L1C series
User manual

L1C platform for LCX and LBX laser sources

REVISION HISTORY

v1.00	April 2019	First version
v2.04	October 2024	Updated with new external dimensions

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1. SAFETY INFORMATION

It is important that this user manual be kept with the product to ensure that users and owners of the product have access to important operating, safety, and other information.

PERSONNEL QUALIFICATION AND TRAINING

All personnel operating the laser product must be adequately trained and qualified for the work involved. Furthermore, they should have read and understood this manual. It is imperative that all personnel understand the potential hazards associated with laser equipment and adhere to the recommendations outlined in this manual. Additionally, these users must possess a working knowledge of at least one of the languages in which the interfaces and product documentation are available.

SIGNAL WORDS IN THE DOCUMENTATION

The following sidebars indicate potential risks that the operator must be aware of. The signal word indicates the severity of the safety hazard and the probability of occurrence if safety precautions are not followed.

DANGER - WARNING - CAUTION

“DANGER” Indicates a potentially hazardous situation that, if not avoided, could result in serious injury.

“WARNING” Indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury.

“CAUTION” Indicates a potential risk of harm that could result in damage to the supported product or to other property.

1-1 Safety instructions

In this manual, the term “product” refers to the L1C laser sources and their accessories (controllers, patch cables, etc.).

The product should be used only for its intended use and within its performance limits, as specified in the data sheet and brochures. If you are unsure of the appropriate use, please contact your local representative or Oxxius Technical Support.

OPERATING SITE

Use the product indoors only. The product enclosure is not waterproof; water ingress may electrically connect the casing with live parts, resulting in an electric shock.

The product is suitable for pollution degree 2 environments where non-conductive contamination may occur. For more information on environmental conditions such as ambient temperature and humidity, refer to the datasheet.

ELECTROSTATIC DISCHARGES (ESD)

Electrostatic discharges occur when friction over objects create a deficit or an excess of electrical charges. When a discharge occurs, the voltages involved are high enough to damage electronic circuits.

The L1C have been successfully tested against ESD with the following amplitudes: +/-4kV at contact, +/-8kV at air.

CAUTION

While the laser sources are equipped with input protection, it is essential to exercise caution when utilizing the product in environments where the air is specifically dry, or on carpeted or vinyl-tiled surfaces. In such cases, discharges exceeding 20kV may occur. To mitigate the risk of ESD damage in such environments, it is important to utilize appropriate attire and equipment, such as antistatic wrist straps.

CONNECTING TO POWER AND GROUNDING

The LBX operates on low voltage, and does not contain hazardous voltages.

The mains power supply input of the unit complies with overvoltage category II. It must be connected to a fixed installation used to supply energy-consuming equipment such as household appliances and similar loads. Be aware that electrically powered products carry risks such as electric shock, fire, personal injury or even death.

Take the following precautions for your safety:

- Before turning on the product, make sure that the voltage and frequency specified on the product match the available power source.
- Use only the power cord supplied with the product. It complies with local safety requirements. Insert the plug only into an outlet with a protective grounding pin.
- Use only intact cords and route them carefully to avoid damage. Check power cords regularly to ensure that they are undamaged. Also, make sure that no one can trip over loose cords.
- If the power cord needs to be replaced, be sure to use a power cord that meets the following specifications :
    - Connector type on the plug side: according to the local standard
    - Connector type on equipment side: C13
    - Current rating: 10 A

- Use the power supply provided with the product or recommended in the product documentation, or a power supply that complies with local regulations.
- It is important to ensure that the product can be disconnected from the power source at any time. To do so, simply pull the power plug. The plug must be easily accessible. In the event that the product is integrated into a system that does not meet these requirements, an easily accessible circuit breaker at the system level must be provided.

LASER SAFETY

The L1C models are sources of laser radiation that present special hazards.

The light produced by a laser source has several characteristics that make it very different from sunlight or the light emitted by an incandescent lamp. These characteristics create specific hazards associated with the operation and maintenance of the laser source:

- Laser light sources produce highly intense light that is either visible or invisible to the human eye,
- Laser beams are often collimated or have low divergence so that they maintain their harmful properties over long distances.
- Laser light is coherent, which means it can create stable interference: vivid patterns that are more intense than non-coherent light of the same wavelength and power.

THE BIOLOGICAL EFFECTS OF LASER BEAMS

The following are known effects of intense laser light on biological bodies:

- Eye trauma: A collimated laser beam focused through the lens of the eye can create an extremely intense light across the retina, which is more intense than what would result from looking directly at the sun. Such exposure can result in irreversible vision impairment.
- Thermal injury: Once laser energy is absorbed, tissue proteins are denatured due to the rise in temperature. This type of exposure results in tissue damage.
- Other damage mechanisms have been demonstrated for other specific wavelength ranges and/or exposure times. For example, photochemical reactions are the primary cause of threshold tissue damage following exposure to either ultraviolet radiation (200 nm to 315 nm) for any exposure time or visible "blue light" radiation (400 nm to 550 nm) for exposures longer than 10 seconds.

Table 1-1: Summary of basic biological effects of light

Photobiological spectral domain	Effects on the eye	Effects on the skin
Ultraviolet A (315 to 400nm)	Photochemical UV cataract	Pigment darkening, skin burn
Visible (400 to 780nm)	Photochemical and retinal thermal injury	Photosensitive reactions, skin burn
Infrared (780nm to 10µm)	Retinal thermal injury	Skin burn

LASER CLASSIFICATION

Laser sources are classified according to their ability to cause harm to exposed bodies, from Class 1 (no hazard during normal use) to Class 4 (serious hazard to eyes and skin).

Most of the LBX models are either Class 3B or Class 4.

- **Class 3B laser products** present a real hazard when intraocular exposure occurs, including accidental brief exposure. However, viewing diffuse reflections is generally considered safe. Class 3B lasers may cause minor skin injuries or even pose a risk of igniting flammable materials, but this is only likely if the beam has a small diameter or is focused.

- **Class 4 laser products** present a real hazard when intraocular exposure occurs, including accidental brief exposure. Viewing diffuse reflections is neither considered safe. Class 4 lasers can cause severe skin burns or even pose a risk of igniting flammable materials.

Please refer to the Manufacturing Test Report for detailed information regarding the laser classification of your equipment.

The following table lists the accessible power and irradiance at the output of each model, as well as the degree of eye protection required to operate in safe conditions:

Table 1-2: Accessible emission of some L1C models

Model	Nominal optical power (mW)	Laser class	Irradiance ($W.cm^{-2}$)	Eye protection required
L1C-5xx-50 (*)	50	3B	4	≥ OD 3
L1C-5xx-100 (*)	100	3B	9	≥ OD 3
L1C-5xx-200 (*)	200	3B	19	≥ OD 3
L1C-5xx-300 (*)	300	3B	29	≥ OD 3
L1C-5xx-500 (*)	500	4	49	≥ OD 4
L1C-785-200	200	3B	19	≥ OD 3
L1C-1064-300	300	3B	29	≥ OD 3
L1C-1064-500	500	4	49	≥ OD 4

(*) “5xx” stands for any wavelength between 530nm and 570nm

SAFETY GUIDELINES

It is important for anyone using a laser source to be aware of the potential risks involved. This awareness is not simply a matter of time spent with lasers; in fact, long-term exposure to invisible risks (such as those associated with infrared sources) can actually lead to a reduction in risk awareness.

Here are some guidelines to follow when working with laser sources:

- Use the laser source in a room where access is controlled by door interlocks. Post warning signs. Restrict access to the area to persons trained in laser safety.
- The laser operator should be responsible for announcing laser use and controlling the laser area.
- All personnel in the area must wear personal protective equipment (especially eyewear) before the laser beam is effective. This should include operators not directly using the laser system.
- Use the laser source in a brightly lit room so that operators work with their pupils dilated.
- Optical experiments should be performed on an optical table with all laser beams traveling only in the horizontal plane and all beams stopped at the edges of the table. Users should never place their eyes at the level of the horizontal plane where the beams are located in case of reflected beams leaving the table.
- Remove any watches or jewelry that may be in the optical plane. All non-optical objects near the optical plane should have a matte finish to prevent specular reflections.
- Never look directly into the laser output port (or output fiber) when the power is on.
- Alignment of beams and optical components should be performed at reduced beam power whenever possible.
- Do not install or terminate fibers or collimators while the laser is on. Follow the specific instructions in this manual.
- Ensure that the work surface is properly ventilated. Gases, sparks, or debris may be generated by the interaction between the laser and the work surface, creating additional safety hazards.

PROTECTIVE EYEWEAR

It is strongly recommended that eye protection be used when operating lasers of any class above Class 1.

Laser safety eyewear is rated according to its optical density (OD), which is the base 10 logarithm of the attenuation factor by which the eyewear reduces the beam power. For instance, eyewear with an OD of 3 will reduce the beam power within the specified wavelength range by a factor of one thousand. Furthermore, laser eyewear utilized in scenarios where direct beam exposure is a possibility must be capable of withstanding a direct impact from the laser beam without breaking. The protective specifications (wavelengths and optical densities) are typically printed on the eyewear itself.

Please refer to Table 1-2 for the recommended eyewear for each model. Oxxius recommends that the user investigate any local, state, federal, or governmental requirements, as well as facility or building requirements, that may apply to the installation or use of a laser or laser system.

STANDARD COMPLIANCE OF THE PLUG-AND-PLAY AND “OEM” VERSIONS

The "Plug-and-Play" version of the LBX laser sources complies with all requirements of the European Laser Safety Standard 60825-1, dated May 2014, and the U.S. FDA CFR 1040.10 and 1040.11, except for deviations according to Laser Notice N° 56, dated May 19, 2019.

The OEM version of the LBX is intended for integration into a larger system under the control of our customers and should not be used "as is" in an open environment such as a laboratory. The equipment into which the laser is integrated must meet the laser safety standards listed above. Therefore, Oxxius is not responsible for any failure to comply with the safety standards of the environment in which the OEM version of the laser source is used.

The following elements are required by the laser safety standards.

LABELLING (ADVISORY LABELS)

It is the manufacturer's responsibility to properly classify a laser and to label the laser with the appropriate warnings and safety precautions as required by regulations. Classification is accomplished by affixing a warning label to the product. In addition to textual warnings, these labels contain information about the emitted wavelength, total output power, and laser classification of the device.

Refer to the following paragraph, "Labels on the Product”.

APERTURE LOCATION

The laser beam is generated inside a protective housing. An aperture label indicates the location of the exit of the laser beam (see Figure 1-3).

REMOTE INTERLOCK

This function is typically used in conjunction with a door or panel to control access to the irradiated area. The LBX has remote interlock via a dedicated connector on the rear panel (see Chapter 3-2, "Instrument Tour"). Please note that laser emission is disabled as long as both terminals of the connector are not electrically connected.

KEY SWITCH

Each L1C is equipped with a key switch (or “actuated key master control”) on its remote control (see Chapter 2-4, "Instrument Tour"). This lock and key control the emission. Laser emission is not possible when the key is not in the lock or in the "OFF" position. Additionally, the key can only be removed in the "OFF" position.

EMISSION WARNING INDICATOR

Each L1C is equipped with an emission indicator located on the remote control (see Chapter 2-4, "Instrument Tour"). In compliance with CDRH requirements, this indicator illuminates for six seconds from the moment the emission command is received until the laser actually emits. This provides a delay to warn the user of the impending emission.

OPTICAL SHUTTER

Mechanical shutters, located at the output port of the L1C, allow the beam to be fully deactivated.

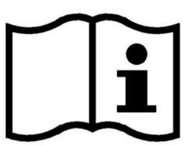
1-2 Labels on the product

Labels on the housing provide information about

- Personal and laser safety,
- Product and environmental safety,
- Product identification

Do not remove or tear these labels.

LABELS REGARDING PRODUCT AND ENVIRONMENTAL SAFETY



This symbol indicates that this manual must be read before using the equipment or performing any level of maintenance.

Labeling according to EN 50419 for the disposal of electrical and electronic equipment at the end of its service life.

For more information, see Chapter 5-6, "Disposal”.

This pictogram stands for “direct current”.

LABELS REGARDING LASER SAFETY

The labels on the laser head identify the laser class, laser aperture location, and emission characteristics. Refer to the following figures to locate these labels on the product.

LASER APERTURE LABEL

This label indicates the aperture from where the laser emission is released.

LASER CLASS LABEL

This label indicates the class of the laser source and warns of the potential hazards of exposure to radiation.

This pictogram indicates that the labeled device has the potential to emit some laser radiation.

The pictogram serves to alert the user to the hazard associated with unprotected eye contact with the beam.

This pictogram serves to alert the user to the hazard associated with the exposure to an unprotected body.

WAVELENGTH LABEL

Emission wavelength: 532 nm
Maximum power: 120 mW

This label indicates the wavelength and power of the emitted light. Please note that this value is calculated as the maximum that the user can access during operation. In most cases, it will therefore be greater than the nominal power of the laser.

STANDARD COMPLIANCE LABEL

Complies with IEC 60825-1 Ed 3, 2014-05 and with FDA 21 CFR 1040.10 and 1040.11, except for deviations pursuant to Laser Notice No. 56, dated May 8, 2019.

This label indicates that the product complies with the laser safety standards IEC 60825-1 and US FDA CFR 1040.10 and 1040.11.

IDENTIFICATION LABEL

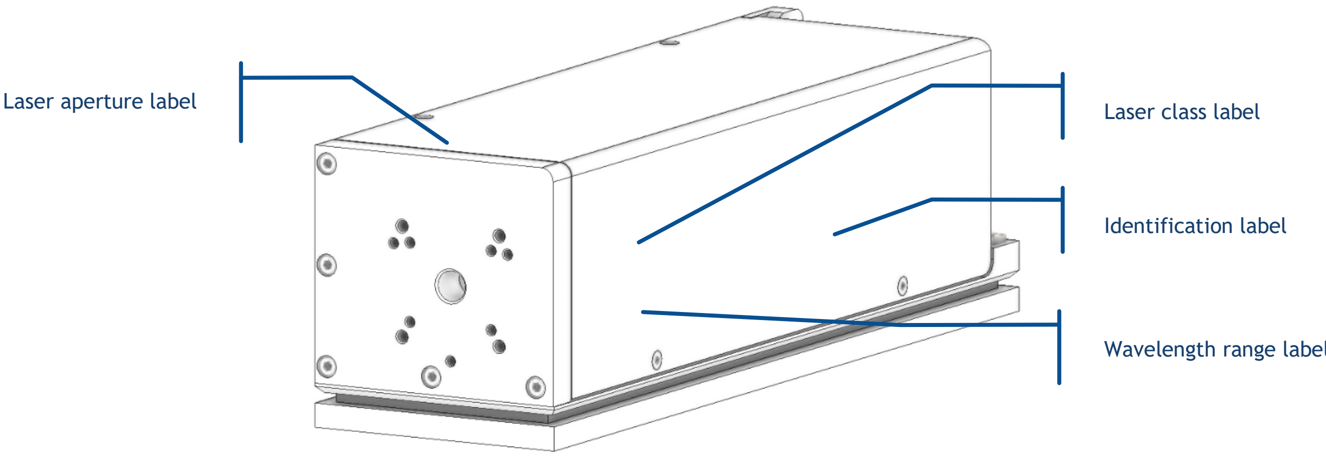
Model: L1C-532S-50-CSB-MPA-0-PP
Supply voltage: 5-12V ⎓ 25W
Serial number: LNC-00870 ;LAS-10850
Manufactured: April 2024

Complies with IEC 60825-1 Ed. 3, dated May 2014
Complies with 21 CFR 1040.10 and 1040.11, except for conformance with IEC 60825-1 Ed. 3, as described in Laser Notice No. 56, dated May 8, 2019.

This label provides the product model, serial number, date of manufacture, acceptable supply voltage and maximum power consumption.

This label also confirms the compliance with the laser safety standards IEC 60825-1, US FDA CFR 1040.10 and 1040.11.

Figure 1-3: Labels on the front panel and removeable cover of the L1C



2. GETTING STARTED

2-1 Product description and variants

THE L1C PLATFORM

The L1C is a platform that embeds a laser source (LaserBoxx model) and additional components, typically an isolator or a modulator. These elements are aligned inside the L1C laser head. The output beam can be available either in free space, or delivered through an optical fiber.

The L1C and can host the following components or options:

- Injection into an optical fiber (either single mode or multimode),
- A motorized power attenuator (“MPA”), that allows for a continuous selection of the output power while maintaining a stable spectrum,
- An optical isolator,
- An optical shutter

Depending on these options, a larger version of the L1C laser head is proposed, referred to as “L1C+”.

LaserBoxx is a family of laser sources based on a common platform and sharing the same footprint. Their architecture draws on state-of-the-art solid-state lasers, enabling rugged and maintenance-free sources providing a high optical power and a stable output in a compact footprint. The L1C family is composed of two types of laser sources:

- The LCX and LPX L1C are monolithic DPSS laser sources,
- The LBX and LSX L1C are models that embed a semiconductor laser diode.

INTENDED USE

The L1C models are designed for delivering optical power in industrial and laboratory environments. Use the product only for its intended purpose. Observe the operating conditions and performance limits specified in the data sheet.

“PLUG-AND-PLAY” AND “OEM” VERSIONS

L1C models are available in two versions:

- The plug-and-play version is designed for operation by a human user. It consists of the laser head and its controller and provides access to important safety features as detailed in Section 1, "Safety Information".

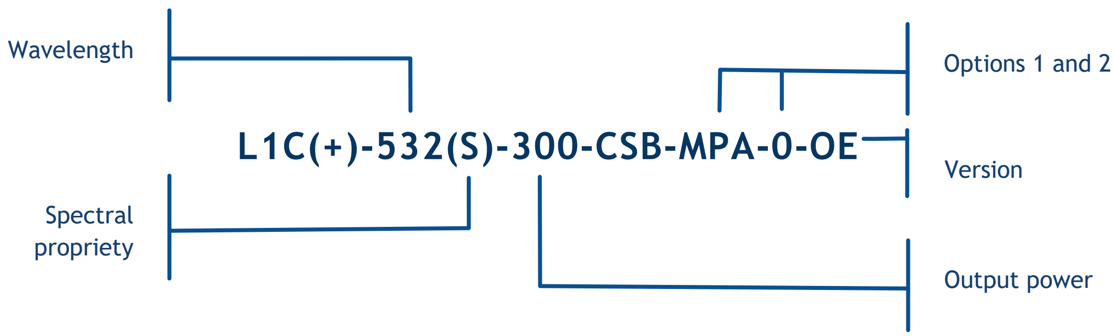
- The Original Equipment Manufacturer (OEM) version is designed for integration into an industrial device or system. This version typically does not include a controller or as many safety features as the plug-and-play version.

WARNING

Using the laser source without its controller is equivalent to using the source as an OEM part. Oxxius is not responsible for any failure to comply with applicable safety standards or local regulations when using a plug-and-play L1C without its dedicated controller.

PART NUMBERS

The part numbers are structured as follows for the models covered in this manual:



Details of the variants are explained table below:

Table 2-1: Variants of the L1C order codes

Category	Possible values	Description
Wavelength	…	Emitted wavelength in nanometers; refer to the product datasheet for available values
Power	…	Rated output power in milliwatts; refer to the datasheet for available values
Spectral propriety	L S	Standard emission spectrum Single longitudinal mode, high spectral purity
Options	MPA ISO	Motorized power attenuator Embedded isolator
Version	OE PPF PP	OEM version Plug-and-play, fixed power Plug-and-play, adjustable power

2-2 Preparing for use

Please use the following information when setting up the unit for the first time, or when changing its location.

OPERATING SITE

The L1C should be unpacked and installed in an area that should be free of dust.

In compliance with IEC EN 61010-1 standard, the plug-and-play version of the product is intended for use in an environment that meets the following conditions:

- Altitude up to 2000 meters,
- Ambient air temperature: from +10°C to +40°C (operating temperature),
- Base plate temperature: from +10°C to +50°C (operating temperature),
- Maximum relative humidity of 80% for ambient air temperature up to 31°C, decreasing linearly to 50% at 40°C,
- AC supply voltage fluctuations within +/- 10% of its nominal value,
- Transient over-voltages occurring up to the levels of overvoltage category II, as specified in standard IEC EN 61010-1,
- Temporary over-voltages occurring on the mains supply

Please also refer to the safety-related requirements listed in chapter 1-1.

ELECTROMAGNETIC COMPATIBILITY CLASS

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the plug-and-play L1C is "Class A". Class A equipment is intended for use in industrial environments. It can cause radio interference in residential environments due to possible conducted and radiated interference. Therefore, it is not suitable for Class B environments. If Class A equipment does cause radio interference, take appropriate measures to correct the interference.

MECHANICAL AND THERMAL CONSIDERATIONS

The laser head generates some heat during operation. Refer to the following cases depending on your requirements.

L1C MOUNTED ON A STANDARD OXXIUS HEATSINK

The laser head can be equipped with an optional heatsink HTSK-10. This model provides an important heat dissipation while keeping the laser head at a fixed temperature, improving its overall stability. Its thermal resistance is approximately 0.10K/W.

Place the heatsink on a stable, flat, and level surface. Clamps and screws are provided to fix the heatsink to its support.

NOTICE

Overheating may affect the operation of the product. Take the following precautions to prevent overheating:

- Keep at least 10 cm (4 inches) between the heat sink fan openings and any nearby objects.
- Do not place the laser head near a heat-generating equipment.

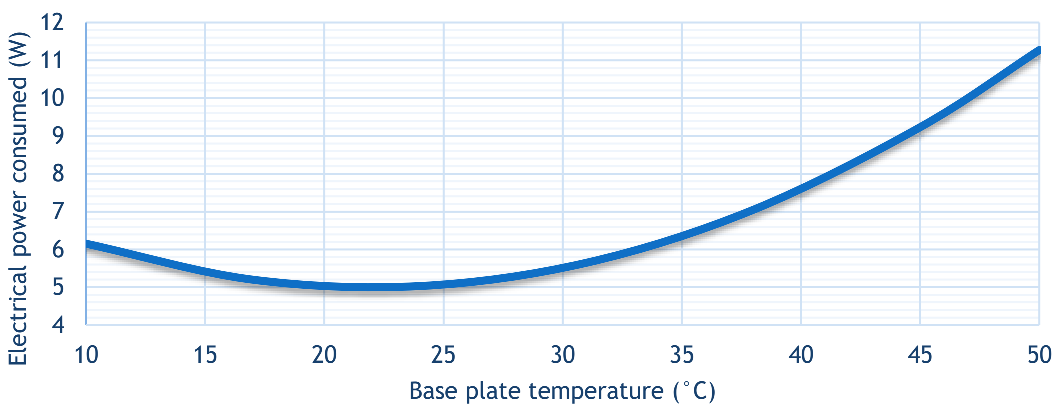
L1C FIXED ON A HEAT-DISSIPATING SUPPORT

The laser head can be mounted directly onto a mounting base, provided that it is flat enough (50 µm flatness or less) and that heat dissipation through it is effective. An optical stage or machined baseplate typically meets these requirements.

See Section 7, Appendix C for detailed drawings of the laser head.

The amount of heat dissipated increases dramatically as the temperature of the laser head itself increases. As an illustration, the electrical power consumed by a typical L1C is plotted against the temperature of its baseplate:

Figure 2-2: Power consumption of a typical L1C (L1C-532-200-CSB-MPA, optical power: 200mW)

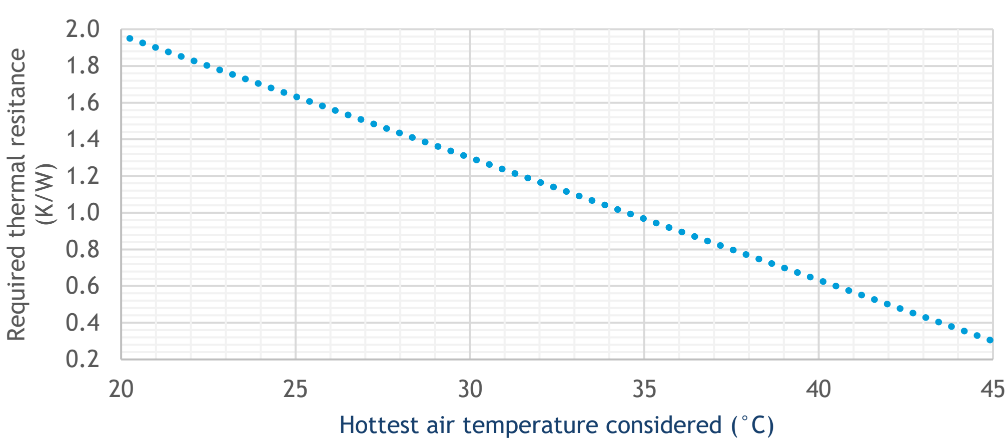


Notable features of this characteristic are:

- The consumed power is maximum when the baseplate is at its hottest,
- The minimum power consumption is reached in an interval typically between 15°C and 25°C.

For these reasons, the supporting medium must ensure proper dissipation of the heat generated. This is the purpose of the standard heatsinks described in the previous paragraph. The following figure can be used as a guide when selecting a heat sink (air heat exchanger). Its thermal resistance should be chosen according to both the hottest temperature of the ambient air and the power consumed by your L1C model.

Figure 2-3: Required thermal resistance for a typical L1C (L1C-532-200-CSB-MPA, optical power: 200mW)



Contact your Oxxius representative to find out the exact power consumption of your model or for detailed advice on this topic.

UNPACKING AND INSTALLING

1. Carefully unpack the product.
2. Keep the original packing materials. Use it to transport or ship the product later.
3. Using the packing list and the following tables, check the equipment for completeness and damage. If the shipment is incomplete or the equipment is damaged, contact your local representative.

Table 2-4: Packing list and accessories of a LBX or LSX model, “Plug and play” version

Name	Quantity
Laser head	1
Controller, including:	1
Laser emission keys	2
Mating connector for the interlock (with short-circuit)	1
Umbilical cable to connect the laser head and its controller	1
AC/DC power supply for the controller	1
Power cord	1
USB cable (“A to B” type)	1
USB Flash drive	1
Tools for adjusting the fiber injection	Optional
1.5mm hexagonal key	(1)
2.0mm hexagonal key	(1)
1.2mm slotted screw driver	(1)
Manufacturing test report	1
Information leaflet warning about optical feedback	1
This user manual	1

ABOUT OPTICAL FIBERS

Special care must be taken with fiber optic patch cords, which must not be bent or subjected to mechanical damage (shear or tensile stress, punching, etc.). An optical fiber is made of glass and is a fragile component. The user is required to handle the patch cables and their optical connectors with care and to have the necessary tools and knowledge to inspect and clean the end tip of the optical connector. These tools are

- A special microscope to inspect the fiber tip. Oxxius recommends using a microscope with 200x magnification, such as the "FS201" available at www.thorlabs.com.
- Some consumables for cleaning the optical connectors. Oxxius recommends using lint-free wiping material, such as the "type A" CLETOP tools available from NTT-AT.

HOW TO CLEAN THE PRODUCT

If necessary, use a dry, lint-free cloth to clean the housing product. When cleaning, remember that the housing is not waterproof. Do not use cleaning agents.

2-3 Product tour

LASER HEAD

Here are the accessible elements on the laser head. For detailed drawings of your model, refer to chapter 7-3.

Figure 2-5: Elements on the front of the L1C laser head

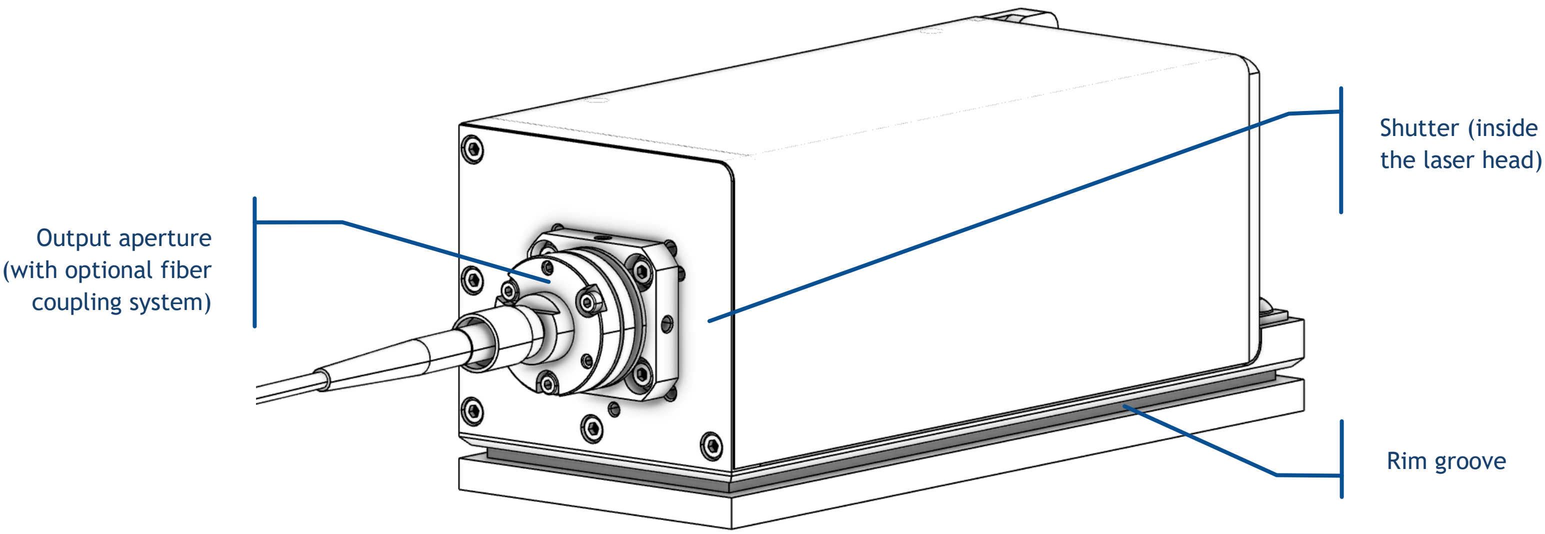


Figure 2-6: Elements on the rear of the L1C laser head

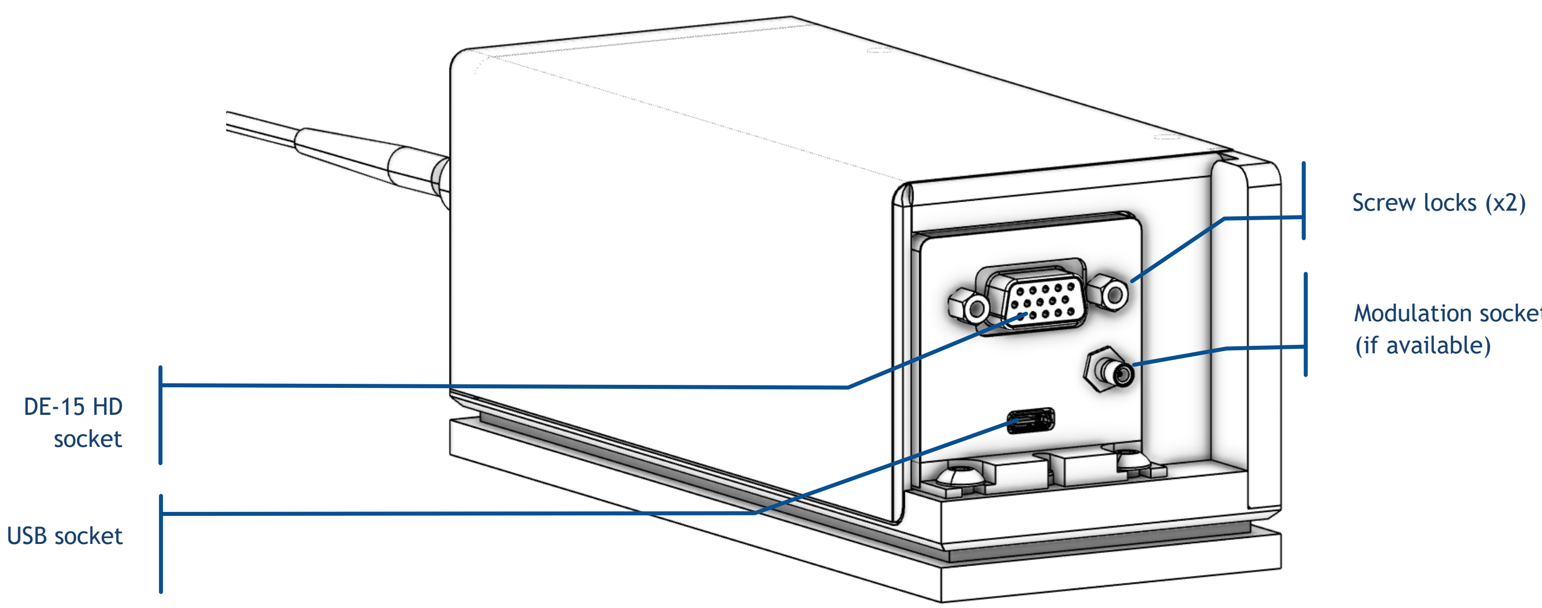


Figure 2-7: Detailed output channel with an optional fiber coupling system

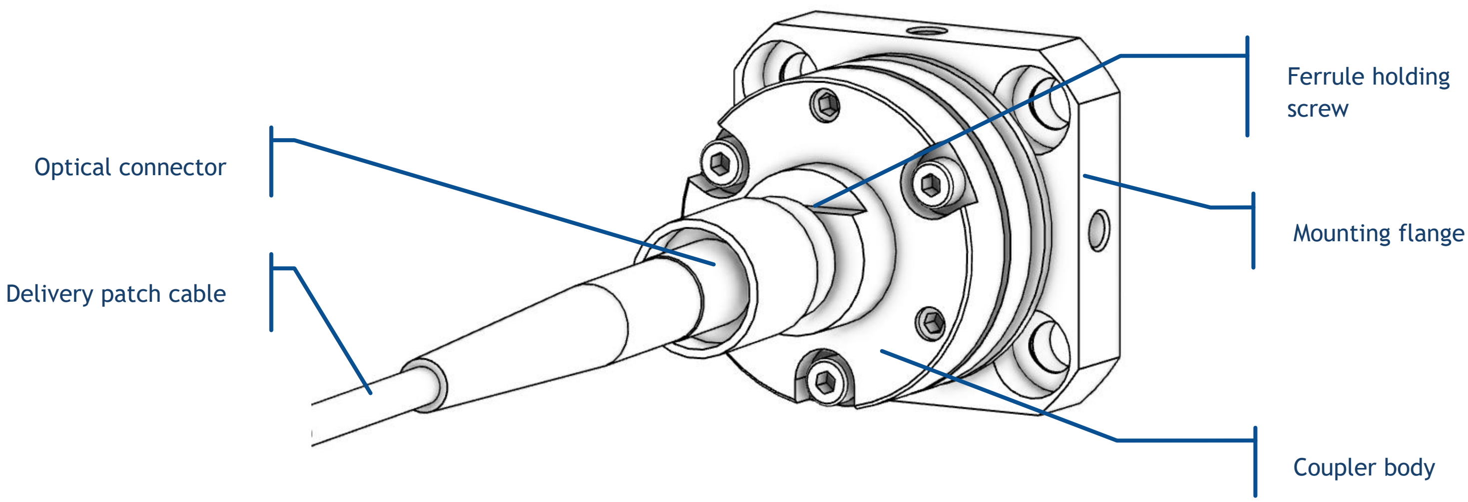
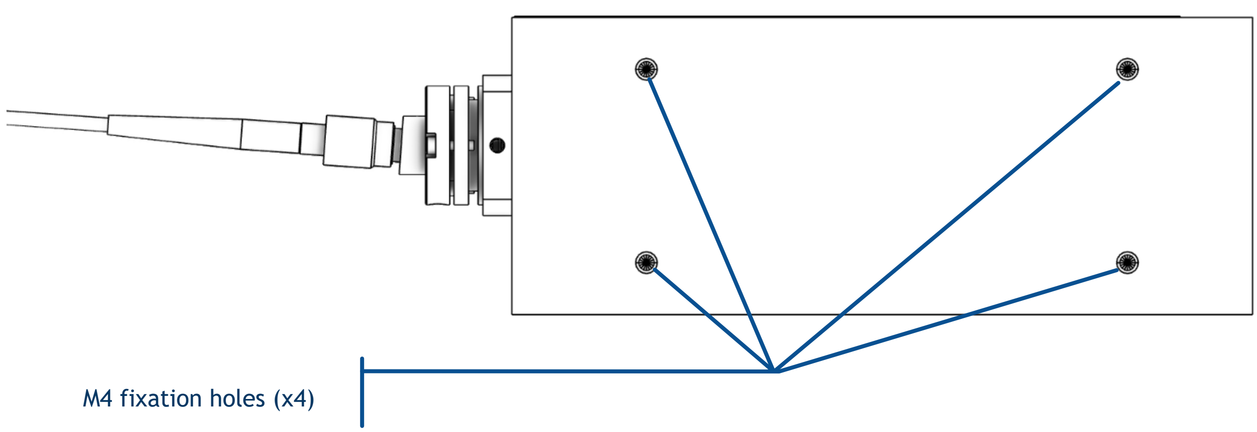


Figure 2-8: Bottom view of the L1C



The following elements are accessible to the user:

- **Base plate mounting holes:** these holes are used to secure the laser head to a base plate or a heat sink.
- **Laser aperture**: this is the opening from which the laser beam is emitted. Its position is also indicated by a label on the laser head. It consists of the following elements:
    - **Electro-mechanical shutter:** When activated, this device bars the beam from being released out of the aperture. The standard shutter is driven by sending either electrical signal or some software commands.

- **Fiber coupling system (option):** This system is designed to inject the power into an optical fiber. It is composed of:
  - **The mounting flange**, which supports the coupler. Note that this flange is precisely centered against the laser beam. Therefore, it is not advisable to loosen these screws and disturb its positioning.
  - **The coupler**, which focusses the laser beam into the optical fiber,
  - **The optical patch cable**, which holds and protects the delivery fiber,
  - **The optical connector** at the extremity of the patch cable allows for connecting the fiber to the fiber coupler
    Take note of flat side on the coupler, right in front of the optical connector: it holds a screw designed to secure the position of the lodged ferule.

- The **rim groove** is designed to fix the laser head to a baseplate using clamps.

- The **M4 holes** at the bottom of the laser head provide an alternate way for fixing the L1C.

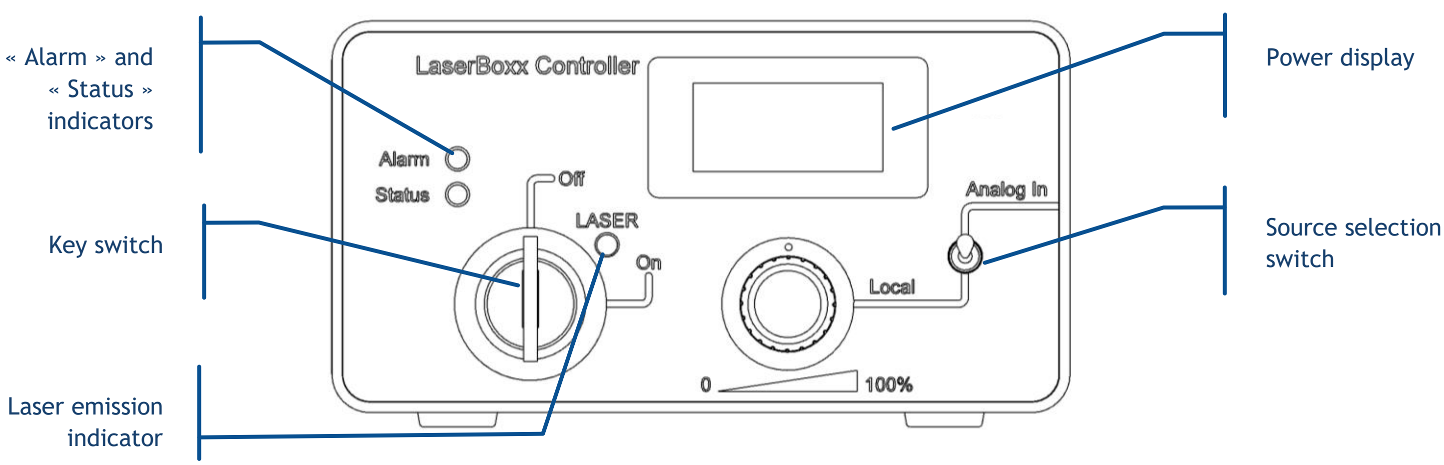
- The **DE-15 HD** socket is the main electronic interface of the laser head. Use the two standoff screws to secure a connector to this socket. Refer to chapter 7-2 for a detailed description of this interface.

- A **micro-USB socket** provides a communication interface with the L1C.

CONTROLBOXX CONTROLLER

The ControlBoxx gives its user access to the necessary controls over the laser: emission, amount of power, status and safety signals.

Figure 2-9: Front panel layout of the ControlBoxx



The following elements are accessible to the user:

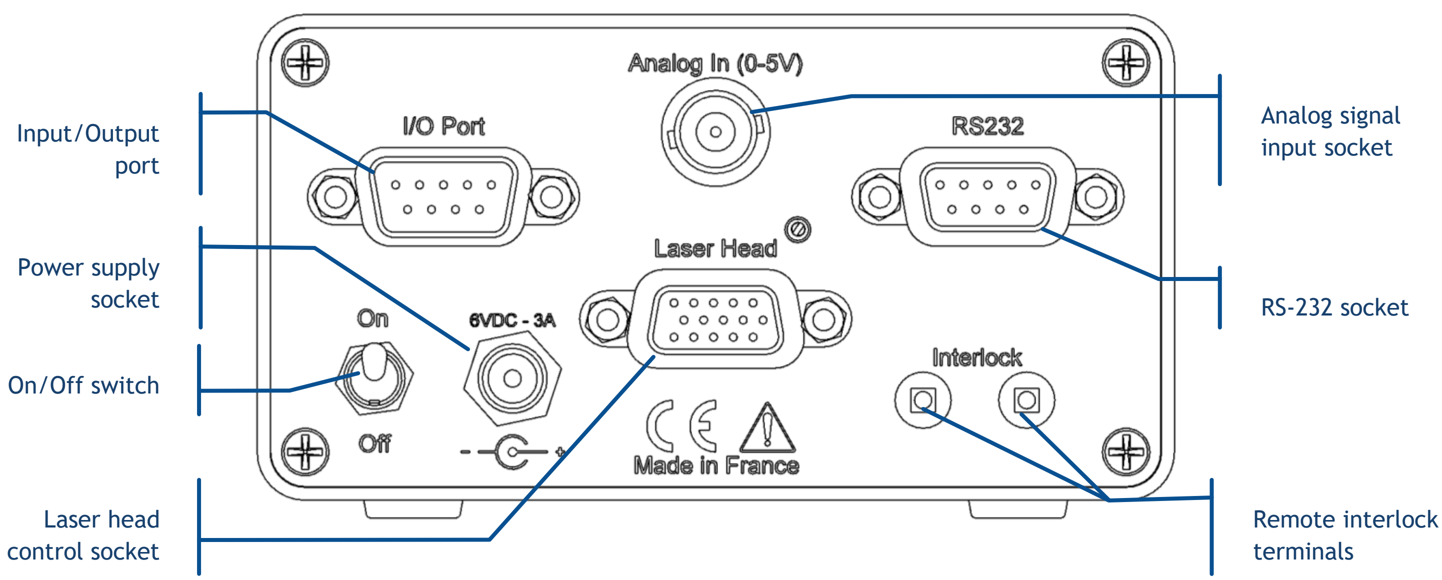
- **Key switch:** A class 3B or class 4 laser system must have a key-operated control. The key is removable and laser radiation is not accessible when the key is removed. When the unit is ready, turning on the key starts the laser emission.

- **Laser emission indicator:** This safety indicator is a light-emitting diode (LED) that glows solid white when the key control is turned on, indicating that the emission can be released at any time. This indicator can be seen without exposure to laser radiation; the white color is used to be visible through most protective eyewear. In accordance with CDRH recommendations, this indicator illuminates six seconds before the actual laser emission to warn of the impending hazard.

These two elements are required by laser safety standards in order to protect the user from an accidental exposure.

- **“Status” indicator:** This indicator is a green LED that shows the status of the laser source:
  - Not lit when the laser is not enabled for emission,
  - lit solid when the laser is emitting and stabilized,
  - blinking when the laser is stabilizing
- **“Alarm” indicator:** This indicator is a red LED that, when lit solid, indicates either the presence of an alarm on one of the laser sources, or that the interlock circuit is open.
- **Source selection switch (model dependent):** This switch allows the user to select the source used to adjust the power:
  - The “Local” position enables the front panel potentiometer and allows the user to adjust the optical power using the front panel knob,
  - The “Analog In” position disables the front panel potentiometer and allows the setpoint to be controlled by applying a voltage to the rear panel BNC socket.
- **Power display:** This panel displays the instantaneous output power, in percentage of the nominal power. The accuracy of this monitoring is better than 5%.

Figure 2-10: Rear panel layout of the ControlBoxx



- **Remote interlock (Φ2 mm banana sockets, two terminals):** the laser emission is disabled when the circuit between these terminals is open. This connector is usually used in conjunction with a door or a panel to control the access to the irradiated area. A pair of mating connectors is supplied to close this circuit and allow the emission.

- **Analog signal input socket (BNC socket):** This input is used to control the optical power from an analog voltage, allowing for power adjustment. Refer to chapter 3-2 for detailed information on power adjustment.

- **Input/Output port (DE-9 Male):** This interface allows the L1C to be controlled and monitored by electrical signals.

- **RS-232 port (DE-9 Female):** This connector can be used to establish a RS-232 communication link.

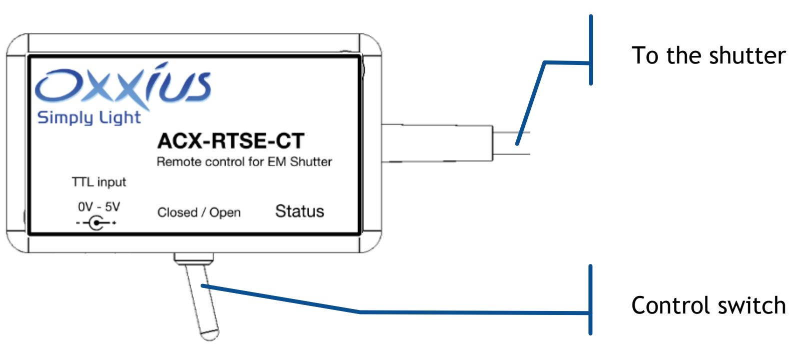
- **Laser head control socket (DE-15 HD Female):** This connector supplies power and signals to the laser head. It must be connected to the controller using the umbilical cable (supplied).

- **Power supply socket (2.1mm coaxial):** Input for power supply (provided) and associated on/off switch.

REMOTE CONTROL FOR SHUTTER (“RTSE-RM” / “RTSE-CT”)

This component allows the user to drive the electro-mechanical shutter manually, or from an external signal.

Figure 2-11: ACX-RTSE remote control



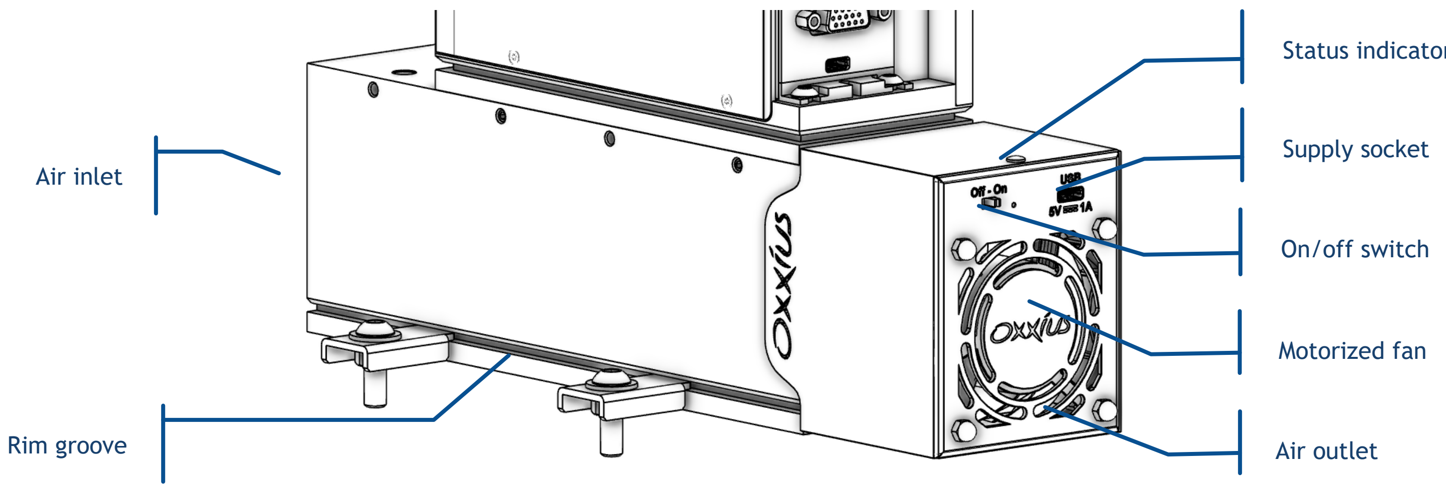
- **Control switch:** Activate this switch to control the shutter manually. If this switched is in “closed” position, the shutter will react according to the signal applied to the SMB socket.

- **Status:** This white LED is lit when the shutter is open.

HEATSINK ("HTSK-10" OPTION)

This heatsink is designed to ensure a stable operation over a broad range of temperatures. The default ("automated") operation consists in transferring a sufficient amount of heat while keeping the fan as quiet as possible.

Figure 2-12: Rear view of the heatsink HTSK-7



- **Air inlet and outlet**: the ambient air will flow through these apertures and carry away the excess heat. Do not block these apertures and leave enough room around them to ensure a proper cooling of the laser unit.

- **On/Off switch:** Use this switch to activate or deactivate the fan operation.

- **Rim groove:** Use this groove to fix the heatsink to your baseplate using clamps.

- **Supply socket (USB C):** Supply the power to the fan through this socket. Use this socket too to monitor the fan operation.

- **Status indicator:** The color LED indicates the status of the fan

Color	Meaning
Green / Yellow / Orange / Red	Automated operation • Green: minimum throughput • Red: maximum throughput
Purple	Manual operation
LED off	Either the fan is not powered or the LED has been deactivated

For detailed drawings, refer to chapter 7-3.

2-4 Installation

SIGNAL CONNECTIONS

- Connect the controller to the laser head using the umbilical cable. Secure both connectors using the locking screws.

- Connect your remote interlock circuit to the remote interlock terminals on the controller. If a complete interlock circuit is not to be used, the shunt wire provided.

WARNING	DEFEATED INTERLOCK CIRCUIT
⚠	Using a shunt wire on the socket renders the interlock circuit ineffective, thereby negating the remote interlock function as a safeguard against accidental exposure to the laser beam.

MODULATION SIGNALS

Connect your source of signal to the relevant input socket:

- For analog modulation (if available), use the BNC socket located on the rear of the ControlBoxx
    - Voltage range: 0 to +5 Volts
    - Impedance: 1.2 kOhms
    - Mating connector: BNC male connector

- For digital modulation (if available), use the SMB socket located on the rear of the laser head
    - Voltage range: 0 to +5 Volts
    - Impedance: 50 Ohms
    - Mating connector: SMB male connector. An example of mating assembly can be found under the reference “BPSMBP1.5M174” over https://ccsukltd.co.uk

OPTICAL OUTPUT

For models with a free-space output: align the output aperture into your light path.

For fiber-terminated models, please connect the optical connector to a compatible adapter. It is important to ensure that the threaded ring of the optical connector is properly fastened. Small adjustments may be required after positioning the laser head in its final location. Please refer to chapter 5-2 for a detailed procedure.

DANGER **LASER RADIATION HAZARD**

For the safety of your surroundings, please ensure that every reflected or unused beam is terminated with a beam stop (or a piece of absorbing material) within the boundaries of the optical table.

CAUTION **OPTICAL FEEDBACK**

In absence of optical isolator, the laser source embedded inside the L1C can be damaged by optical feedback, especially the LBX models emitting in the red and infrared spectrum.

Optical feedback occurs on semiconductor laser diodes when their output is collimated and subsequently retro-reflected. In these conditions, the intensity of the retro-reflected beam can be high enough to damage this the diode facet, resulting in its irreversible degradation. This failure mechanism is **not covered** under Oxxius' standard warranty.

Oxxius strongly recommends that users take the following precautions when installing their laser head:

1) All reflective surfaces in the optical path should be slightly angled so that surface reflections are not reflected back to the laser source,

2) Use angle-polished ferules when coupling light into optical fibers,

3) Avoid using mirrors placed at normal incidence into the optical path. If mirrors must be placed at normal incidence, then an isolator is required.

4) Avoid focusing the beam the onto a highly reflective surface without an isolator installed,

5) Avoid sweeping the beam back and forth across the laser during alignment operations (e.g using a retro-reflected beam to align through a pinhole in a confocal microscope).

CONNECTING TO POWER

1. Please observe the safety instructions described in section 1, "Safety Information".
2. Connect the output cable of the power supply to the rear panel of the controller.
3. Connect the power supply to a power outlet with ground contact using an appropriate AC power cable. Only use the AC power cable delivered with the product.

The standard power supply provided with the L1C has the following characteristics:

Output voltage	9 Volts ⎓
Power rating	40 Watts

WARNING

For electrical safety, Oxxius recommends using the standard power supply provided with this product. A protective ground connection integrating a grounding conductor is essential for a safe operation. To avoid electrical shock, please ensure that the power cord is plugged into a properly wired receptacle.

In the event that you require the use of your own power supply for the laser sources, please ensure that the controller is connected to a source that complies with the following specifications:

Input	Output
Voltage: 100-240 VAC	Any voltage between 5 Volts ⎓ and 12 Volts ⎓
Frequency: 50-60 Hz	Power (minimum): 30 W
Protective ground	Regulation: +/- 5%
	Line voltage regulation: +/-1%

As defined in UL 60950-1, a SELV source is a "secondary circuit that is designed and protected in a way that ensures its voltages do not exceed safe levels under normal and single default conditions." This secondary circuit is isolated from the primary power source (AC mains) and is powered by a transformer, converter, or equivalent isolation device. The power supplies included with the plug-and-play L1C models adhere to these specifications.

COMMUNICATION

Communication with the L1C involves using a computer (or a similar device). Please refer to the following chapter for detailed instructions on installing the software for control and monitoring.

USB COMMUNICATION

USB communication is available on any model, using the socket located on the read side of the laser head. The required cable (provided with plug-and-play configurations) is a standard “USB A to micro-B” cable.

Figure 2-13: Example of USB A to micro-B cable

RS-232 COMMUNICATION

RS-232 communication is also available from the ControlBoxx .

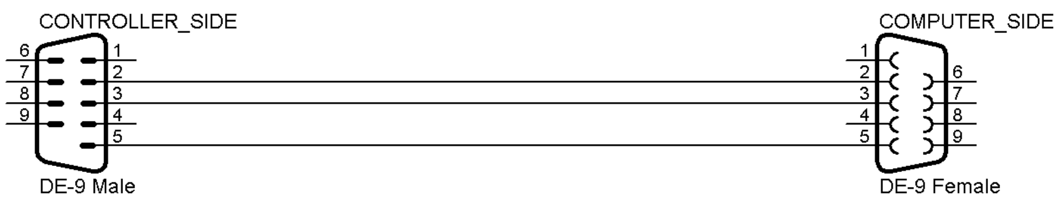
Use a commercial **straight cable** terminated by DE-9 connectors (male <-> female).

Figure 2-14: A commercial RS-232 cable

An alternative option is to construct the cable in accordance with the schematics provided below.

Figure 2-15: Pin assignment and wiring schematics for RS-232 communication using a ControlBoxx

ControlBoxx side DE-9 male connector	Pin	Computer side DE-9 female connector	Pin
Rx	2	Rx	2
Tx	3	Tx	3
Ground	5	Ground	5
Case	Shield	Case	Shield



2-5 Installing the software suite

The Oxxius Laser application software allows users to monitor and control one or several laser sources linked to a personal computer.

PREREQUISITES

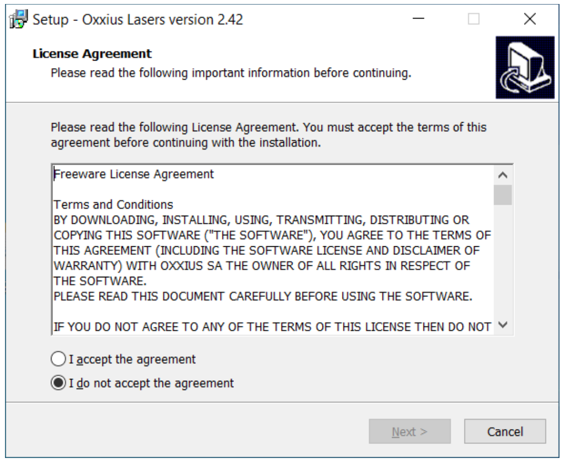
- Oxxius Laser requires either a serial port (for RS-232 communication) or a USB port (using either the native USB protocol or a virtualized serial communication).
- Oxxius Laser is compatible with the following operating systems:
    - Windows 10 or 11,
    - Windows 8 (32-bit and 64-bit versions),
- Microsoft’s .NET framework is required. If it is not installed, the user will be prompted to download and install it.

INSTALLATION

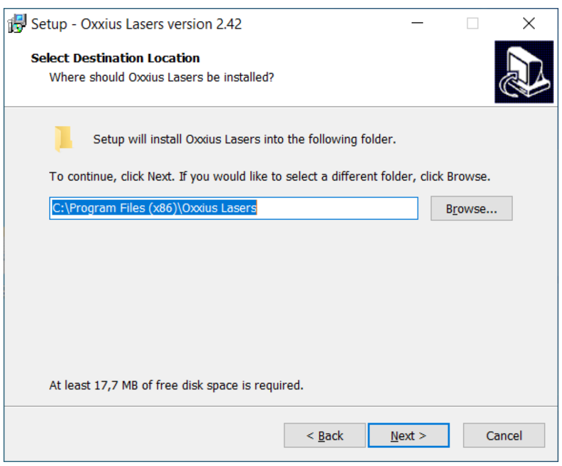
Locate the installer “setup.exe” on the USB flash drive provided with the laser source, and execute it. Alternatively, you can download the latest version of our control software from the following URL:

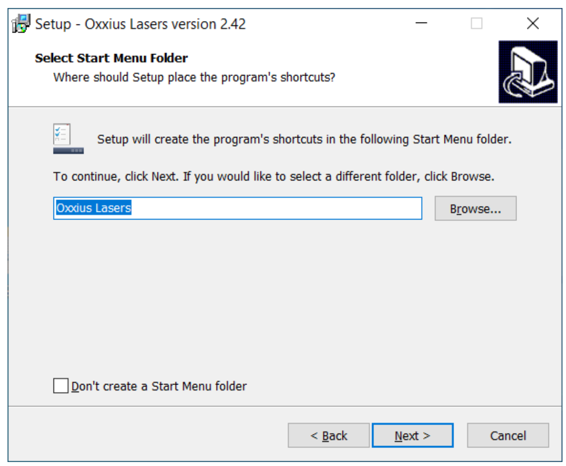
HTTP://WWW.OXXIUS.COM/DOWNLOAD/F09512DD.EXE

Executing the file “setup.exe” prompts a standard installation wizard. Please take note of the license agreement and proceed by selecting “I accept the agreement”

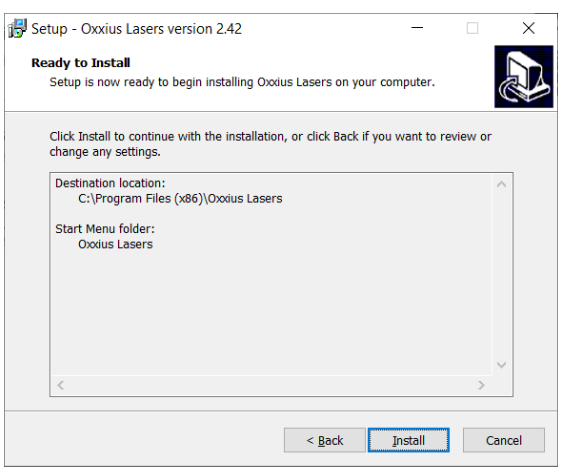


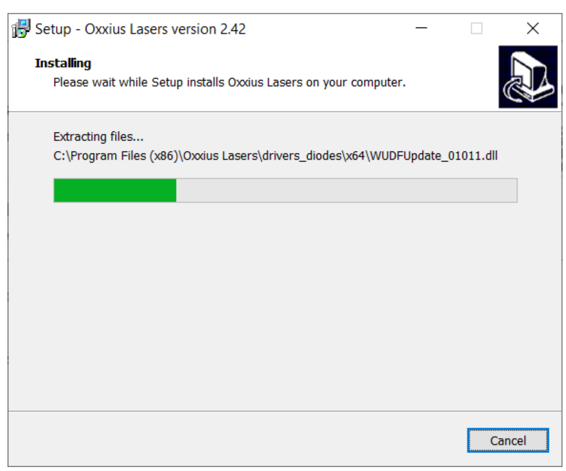
Click on « Next » twice, unless you need to set a specific save folder.



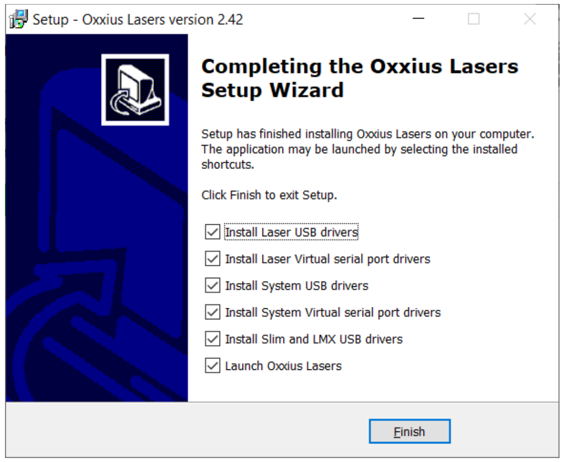


Click on « Install ».





The final step of the installation prompts the user to install the USB drivers to communicate with various models (see the screenshot below). To proceed, select all the features proposed.



To complete the installation, please click "Finish." Your operating system may require you to restart your computer.

3. OPERATION

Please note that in this section, the laser source is assumed to be correctly installed and connected. If you require assistance on this topic, please refer to the previous section.

3-1 Principle of operation

The L1C platform incorporates a LaserBoxx laser source (LBX, LSX, LCX or LPX models) and offers an additional functionality.

- The L1C-MPA models feature a motorized power attenuator (MPA), enabling users to adjust the delivered power while maintaining the spectral characteristics of the optical signal.
- The L1C-ISO models include an optical isolator, ensuring the source operates consistently, even in the presence of a specified amount of optical feedback.

3-2 How to operate the L1C

Most of the procedures described in this chapter rely on Oxxius' graphical user interface (GUI); refer to chapter 4-2 for a description of this GUI.

HOW TO POWER UP THE SOURCE AND RELEASE THE EMISSION

- Connect the power supply to your mains socket.
- Turn on the power switch on the controller (on the back panel of the ControlBoxx, or on the front panel of the RemoteBoxx). The laser head then begins to stabilize the temperature of its inner elements, and communication becomes accessible (over RS-232 or USB). On the ControlBoxx, the optical power is displayed.
- Close the interlock circuit. At this purpose, you can use the dedicated mating connector and shunt wire.

DANGER	**IMPENDING LASER EMISSION**
	Before proceeding further, please ensure that the appropriate safety measures are in place to guarantee the safety of any personnel potentially exposed to laser radiation. Please refer to section 1, "Safety Information", for a list of recommendations.

- Turn the emission key clockwise until the end stop. The laser emission indicator lights up in solid white, which indicates that the laser is armed. The start-up sequence will also begin, which may take up to ten minutes. During this time, status indicator will blink in green. Refer to the next paragraph if your model is from the "S" series.

Note that even if the start-up sequence is immediate, a six-second safety delay is still enforced between the moment the key is armed and the actual release of the emission.

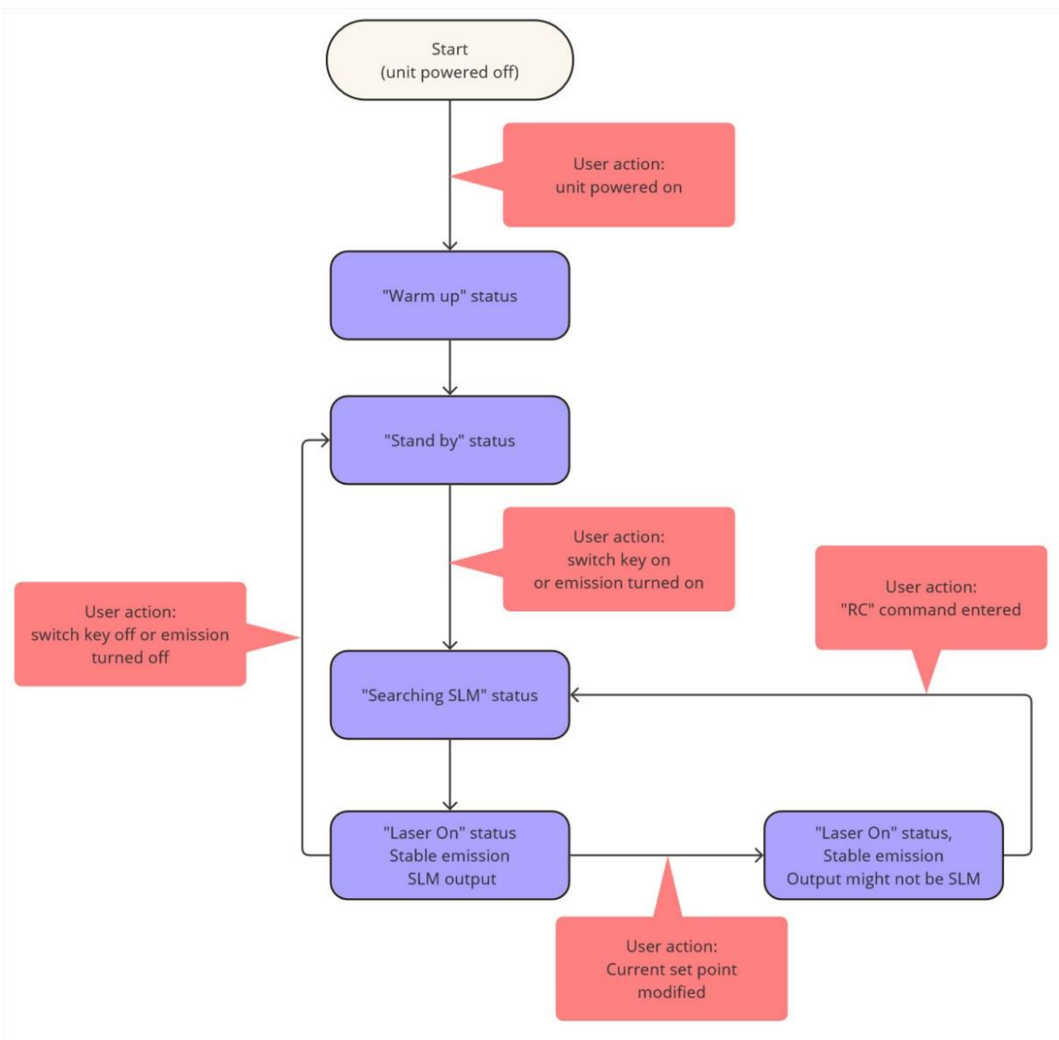
Once the status indicator has turned in solid green, the laser is emitting steadily. If a manual shutter is present on the laser head, release the beam by rotating the lever to its "Open" position.

SPECIFIC START-UP SEQUENCE ON THE "SLM" MODELS

These models deliver a laser output that consists in a single longitudinal mode (also referred to as "SLM"). Refer to chapter 2-1, "Part numbers".

In order to ensure the single longitudinal mode, the emitter's operation must be carefully controlled. Consequently, the start-up sequence on these lasers encompasses specific steps, as detailed in the following status chart:

Figure 3-1: Startup sequence on a "SLM" LBX model



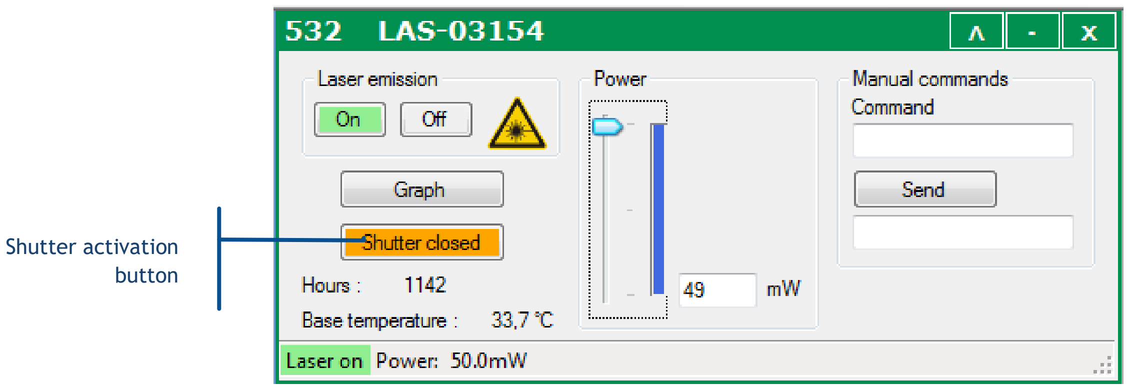
The step “Searching SLM” is meant to result in a stable emission and a single longitudinal mode output.

NOTES

- On LBX models, the value of the current is an important factor in completing the start-up sequence. By default, the nominal current (100%) is the only guaranteed value resulting in an SLM emission.
- While it is possible to modify the current while in operation, we recommend re-running the start-up sequence in order to ensure a stable and SLM emission. This is done by entering the command “RC”.

HOW TO OPERATE THE SHUTTER AND RELEASE THE EMISSION

The shutter can be activated by the laser head or by a remote control, depending on the option ordered. To activate it, open the control window and locate the shutter activation button (as shown in the illustration below)



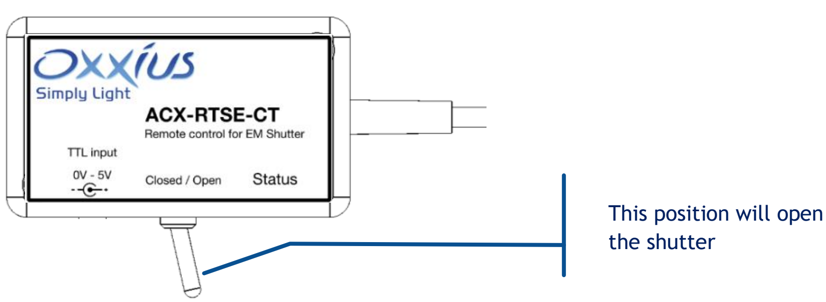
The text on the button describes the current state of the shutter. Press the button to modify this state (open or closed).

NOTE

For safety reasons, operating the shutter is only possible when the emission is stabilized (“Laser on” state).

SHUTTER LINKED TO A REMOTE CONTROL

- Use the control switch to open or close the shutter, as indicated on the label. Note that the Status LED is lit in solid white as the switch is in open position.



Note that the Status LED will lit in solid white as the switch is in “Open” position.

HOW TO POWER DOWN THE L1C

Here is the normal sequence to turn the emission off and shut down your source:

- Close the shutter (using a manual shutter: rotate the lever to “Close”),
- Turn off the emission by rotating the emission key anti-clockwise,
- Turn off the power switch on the controller. RS-232 and USB communication will no longer operate.
- Disconnect the power supply from your mains socket.

HOW TO SET THE POWER LEVEL

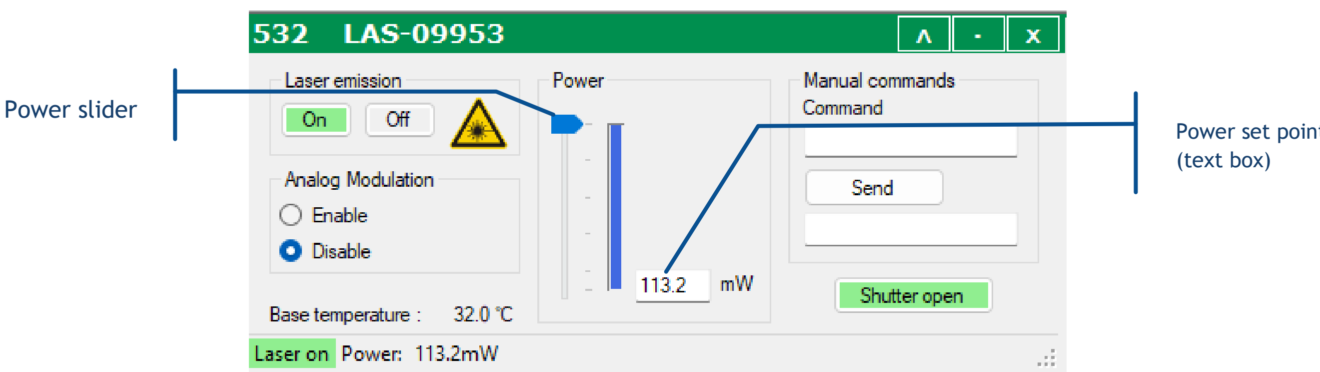
The power is modified by the MPA (if present), in a manner that does not induce mode hops.

MANUAL TUNING FROM THE CONTROLBOXX (IF IN USE)

Ensure that the source selector on the front panel is set to “Local”. Then, turn the front knob to change the power setpoint.

- A clockwise rotation increases the power,
- Each turn represents approximately 10% of the nominal power,
- The monitored power displayed on the LED panel should change accordingly

USING THE GRAPHIC USER INTERFACE



- Locate the slider that controls the current setpoint in the command window.
- Enter a new setpoint in the text box and press the Enter key to confirm.
- Alternatively, you can click and drag the slider to a new value. The text box below should reflect this new value.

EXTERNAL MODULATION FUNCTIONS

Using these functions, the optical output can be modulated according to incoming electrical signals.

ANALOG MODULATION

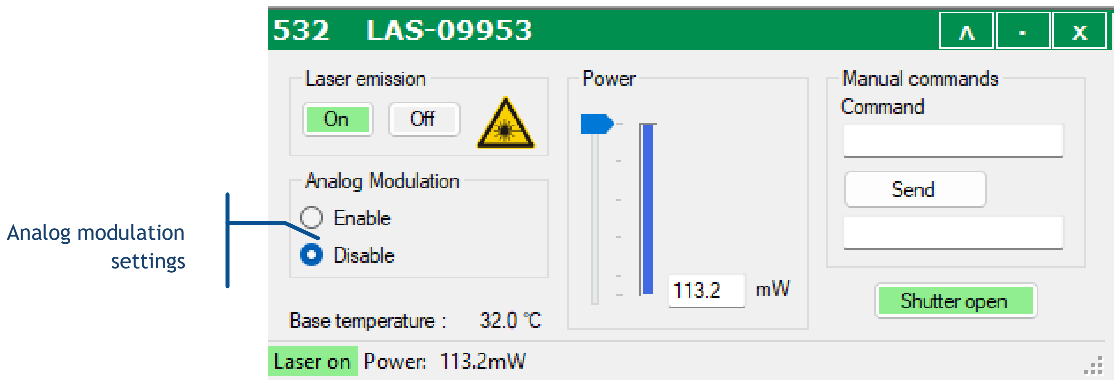
Using this function, the output power will vary in a linear way against the analog voltage applied to the LaserBoxx.

Where to apply the signal

Apply your signal on the BNC socket at the back side of the ControlBoxx. Make sure to switch the source selection to "Analog In".

How to enable this function

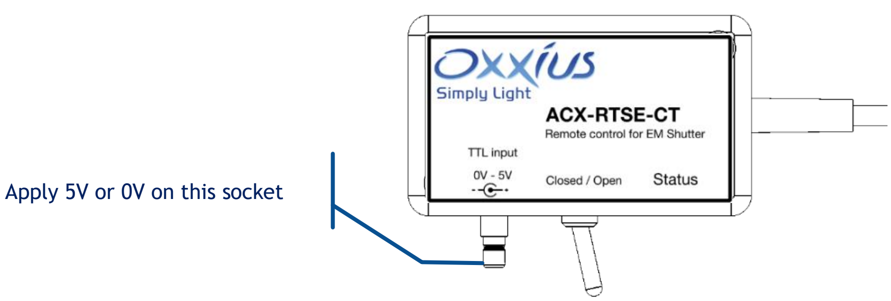
From the GUI, select "Analog modulation: Enable".



DIGITAL MODULATION

If available, this function allows for binary ("on" / "off") modulation driven by a 5V signal. Refer to the specifications of your L1C for exact speed and modulation characteristics. Apply a voltage on the center terminal of the SMB socket to operate the shutter. The switch must be in the "Close" position.

- A voltage of +5V opens the shutter. The Status LED is then solid white.
- A 0V voltage closes the shutter. The Status LED is then off.



4. ADVANCED OPERATIONS

This section offers comprehensive details on the accessories and options, as well as on alternative control methods for the laser source.

4-1 Fiber-coupling options

These options are designed to inject the output laser beam into the core of an optical fiber which then guides the optical signal along.

A fiber-coupling option is composed of an injection component (or “fiber coupler”), fixed to the laser head, to which a patch cable is attached. The following options are available for coupling on specific types of fiber:

- FC-MM indicates a coupling option over a multimode fiber,
- FC-SM indicates a coupling option over a single mode fiber,
- FC-PM indicates a coupling option on a polarization-maintaining single mode fiber.

HANDLING PRECAUTIONS AND INSTALLATION

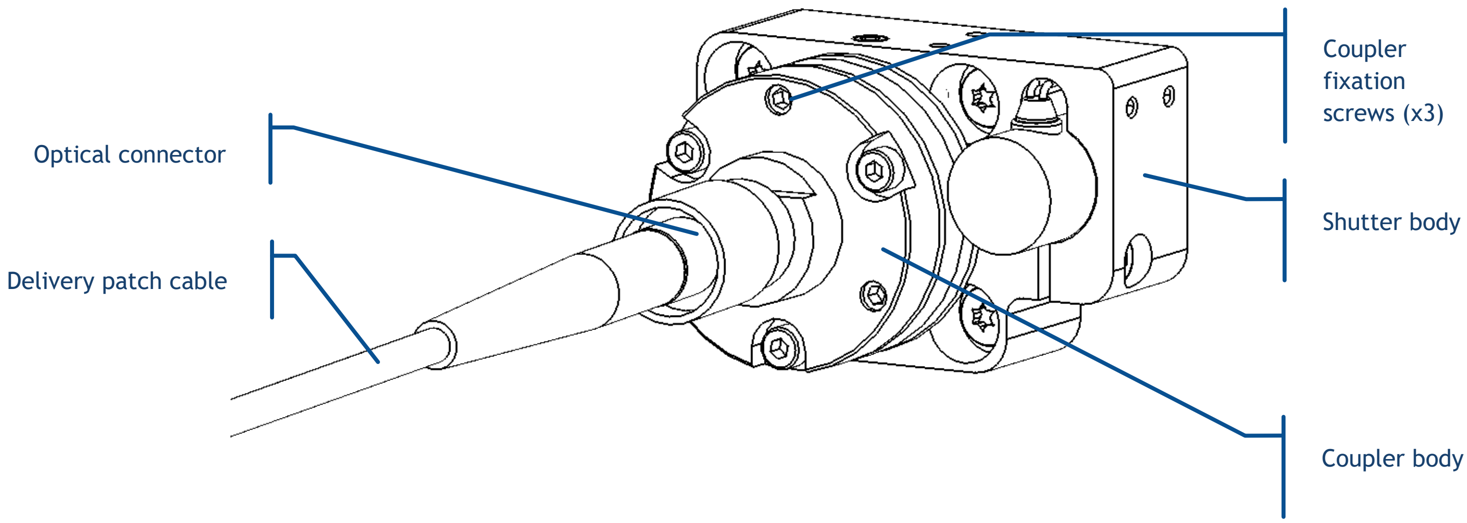
An optical fiber is made of glass and is a fragile piece of equipment. It is generally sheathed inside a patch cable, terminated by optical connectors on both ends. It is important to handle these components with care, as they should not be bent nor receive mechanical damage (shear stress, punching, etc.).

The user is expected to handle the patch cable with care, but also to have the necessary tools and knowledge to inspect and clean the end tip of the fiber. These tools are:

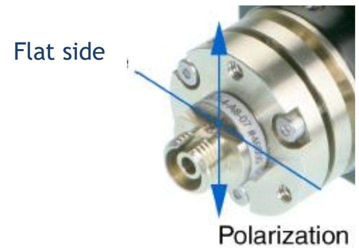
- A specific scope to inspect the end tip of the fiber. We recommend using a 200x magnification device, as the “FS201” available from www.thorlabs.com
- Some consumables to clean the optical connectors: some lens cleaning tissue, some pure ethanol (or isopropyl alcohol) and a CLETOP tool (“A” type) from NTT-AT.

INSTALLATION

- In most cases, the fiber coupler is housed inside the shutter body and aligned with the output beam (refer to the figure above). The patch cable is attached to the fiber coupler.



- On polarization-maintaining coupling devices: the orientation of the coupler determines the orientation of the polarization of the signal being injected. On a standard assembly, the flat side (indicated in the following picture) is perpendicular to the direction of the incoming polarization



- Should the shutter no longer be fixed to the laser head or the coupler no longer be aligned with the beam, please contact your local Oxxius representative.

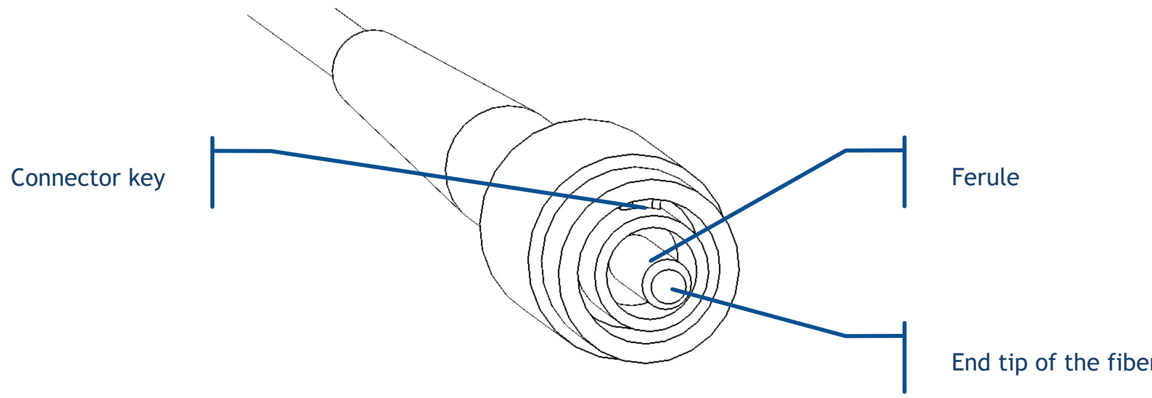
NOTE: The coupling efficiency can be altered once the laser head has been fixed to its support, especially with single mode fibers. As a result, it is often necessary to make fine adjustments to the injection after the laser head has been fixed.

ROUTINE MAINTENANCE

- If the fiber is not in use (or the patch cable is not terminated), ensure that the connector at the far end of the cable is protected (cap closed).
- Whenever an optical connector is being pulled out from its adapter, inspect the ferrule using an inspection microscope and clean it if necessary (refer to the detailed procedure below) before securing it back into another adapter.

CLEANING PROCEDURE FOR OPTICAL CONNECTORS

1. Check the circumference of the ferule, where metal dust often accumulates. Clean any dirt using lens-cleaning paper soaked in alcohol.



DANGER

Prior to viewing the optical connector and the delivery end of the fiber, please ensure that the laser source is unable to emit (emission key turned off, or power supply off).

2. Use the microscope to view the end face of the ferrule and the tip of the fiber.
   - If some particles (foreign material) are visible, wipe the ferule on the CLETOP to remove them from the surface. Refer to the user manual of this tool for detailed guidance.
   - If numerous or large particles are present, it may be necessary to first wipe the ferrule on a sheet of lens cleaning paper. Fold the paper to create a sufficiently soft layer. Soak it in alcohol, then gently scrub the ferule in it. For oily or stubborn materials, use acetone instead of alcohol.
     Finish the cleaning using the CLETOP.
   - Note that the presence of scratches or shards near the fiber core is damage that cannot be repaired with these methods. If you require assistance in polishing the optical connector, please contact your Oxxius representative.

TROUBLESHOOTING WITH THE FIBER INJECTION

Refer to chapter 5-2, “Recovering missing power”.

4-2 How to use the monitoring application

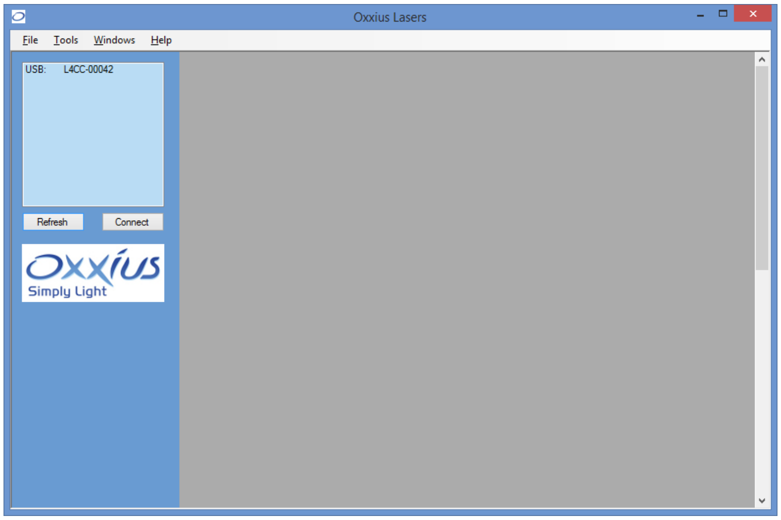
APPLICATION TOUR

DEVICE DETECTION

Connect your L1C to your computer using RS-232 or USB, then launch the executable file “Oxxius laser”. The window on the left lists the detected devices upon startup.

- Note that a unit connected through USB appears automatically on the laser list.
- A unit connected through any RS-232 port must be scanned manually. This is the purpose of the "Refresh" button located on the bottom left of the frame.

Figure 4-1: “Oxxius laser” start-up window



Each laser is identified on the list by its communication port, model, emission wavelength and serial number. To connect a laser, select it from the list and click on the “Connect” button. Alternatively, double-clicking on a listed laser opens its control panel.

DESCRIPTION OF THE CONTROL WINDOW

When expanded, the control window includes the following elements:

- “On” and “Off” buttons to control the laser emission,
- A pictogram warning about the laser radiation,
- A button to display some of the operational data on a chart,
- A button to control the output shutter,
- Some indicators displaying the monitored temperature and the cumulated emission time,
- A box and a slider to modify the output power,
- A command console to send software commands and queries,
- A status bar to indicate the laser status and the output power.

Figure 4-2: Control panel of a L1C based on a LBX or LSX model

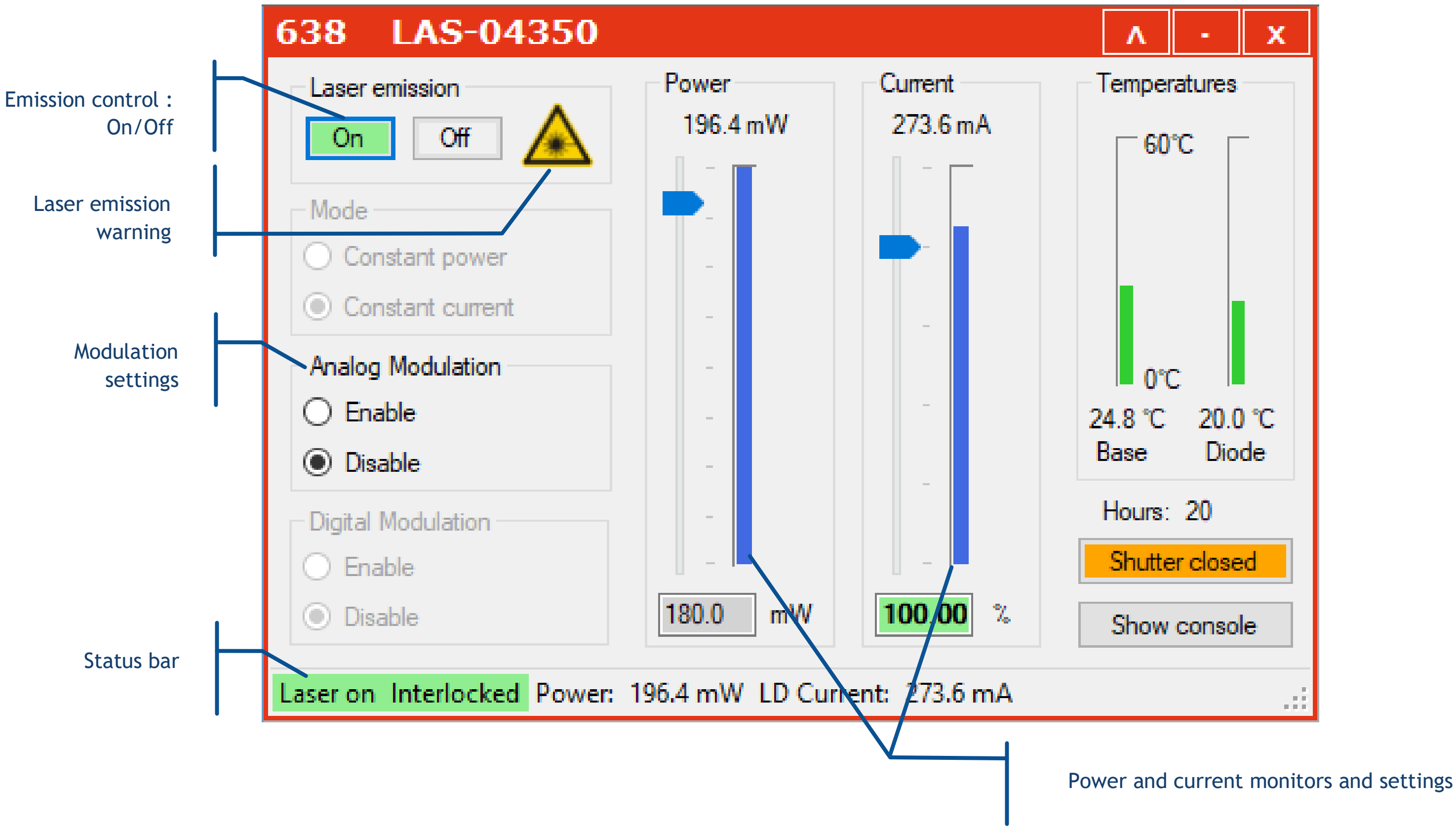
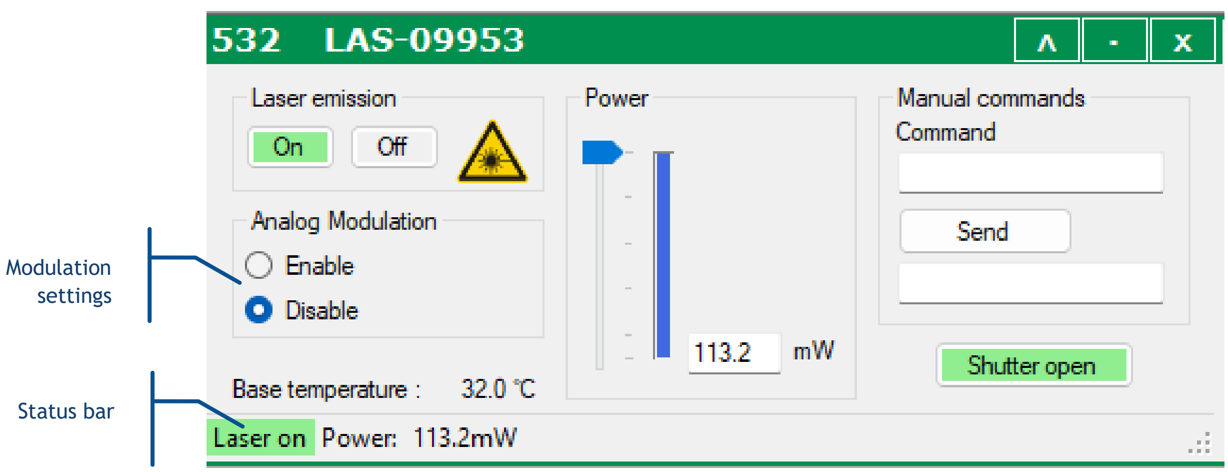


Figure 4-3: Control panel of a L1C based on a LCX or LPX model



The layout depends on the laser model and may slightly differ compared to the above illustrations.

TYPICAL USAGE OF THE CONTROL PANEL

Once the laser source is connected, then the user can click the "Emission On" and “Off” buttons to start or stop the emission. This will have an effect over the actual laser emission only if the key switch had been turned on too.

Once the laser emission is stabilized, clicking on the “Shutter” button will operate this former.

The output can be adjusted (if this adjustment is possible) by displacing the slider or by entering a new power set point into the text box.

SENDING QUERIES AND COMMANDS

Software queries and commands can be entered via the command box:

- If the command box is not visible, press the “Show console” button to make it appear.
- Type your query in the provided box and validate it by pressing the “Enter” key or by clicking the “Send” button.

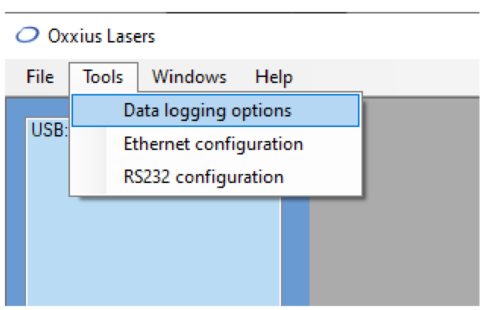
The requested unit will provide an answer in the text box below. An acknowledged command will result in the string “OK” being returned, or in the same command echoed back. For example, “P 50” will result in the answer “P=50.0”. If a syntax is not understood, the sequence "????" will be returned.

Please refer to chapter 7-1 for the list of these commands.

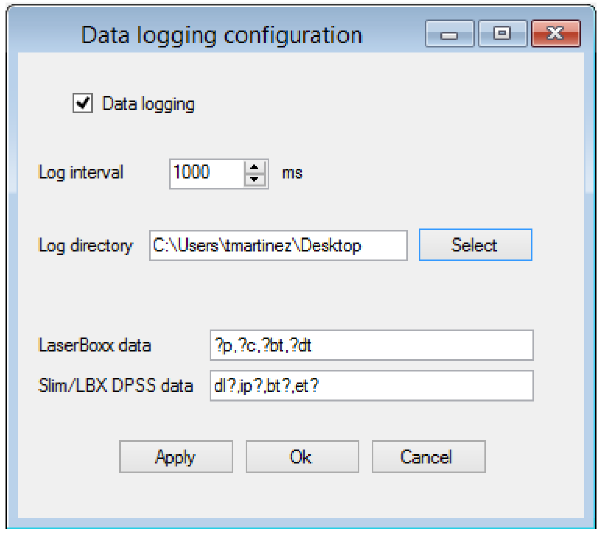
DATA LOGGING AND CHART DISPLAY

Data logging is a function that allows the user to record the functional status of the laser source over time.

Prior to use, this function must be configured: click on the “Tools” menu and select “Data logging options.”



This opens a separate configuration window:



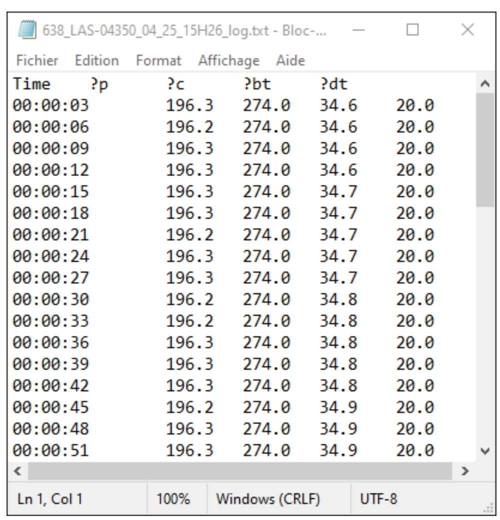
The following elements are present inside this window, from top to bottom:

- To activate (or deactivate) data logging, please tick the box called “Data logging”.
- The “log interval” determines how often the unit is polled for data. The default value is “1000 ms”.
- The “log directory” is where the record file will be created and data will be saved. Click on the “Select” button to change this directory.

NOTE: This location must be a directory for which you have the appropriate rights (file creation and write access). Failure to do so will result in an error when the record is launched.

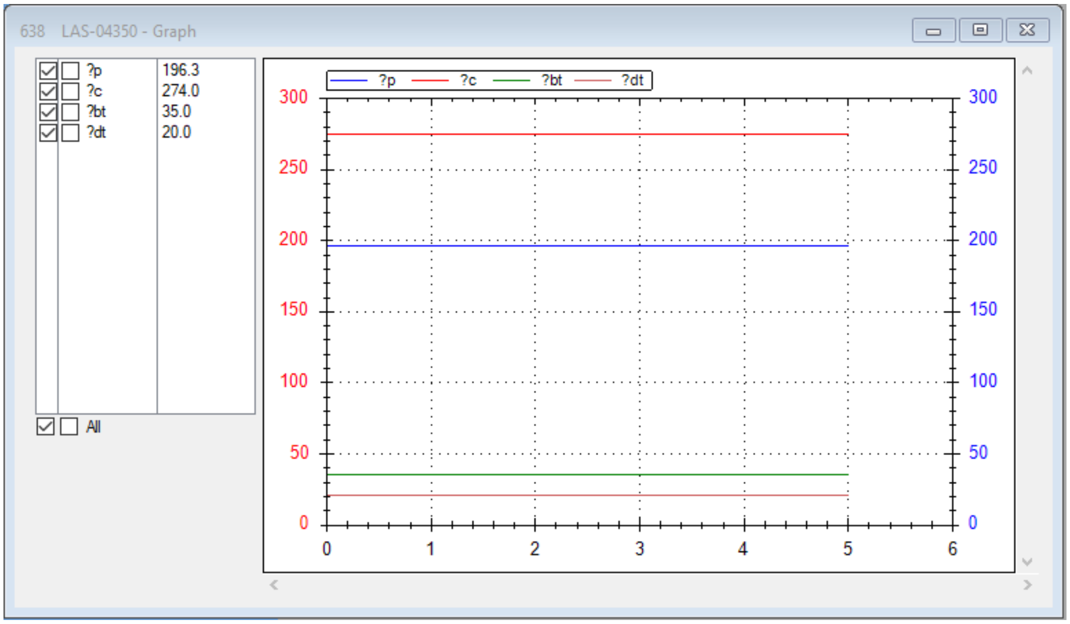
- The two following boxes contain the set of queries the laser sources will be polled for.
    - Fill the box named “LaserBoxx data” with queries you need to record.
    - The separator is a comma “,”.

Once you have completed the process, please click the "OK" button. This will create a file named `COM`**`XX`**`-LBX-`**`MM_DD_HHHH`**`_log` in the record directory. The "XX" represents the number of communication ports, which should match the number displayed in the laser list. The "MM" is the current month, "DD" is the current day, and "HHHH" is the current time. The record's syntax is plain text, allowing it to be opened by any text editor.




```
Time      ?p       ?c       ?bt      ?dt
00:00:03           196.3    274.0    34.6     20.0
00:00:06           196.2    274.0    34.6     20.0
00:00:09           196.3    274.0    34.6     20.0
00:00:12           196.3    274.0    34.6     20.0
00:00:15           196.3    274.0    34.7     20.0
00:00:18           196.3    274.0    34.7     20.0
00:00:21           196.2    274.0    34.7     20.0
00:00:24           196.3    274.0    34.7     20.0
00:00:27           196.3    274.0    34.7     20.0
00:00:30           196.2    274.0    34.8     20.0
00:00:33           196.2    274.0    34.8     20.0
00:00:36           196.3    274.0    34.8     20.0
00:00:39           196.3    274.0    34.8     20.0
00:00:42           196.3    274.0    34.8     20.0
00:00:45           196.2    274.0    34.9     20.0
00:00:48           196.3    274.0    34.9     20.0
00:00:51           196.3    274.0    34.9     20.0
```

Additionally, the logged parameters can be visualized in real time by entering "graph" in the command console. This will open a separate window displaying the recorded parameters as plots against time (on the abscissa).



The frame on the top left lists the parameters that were polled for and their current values.

- Tick on the leftmost box of a line to have the corresponding plot to appear the left axis. Tick on the right box to have the plot to appear on the rightmost ordinate axis.
- Using the left mouse button, click and drag inside the plot frame to zoom over that area.
- To access the dedicated menu for zoom and display, simply click the right mouse button inside the plot frame. To view the value of a nearby point, simply leave your mouse pointer over one of the plots.

4-3 Resources for developers

Software resources are available for users who wish to develop their own control program.

COMMUNICATION LIBRARIES AND EXAMPLE PROGRAMS

The USB Flash drive included with each unit contains the following resources for developers:

- A USB library to drive the LaserBoxx. It can be used with either Visual C++, Visual C#, Visual Basic, Labview or any other languages supporting ".NET" libraries. The documentation for this library is available in the file "LaserBoxxUsbHelp.chm".
- An application program based on Labview

RS-232 COMMUNICATION

Please refer to the following tables for the parameters for RS-232 communication. To avoid leakage currents and potential damage to the equipment, we recommend connecting the power supply of the laser head (or its controller) and the power supply of the communicating equipment to the same electrical network.

Table 4-4: communication parameters of the RS-232 communication

Bit rate	115200 bauds
Data bits	8
Parity	None
Stop bit	1
Flow control	None

Table 4-5: Syntax for queries and commands

		Acknowledgement
Query	?QUERY<LF>	QUERY=TXT<CR><LF>
Command	COMM AND=TXT<LF> or COMMAND TXT<LF>	COMMAND=TXT<CR><LF>

"Command" is a string of ASCII character, <CR> stands for the "Carriage Return" ASCII code 13, and <LF> stands for the "Line Feed" ASCII code 10.

Refer to chapter 7-2 for a list of commands.

USB OPERATING IN VIRTUAL SERIAL PORT

The USB port can be configured as a virtual serial port. To proceed, send the command "CDC 1" (CDC, <space>, 1) to your unit, then proceed to a "cold" restart by toggling its power supply off and on.

The command "CDC 0" reverts this setting.

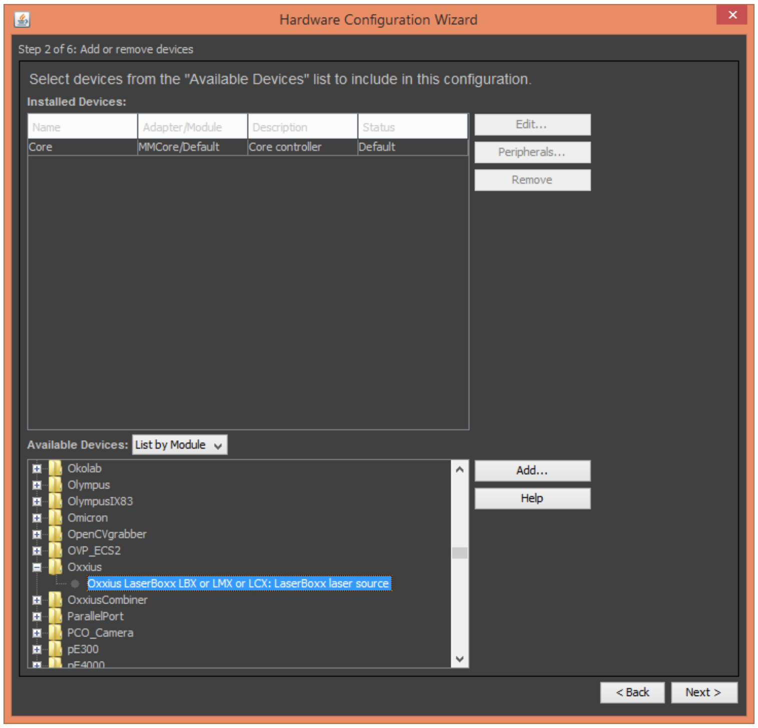
INTERFACING WITH MICROMANAGER

The L1C are supported by Micro-Manager, the open-source microscopy software. For detailed information, please visit the following URL:

https://micro-manager.org/wiki/Oxxius

Communication with a L1c via Micro-Manager is achieved through serial communication. One possibility is to convert the USB port of you L1C into a virtual serial port; please refer to the previous paragraph for detailed instructions about this procedure. Alternatively, refer to chapter 2-4 for instructions on how to communicate with the L1C using its RS-232 port.

Once your L1C is connected to your PC, take note of the COM port being effectively used by the L1C by using Windows' Device Manager. Execute MicroManager and open the "Hardware Configuration Wizard" to detect and configure your L1C: amongst the available "Devices", select and add one "Oxxius LaserBoxx" as illustrated below.



Press "Next" to proceed to the COM port configuration. Enter the COM port of your L1C and also the communication parameters specified in table 4-4. Continue through the Wizard process until it is finished.

4-4 Operating the laser using an electronic interface

The L1C can be driven using electronic signals, in order to facilitate in order to facilitate its integration into larger systems.

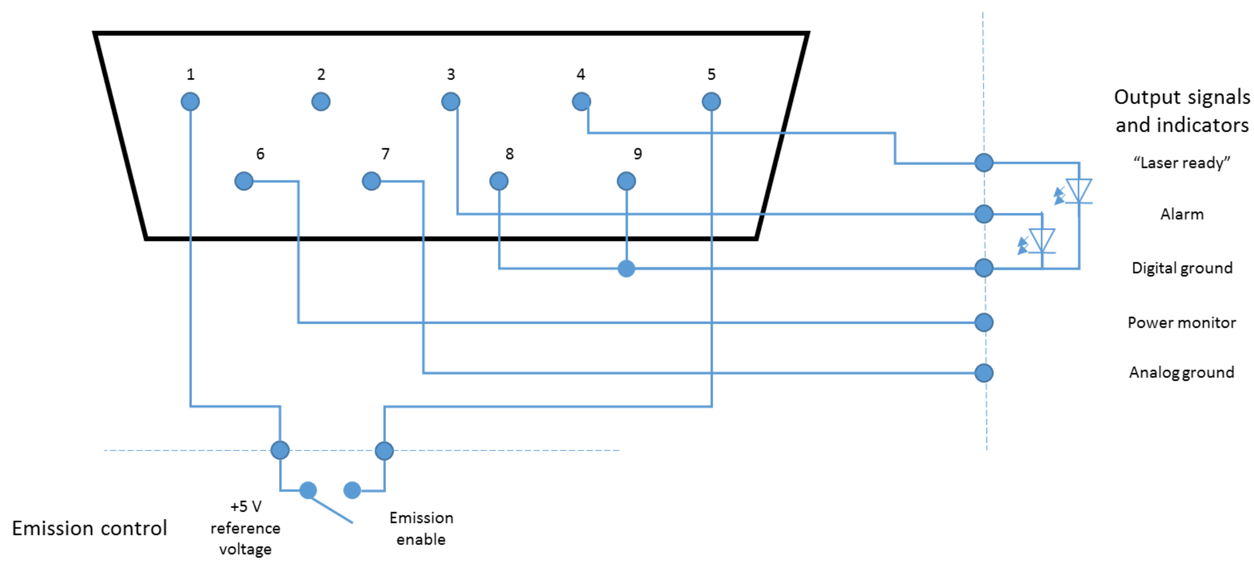
INTERFACING WITH THE CONTROLBOXX

Here are the signals present on the "Input/Output" interface of the ControlBoxx:

Table 4-6: Pin assignment of the ControlBoxx interface

Pin number	Signal name and function	Direction	Description	Drive or load
1	Reference voltage	Output	+5V DC. Use this reference to drive your inputs on this I/O port	100 Ω
2	Not connected	-	-	-
3	Alarm TTL low: Normal TTL high:Default	Output	Indicates the presence of an alarm. A LED can be connected directly to this output	610 Ω for a LED connection (5 mA)
4	“Laser ready” TTL low: Laser not ready TTL high: Laser ready	Output	Indicates that the laser source is ready for emission. A LED can be connected directly to this output	610 Ω for a LED connection (5 mA)
5	“Laser enable” TTL low: Emission off TTL high: Emission on	Input	Enables or disables the emission.	3 kΩ Internally pulled-up
6	Optical power monitor Delivers a voltage between 0 and 2V.	Output	The voltage is proportional to the optical output. Note that the maximum voltage can vary between units.	2.5 kΩ
7	Analog ground	Ground	Analog ground of pin number 6	
8, 9	Digital Ground	Ground	Digital ground for TTL signals	

The following diagram presents an example of interfacing:



INTERFACING WITH THE LASER HEAD

For integration purpose, it is possible to interact directly with the L1C head using its electrical interface. Refer to chapter 7-2 for detailed information about this interface.

5. TROUBLESHOOTING

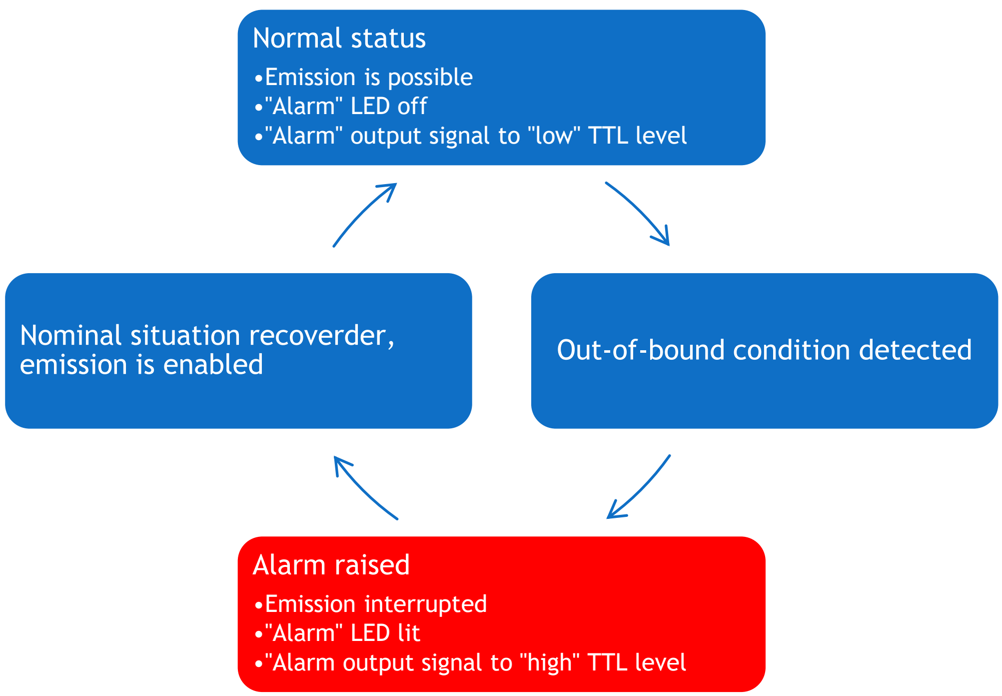
5-1 Operating Status and alarms

An alarm is a status indicating that certain operational conditions are off-limits. When an alarm is raised, laser operation is not possible until the cause of the alarm is fixed. To resume emission, the unit must be reactivated by the emission key.

The user is informed of the alarm status in one of the following ways:

- the “Alarm” LED is lit in solid red on the controller,
- the alarm electrical signal is raised on either electronic interface (on the LaserBoxx or either controller),
- the software query “AL?” returns the specific identification of the alarm

Transition to and from the alarm status is summarized in the following chart:



Please refer to the following table for a detailed overview of the potential sources of alarms and recommended measures.

Table 5.1 Alarm status detailed

Alarm	Cause of the alarm	Required action
Power supply alarm	The DC supply voltage is outside its limit range	Check the supply voltage using the command “VA?”. Measure the actual voltage at the unit’s supply terminals. Refer to your unit’s specifications for allowable voltage ranges.
Laser head temperature alarm	The base temperature of the laser head is outside its nominal range	Check the installation of the laser head (section 3), in particular the effectiveness of the heat dissipation beneath the base plate. Refer to the specifications for allowable temperature ranges
Interlock alarm	The interlock circuit is open	Check the continuity of the interlock circuit.

HOW TO RESUME POWER AFTER AN UNEXPECTED INTERRUPTION

When an alarm is triggered, the interlock circuit is opened or the power supply is shut down, the emission is then interrupted in a manner that is considered “unexpected”.

DANGER	RISK OF EXPOSURE TO RADIATION
	When in doubt what caused the emission to be interrupted, it is highly recommended to turn off the emission key before any investigation. Otherwise, the radiation may be restored before the user(s) could anticipate it.

In order to restore the operation of the L1C, the following conditions must be met:

- The power supply must be restored to its nominal value,
- The remote interlock circuit must be closed,
- Any internal alarm must be cleared. To proceed, either
  - Open the software interface and press the button labelled ‘Reset’, or
  - send the software command “DL 0” to the L1C

The conditions for the emission to be restored also depend on its laser classification:

- A class 3B laser source will resume its emission immediately as soon as the last blocking condition listed above is cleared.
- A class 4 laser source will not resume its emission even after the blocking conditions above are all cleared. The user must first set the key switch in the "OFF" position before proceeding to the power-on sequence.

ISSUES RELATED TO THE SUPPLY VOLTAGE

It is important to note that a non-suited power supply may impair the operation of the laser unit. In particular, an undersized power supply may result in a drop in the supply voltage during operation, which is detected as insufficient and is indicated by an alarm. Another possible consequence of an insufficient supply power is an unstable optical output. To ensure that the voltage supplied to the laser unit is sufficient and stable, use the query "VA?" to check the measured voltage. For detailed instructions about sending software queries, please refer to chapter 4-2.

5-2 Recovering missing power

This paragraph refers to models that are coupled to an optical fiber. If the performance of the injection is below the original specifications, please check the following points in order:

FIBER CONNECTORS

- Check the cleanliness of the connectors and clean them if necessary (refer to chapter 4-1, paragraph "Cleaning procedure"),
- If the connector is damaged, replace the patch cable or re-polish the connector.

FIBER COUPLER

- Perform the "thumb test" (refer to the next paragraph "Coupling on a single mode fiber") to check that the injection on the fiber coupler is centered,

- If the injection is not centered, follow the procedure developed in the next paragraph

MECHANICAL FIXATION

In some cases, the fixation of the laser head can induce some mechanical stress that reduces the injection ratio and create an unstable coupling. To check this, loosen the screws maintaining the laser head on its support while observing how the delivered power fluctuates. To address these fluctuations, we recommend the following solutions:

- Use a mechanical support with a better flatness,
- Use a heatsink (HTSK-10) in order to improve the stability of the coupling

INJECTED POWER

The software provided by Oxxius monitors the amount of power injected into the fiber coupling. It is important to ensure that this value is sufficient in relation to the conditions listed in the manufacturing test report.

EXTERNAL ASPECT OF THE PATCH CABLE

If the delivered power is nearly nil at the delivery end of the fiber, please check the integrity of the patch cable. Marks or tight bends may indicate a severed optical fiber.

MEASUREMENT EQUIPMENT

Please verify that your power meter is set to the correct wavelength and has been recently calibrated.

5-3 How to maximize the transmission over an optical fiber

When a fiber coupling option is ordered on a L1C, its alignment is performed and tested at Oxxius' facilities. However, minor adjustments may be necessary after the system is positioned in its final location or when the optical fiber is being replaced.

The following procedure outlines the steps to maximize the coupling efficiency, defined the fraction of the laser's power actually transmitted by the fiber.

INTRODUCTION

The fiber coupling system focuses the incoming beam into the delivery fiber. In an ideal situation, the focusing point matches the size and position of the core of the fiber. Due to the small distances involved, this situation does not necessarily occur when a new fiber is installed, so that the user must tilt the flange supporting the fiber in order to displace the focusing point against fiber core the until the transmitted power is maximized.

At this purpose, the user is given access to three adjustment screws to tilt the mobile flange. In addition to that, three locking screws are used to lock the mobile flange in position once the power is maximized.

Figure 5-2: Accessible elements on a single mode coupling system

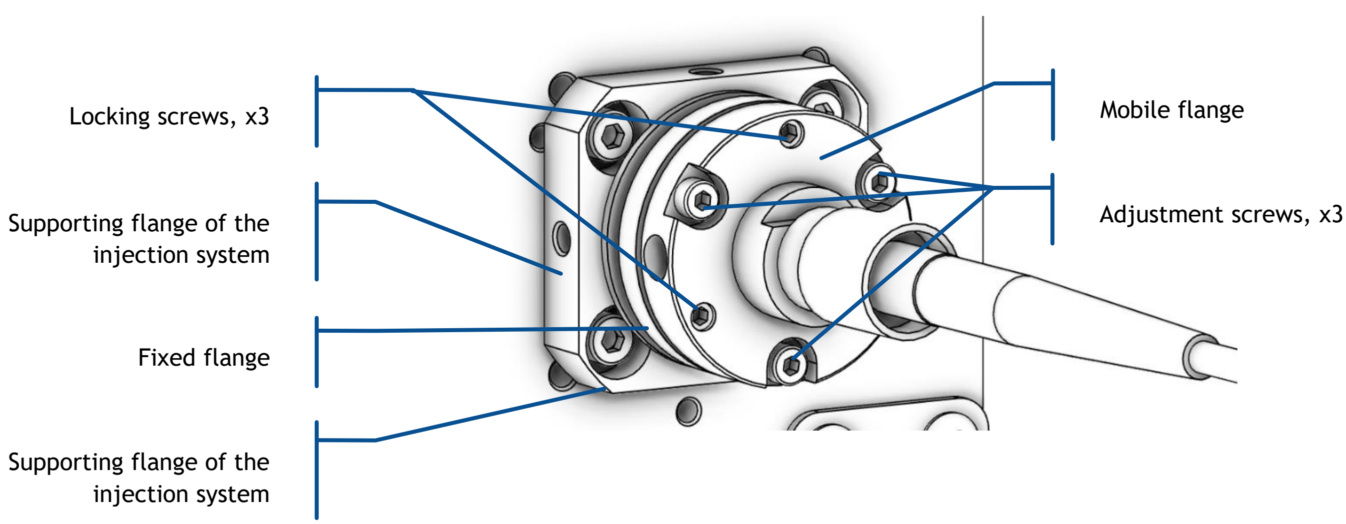
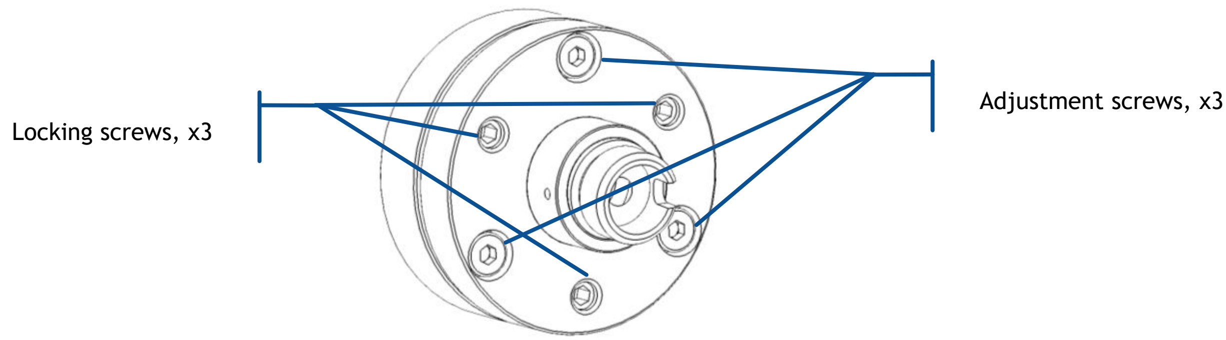


Figure 5-3: Accessible elements on a multimode coupling system



The following tools are required for the procedure. Refer also to the packing list in chapter 2-1.

- One 1.5mm hexagonal key
- One 1.2mm flat screwdriver (for single mode coupling systems only)
- An optical power-meter adapted to the range of power and wavelengths to be measured (typically a few hundreds of milliwatts from 375nm to 1064nm).

CAUTION	BEAM AND COUPLER CENTERING
⚠	In this chapter, the fiber coupling system is assumed to be properly centered against the laser beam. It is not advisable to detach the supporting flange (or the shutter body) from the front of the laser head. Please contact Oxxius should the supporting flange be detached from the laser head, as this situation requires a specific alignment procedure.

PROCEDURE

PREPARATION

- The power meter is assumed to be calibrated and set at the appropriate wavelength.

- Connect the delivery end of the fiber to your power meter and follow the standard procedure to power up the laser. Modify the set point so that the incoming power into the fiber coupling system is lower than 20mW on a single mode fiber, or 50mW on a multimode fiber.

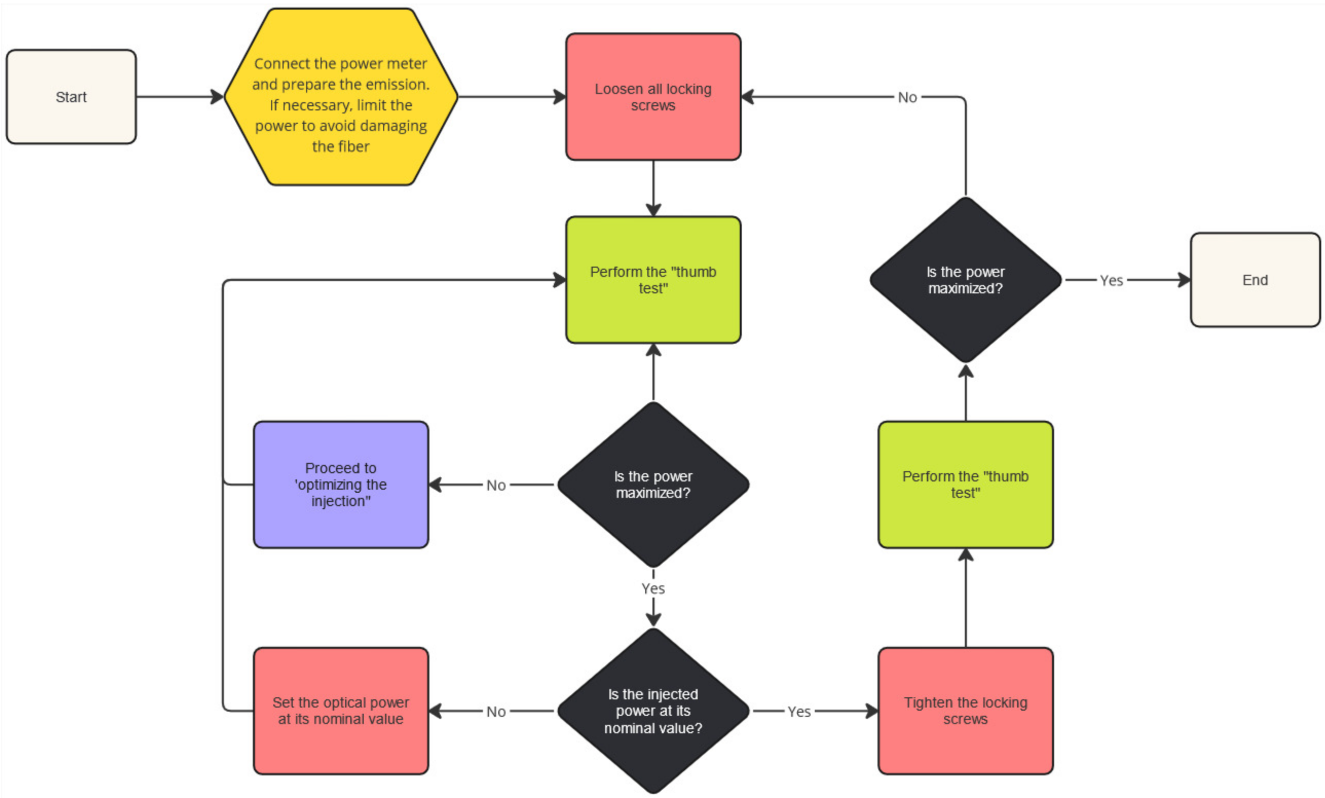
WARNING	LASER SAFETY AND RISK OF OPTICAL DAMAGE
⚠	The laser power is about to be released. From this point forward, safety measures must be implemented to prevent accidental exposure. An excessive power may damage the end tip of the fiber, particularly if the coupling efficiency is low. It is important to adhere to the recommended values above.

- Release the laser emission and check the value detected by your power meter. Please use the Maunfacturing Test Report delivered by Oxxius as a reference document.

QUICK OPTIMIZATION PROCEDURE

In this paragraph, the decrease of injection efficiency is assumed to be limited. In other words, the power at the delivery end of the fiber is still measureable and one can proceed with the thumb test.

Here is the general flow chart for restoring the injection efficiency:



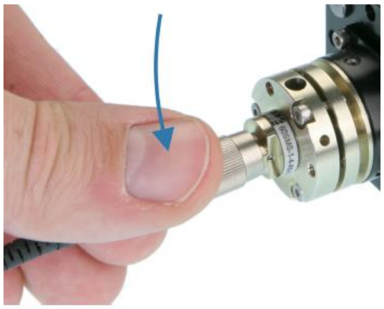
The main steps of this procedure are detailed hereunder.

LOOSENING THE LOCKING SCREWS

Use the 1.5mm hexagonal key to loosen these screws by at least two turns. The gap beween the tip of the screw and the fixed flange must be visible from the side of the coupler.

CHECKING THE ALIGNMENT: THE "THUMB TEST"

Figure 5-4: The "thumb test"



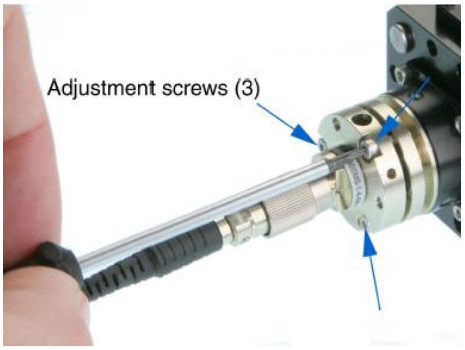
A convinient way of checking the optimal alignment consists in gently pressing the cone-shaped part (the boot) between the optical cable and the back of the optical connector. Do this in a given direction (as in figure 5-5 above), and the transmitted power should be modified. Release your pressure, and the power should return to its initial value.

- If the aligment is optimized, then pressing in any direction results in a decrease of power, while releasing the pressure restores that maximal value. This is a conclusive thumb test.
- If on the contrary the alignment is not optimized, then there exists a direction along which pressing the boot causes an increase of power.
- If the power does not significanly change when you release the pressure, then this might mean that the screws are set out of their usual adjustment range (too tight or too loose).

We advise applying gentle pressure towards each of the three adjustment screws in order to identify which of these screws has the greatest impact on maximizing the injection ratio.

OPTIMIZING THE INJECTION

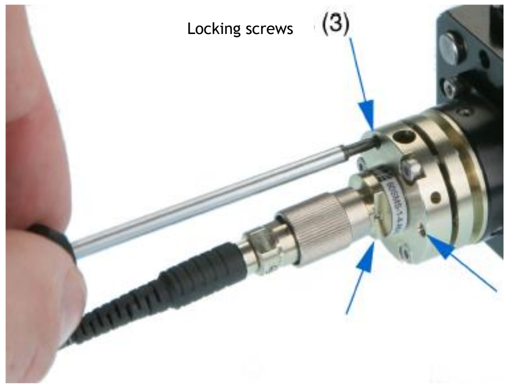
The objective of this step is to maximize the transmitted power by utilizing the 1.5mm hexagonal key on the adjustment screws.



- Select one of the screws (1) and rotate it gently in one direction or another, until the optical power reaches a relative maximum.
- Repeat the previous step with the next adjustment screw (2), and then the last one (3).
- If the thumb test is unsuccessful go back to optimizing screw 1, then screw 2, and so on. We advice that you maintain that sequence for your adjustments (1 -> 2 -> 3 -> 1 -> 2).

Persistent squeaks on a screw indicate that it is being tightened too strongly. If that is the case, loosen that screw. There is a possibility that you will also have to loosen the other screws and proceed back to the beginning of this paragraph.

TIGHTENING THE LOCKING SCREWS



The objective is to maintain the same (and now maximized) coupling efficiency while having the locking screws tightened.

- Record the value of the transmitted power, then rotate each of the the three locking screws so that they come into contact with the opposite flange.
- Select one screw (1) and tighten it gently while checking the transmitted power. The power should decrease a little bit. Proceed likewise with a second screw (2). The power should also slightly decrease.
- While watching the transmitted power, tighten the third locking screw until the power increases to a maximum. Ideally, this maximum should match the transmitted noted before.
- If that is not the case, proceed to tightening (1) a bit more, then (2), and finally (3) again until the power increases.
- If the power obtained is still far from the target power, loosen the three locking screws and proceed to the beginning of this paragraph all over again.

5-4 Issues with back reflection

An excessive amount of back-reflected light entering the laser aperture is likely to interfere with the operation of the L1C, or even damage its source. To verify that this is the cause of instability, we recommend starting the emission with the shutter closed (or using any other beam dump) and noting if the laser operates normally under this condition.

Oxxius also recommends the following precautions when working with open beam laser modules.

- When coupling the light into optical fibers, use angle-polished connectors such as FC/APC,
- Any optical surfaces in the optical path should be slightly angled to avoid back reflections. If a reflective surface must be placed at normal incidence, then the use of an isolator is required.

5-5 Uninstalling and repacking procedures

If your LaserBoxx unit does not seem to be operating correctly, please enquire by our technical support team or your local representative for support.

WARNING

Attempting to open the laser head or the controller is likely to result in damages and will void the product’s warranty.

It is necessary, for a unit to be returned, to obtain a returned merchandise authorization (RMA) from our technical support team.

The list of our local representatives can be found on our website: www.oxxius.com

The address of our headquarters is as follows:

Oxxius S.A.
4, rue Louis de Broglie
F-22300 Lannion, France
Phone: +33 296 48 70 28
Fax: +33 296 48 21 90
E-mail: service@oxxius.com

5-6 Disposal

Oxxius is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

A product labeled as follows cannot be disposed of in normal household waste

Disposal via collection points for waste electrical and electronic equipment is not permitted either. As a manufacturer, Oxxius completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

6. WARRANTY

LIMITED LIFETIME WARRANTY

During the warranty period, Oxxius will, at its option, either repair or replace product.

The Oxxius representative from whom you purchased your device should be the first point of contact when service of any kind is required for your Oxxius devices.

All transportation, insurance and freight charges associated with warranty service and repairs on Oxxius devices are the responsibility of the purchaser.

USER'S RESPONSIBILITIES

Technical specifications have to be followed by the user in order to respect the conditions for which the product has been developed. Improper electronics levels or environmental conditions (such as condensation, moisture, dust ...) will void the warranty.

LIMITATIONS OF WARRANTY

This warranty applies when this device is purchased only from Oxxius or from an Authorized Oxxius representative and is subject to the limitations set forth herein.

The following items are not covered by this warranty:

- Any damage to the device resulting from customization or modification integrating products from others manufacturers.
- Any device, whose serial number is missing, altered.
- Any repairs or adjustments made by unauthorized people.
- Any attempts to open the laser device.
- Any use in improper environmental conditions (condensation, dust …).
- Any faulty customer equipment system.
- Fiber optic patch cables and coupling optimization.
- Scratches on optical output windows or on any other optical component supplied with options due to bad cleaning method.
- Repaired or replaced parts are warranted for the duration of the original warranty period only.

THE FOREGOING CONSTITUTES THE ONLY WARRANTY WITH RESPECT TO THE PRODUCT AND IS MADE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS.

OXXIUS makes no warranty of any kind with regard to the information contained in this guide, included but not limited to, implied warranties of merchantability and suitability for a particular purpose.

7. TECHNICAL DOCUMENTS

This section lists the software commands and as well as the mechanical drawings of the laser head and the controllers.

7-1 Software commands

COMMUNICATION AND IDENTIFICATION

Purpose	Command	Syntax and result
Configuration of the USB port: standard or virtual serial port. A cold reboot of the laser is required once this parameter has been modified.	CDC	`CDC 0` (CDC,<space>,0): Standard USB `CDC 1` (CDC,<space>,1): USB port configured as a virtual serial port
Retrieves the configuration of the USB port	?CDC	"`0`" Standard USB "`1`" USB port configured as a virtual serial port
Retrieves the unit's serial number	?HID	"`LAS-XXXXX,llll`", where XXXXX is a five-digit number and llll is the emitted wavelength
Retrieves the type of laser	INF?	"`LCX-532-50`" for a 50mW LCX emitting at 532nm
Retrieves the version of the embedded software	?SV	"`1.6.8`" for a firmware version 1.6.8

CONFIGURATION AND STATUS

Purpose	Command	Syntax and result
Retrieves the temperature of the base plate of the L1C (expressed in Celsius degrees)	?BT	"`22.1`" for a baseplate at 22.1°C
Retrieves the cause of the latest alarm (see section "Troubleshooting" for more information about alarms)	?F	"`0`" : No alarm "`1`" : Out-of-bounds diode current "`2`" : Out-of-bounds output power "`3`" : Out-of-bounds supply voltage "`5`" : Baseplate temperature "`7`" : Interlock "`8`" : User-generated alarm (using the command RST)
Retrieves the laser operation time, in hours	?HH	"`49`" for 49 hours of cumulated operation time.
Retrieves the status of the interlock circuit	?INT	"`0`" Interlock open, laser emission is not authorized "`1`" Interlock closed, laser emission is authorized
Measures the voltage suppling the laser head (expressed in Volts)	?IV	"`6.601`" for a voltage of 6.601 Volts
Queries the state of the laser module	?STA	?STA returns a number corresponding to one of the following status: "`1`" : Warm-up phase

(see section “Troubleshooting” for more information concerning the laser status)		“2” : Stand-by (no emission) “3” : Emission On “5” : Alarm present “6” : Sleep mode “7” : Searching for SLM point
Re-initialize the unit	RST	`RST 0` (RST,<space>,0) Resets the microcontroller
Switches the source to “Sleep mode”, thus greatly reducing consumed power. A complete start-up sequence is required after recovering from the “Sleep mode”.	T	`T 0` (T,<space>,0): turn the emission off and switches the source to “Sleep mode” `T 1` (T,<space>,1): recovers from sleep mode and resumes the emission on
Retrieves the status of the temperature regulation loop	?T	“0” Temperature regulation loop is deactivated “1” Temperature regulation loop is activated

OPERATION

Purpose	Command	Scope	Syntax and result
Sets the laser diode current to a new value. “C” also updates the default value (used on startup). “CM” does not update the default value, thus sparing stress on the internal EEPROM. Values must range between 0% and 125%.	C CM	LBX and LSX only	`C 40` (C,<space>,40) sets the optical power at 40% of the nominal current, and updates the default value. `CM 12.5` (CM,<space>,12.5) sets the optical power at 12.5% of the nominal current, but does not update the default value used on startup.
Retrieves the monitored current of the laser.	?C	LBX and LSX only	“550.4” for 550.4 mA
Control of the laser emission	DL	Any model	`DL 0` (DL,<space>,0): switches the emission off `DL 1` (DL,<space>,1): switches the emission on `DL 2` (DL,<space>,2): switches the emission on at low power for optical alignment purpose (on LCX and LPX models only)
Retrieves the emission status	?L	Any model	“0” Emission is off “1” Emission is off “2” Emission is on at low power
Modifies the power set point (for models that accept power adjustment)	IP	Any model	`IP 100` (IP,<space>,100) sets the optical power at 100% of the nominal power. `IP 50` (IP,<space>,50) sets the optical power at 50% of the nominal power.
Get the laser’s output power (in milliwatts)	?P	Any model	“53.6” for a power of 53.6mW
Opens or close the electro-mechanical shutter	SH	Any model	`SH 0` (SH,<space>,0) Closes the shutter `SH 1` (SH,<space>,1) Opens the shutter

Retrieves the laser's power set point (in milliwatts)	?SP	Any model	"40.0" for a set point of 40.0mW

After having received and successfully processed a command, the L1C returns an acknowledgement message: "OK".

If the entered command or query is not understood by the unit, the following error message is returned: "????"

7-2 L1C electrical interface

It is possible to interface directly with the laser head using the electrical interface on its rear panel.

Warning

Using the laser head without its controller is equivalent to using the laser as an OEM part. The OEM version is intended for integration into a larger system supervised by the user and should therefore not be used "as is" in another environment such as a laboratory. The equipment into which the laser is integrated must comply with the laser safety standards listed in section "Warranty and certification".

Oxxius bears no responsibility in any lack of compliance with safety standards of the environment in which the L1C is used without its controller.

Here are the signals present on this interface:

Pin #	Name, function	Type	Description	Drive or load
1	Emission key Actuated key master control	Input	TTL Low = No emission is possible TTL High: Laser emission is armed on class 3B laser sources TTL rising edge : Laser emission is armed on class 3B and class 4 laser sources	LCX/LPX models: 100 kΩ pulled down LBX/LSX models: 10 kΩ pulled down
2	Laser Enable	Input	TTL Low = Emission is enabled TTL High= Emission is disabled	LCX/LPX models: 100 kΩ pulled down LBX/LSX models: 10 kΩ pulled up
3	Interlock	Input	0V, or terminal left open: Laser emission is not possible. An error is raised. +5V : Laser emission is possible	LCX/LPX models: 100 kΩ pulled down LBX/LSX models: 10 kΩ pulled up

4	RS-232 Rx	Input	To be connected to Tx on computer side	
5	RS-232 Tx	Output	To be connected to Rx on computer side	
6	Power supply GND	Ground	Ground for pins 4, 5, 11, 12 and TTL signals.	
7	Alarm	Output	TTL Low = No alarm TTL High= Alarm present	2 kΩ, available to supply a LED (2mA)
8	Power adjustment (once the option is activated)	Input	0V to 5V DC (30% to 100% of the optical power)	LCX/LPX models: 4.7 kΩ LBX/LSX models: 1.25 kΩ
9	+5V DC	Output	5V DC output	10 mA maximum
10	Analog Ground	Ground	Ground for analog signals (pins 8 and 14)	
11.12	Power Supply In	Supply	DC power supply Input (min +5V, max +12V)	< 25 Watts
13	Power Supply GND	Ground	Ground for pin 11 and 12	Ground
14	Laser Power Out	Output	Voltage between 0 to 2V maximum. Note: Max voltage can change from one unit to another	2 kΩ, appropriate load to supply a LED (2mA)
15	Laser Ready	Output	TTL Low = Laser not ready TTL High= Laser ready	2 kΩ, appropriate load to supply a LED (2mA)
Shell	Chassis Ground		Ground	

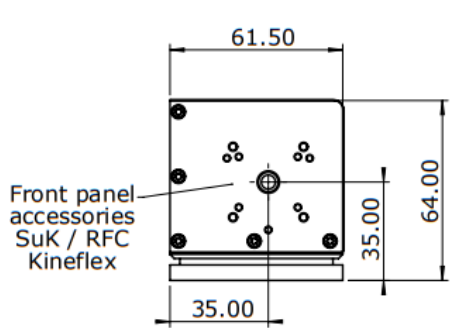
The connector of the interface on the laser head is a female 15-pin Sub-D type. The mating male connector can be found on Radio Spares under the reference “674-0953”.

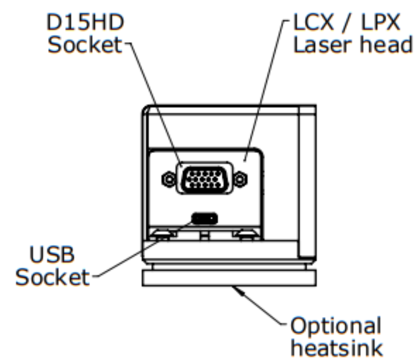
Note concerning the pins supplying the current:

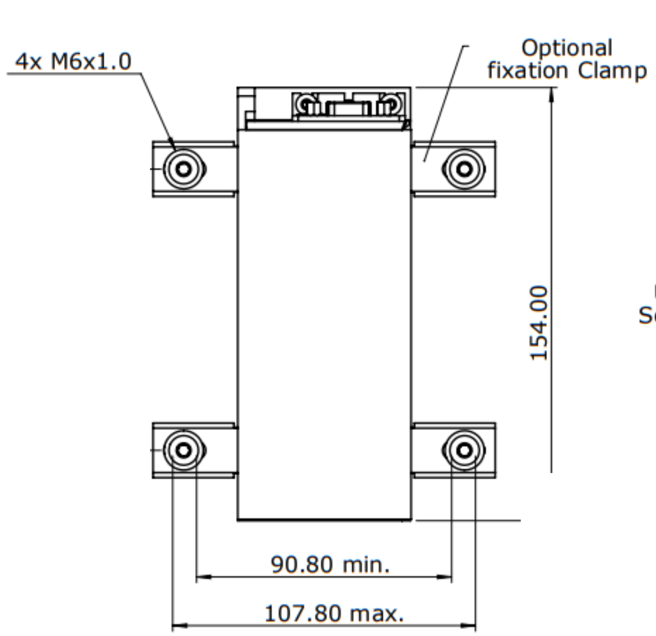
The four pins 6, 13, 11 and 12 do have to be connected to your power supply in order to operate the connector and its socket within specifications.

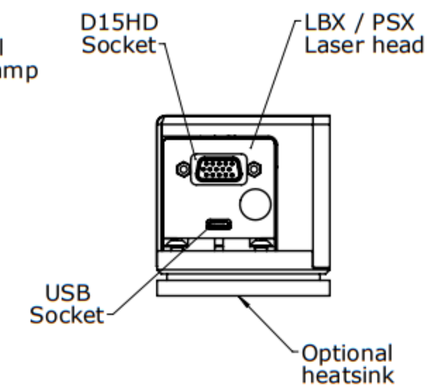
7-3 Mechanical drawings

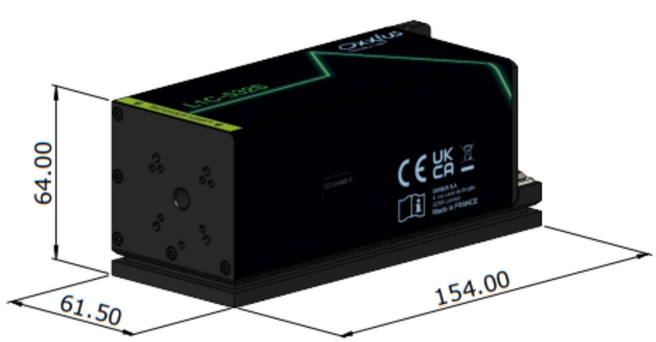
L1C LASER HEAD



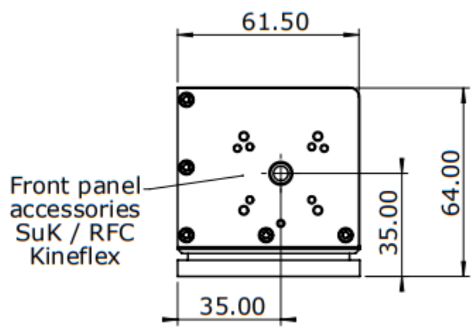


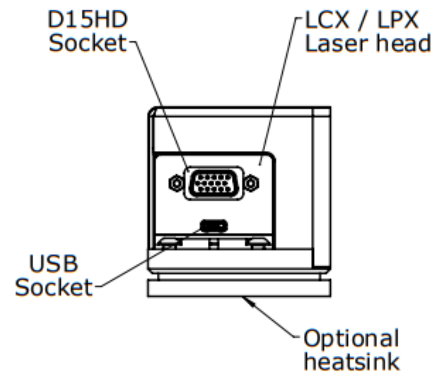


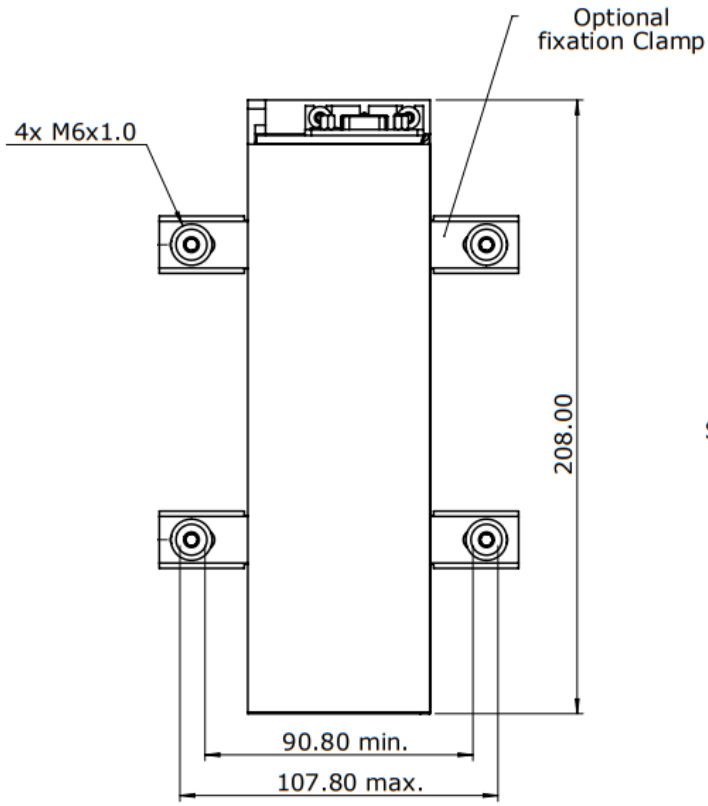


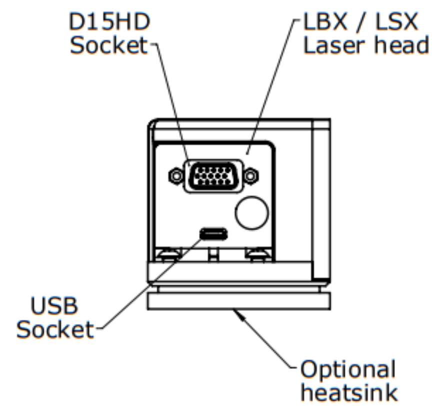


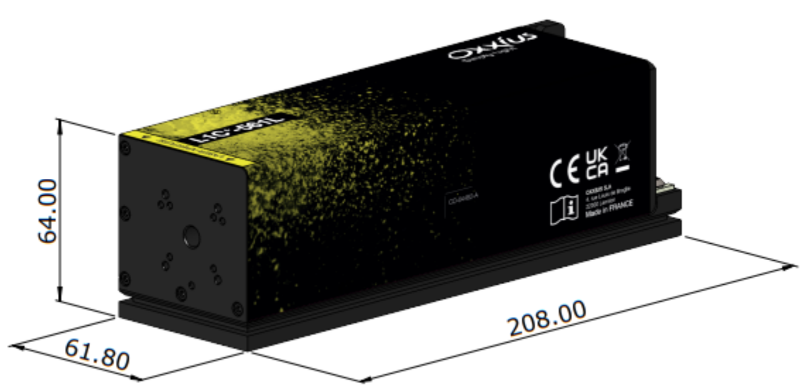
L1C+ LASER HEAD



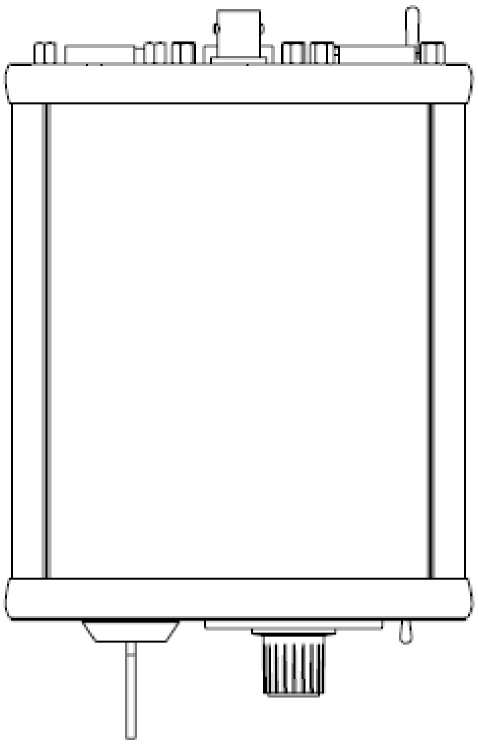




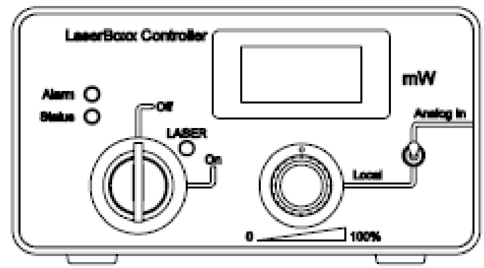




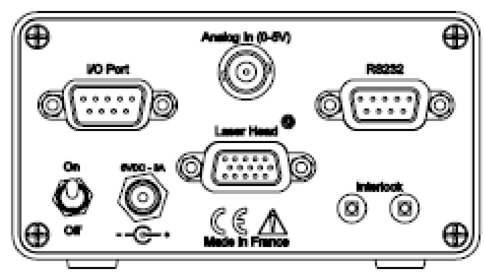
Top view



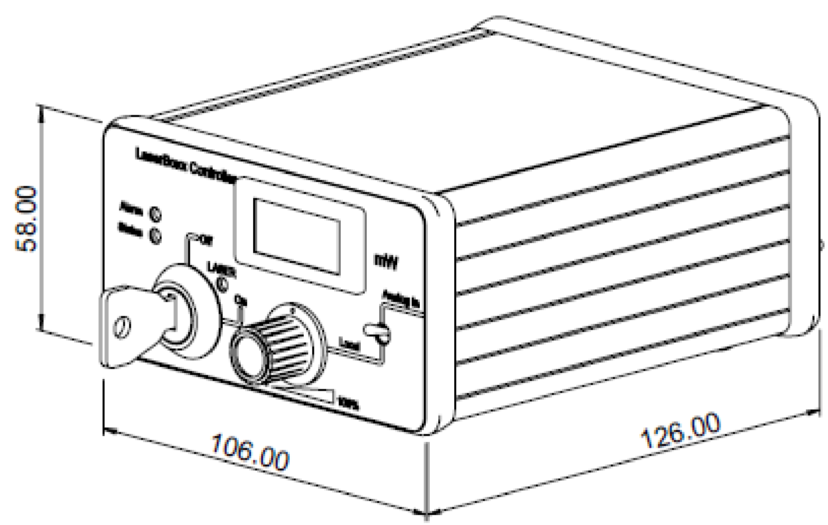
Front view



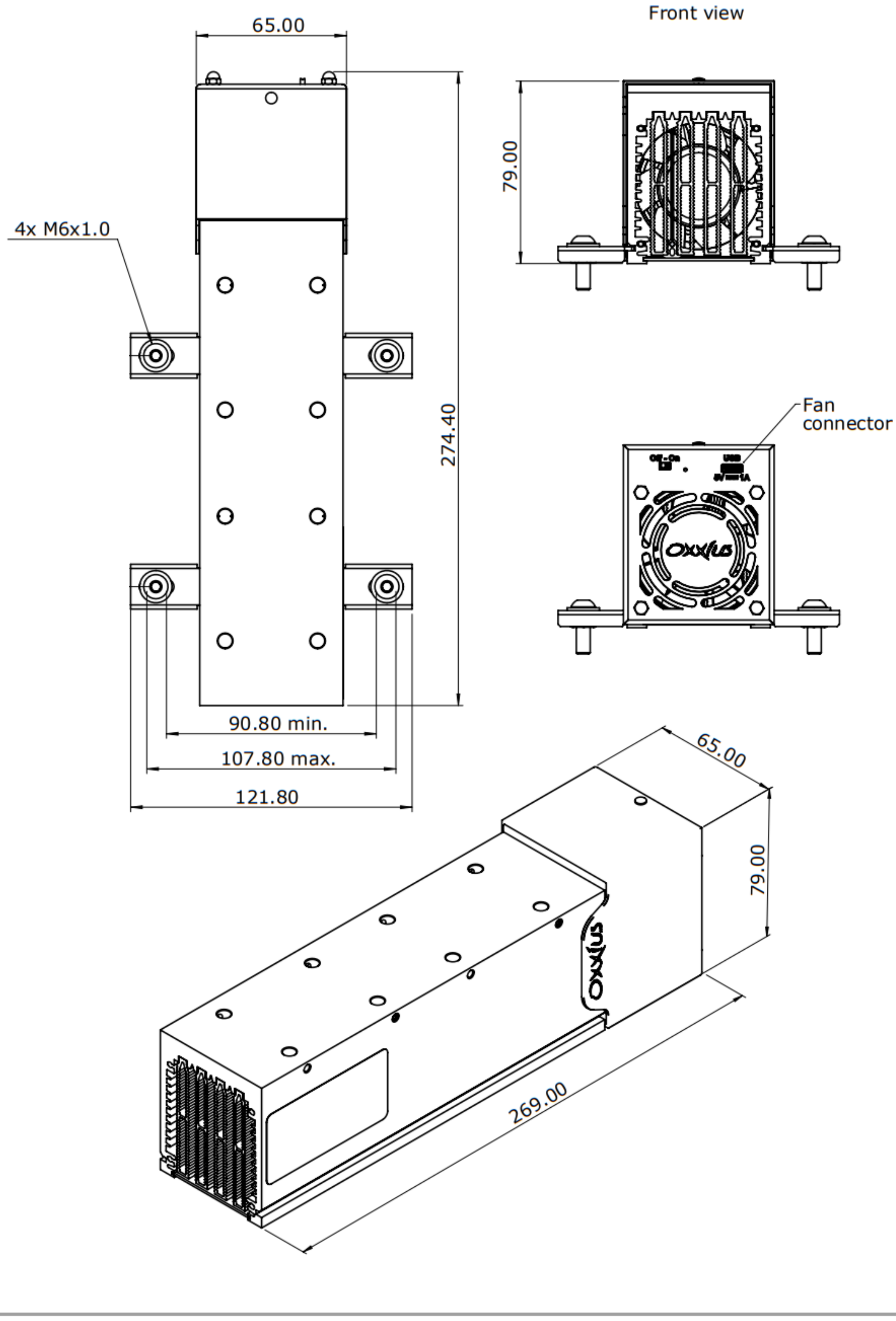
Rear view



All dimensions in mm



HTSK-10 HEAT SINK (OPTION)



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