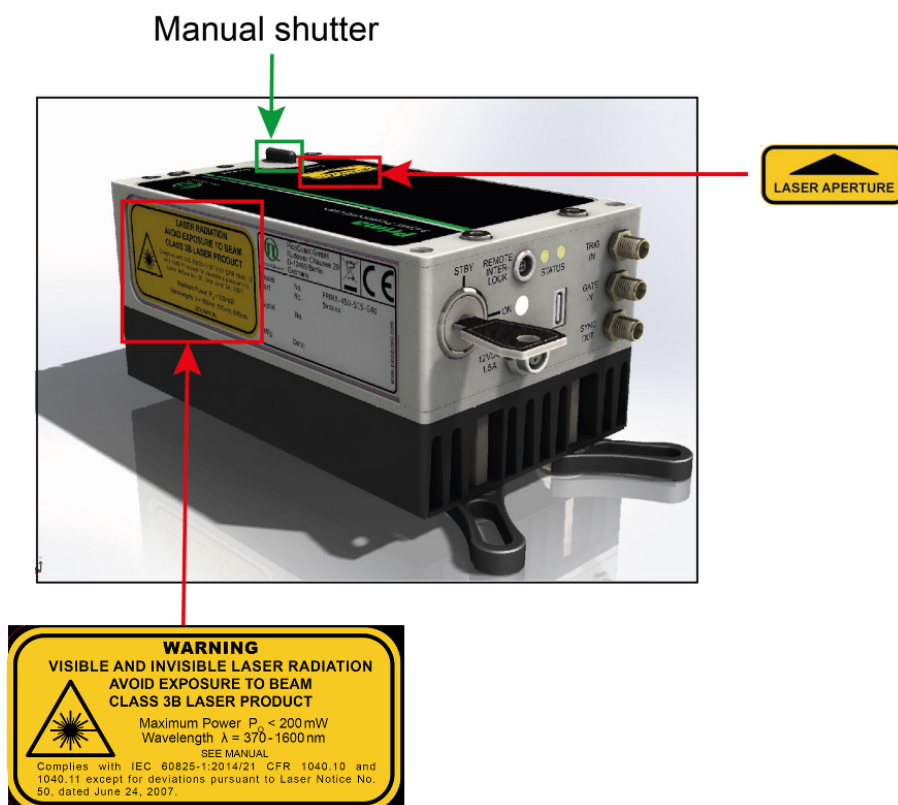


Figure 1: Laser warning label, laser aperture label, and manual shutter as well as their location on the PRIMA laser module housing.

⚠ WARNING

For information on the wavelength and optical power for selecting the correct eye protection, see product label or laser delivery report!

The PRIMA also features a manually operated mechanical shutter (highlighted by a green box in Fig. 1). The shutter is operated by turning the black lever into the desired position:

- If the lever points towards the setting **CLOSED**, then laser emission is mechanically **blocked**.
- If the lever points towards the setting **OPEN**, then laser emission is **not blocked** by the shutter.

⚠ WARNING

Laser light can be emitted from the aperture when the shutter is open. Ensure that all applicable laser safety measures are observed before opening the mechanical shutter.

NOTICE

If the serial number is not legible, it can be read out using software.

1.5 Remote Interlock Connector

PRIMA has a remote interlock connector on the side of the interface 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 *PRIMA* will resume laser emission as soon as the remote interlock circuit is closed or once power is restored after a power loss. An open interlock circuit (or activated Soft Lock) is indicated by white blinking "ON" LED.

The remote interlock connector (LEMO connector) is located on the interface panel as shown in Fig. 2.

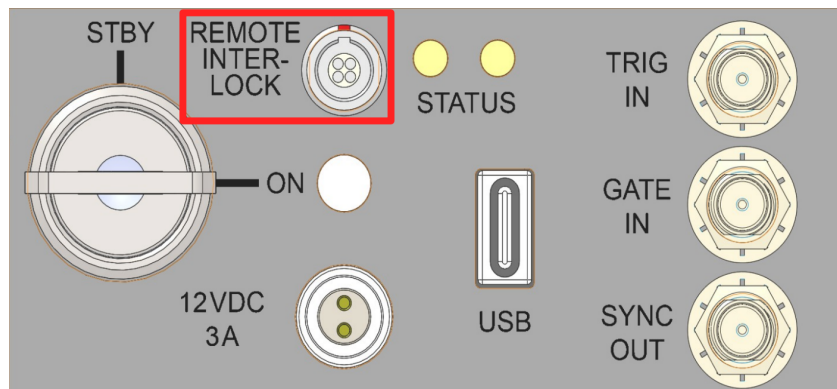


Figure 2: Location of the remote interlock connector (highlighted with a red box) on the interface panel of the *PRIMA*.

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. 3. In order to activate laser emission, **pins 2 and 3** need to be bridged using a suitable adapter.

Do **NOT** apply any voltage.

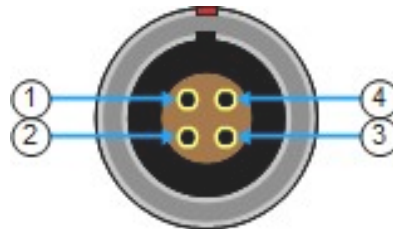


Figure 3: remote interlock connector

⚠ 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.

2. Introduction

PRIMA is a compact, stand-alone, and affordable laser module offering up to 3 individual emission wavelengths that can be operated in picosecond pulsed, nanosecond pulsed, and continuous wave (CW) mode.

The picosecond pulses can be triggered either by the module's internal clock or by an external oscillator at up to 200 MHz. The module is fully computer controlled, making its operation very easy: Connect *PRIMA* to a PC via an USB port and all changes in operation parameters can be done via a convenient software interface.

Red, green, blue, and beyond: three commonly used wavelengths

PRIMA provides laser light at three wavelengths commonly used in materials science, chemistry, and life science for routine excitation in spectroscopy or microscopy applications to study a wide range of samples, including novel nanomaterials, quantum dots, molecules, and fluorophores.

PRIMA is the perfect tool: Capable of covering most of your needs when it comes to daily lab tasks, such as lifetime or quantum yield measurements, photoluminescence, and fluorescence.

Each wavelength can be operated individually, one at a time. The *PRIMA* can be equipped with different wavelength combinations, ranging from UV to NIR.

Pulsed, CW and fast switched emission modes

No matter what type of operation mode you need, *PRIMA* offers full flexibility and enables time-resolved or steady-state measurements as well as the use of the fast CW switching capability. Two picosecond pulsed modes can be driven either internally at selected repetition rates between 1 kHz to 200 MHz or externally at rates from single shot up to 200 MHz. Four nanosecond pulsed modes are limited to 100 MHz. CW emission can be either controlled via *GATE IN* or via the module's free running burst generator for pulse lengths from 10 ns to 1 ms.

Each wavelength can achieve an average pulsed optical output power of typically 5-10 mW depending on the wavelength. In CW mode, higher average power (up to 50 mW) can be reached for each individual wavelength. Switching the CW emission between the ON and OFF states has a rise/fall time of less than 3 ns.

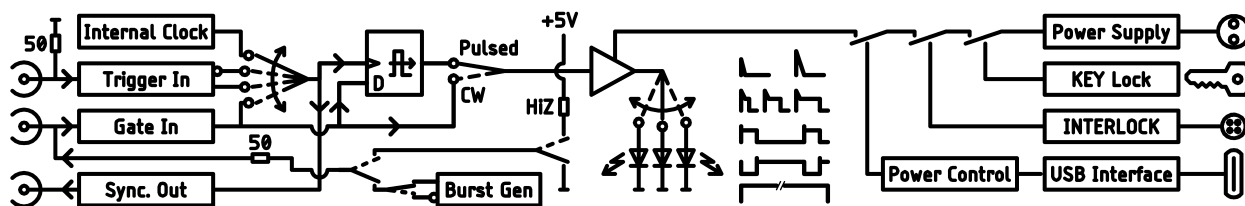


Figure 4: Simplified schematic of the PRIMA

While constant repetition rates can be set internally, burst excitation patterns can be triggered by a suitable trigger source (such as the oscillator module of PicoQuant's Sepia PDL 828). You can even combine *PRIMA* with other laser diode heads to create even more sophisticated excitation patterns, including not only bursts, but also Pulsed Interleaved Excitation (PIE) or Alternative Laser Excitation (ALEX). This makes *PRIMA* a versatile tool that can be used in many environments.

Easy to use

Being a stand-alone module, *PRIMA* does not require any additional laser driver. The settings and operating parameters are fully computer controlled via an intuitive control software based on the well-known Sepia graphical user interface.

3. Hardware Description

3.1 Interface panel

NOTICE

The interface panel does not feature any manual controls for setting the operating parameters (e.g., intensity, repetition rate, trigger source selection) of the *PRIMA*. These settings must be made via a Graphical User Interface (GUI), see section 5.2 for more details.

However, the laser device can also be used without being connected to a PC. The *PRIMA* will then operate with the last set of operating parameters stored in its memory.

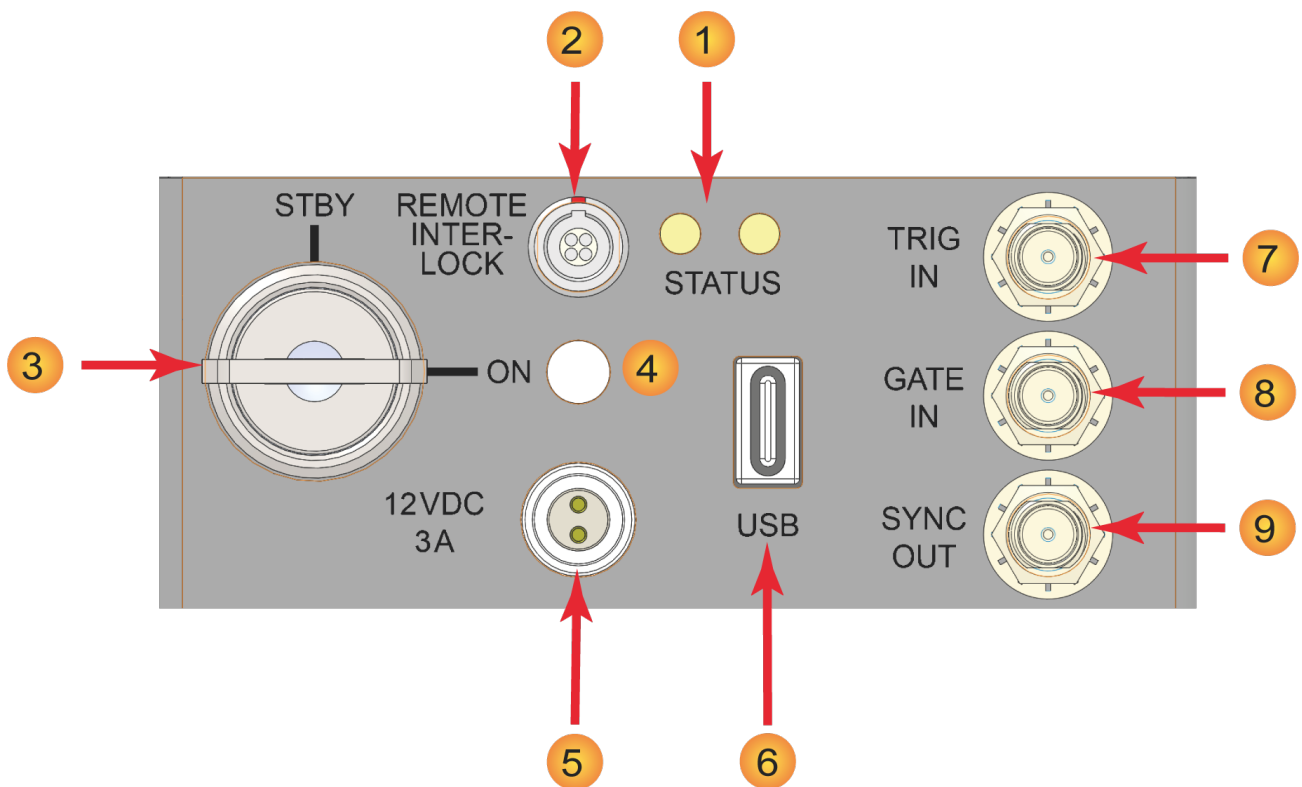


Figure 5: Interface Panel

1

Status indicators. These two LEDs provide information about the general operation status (left LED) as well as the emission mode and trigger status (right LED).

Left LED (status indicator):

When the *PRIMA* is powered on, this LED lights up orange and starts flashing orange and then green after a few seconds. After approximately 15 seconds, this indicator should permanently show green.

If the status indicator shows red for more than 2 seconds, an internal error occurred. The exact nature of the error can be read out via the software API. Please refer to the *PQLaserDrv API Manual* for more details.

Right LED (emission mode and trigger status indicator):

This indicator lights up blue when the *PRIMA* is operating in picosecond pulsed mode, light blue when it is operating in nanosecond pulsed mode and orange when it is running in CW mode.

If the *PRIMA* is operated at either very low repetition rates, long gating periods, or with an invalid trigger level, the indicator will turn off after about 100 ms until the next event switches the LED back on.

This right LED will only be lit when a valid trigger signal (either internal or external) is present, regardless of the position of the key switch.

2

REMOTE INTERLOCK socket for remote interlock connector (see section 1.5).

3

Key switch (laser switch):

Turning the key to the *ON* position activates the laser. Power to the laser can be locked off by turning the key to the *STBY* position and removing the key.

4

Laser emission indicator:

The behavior of the LED and the associated different laser states are summarized in the following table:

LED behavior	Laser emission state	Condition
constant OFF	No laser emission	Power supply not connected
constant BLINKING with 0.3sec, color: dark white	No laser emission but ready to emit	Key switch = STBY and/or interlock not connected (resumes emission automatically when interlock is connected)
constant ON, color: bright white	Laser active	Key switch = ON and interlock connected

-
- 5 Main **POWER** input socket for the power supply.
-
- 6 **USB-C** connector to interface the *PRIMA* with the PC.
Changing the operating parameters of the *PRIMA* requires a connection via the USB 2.0 interface to a PC running a compatible software application (e.g., PicoQuant's *PQLaserDrv.exe*).
-
- 7 **TRIGGER IN**: external trigger input with variable trigger threshold (female SMA connector)
-
- 8 **GATE IN**: gating input (female SMA connector)
The gating function affects the triggering mechanism. The gating input accepts TTL pulses and is effective if the *PRIMA* is being triggered either from the internal oscillator or from an external source. The gating function can perform transition between on and off states within nanoseconds. Presuming a precise timing, it can switch between two laser pulses, even at high repetition rates. In **CW mode**, the laser emission follows the gate signal within nanoseconds to execute any arbitrary pulse length.
-
- 9 **SYNC OUT**: Synchronization output connector (female SMA connector)
-

3.2 Laser Locking Behavior

- The key switch 3 interrupts the laser power supply when it is in the vertical position (STBY). The key can only be removed in this position. It's a good practice to keep the key switch locked unless the *PRIMA* can be operated in accordance with the safety regulations.
- The remote interlock 2 shuts the laser power supply off when the loop current is interrupted.
- To comply with laser safety regulations, laser emission is locked off for at least the first 10 seconds after the main power is switched on.
- Laser emission is disabled as long as the *PRIMA* is checking its hardware while powering up.
- The *PRIMA* laser will be locked as soon as it detects abnormal operating conditions. In this case, the left status indicator LED 1 flashes red.
- Losing the trigger signal when the *PRIMA* is triggered externally does NOT activate the hardware lock.
- The controller can be instructed via the GUI or via any software that uses the programming library (API DLL) to hold the laser soft-locked regardless of the position of the key switch. Refer to section 5.2.3 (GUI) and the separate API manual for more information on soft locking.

⚠ WARNING

Soft locking the lasers does not ensure eye safety!

3.3 Optical output

The *PRIMA* features one optical free beam output equipped with a manually controlled laser output shutter.

The laser output can be coupled into either multi mode (MM) or polarization maintaining (PM) single mode fibers, depending on the wavelength configuration.

NOTICE

If a fiber coupler is attached to the output: the fiber type used is indicated in the individual test report.
Do not remove the fiber from the coupling optics, as this will result in the loss of the coupling adjustment! Readjustment is a demanding task and needs experience.

3.4 Product Label

The product label (see Fig. 6) can be found on the side of the *PRIMA* module, next to the laser safety label. It shows all relevant information needed to identify the device, including product name, part number, serial number, manufacturing date as well as the PicoQuant logo with address, CE label, and waste regulation identifier.

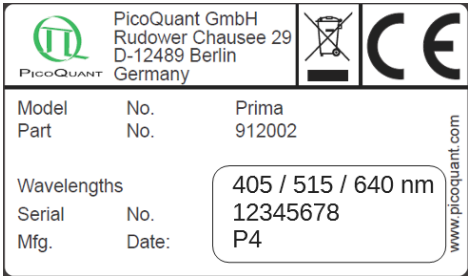


Figure 6: PRIMA product label, example.

This product information must be communicated to PicoQuant in all communication and trouble shooting processes regarding this device.

3.5 Orientation of laser polarization plane

The polarization plane is marked on the front of the laser housing with a round yellow label, as shown in Fig. 7.

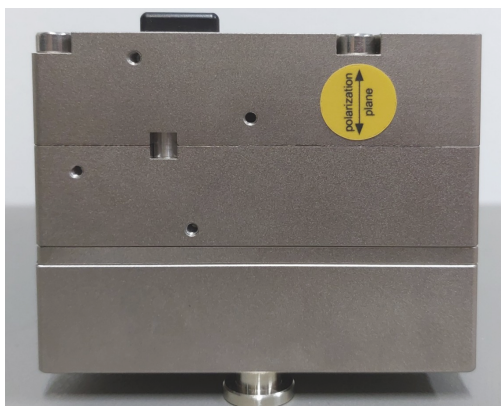


Figure 7: Polarization plane label

NOTICE

It depends on the model whether the polarization plane is horizontal or vertical.

3.6 Cooling Fan – Heat Dissipation

A special design for heat dissipation was required to ensure stable laser emission. The laser module is therefore equipped with cooling fans on the heat sink located at the bottom of the housing. For best laser performance and stability, please ensure free air circulation around the whole laser module. By default, the cooling fans will be running when the *PRIMA* is powered on and **cannot** be switched off during operation.

⚠ CAUTION

Do not block the fan apertures. This might lead to laser instability or damage to the laser module!

NOTICE

A note on vibration-sensitive measurements: In all tests carried out at PicoQuant, there has never been a noticeable influence of fan vibrations on such measurements.

4. Installation

4.1 Scope of Delivery

Your *PRIMA* is delivered with a series of cables and accessories. Start by unpacking the delivery box and check that all components listed in the table below are present.



PRIMA 3-Color Picosecond Laser



2 keys for the laser key switch



*Remote interlock stub plug
(4 pin LEMO plug with green end cap)*



*Cable USB 3.0 C MALE TO
USB 3.0 A MALE (2m, 6.5x ft)*



12V power supply



*The manual and operation software
can be downloaded from our website:
www.picoquant.com/downloads*

4.2 Preparations

Before installing and using the *PRIMA*, please make sure to have

- a solid base onto which the *PRIMA* can be placed (e.g., an optical table)
- a computer to install and run the operating software. The computer needs to have a free USB slot as well as a Windows 10 or 11 operating system.

Ensure that all of the following conditions are met before proceeding with the installation (the numbering refers to the interface panel as shown in Fig. 5):

- Laser key switch **3** is set to the position **STBY** (vertical)
- Green remote interlock stub connector is plugged into the remote interlock socket **2**

4.3 Electrical Power and Signal Connections

- If desired, connect an external trigger signal to the connector labeled **TRIGGER IN** **7**
- If desired, connect the **SYNC OUT** output connector **9** to an external device, e.g., TCSPC electronics from PicoQuant such as the TimeHarp 260, PicoHarp 300, MultiHarp 150, HydraHarp 400, or an oscilloscope.
- Plug the power cable into the **main power socket** **5**, but do not plug the power cable into a power outlet until you have installed the PicoQuant laser driver software (see section 4.4).

4.4 Software Installation

Once the *PRIMA* is in its dedicated place and the relevant cables have been inserted, connect the *PRIMA* to the host computer using the delivered USB-C cable. A USB 2.0 port can be used.

NOTICE

The *PRIMA* should not be powered on before the control software is installed on the host computer!

The control software “PQLaserDrv.exe” for your *PRIMA* 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.

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 *PRIMA* but also the Sepia devices from PicoQuant. In case you need to control multiple lasers, it is necessary to install all relevant components (see the last item in the list above).

- 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 *PRIMA* can be switched on (see chapter 5). When the laser is powered on for the first time, Windows will detect a new device and installs the necessary device drivers.

5. Operation






This section describes in detail step by step how to switch on the *PRIMA* and how to use the GUI to set the various laser module settings (e.g. power intensity, trigger source, repetition rate, fan control).

For optical power detection use a suitable powermeter and pay attention to the wavelength settings.

WARNING

Never look into the laser! Keep in mind, that some wavelengths at the edge of the visible range only appear to have low power for the eyes.




5.1 Powering the system ON

- Ensure that the laser key switch  is set to the **STBY** (vertical) position.
- Ensure that the laser output shutter is closed (see Fig. 1).
- Ensure that the green remote interlock connector is plugged into the remote interlock socket. 
- Connect the external power supply to  and the power outlet to start up the *PRIMA*. The LED labeled **ON**  flashes dark white. The left status indicator LED  lights up orange first, then flashes orange and then green for a few seconds until it lights up green continuously. After about 15 seconds the system is ready for operation.

NOTICE

There is a delay due to software startup. The *PRIMA* remains locked during this time and the **ON** LED flashes dark white.

In order to reach stable output power, please let the *PRIMA* laser warm-up for about five minutes before activating the laser emission via the key switch.

- Turn the key switch  to the **ON** position (horizontal). The LED labeled **ON**  lights up brighter and constantly white. The right status indicator LED  will lights up blue when the *PRIMA* is operating in picosecond pulsed mode, light blue when it is operating in nanosecond pulsed mode and orange when it is running in CW mode.

⚠ WARNING

Before proceeding to the next steps, please make sure that all safety measures have been taken according to chapter 1.3 Laser Safety Instructions.

- Open the laser output shutter.
- Adjust the operating parameters through the appropriate software (e.g., with *PQLaserDrv.exe*).

If you cannot detect a laser beam, please check chapter 3.1, point 1.

Please note, if the GUI setting is set to external triggering but no signal has been applied by the operator, no light will be emitted; the same applies if the gate impedance has not been set correctly.

5.2 Setting Operating Parameters with PQLaserDrv Graphical User Interface

NOTICE

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

The 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 section 4.4).

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

An overview of the GUI with all control elements is shown in Fig. 8 below.

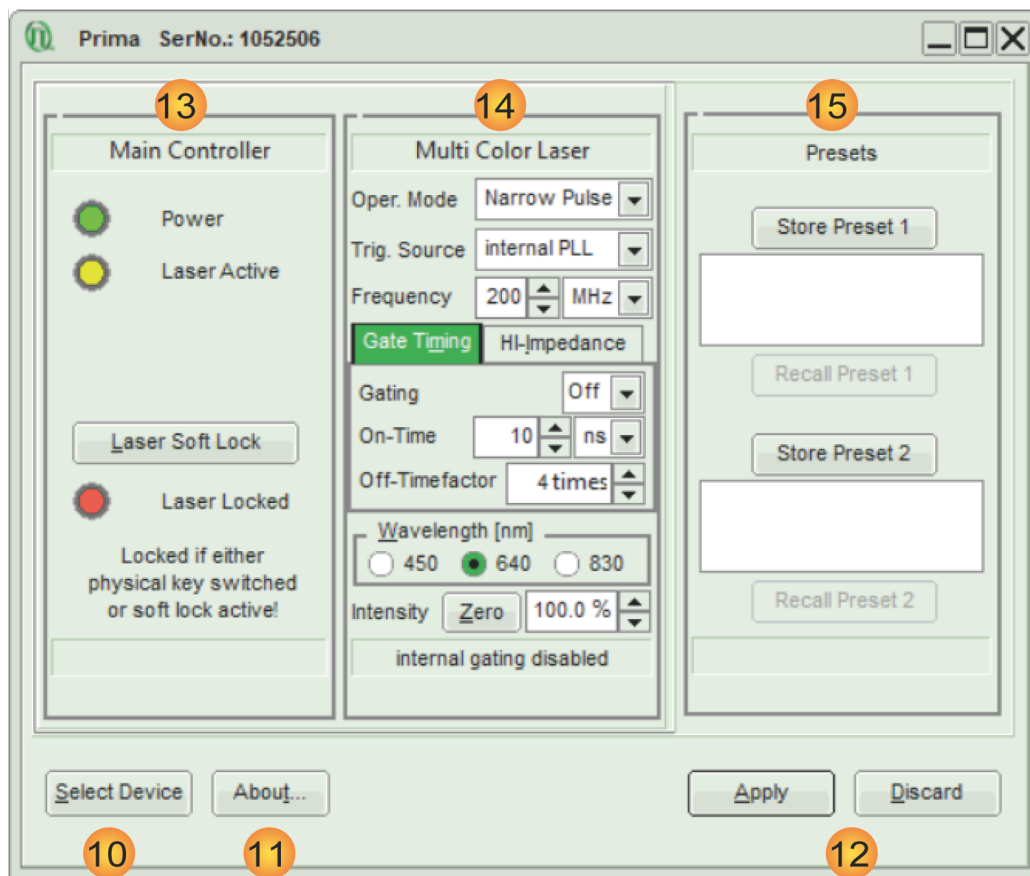


Figure 8: PQLaserDrv GUI with a connected PRIMA
- Overview of all main button and control groups

5.2.1 "Select Device" button

The **Select Device** 10 function is useful if more than one *PRIMA* (or any other USB laser device from PicoQuant) is connected to the same host computer. It can also be used to restore the USB connection to the device if it is interrupted for any reason during operation.

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

A modal dialogue with a **Cancel** and **OK** button presents a list box with the currently connected devices (Fig. 9). When opening the list box, all detected devices are listed by their serial number. The currently selected device is marked with an asterisk “*”.

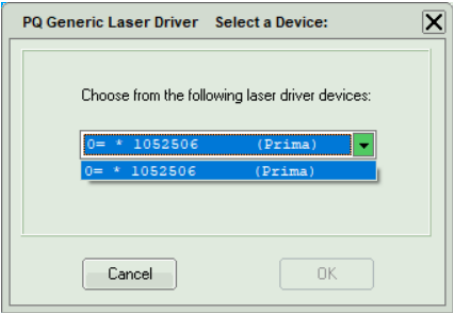


Figure 9: Select device

Cancel	Back to the main window without any changes.
OK	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.

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...** 11 , see Fig. 8.

For every support request its is recommend to save the entire information by clicking on the button labeled **Copy Support Infos** (see Fig. 10), save the information as a plain text file, and send it per mail to **support@picoquant.com**.



Figure 10: 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. 11.

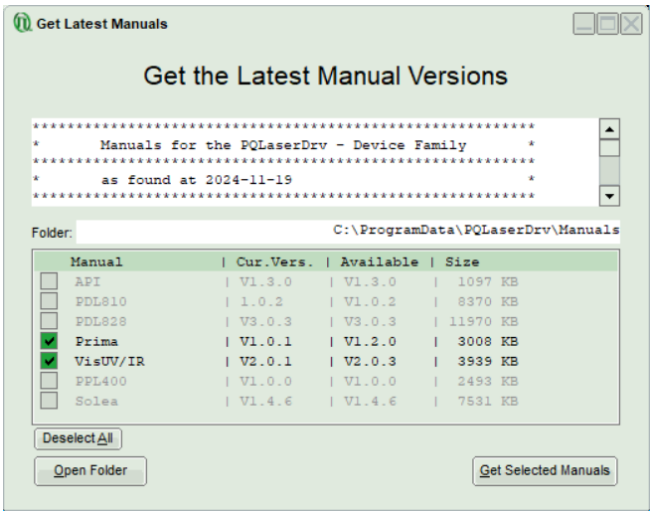


Figure 11: A potential result screen after searching for latest manual versions

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 12 must be used to confirm or discard the configuration changes made in the GUI. The label of any control panel on which changes have been made but not yet committed, will highlighted in orange. These highlights are retained until the changes are either applied or discarded.

5.2.4 "Main Controller" Control Panel - Soft Lock and Unlock of the PRIMA

The PRIMA can be locked (no laser light emission) not only with the hardware key switch 3 on the interface panel, but also via the GUI by clicking on the button labeled **Laser Soft Lock / Laser Soft Unlock** in the Main Controller panel 13 on the left side of the software window.

The mechanism behind the soft lock is similar to that of an interrupt via the interlock loop.

 **WARNING**

Soft locking the laser does not ensure eye safety!

The **Laser Unlocked** state is recognizable in the software by the **Laser Locked** indicator turning dark red (see Fig. 12, left). In addition, the ON LED ④ on the *PRIMA* is blinking dark white if the key switch ③ is in ON-position and the interlock connector ② is not connected, or if the key switch is in STBY-position. If the key switch is in ON-position and the interlock connector is connected, the ON LED ④ lights up bright white constantly.

The **Laser Soft 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 ③ or remote interlock circuit (see Fig. 12, middle), or **Laser Soft Unlock** (see Fig. 12, right) in case the system was soft locked (this even masks a hard lock state).

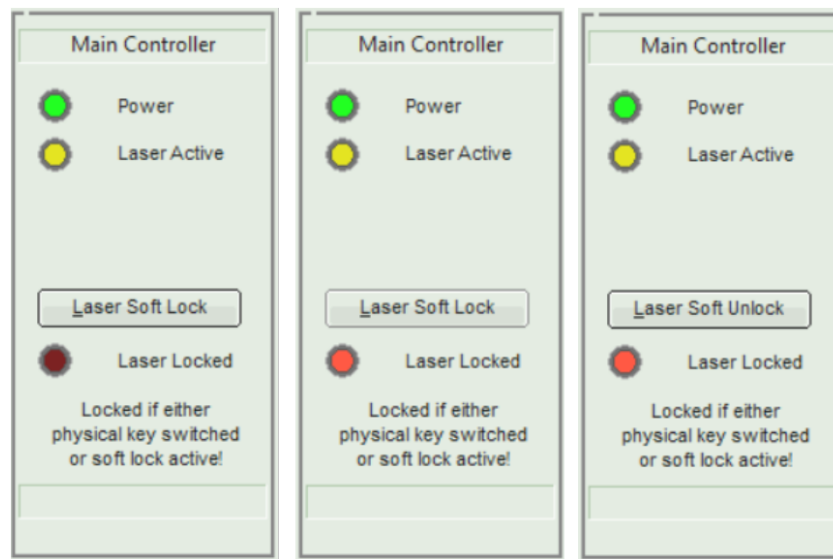


Figure 12: PRIMA locking status indicator in the GUI: laser unlocked (left), laser hard locked via key switch (middle), laser soft locked (right)

NOTICE

The lock state indicated in the GUI may refresh with a slight delay (< 1 s) with respect to the hardware LED on the front panel of the *PRIMA*.

The soft lock state is not persistently stored in the system; it is lost after power down / power up.

⚠ WARNING

Before unlocking the laser, please refer to chapter 1.3 for laser safety instructions.

5.2.5 "Multi Color Laser" Control Panel

Figure 13: shows the laser control elements **Multi Color Laser** 14 available for the *PRIMA*.

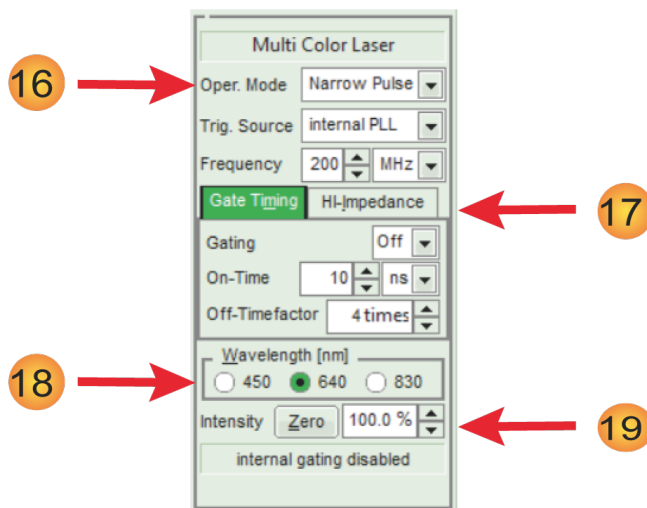


Figure 13: GUI control panel
"Multi Color Laser" for the *PRIMA*

Oper. Mode: 16

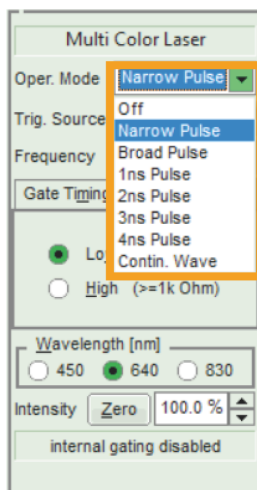


Figure 14: list of operation modes
under selection box "Oper. Mode"

Use the top selection box to choose the operation mode for the *PRIMA*. Note that the control elements located just below from the mode selection box will change depending on the chosen operation mode.

The following operation modes are available for the *PRIMA*:

- **Off**: Selecting this option will turn laser emission off. No additional controls will appear below the selection box when the *PRIMA*'s operating mode is set to **Off**.
- **Narrow Pulse**: This option enables the emission of picosecond laser pulses with narrow temporal pulse widths and steep falling edge without afterpulse. Pulses from the *PRIMA* can be triggered either internally or externally up to 200 MHz.
- **Broad Pulse**: In this operation mode, the *PRIMA* will generate picosecond laser pulses in a similar way as in the Narrow pulse mode. The main difference is that pulses will have a higher optical output power but with a broader pulse width (typ. < 1 ns, depending on wavelength). Again, the pulses can be triggered internally or externally up to 200 MHz.
- **1 ns Pulse, 2 ns Pulse, 3 ns Pulse and 4 ns Pulse**: In one of these operation modes, the *PRIMA* will generate ns laser pulses in a similar way as gated CW. However, these pulses can be triggered internally or externally up to 100 MHz. The 1...4 ns time actually refers to laser current time base and can result in slightly shorter optical pulse length depending on lasing wavelength and intensity setting.
- **Contin. Wave**: By choosing this option, the *PRIMA* will generate laser light as a continuous wave (CW).

Pulse Modes

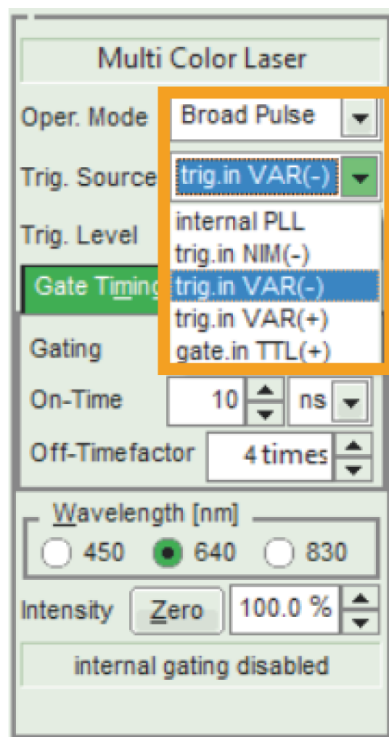


Figure 15: trigger source options under selection box "Trig. Source"

- After selecting one of the Pulse Modes, a new selection box called **Trig. Source** will appear below the mode selection box. The following trigger modes are available for the *PRIMA*:
 - Choose the option **internal PLL** to use the *PRIMA*'s internal clocks for triggering the picosecond and nanosecond pulses. Upon selecting this option, a spin edit box labeled **Frequency** appears, which allows setting the repetition rate from 1 kHz to 200 MHz or from 1 kHz to 100 MHz in case of ns pulses (see Fig. 16). The frequency unit (kHz or MHz) can be selected from the selection box next to it.

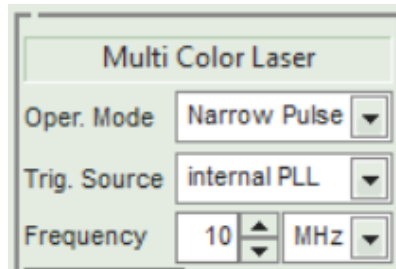


Figure 16: spin edit box "Frequency"

- Select one of the options **trig.in NIM(-)**, **trig.in VAR(-)**, **trig.in VAR(+)**, **gate.in TTL(+)** to trigger the *PRIMA* laser module via an external signal source.
 - Choose **trig.in NIM(-)** or **gate.in TTL(+)** when using the corresponding signal type as trigger source. No additional control element will appear in this case. The preconfigured settings in the background read:
 trig.in NIM(-): -0.4 V, falling edge
 gate.in TTL(+): +1.2 V, rising edge
 - The option **trig.in VAR(-)** will trigger upon the falling edge of an electrical pulse, while **trig.in VAR(+)** does the same on the rising edge of such a signal. Both of these options will also spawn an additional spin edit box called **Trig. Level**, where the threshold of the trigger signal can be set in V between -1 V to +1 V (see Fig. 17).

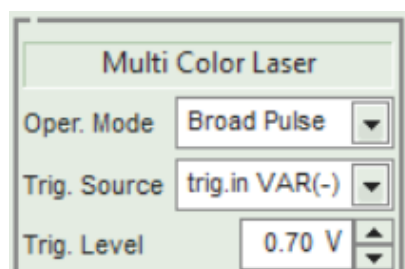


Figure 17: Additional control elements for external triggering in both narrow and broad pulsed mode

Contin. Wave

- By choosing this option, the *PRIMA* will generate laser light as a continuous wave (CW).
 - In this mode, the laser produces no picosecond pulses. However, the laser can still be modulated on a longer time scale (i.e. 10 ns...1 ms) via internal gating or arbitrary length with external gating.
 - No additional controls will appear below the **Operating Mode** selection box when the *PRIMA* is running in **CW**-mode.
 - In **Contin. Wave** mode, the desired electrical synchronization output can be selected via **Trig. Source**.

Gating and Gate Timing: 17

- *PRIMA*'s laser emission can be gated both internally and externally, even simultaneously (i.e. turned on and off in various pattern) in all emission modes.
- Internal Gating is activated by choosing the **On** or **Inv.** option in the Gating spin edit field.

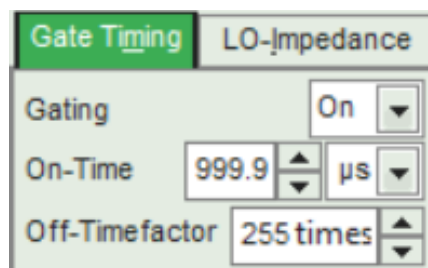


Figure 18: Gating Timing options

- Overview of options:
 - **On** option results in short on times and long off times.
 - **Inv.** option results in long on times and short off times.
 - **Off** option turns internal gating generator off.
- The **On-Time** spin edit box allows setting the time where the *PRIMA* is emitting laser light. The time unit (ns, µs, ms) can be selected from the selection box located next to it. Only a value within the **validity range of 10ns-1ms** can be selected. Invalid values cannot be entered.
- The time in which the laser emission is kept off is defined by the value in the **Off-Timefactor** edit box. The **Off time** is the **On-Time** value multiplied by the **Off-Timefactor**. The resulting duty cycle and period time is displayed at the bottom (see Fig. 18).
- External gating must be provided by a gating signal fed into the **GATE IN** input connector, see Fig. 5 8.

- With gate impedance set to **50 Ohm** and **Gating ON** or **Inverted GATE IN** acts as an output for burst generator monitoring:
 - The tab on the right side allows selecting the impedance for the applied external gating signal via two radio buttons: either **Low (50 Ohm => 0 Volt)** or **High ($\geq 1\text{ kOhm}$ => +5 Volt)**. Note that the tab's label will change accordingly to **HI-Impedance** or **LO-Impedance** depending on the chosen option.

NOTICE

Setting the impedance to **Low** disables the laser emission until a valid external gating signal is provided, while setting to **High** an internal pullup resistor sets the gate **ON** if **Gate In** is left floating.

The state of the internal gating (enabled or disabled) is displayed at the bottom of the **Multi Color Laser** control panel.

Wavelength Selection: 18

- The three radio buttons in the **Wavelength [nm]** section allow choosing the emission wavelength of the **PRIMA**.

NOTICE

Switching the wavelength is not instantaneous. The laser module will require some time (typically <200 ms) before stable emission at the new wavelength is available.

The intensity setting will be stored in the **PRIMA** individually for each wavelength, however independent of the Oper. Mode.

Intensity:

- The **Intensity 19** of the **PRIMA**'s driving current can be set on a freely adjustable scale from 0 to 100 %, with a step width of 0.1%.

NOTICE

The optical output power does not correlate linearly with the current intensity scale. Each wavelength has a particular threshold value for laser emission, a particular slope, and a particular maximal power value.

- The **Zero** button provides an easy toggle between any intensity value and zero intensity. This is useful in case the *PRIMA* needs to be switched off quickly. The button saves the previously set intensity, which is also indicated by the fact that the name of the button changes from **Zero** to the corresponding percentage value. Pressing the button again restores this intensity setting (or vice versa).

NOTICE

When entering an invalid intensity value (i.e. outside of the 0 to 100% range or with a step width lower than 0.1%), the edit box will show a red outline and the **"Apply"** button will be disabled.

5.2.6 "Presets" Control Panel

Two working configurations can be saved and recalled in the control panel labeled **Presets**, see Fig. 8 15. 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. 19).



Figure 19: 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 (see Fig. 20). 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. 19).

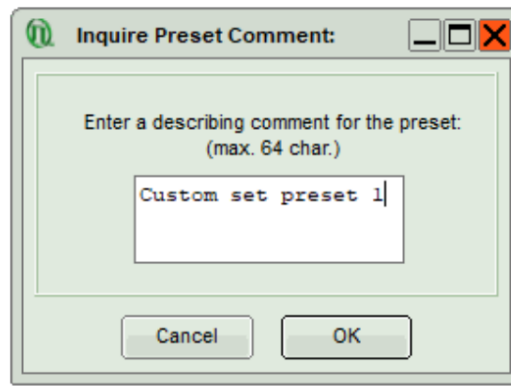


Figure 20: Edit comment for a preset

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. Troubleshooting, Tips and Tricks

6.1 Power stability

Please allow a start-up and warm-up time of about five minutes between powering up the laser module and activating it through the laser key switch. This thermal equilibration time will ensure the ideal stability of the optical output power.

6.2 Pulse Repetition Rate and Intensity Settings

Changes to the pulse repetition rate have an impact on the total average output power of the laser. The pulsed average power is typically proportional to repetition rate, however pulse energy may not scale linearly especially at higher repetition rates.

The intensity setting allows for variation of the laser drive current under all operation modes. In CW mode, the power scales nearly linear. Under pulsed operation, the optical pulse energy is nonlinear related to the drive current and as such may show a high threshold value and steep increase thereafter for the intensity setting.

7. Technical Data / Specifications

Optical output

Available wavelengths	375 - 1600 nm
Nominal max. pulsed power ¹	up to 10 mW
Nominal CW power	up to 50 mW
Average Beam dimension ²	1 mm ± 0.3 mm
Beam circularity	> 0.3
Polarization	Linear for all three wavelengths, orientation indicated via label
Polarization Extinction Ratio (PER)	typ. > 30:1 (> 15 dB)
Spectral width (pulsed, FWHM)	< 7 nm
Spectral width (CW, FWHM)	< 3 nm

Repetition rates

<i>Internal</i> Range	User selectable 1 kHz to 200 MHz 1000 increments of 1 kHz from 1 to 999 kHz 200 increments of 1 MHz from 1 to 200 MHz
<i>External</i> Range	0 Hz to 200 MHz
Trigger level	-1V ... +1V into 50 Ohm
Trigger voltage	-3V to +5V into 50 Ohm
Timing Jitter	< 12 ps (rms)
Connector	SMA

Synchronization output

Amplitude	< -800 mV into 50 Ohm (NIM)
Connector	SMA

Gating input

Rise / Fall time	< 3 ns
ON Time Gate	freely adjustable from < 10 ns to 1 ms
OFF Time Gate (as a factor of ON Time Gate)	freely adjustable from 1 to 255
Impedance	10 kOhms with pull-up 50 Ohms with pull-down
Connector	SMA

Dimensions

Size (h x w x l)	(75 x 83 x 140) mm
Weight	approx. 1 kg

Operation

Temperature range	10 to 35 °C
Rel. humidity	< 80 % (non condensing)
Max. power consumption	< 30 W

Interface

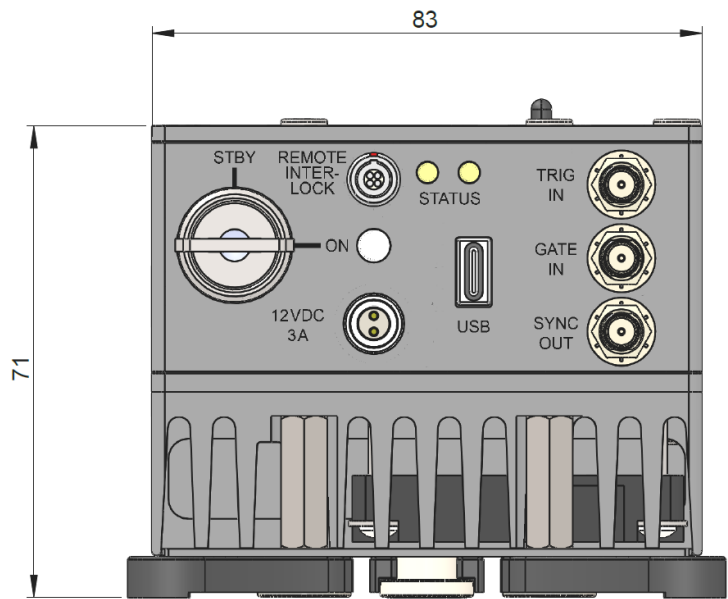
PC interface	USB 2.0
Connector	USB-C
Operating system	Windows TM 10 and 11

¹ This is the maximum average power at maximum intensity setting and maximum repetition rate.

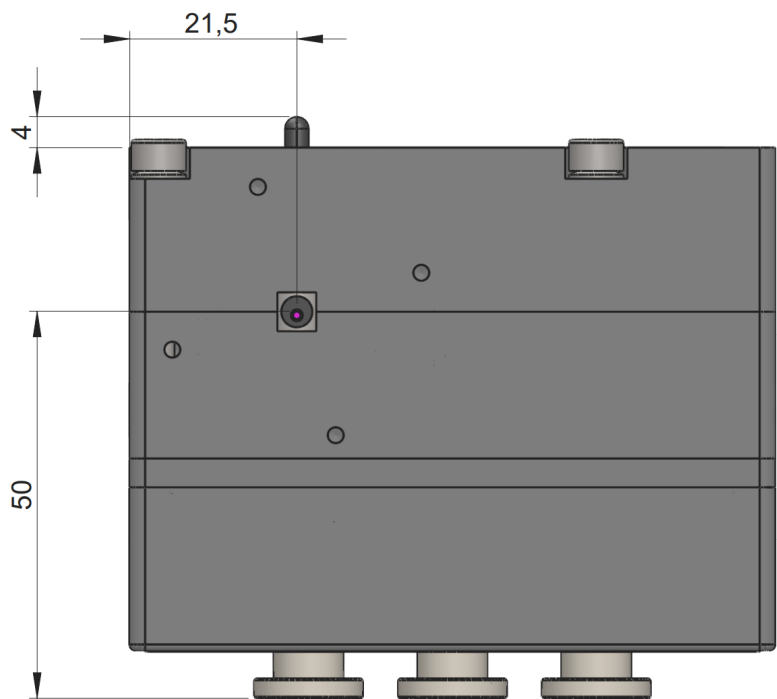
² Measured at 1 m distance from laser aperture

Dimensions of the *PRIMA* laser modules (all values given in mm):

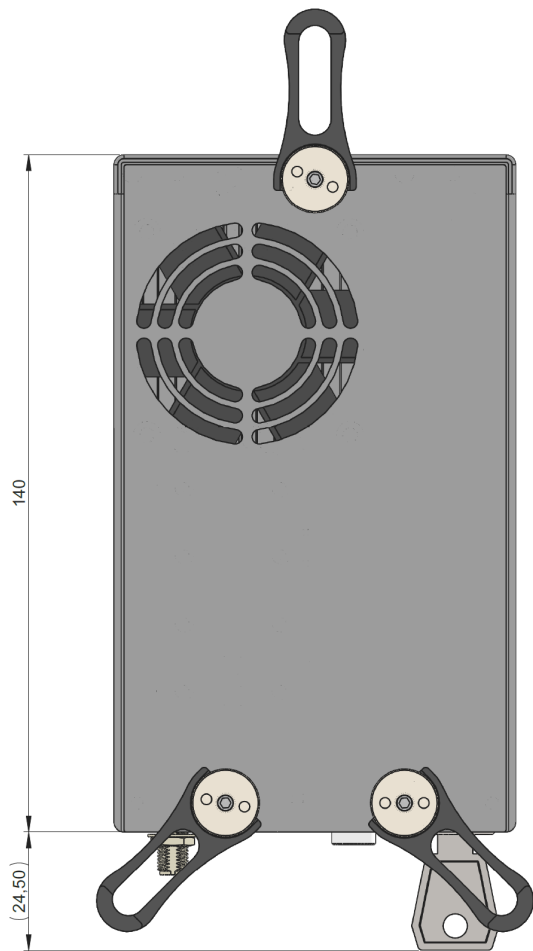
Back of Part No. 912001:



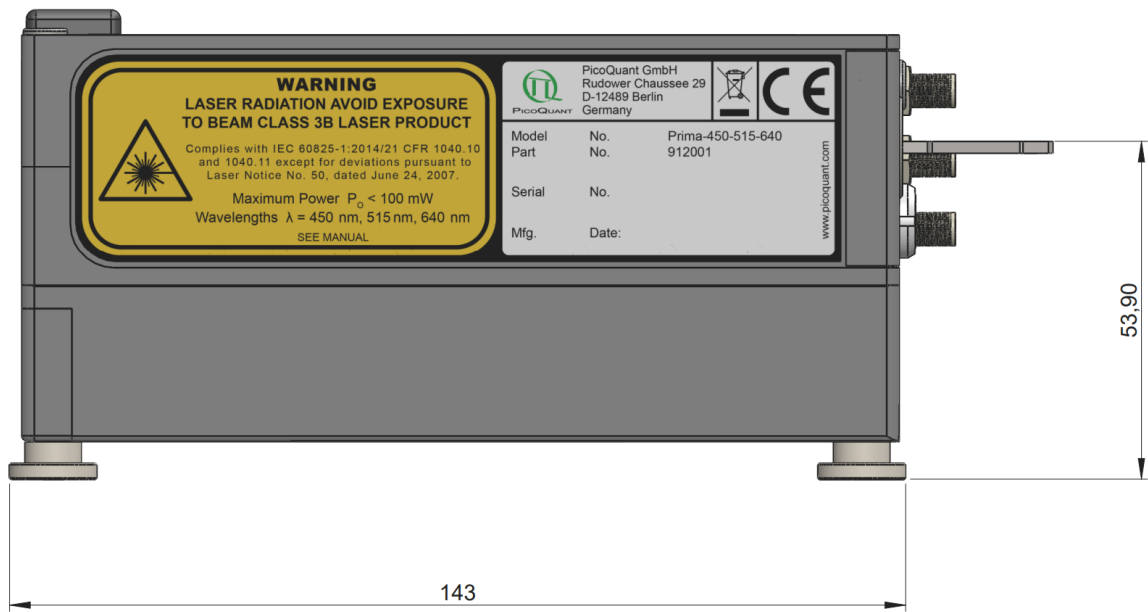
Front of Part No. 912001:



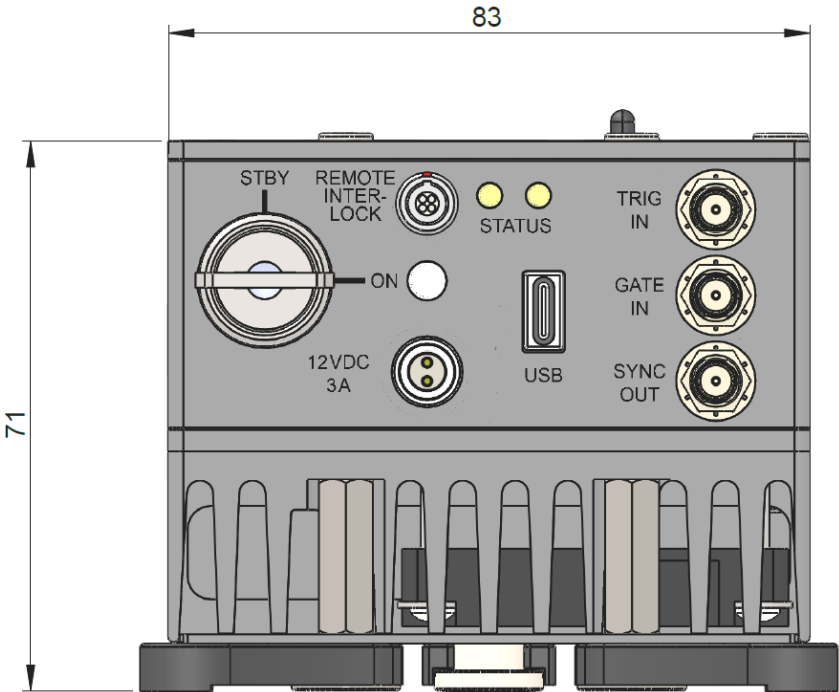
Bottom of Part No. 912001:



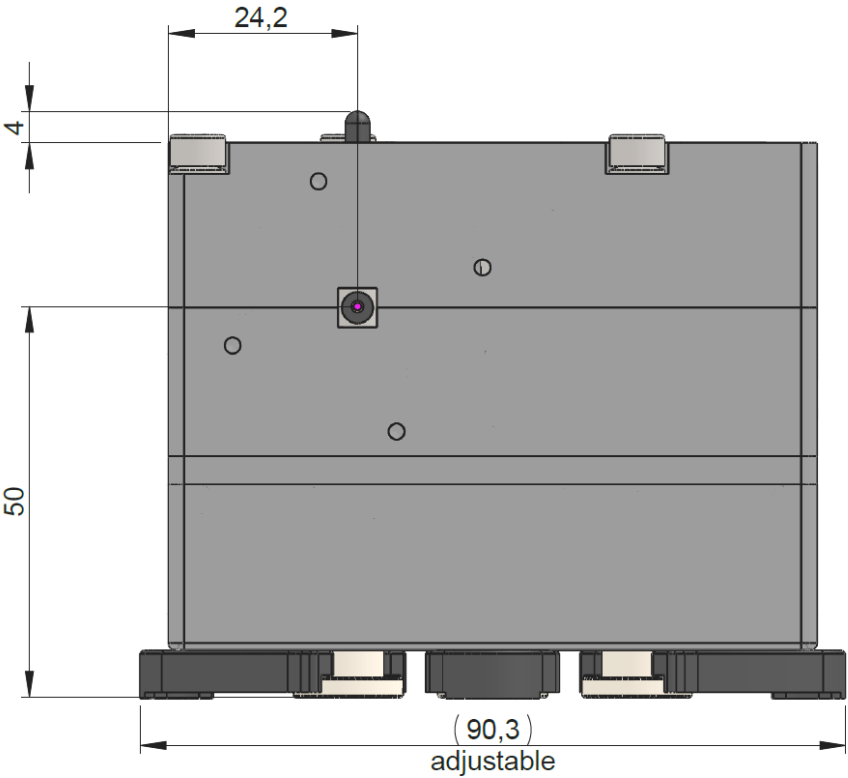
Side of Part No. 912001:



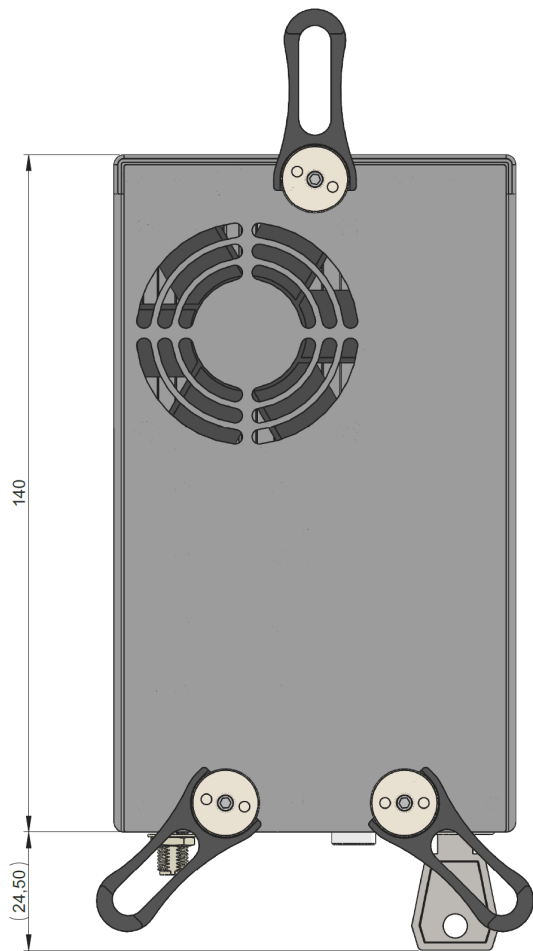
Back of Part No. 912002:



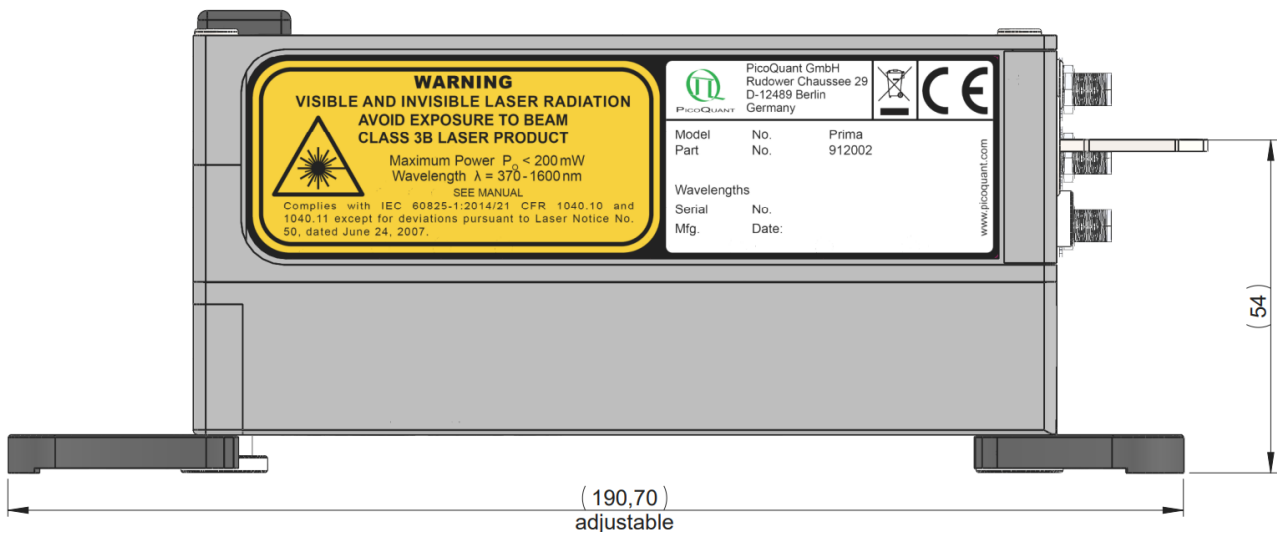
Front of Part No. 912002:



Bottom of Part No. 912002:



Side of Part No. 912002:



8. 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.

9. Legal Terms

9.1 Copyright

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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

10. Further Reading

10.1 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.

10.2 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>

11. Appendix

11.1 Abbreviations

BNC	British Naval Connector or Bayonet Nut Connector or Bayonet Neill Concelman
CAMAC	Corporations and Markets Advisory Committee
FWHM	Full Width at Half Maximum
IEC	International Electrotechnical Commission
IR	Infra-red
IRF	Instrument Response Function
LED	Light Emitting Diode
MOFA	Master Oscillator Fiber Amplifier
NIM	Nuclear Instrumentation Methods
RMA	Return Merchandise Authorization
SMA	Sub-Miniature version A (connector type)
STED	STimulated Emission Depletion
TCSPC	Time-Correlated Single Photon Counting
TTL	Transistor-Transistor Logic
UV	Ultra-violet
VIS	Visible
WEEE	Waste Electrical and Electronic Equipment

11.2 System Delivery Report

The delivery report of your laser, including all final production test results for pulse shape, optical power, and linewidth is delivered with each laser source. A PDF copy can be provided on request.

11.3 Overview of Laser Warning Labels by Module Type

The table in this section provides an overview of laser warning labels by model type.

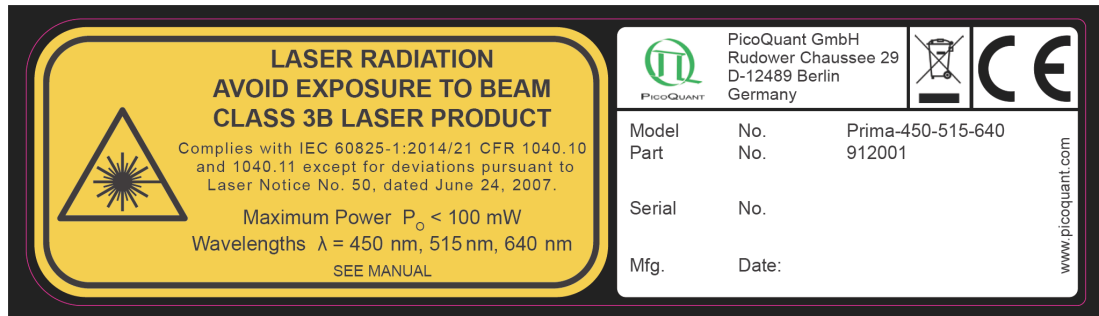


Figure 21: Warning label for Model type PRIMA-912001

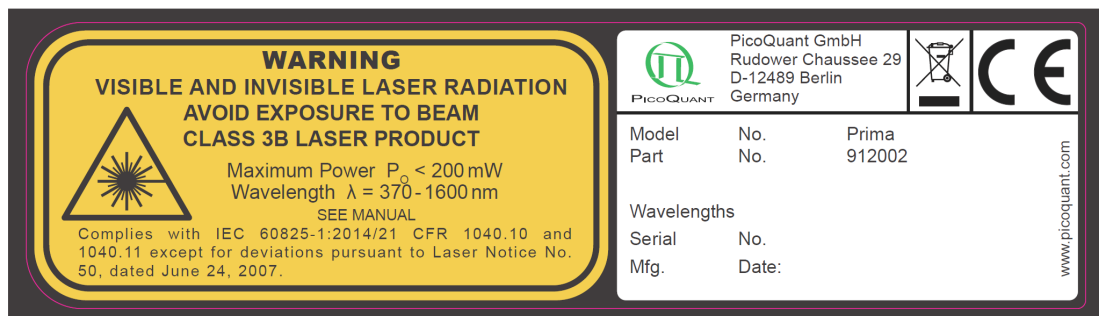


Figure 22: Warning label for Model type PRIMA-912002

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.



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