



L1C-AOM

User manual

L1C platform for LCX laser sources and acousto-optic modulator

Copyright 2019 Oxxius S.A. All rights reserved.

REVISION HISTORY

v1.0	April 2019	First version
v1.1	August 2019	Specific version for the L1C-AOM
v1.2	July 2020	
v1.3	November 2020	Corrected for the BTC-AOM with two L1C sources

TABLE OF CONTENTS

Preface	7
1. Safety information	8
1-1 Laser safety	9
The danger of laser sources	9
Safety guidelines	10
Standard compliance of “Plug and play” and “OEM” versions	11
1-2 Electrical safety	14
1-3 Hazardous materials	15
1-4 Decommissioning and disposal	15
2. Getting started	16
2-1 Overview	16
The L1C	16
The BTC-AOM	16
The LaserBoxx sources	16
“Plug and play” and “OEM” versions	17
2-2 Operating environment	17
2-3 Unpacking and installing	18
Packing list	19
Unpacking	19
2-4 Elements description	20
Laser head	20
Heatsink (Option)	23
Remote control	23
BTC-AOM controller	25
2-5 How to install the L1C	26
2-6 How to install the software suite	32
3. Operation	36
3-1 Principle of operation	36
3-2 How to operate the L1C: the essential functions.....	36
How to power up the L1C.....	36
How to set the power level.....	37
How to activate the shutter	37
How to power down the L1C	38

3-3 How to configure the L1C.....	39
Modulation functions	39
Input/Output port.....	40
3-4 Using the control software	42
Running the control program.....	42
Sending queries and commands	43
Data logging	44
4. Advanced operations.....	47
4-1 Using Oxxius software to operate the L1C.....	47
Computer requirements.....	47
Installing the software suite	47
Description of the interface panel	47
Description of the control panel.....	48
Using the control panel	49
Sending queries and commands	50
Data logging	50
4-2 LaserBoxx with fiber-coupling	53
Coupling on a single-mode fiber.....	53
Coupling on a multi-mode fiber	59
5. Troubleshooting.....	61
5-1 Alarms detailed.....	61
5-2 Recovering missing power levels	62
5-3 Uninstalling and repacking procedures.....	64
5-4 Oxxius Worldwide contacts.....	64
6. Warranty and certification	65
6-1 Standard warranty	65
6-2 Declaration of conformity	66
7. Technical documents	67
7-1 Resources for developers	67
7-2 Software commands	68
Commands for the BTC-AOM	68
Sending commands to the individual laser sources	71
7-3 Mechanical drawings.....	75
L1C laser head	75
BTC-AOM.....	76

PREFACE

AUDIENCE

This manual should be read by all personnel who install or operate the L1C laser source.

Important



Read this manual carefully before operating this device for the first time. Pay special attention to the “Safety information” section.

This manual is composed of the following sections:

1	Safety information	Be sure to read this section first in order to use the laser sources safely
2	Getting started	Describes the elements of the unit and how to install it
3	Operation	Describes some basic ways of operating the unit
4	Troubleshooting	Instructions about to solve operation-related issues
5	Warranty and certification	Details the warranty applied on this device and its conformity to related standards
6	Technical documents	Miscellaneous technical information

HOW TO USE THIS MANUAL

This manual contains information required for safe operation, installation and routine maintenance of the equipment.

Please read this manual carefully prior to using this laser source, in order to ensure a thorough understanding of all its functions and its efficient use.

1. SAFETY INFORMATION

Please read, understand, and follow all safety information contained in these instructions prior to using this laser source. Retain these instructions for future reference.

Only authorized personnel, familiar with the potential dangers presented by laser equipment during operation or installation, should be allowed to work with this laser system. It is of utmost importance that personnel working with the system read, understand and observe the information and instructions written in this manual.

If there are any questions or sections that are not understood, do not hesitate to contact Oxsius.

WARNING



Use of controls or adjustments or performance of procedures other than those specified herein may result in any of these hazards:

- Laser hazard
- Heat hazard

The degree of seriousness of the hazard is indicated by the use of the following signal words:

DANGER

Indicates an imminent hazard which, if not avoided, is extremely likely to result in serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It is also used to alert the user against unsafe working practices and potential damage to the equipment.

QUALIFICATION AND TRAINING OF PERSONNEL

Personnel who install and/or operate the laser must be adequately qualified for the work concerned and should have read this manual. The user must clearly specify the sphere of responsibility, competence and certification for personnel concerned.

1-1 Laser safety

THE DANGER OF LASER SOURCES

Light produced by a laser source exhibits several proprieties that make it much different from sunlight or from the light emitted from a bulb. These proprieties induce specific hazards associated during operation and service of the laser source:

- Lasers light sources produce a highly intense light, either visible or invisible to the human eye,
- Laser light is coherent which means that it is able to build stable interferences. These interferences can be intense patterns that are more hazardous than non-coherent light of the same wavelength and intensity,
- Laser beams are often collimated or diverge slowly, so that they maintain their harmful proprieties over long distances.

BIOLOGICAL EFFECTS OF LASER BEAMS

Here are some known and documented effects of intense laser light over biological bodies:

- Eye injury: because of its high degree of collimation, a laser beam act as an almost punctual source of intense light. A laser beam of sufficient power can in theory produce retinal intensities at greater magnitudes than conventional light sources, even greater than what would be a direct viewing of the sun. Permanent blindness can result from such exposures.
- Thermal injury: the most common cause of laser-induced tissue damage is thermal in nature, where the tissue proteins are denatured due to the temperature rise following absorption of laser energy.
- Other damage mechanisms have also been demonstrated for other specific wavelength ranges and/or exposure times. For example, photochemical reactions are the principal cause of threshold level tissue damage following exposures to either actinic ultraviolet radiation (0.200 μm -0.315 μm) for any exposure time or "blue light" visible radiation (0.400 μm -0.550 μm) when exposures are greater 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 C (200 to 280nm)	Photokeratitis	Erythema (sunburn) Skin cancer
Ultraviolet B (280 to 315nm)	Photokeratitis	Accelerated skin aging Increased pigmentation
Ultraviolet A (315 to 400nm)	Photochemical UV cataract	Pigment darkening Skin burn
Visible (400 to 780nm)	Photochemical and thermal retinal injury	Photosensitive reactions Skin burn

LASER CLASSIFICATION

The laser sources are categorized according to their ability to harm the exposed bodies, from class 1 (no hazard during normal use) to class 4 (severe hazard to eyes and skin).

The classification of a laser is based on the concept of accessible emission limits (AEL) that are defined for each laser class. This is usually the maximum power (in Watts) or energy (in Joules) that can be emitted over a specified wavelength range and exposure time.

It is the responsibility of the manufacturer to provide the correct classification of a laser, and to equip the laser with the appropriate warning labels and safety measures as prescribed by the regulations.

The identification process is accomplished by affixing a warning label onto the product. Along with text warnings, these labels include information pertaining to the emitted wavelength, the total output power and the laser classification of the device.

SAFETY GUIDELINES

Any person using a laser source should be aware of the risks involved. This awareness is not just a matter of time spent with lasers; on the contrary, long-term dealing with invisible risks (such as with infrared sources) tends to dull risk awareness.

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

- Use the laser source in a room with access controlled by door interlocks. Post warning signs. Limit the area access to individuals who are trained in laser safety.
- The operator of the laser should be responsible for notifying the laser usage and for controlling the laser area.
- All personnel present in the area must be wearing personal protective equipment (in particular eyewear) before the laser emission is effective. This should include operators that are not directly using the laser system.
- Use the laser source in a brightly lit room so that the operators work with their pupils narrowed.
- Optical experiments should be carried out on an optical table with all laser beams travelling in the horizontal plane only, and all beams should be stopped at the edges of the table. Users should never put their eyes at the level of the horizontal plane where the beams are in case of reflected beams that leave the table.
- Watches and other jewelry that might enter the optical plane should be dropped off. All non-optical objects that are close to the optical plane should have a mat finish in order to prevent specular reflections.
- Never look directly into the laser output port (or a delivery fiber) when the power is on.
- Alignment of beams and optical components should be performed at a reduced beam power whenever possible.
- Do not install or terminate fibers or collimators when the laser is active. Follow the dedicated instructions in this manual.
- Ensure that the work surface is properly vented. Gases, sparks or debris can be generated from the interaction between the laser and the work surface, posing additional safety hazards.

PROTECTIVE EYEWEAR

The use of eye protection is strongly recommended when operating lasers of any class beyond class 1.

Eyewear is rated for optical density (OD), which is the base-10 logarithm of the attenuation factor by which the eyewear is reducing beam power. For example, eyewear with OD 3 will reduce the beam power in the specified wavelength range by a factor of one thousand. In addition, laser eyewear used in situations where direct beam exposure is possible should be able to withstand a direct hit from the laser beam without breaking. The protective specifications (wavelengths and optical densities) are usually printed on the goggles themselves.

Oxxius recommends that the user investigate any local, state, federal or governmental requirements as well as facility or building requirements that may apply to installing or using a laser or laser system.

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

The L1C in its “Plug and Play” version complies with all the requirements of the European Laser Safety Standard 60825-1, and US FDA CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice N° 50, dated June 24, 2007 (refer to Laser Products - Conformance with IEC 60825-1 and IEC 60601-2-22; Guidance for Industry and FDA Staff (Laser Notice No. 50)).

The L1C in “OEM” version is intended for integration into a larger system under the control of our customers 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 above. Therefore, Oxxius bears no responsibility in any lack of compliance with safety standards of the environment in which the L1C, OEM version, is used.

DESCRIPTION OF HAZARD CLASSES

The L1C either belong to class 3b or class 4.

Class 3b laser sources: laser products that are normally hazardous when intrabeam ocular exposure occurs including accidental short time exposure. Viewing diffuse reflections is normally safe. Class 3B lasers may produce minor skin injuries or even pose a risk of igniting flammable materials. However, this is only likely if the beam has a small diameter or is focused.

Class 4 laser sources: laser products that are normally hazardous when intrabeam ocular exposure occurs including accidental short time exposure. Viewing diffuse reflections is not safe. Class 4 lasers can produce severe skin injuries and can pose a risk of igniting flammable materials.

SAFETY FEATURES ON THE LASER UNITS

The aforementioned safety standards demand that some safety features are present on the laser units, in order to inform the user about the laser radiation and prevent an accidental exposure. Some of these features are only present on the “Plug and Play” versions of the products.

LABELLING (ADVISORY LABELS)

Advisory labels are applied where specific dangers exist, or where a specific attention is required. Do not remove nor tear these labels.



This symbol appears on the L1C. It means that reading this instruction manual is mandatory prior to using the equipment or to performing any level of maintenance.



This symbol warns the user against the danger of being exposed to hazardous visible or invisible laser radiation

The labels present on the laser head inform the user about the laser class, the location of the laser aperture and the emission wavelength. Refer to the following figures to locate these labels on the L1C.

Figure 1-2: Locations of the labels on a L1C

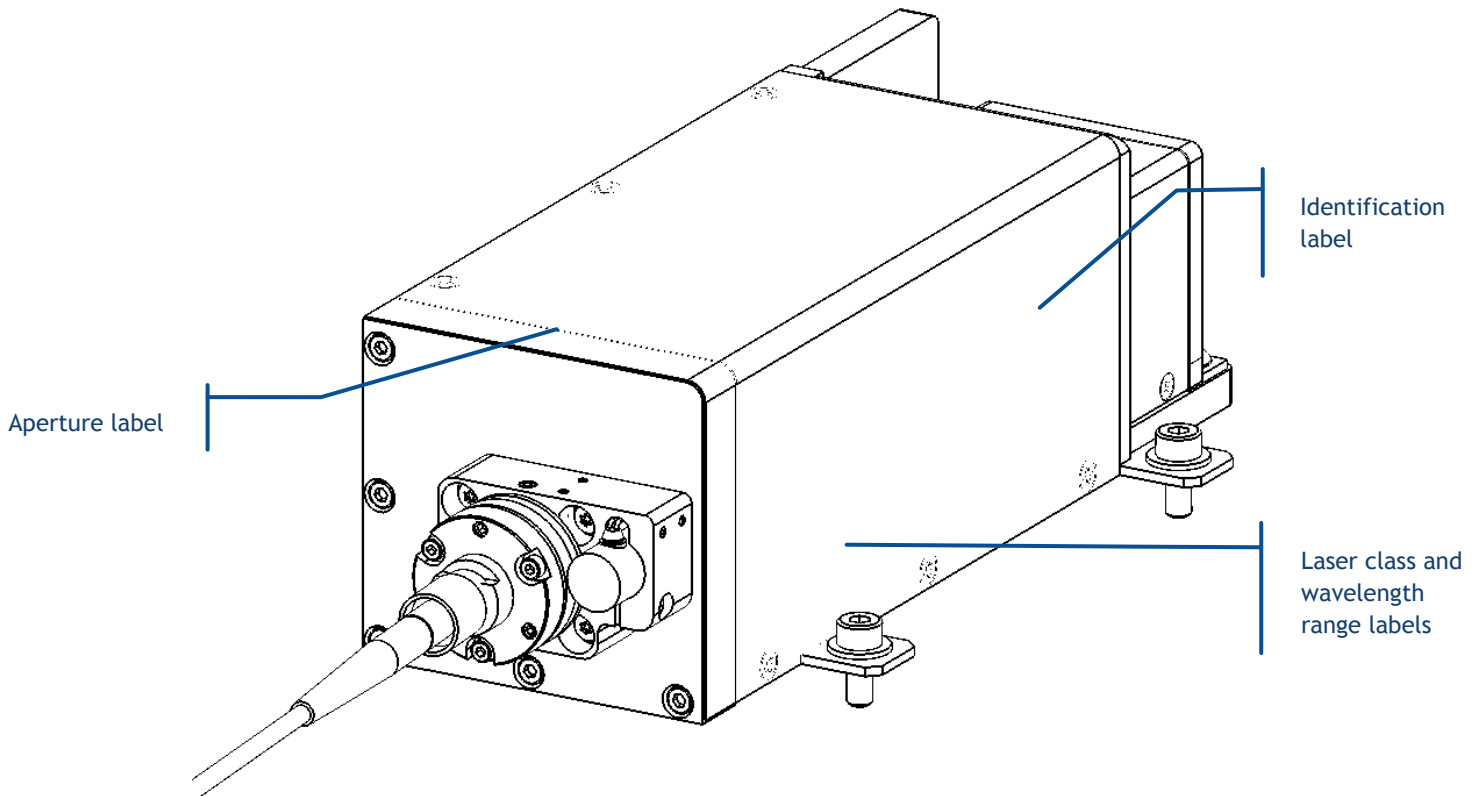


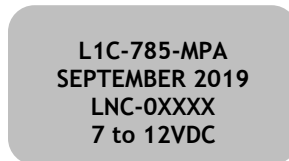
Figure 1-3: Aperture label



Figure 1-4: Laser class and wavelength range labels



Figure 1-5: Identification label



APERTURE LOCATION

The laser radiation is generated within a protective housing which should only be opened by trained operators. An aperture label indicates the position of the laser beam output (refer to figures 1-2 and 1-3).

INTERLOCK

The “Plug and Play” version of the L1C is provided with an interlock circuit accessible from the controller, and terminated by dedicated terminals (refer to chapter 2-4, “Elements description”). When this circuit is open, the laser emission is not possible.

ACTUATED KEY MASTER CONTROL

The “Plug and Play” version of the L1C is provided with an actuated key master control on its remote control (refer to chapter 2-4, “Elements description”). This lock and key control the emission. The laser

emission is not possible when the key is absent from the lock, or when in “OFF” position. The key is removable only when in “OFF” position.

EMISSION WARNING INDICATOR

The controller of the L1C has an emission indicator located on the front panel of its controller (refer to chapter 2-4, “Elements description”). In compliance with CDRH requirements, this indicator is lit for 6 seconds from the moment where the emission command is received to the moment where the laser is actually emitting. It is thus providing a delay for the user to be warned about the imminent emission.

OPTICAL SHUTTER

A mechanical shutter, located at the output aperture of the L1C, allows for a complete extinction of the beam.

1-2 Electrical safety

The L1C operates from low voltages, and does not contain hazardous voltages.

ABOUT THE POWER CORD

In the event where the power cord has to be replaced, please make sure to use a power cord that meets the following characteristics :

Connector on wall plug side	In accordance to local standard
Connector on device side	C13 type
Current Rating	10 A

An external protection device (typically a circuit breaker) has to be present ahead the equipment.

LOW VOLTAGE DIRECTIVE 2006/95/EC

This directive ensures that electrical equipment within certain voltage limits provides a high level of protection for European citizens. The directive covers electrical equipment with a voltage between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current. It should be noted that these voltage ratings refer to the voltage of the electrical input or output, not to voltages that may appear inside the equipment.

1-3 Hazardous materials

The laser source contains indium, used as a heat conductor. Indium is toxic; do not open the laser source.

ROHS 2 COMPLIANCE

The L1C and its controller complies with RoHS 2 directive.

1-4 Decommissioning and disposal

WEEE (WASTE ELECTRICAL ELECTRONIC EQUIPMENT) - EUROPEAN DIRECTIVE 2002/96/EC



This symbol on the product(s) and / or accompanying documents means that used electrical and electronic products should not be mixed with general household waste. For proper treatment, recovery and recycling, please return this product to your local representative.

Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

This symbol is only valid in the European Union. In any case, dispose of the system according to appropriate local regulations, paying particular attention to disposal of indium components in the laser head.

2. GETTING STARTED

This section provides the necessary information to install the L1C and check its functionalities.

2-1 Overview

THE L1C

The L1C is a platform that embeds a laser source (LaserBoxx model) and additional components, typically an isolator or an attenuator. These elements are aligned on the baseplate of the L1C for improved stability. The output beam can be available either in free space, or delivered through one or several optical fibers.

In particular, the L1C-AOM features one laser source and an acousto-optic modulator (“AOM”). The AOM allows for a fast modulation of the optical power.

The L1C can feature additional functionalities:

- optical “clean-up” filters (OPT-CLUP)
- optical isolator
- dual output

THE BTC-AOM

The BTC-AOM is a controller meant to drive up to two L1C. It handles the laser safety functions, the signal delivery and the communication with these laser sources.

THE LASERBOXX SOURCES

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.

These laser sources feature:

- Ultraviolet, visible or infrared outputs (from 375nm to 1100nm), emitted from either laser diodes or from patented alignment-free monolithic resonators,
- common mechanical and electrical interfaces,
- a low power consumption,

- an outstanding power stability and low-noise emission,
- temperature-stabilized emitters and beam-shaping optics,
- USB and RS232 communication channels

The LaserBoxx family is composed of two types of laser sources:

- The LCX LaserBoxx are models that consist of a monolithic DPSS laser source,
- The LBX LaserBoxx are models that embed a semiconductor laser diode.

“PLUG AND PLAY” AND “OEM” VERSIONS

The L1Cs exist in two versions:

- The “plug and play” version is meant to be accessed physically by the user, typically in a laboratory or a “bench-top” environment. It provides a direct access to most of the operation-related functions and to all the safety features. Refer to section 1, “Safety information” for a detailed list of these safety features, and their relevant standard compliance.
- The Original Equipment Manufacturer (or “OEM”) version is designed for integration into an industrial device or system. It only provides the necessary safety functions for the integrator to build himself a standard-compliant device or application.

WARNING



Using the L1C or any laser source without its controller is equivalent to using the source as an OEM part. The OEM version is intended for integration into a 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 dedicated controller.

2-2 Operating environment

In compliance with IEC EN 61010-1 standard, the “Plug and play” L1C is intended to be used in an environment meeting the following conditions:

- Indoor use,

- Altitude up to 2000 meters,
- Ambient air temperature: from +15°C to +38°C (operating temperature),
- Base plate temperature: from +15°C to +50°C (operating temperature),
- Maximum relative humidity of 80% for ambient air temperatures up to 31°C, decreasing linearly to 50% at 40°C,
- AC supply voltage fluctuating within +/- 10% of its nominal value,
- Transient over-voltages occurring up the levels of overvoltage category II, as specified in standard IEC EN 61010-1,
- Temporary over-voltages occurring on the mains supply,
- Applicable pollution degree of the intended environment (pollution degree 2)

Electromagnetic Compatibility Directive 2014/30/UE

This directive describes the ability of a device, equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance. The Oxxius laser L1C is compliant with this directive.

Electrostatic discharges (ESD)

ESD are created when friction over objects create a deficit or an excess of charge. A discharge might eventually occur so as to even the charge difference. When this discharge occur, the voltages involved are high enough to damage electronic circuits.

The LaserBoxx laser sources and the L1C have been successfully tested against ESD of the following amplitudes: +/-4kV on contact, +/-8kV on air.

CAUTION



Although input protections are integrated in the laser sources, a particular attention is required when using the product in dry air and on a floor presenting a carpet or a vinyl tiled surfaces: in such conditions, discharges in excess of 20kV can occur.

In order to prevent ESD damage during handling, use appropriate clothing and equipment (antistatic wrist straps, etc.).

2-3 Unpacking and installing

The L1C should be unpacked and used in an area satisfying the following conditions:

- a dust-free area,
- an area free from vibrations

PACKING LIST

The tables below list the standard elements and accessories shipped with the L1C.

Table 2-1: Packing list and accessories of one L1C, “Plug and play” version, with its BTC-AOM controller

Name	Quantity
L1C laser head (embedding the laser source and the AOM)	1
Cable linking the L1C to its controller, with its emission indicator	1
BTC-AOM controller, including:	1
Mating connector for the interlock (with short-circuit)	1
Termination load	1
Remote control, including	1
Laser emission key	2
Tools for adjusting the fiber injection	Optional
1.5mm hexagonal key	(1)
2.0mm hexagonal key	(1)
1.2mm slotted screw driver	(1)
Power supply (AC/DC converter, 24V output)	1
Power cord	1
USB cable (“A to B” type)	1
USB Flash drive	1
Manufacturing test report	1
This user manual	1

UNPACKING

Unpack the different elements of the package listed on table 2-1 and check that none of the items is missing or appears damaged.

Please contact your representative if you have to report any issue with the packaged items (see our homepage www.oxxius.com for contact information). Keep the packaging box to be able to ship the laser back if necessary.

Follow the instructions below to install the L1C safely:

- avoid undue pressure or impact to the equipment during handling and installation,
- the laser bench should be placed on a flat surface,
- do not put any objects on top of either the laser bench or its remote control

FIBER-TERMINATED OUTPUTS

A specific attention is required with fiber optic patch cables, which should not, under any circumstances, be bent nor receive mechanical damage (shear stress, punching, etc.). An optical fiber is made of glass and is a fragile piece of equipment.

The user is required to handle the patch cable and their optical connectors with care, as well as to have the necessary tools and knowledge to inspect and clean the end tip of the optical connector.

These tools are:

- A specific microscope to inspect the end tip of the fiber. Oxxius recommends using a 200x magnification microscope, such as the “FS201” available from www.thorlabs.com
- Some consumables to clean the optical connectors. Oxxius recommends using “type A” CLETOP tools available from NTT-AT.

2-4 Elements description

LASER HEAD

Here are the accessible elements on the laser head. For annotated drawings, refer to the section “Technical documents”, annex B.

Figure 2-3: Front view of the laser head of the L1C (fiber-coupled output)

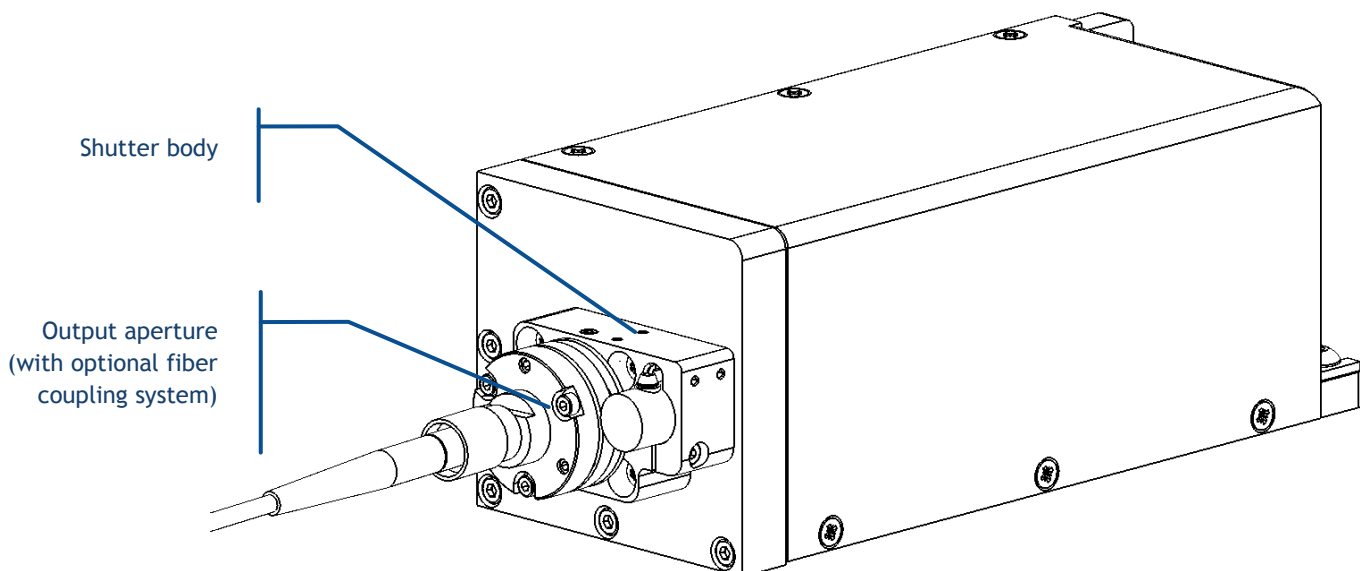


Figure 2-4: Bottom view of the L1C

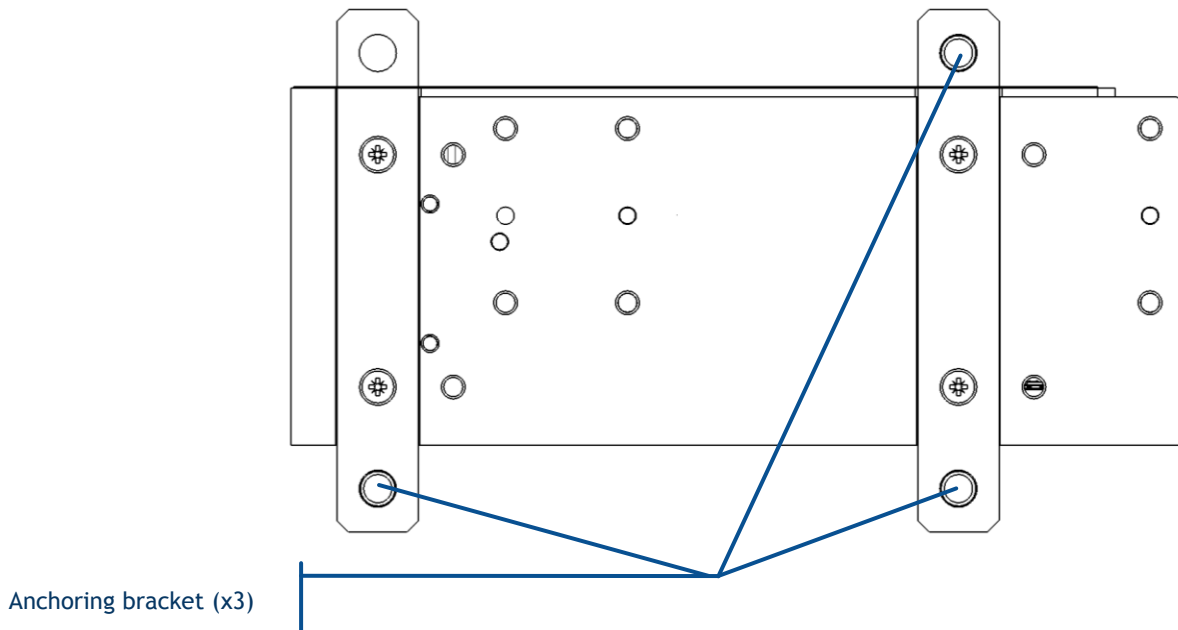


Figure 2-5: Rear view of the laser head of the L1C

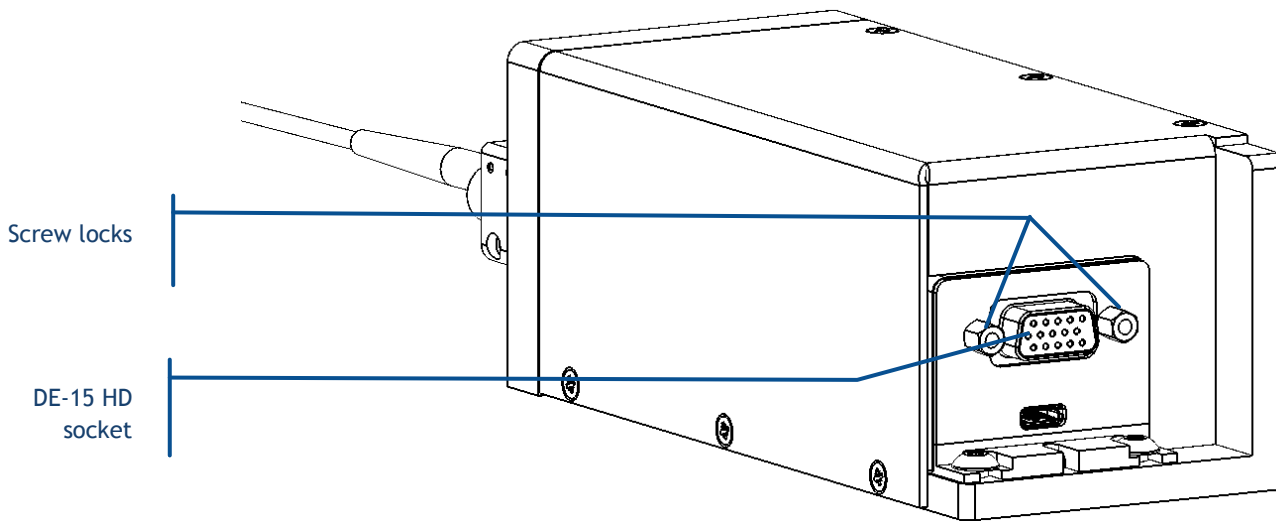
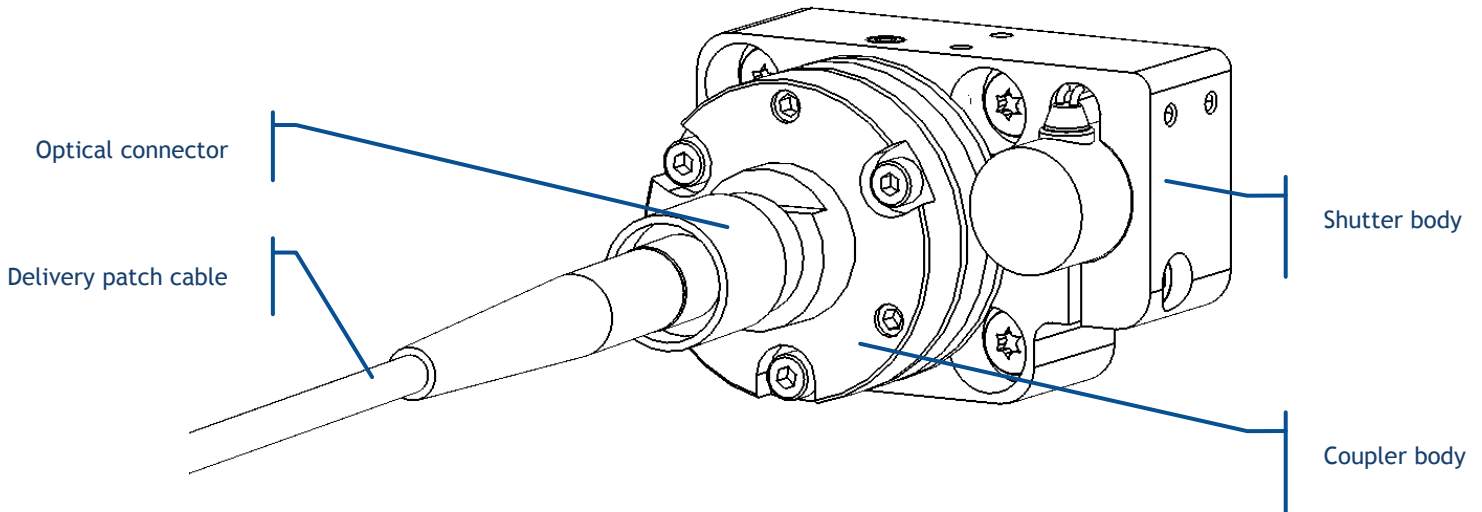


Figure 2-6: Detailed output channel with an optional fiber coupling system



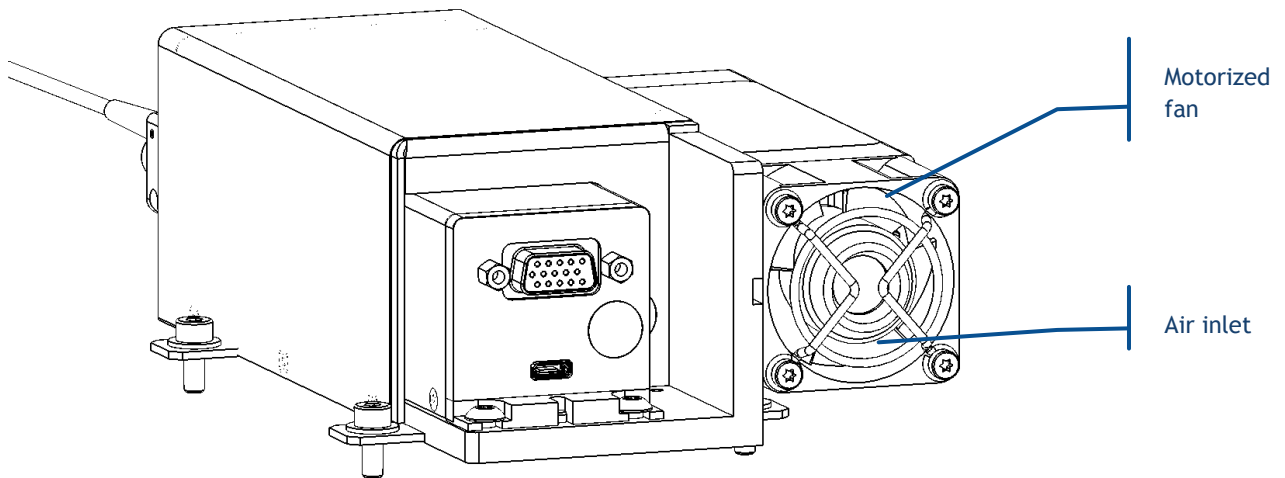
The following elements are accessible to the user:

- **Laser aperture:** this is the aperture from which the laser beam is released. The aperture's position is also indicated by an arrow at the top of the laser head. It consists of the following elements:
 - o **Optical shutter:** When activated, this device is used to prevent any light from being released out from the output channel. It can also act as a mechanical support for the optional fiber coupler. Two shutters are present on the L1C:
 - a manual version, where the user can either release or shut the beam off by moving the slider in front of the positions "OPEN" or "CLOSE"
 - an electro-mechanical version, driven by either electrical signals or software commands
 - o **Fiber coupling system (option):** This system is designed to release the optical output into a delivery fiber. It is composed of:
 - **The coupler**, which focusses the laser beams into the optical fiber
 - **The optical connector**, used to lock the optical fiber in position into the fiber coupler
 - **The optical patch cable:** this removable component holds and protects the delivery fiber.
- **Base plate fixation holes:** these holes are used to fix the laser head to a baseplate.
- **DE-15 HD socket:** this socket holds the electronic interface of the laser head. Refer to section 4-2 for a detailed description.

- **Screw locks:** the DE-15 HD connector should be fixed to the laser head using these standoff screws.

HEATSINK (OPTION)

On a L1C, a heatsink can be necessary to ensure a stable operation over a broad range of temperatures. Here are the accessible elements on the heatsink. For detailed drawings, refer to the section “Technical documents”, annex C.

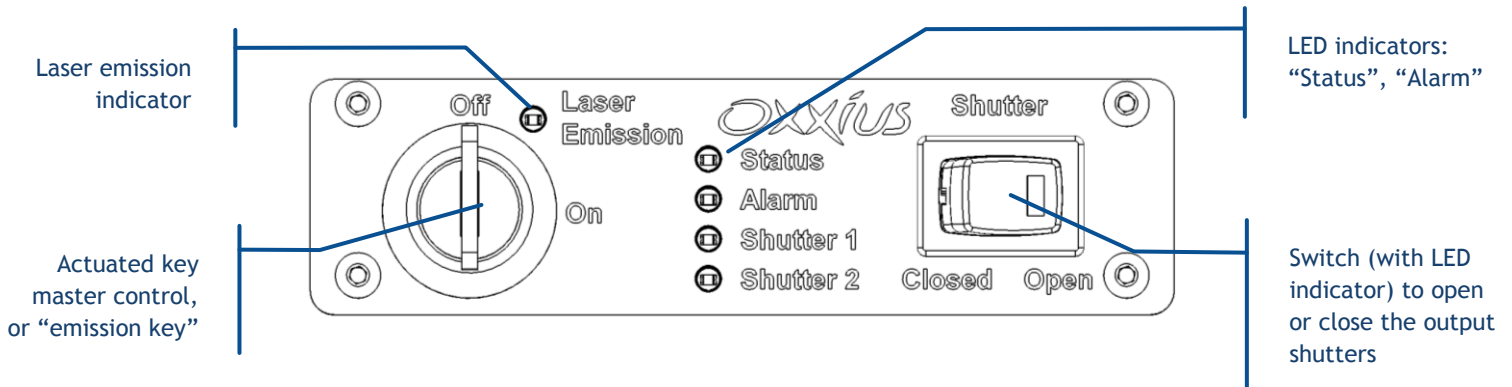


- **Air inlet and outlet:** ambient air will flow through these apertures and transfer the excess heat. Do not block these apertures and leave enough room around them to ensure a proper cooling of the laser unit.
- **Fan supply socket (2.1mm coaxial):** Input for the motorized fan inducing the air flow.

REMOTE CONTROL

The remote control of the controller is meant to bring the most essential control elements closer to the user.

Figure 2-7: Front panel of remote control



- **Actuated key master control:** Also referred as the “Emission key”. A class 3B or class 4 laser system must incorporate 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 the key on will start the laser emission.
- **Laser emission indicator:** This indicator is a light-emitting diode (LED) which lights in solid white when the key control is switched on, indicating that the emission is enabled. It is located on the remote control so that it can be seen without requiring the user to face the laser radiation, and its white color is meant to be visible through most protective eyewear. In accordance with CDRH recommendations, this indicator blinks five seconds prior to the actual laser emission, in order to warn about the imminent hazard.

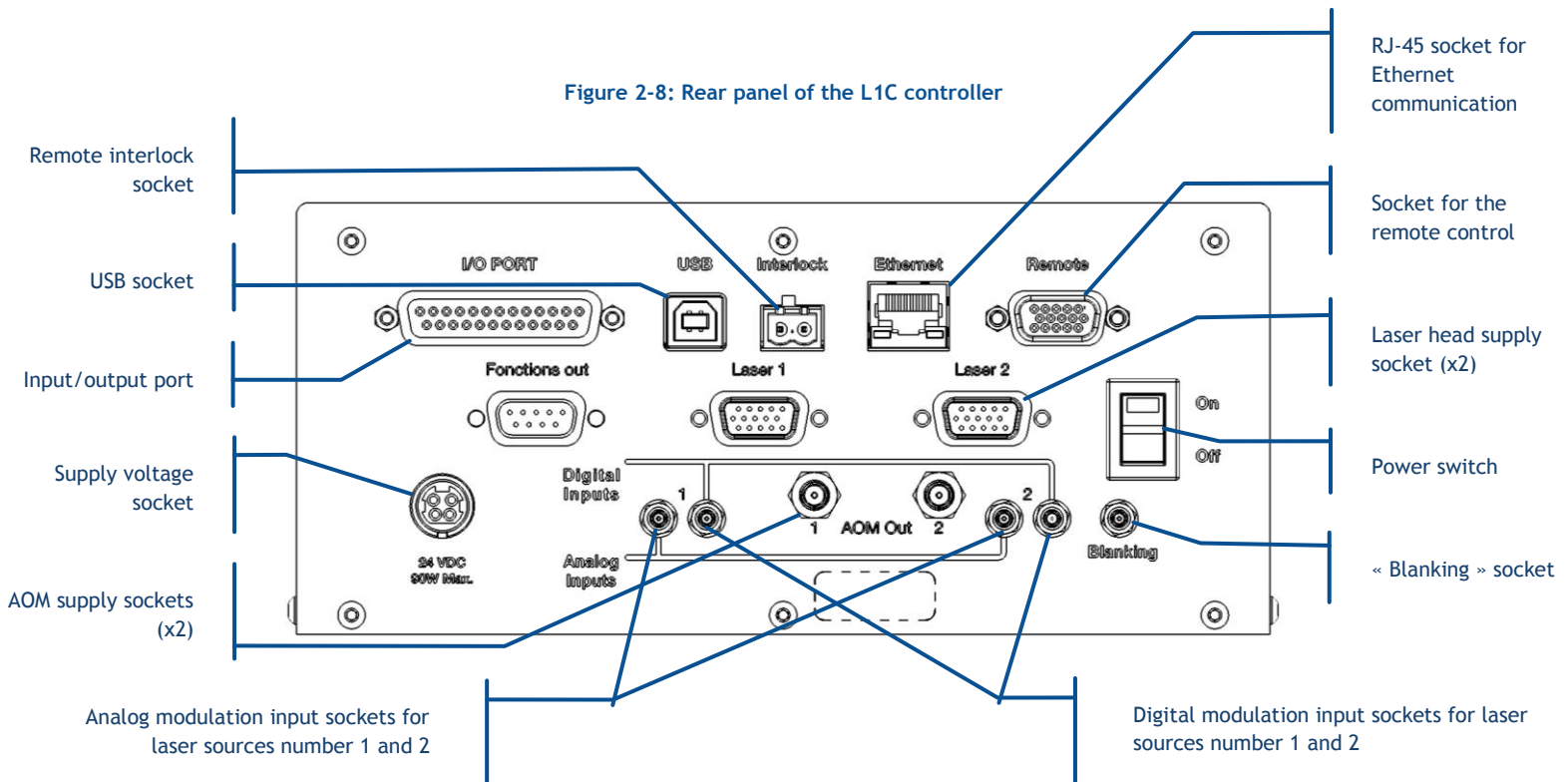
The two aforementioned elements are required by laser safety standards in order to protect the user from an inadvertent exposure.

- **“Status” indicator:** This indicator is a green LED indicating the status of the BTC-AOM:
 - o It is unlit when none of the laser sources is enabled for emission,
 - o It is lit solid when all the sources that are enabled for emission are emitting and stabilized,
 - o It is blinking when, amongst the sources that are enabled for emission, at least one of them is under stabilization
- **“Alarm” indicator:** This indicator is a red LED that, when lit solid, indicates either the presence of an alarm on one the laser sources, or that the interlock circuit is open.
- **Shutter switch and indicator:** When this switch is on its “Closed” position, all the output shutters are forced closed, regardless of their command signal. The LED indicator is lit when this shutter is on its “Open” position.
- **“Status” indicator:** This indicator is a green LED indicating the status of the L1C:
 - o It is unlit when none of the laser sources is enabled for emission,
 - o It is lit solid when all the sources that are enabled for emission are emitting and stabilized,
 - o It is blinking when, amongst the sources that are enabled for emission, at least one of them is under stabilization
- **“Alarm” indicator:** This indicator is a red LED that, when lit solid, indicates either the presence of an alarm on one the laser sources, or that the interlock circuit is open.
- **Blanking switch and indicator:** This switch activates the “blinking” function, a function designed to shut off all the laser radiation exiting the laser head. The LED indicator is lit when blanking is activated.

BTC-AOM CONTROLLER

The L1C-AOM requires a controller to supply the AOM with power and control signals. Note that a single controller can accommodate up to two laser heads (labeled “1” and “2”).

Here are the elements accessible on the rear panel of the controller:



- **Remote interlock socket:** the laser emission is disabled when both terminals are not electrically connected. This socket is usually used in conjunction with a door or a panel in order to control the access to the irradiated area. A couple of mating connectors is provided with the L1C to close this circuit, thus allowing the emission.
- **USB socket:** This socket is used to communicate with the L1C using a personal computer.
- **Input / output port:** This port allows the user to access to miscellaneous functions of the controller by applying appropriate electrical signals. Refer to chapter 3.3, “How to configure the L1C”, for a detailed description of the accessible functions.
- **Supply voltage socket:** Input socket for the power supply.
- **AOM supply sockets:** The power signal supplying the AOMs are delivered from these sockets. Connect the AOM supply cables to these sockets.
- **Analog input sockets:** These inputs are used to control the optical power by applying an analog voltage. Refer to section 4, “Advanced operation” for detailed information, and to the product specifications of each source concerning the modulation characteristics.

- **Digital input sockets:** These inputs are used to quickly turn the optical power on and off by applying a digital voltage. Refer to section 4, “Advanced operation” for detailed information, and to the product specifications of each source concerning the modulation characteristics.
- **Socket for the blanking function:** This is used to activate the blanking function, shutting down all the laser sources at once.
- **Power switch:** This is the main switch to power on the controller and its laser heads.
- **Socket for the remote control:** Connect the remote control to this socket.

2-5 How to install the L1C

WARNING



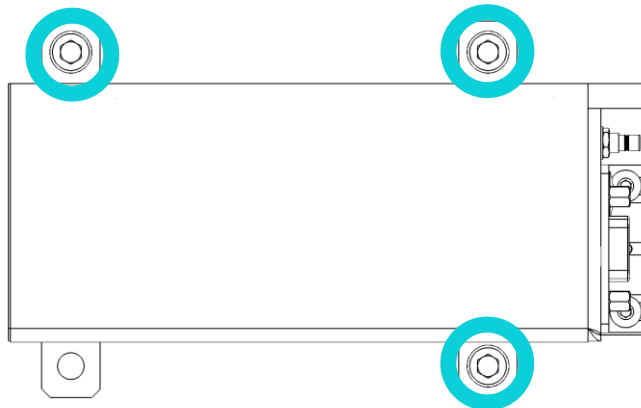
Prior to installing, please take into account the following safety recommendations:

- Disconnecting the controller from its electrical supply can be achieved either by toggling the power switch off (on the rear panel), or by disconnecting the supply connector from its socket (on the rear panel).
- No user adjustment is possible inside each individual LaserBoxx sources. Any attempt to open these elements might damage them and will void the warranty.

MECHANICAL INTERFACING AND THERMAL MANAGEMENT

The optical bench should be fixed to a metallic base which flatness is better than 0.05 mm. This requirement ensures that no excessive constraint is applied to it. Standard machining of opto-mechanical components will typically meet this requirement.

Figure 2-9: Fixing the laser head

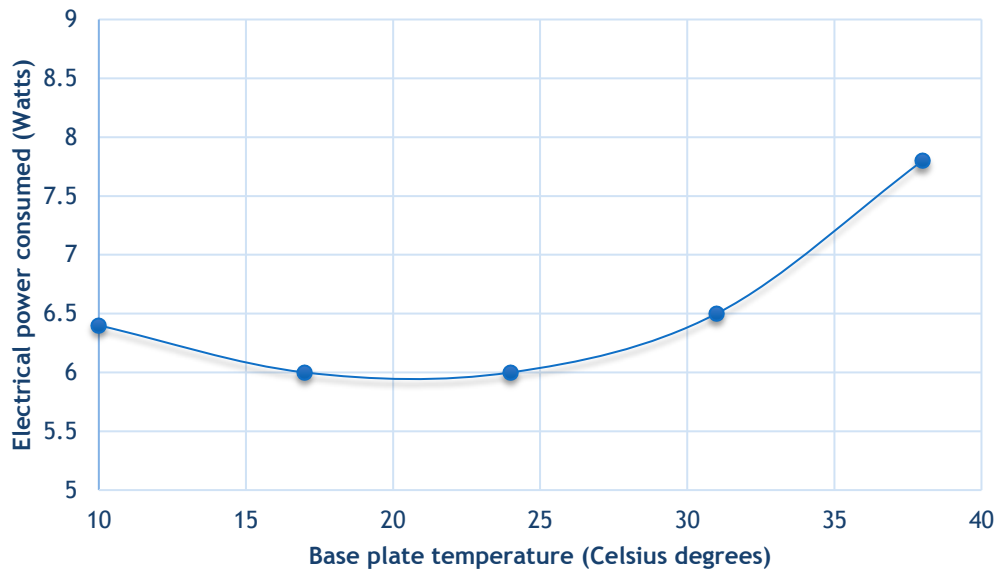


Use the M6 screws and the anchoring brackets circled above to fix the laser head. A torque of 0.2 m.N is recommended.

If a heatsink is present, a free space of 10 centimeters should be maintained around the air inlets and outlets in order to ensure a sufficient air flow.

The L1c generates some heat while in operation. The amount of heat released is sharply increasing as the temperature of the module's baseplate is itself increasing. As an illustration, here is the typical electrical power consumed by a L1C against the temperature of its base plate:

Figure 2-10: Typical power consumption of a L1C (532nm, 500mW output)



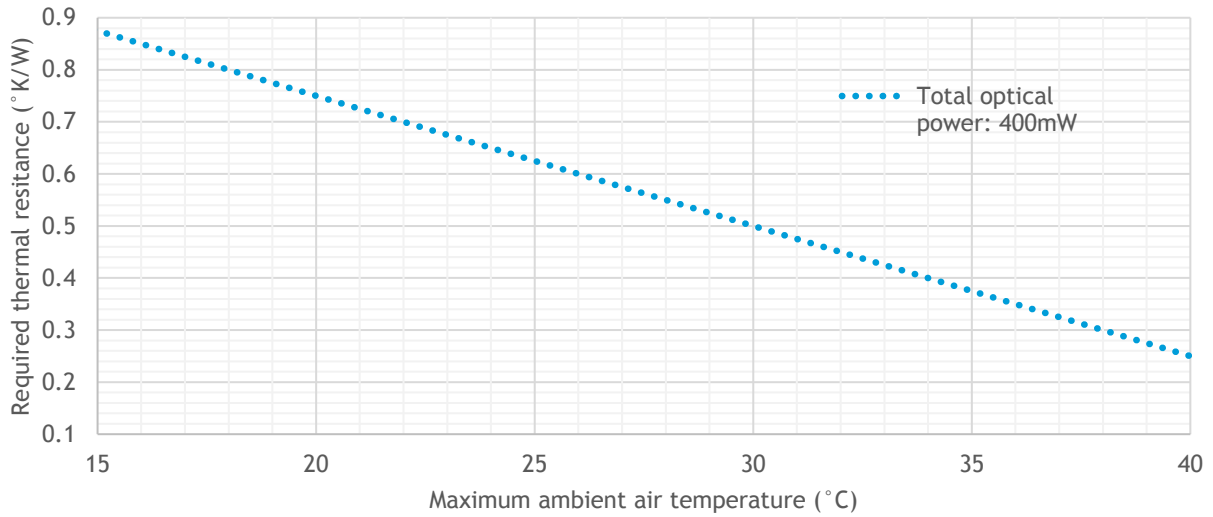
Noticeable features of this characteristic are:

- The maximum consumed power is reached as the base plate is at its hottest,
- The minimum consumed power is reached in a zone typically between 15°C and 25°C

For those reasons, the supporting medium must ensure a proper dissipation of the generated heat. This is the purpose of the heatsink proposed as an option.

The following figure can guide you when selecting a heatsink (air heat exchanger). Its thermal resistance should be selected in accordance with both the hottest temperature of the ambient air, and the power consumed by your combiner.

Figure 2-11: Required thermal resistance required for a typical L1C unit



Contact your Oxxius representative to learn about the exact power consumed by your model, or for detailed guidance on this topic.

OPTICAL OUTPUT

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

For a fiber-terminated output: connect the optical connector to your own light path. Make sure to properly fasten the threaded ring of each optical connector. Small adjustments may be required after positioning the laser head in its final location. Refer to section 5 for the re-alignment procedure.

DANGER: LASER RADIATION HAZARD



For your own safety, make sure to terminate every unused beam (or reflected image) with a beam stop (or an absorbing material).

CAUTION:**OPTICAL FEEDBACK**

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 retro-reflected beam focuses back onto the laser diode facet and can create a power density high enough to damage this facet, resulting in an irreversible degradation of the resonator. This failure mechanism is **not covered** under Oxixus' standard warranty.

Oxixus recommends his users to take the following precautions when working with the L1C:

- 1) All reflective surfaces in the optical path should be angled slightly so that surface reflections will not be reflected to the laser source,
- 2) Use angle-polished fibers when coupling the light into optical fibers,
- 3) Avoid using mirrors placed at normal incidence into the light path. If mirrors must be placed at normal incidence, the use of an isolator is required.
- 4) Avoid focusing the beam the onto a mirrored surface without installing an isolator into the light path,
- 5) Avoid sweeping the beam back and forth across the laser during alignment operations (for example utilizing a retro-reflected beam to align through a pinhole in a confocal microscope). If such a possibility is unavoidable, use an isolator at the output of the laser diode during the alignment process to prevent permanently damaging the laser

ELECTRICAL CONNECTIONS**Procedure:**

- Connect the umbilical cable between each L1C laser head and the rear panel of the BTC-AOM controller. Mind the emission indicator LED, which is meant to be connected by the laser head side. Secure each connectors using the locking screws.
- Connect the coaxial supply cable of each AOM to the rear panel of the BTC-AOM

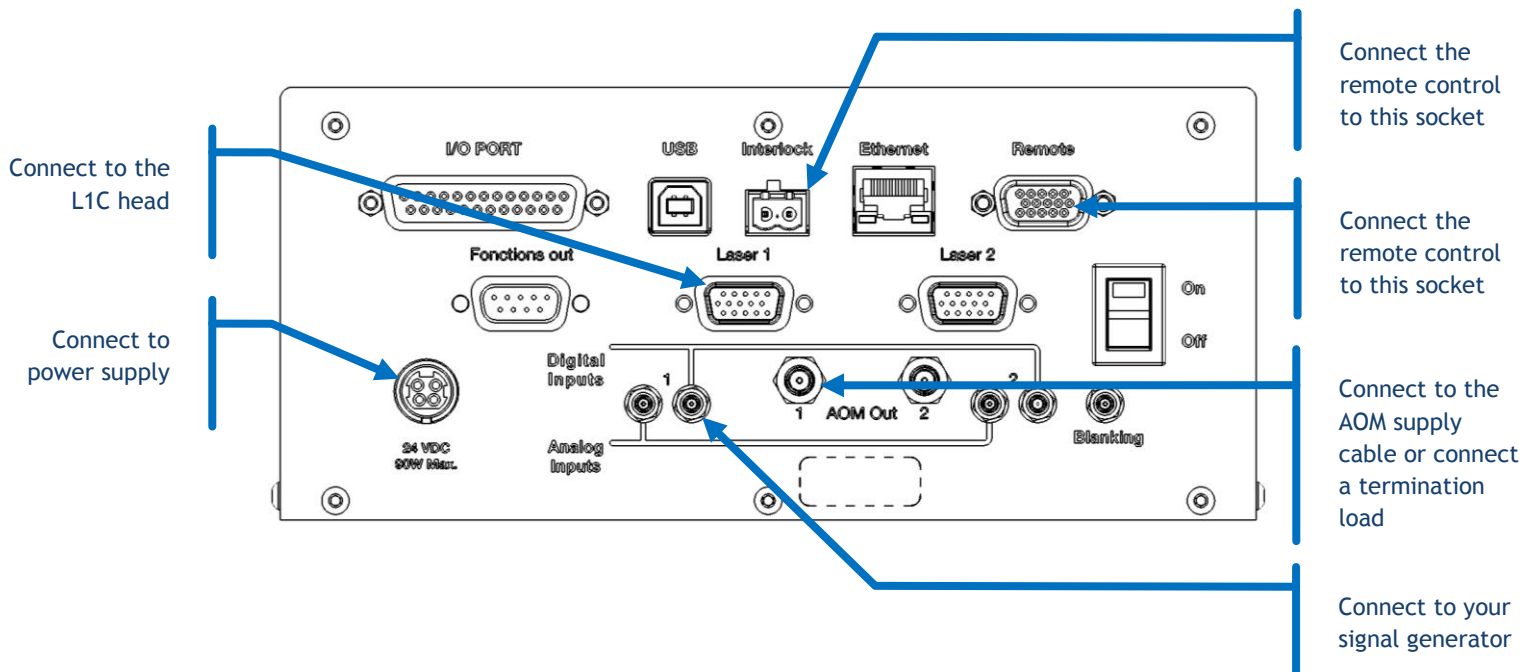
CAUTION

TERMINATE HIGH POWER OUTPUTS



Make sure that both “AOM Out” supply sockets are connected to either an AOM supply cable or to a termination load. Turning on the power supply while one of these sockets is not terminated might damage the controller.

- Connect the remote control to the rear panel of the BTC-AOM
- Connect your interlock safety circuit to the “Interlock” pins on the rear panel of the controller. If you are not using any interlock circuit, use the mating connector (provided) to short-circuit these pins.
- Connect the power supply to the rear panel of the controller



- If you intend to operate a signal modulation from an external source, connect your signal generator to one of the SMB socket on the rear panel of the controller

CHARACTERISTICS OF THE POWER SUPPLY

The power supply provided with each “Plug and Play” L1C has the following characteristics:

- Output voltage (direct current): 9 Volts

- Power rating: 45 Watts


In case you have to use your own power supply, the input voltage socket at the rear panel of the controller must be connected to a “SELV” source complying with the following specifications:

Input	Output
<ul style="list-style-type: none"> - Voltage: 100/240 VAC - Frequency: 50/60 Hz - Protective ground 	<ul style="list-style-type: none"> - Voltage (direct current): <ul style="list-style-type: none"> o Absolute ratings : 4.5V minimum, 12.5V maximum o Specifications: Any voltage between 7.0V and 12.0V - Power: 30 W minimum - Regulation: +/- 5% - Line voltage regulation: +/-1%

A SELV source, as stated by UL 60950-1, is a “secondary circuit which is so designed and protected that under normal and single default conditions, its voltages do not exceed a safe value”. This “secondary circuit” has no direct connection to the primary power (AC mains) and derives its power via a transformer, converter or equivalent isolation device.

The power supply provided with each “Plug and Play” model meets these requirements.

Warning



For electrical safety, Oxsius recommends to use the standard power supply supplied with this product. A protective ground connection integrating a grounding conductor is essential for a safe operation. To avoid electrical shock, plug the power cord into a properly wired receptacle.

USB COMMUNICATION

Communication with the L1C can be achieved by connecting a computer (or other similar device) to the controller. Connect your computer to the USB socket located on the rear side of the controller. The required cable is a standard “USB A to B” cable (see figure 2-13 below).

Figure 2-12: USB “A to B” cable



Refer to the following chapter for the procedure detailing the software installation on a host computer.

ETHERNET COMMUNICATION

The combiner accepts 10 or 100BASE-T Ethernet through its RJ45 socket. The use of a category 5 cable is recommended.

The combiner's network configuration consists of:

- its IP address,
- its subnet mask,
- the gateway IP address,
- a TCP port number

The three first items can either be configured manually (for a static assignment), or be assigned by a connected DHCP server. Refer to paragraph 3-4 for detailed instructions on how to send software commands to the combiner.

PROCEDURE FOR A DHCP-BASED ASSIGNMENT

- Send the command "DHCP 1"
- Wait a couple of seconds for the assignment to operate
- Check the IP address using the query "?EIP". If the answer is different from "0.0.0.0", then the DHCP assignment has succeeded. If the answer is "0.0.0.0", then the DHCP assignment did not succeed. Please retry or contact your network administrator for support.

PROCEDURE FOR A STATIC ASSIGNMENT

- Send the command "DHCP 0"
- Send the command "EIP" followed by the IP address to assign
- Send the command "EMA" followed by the IP subnet mask to set
- Send the command "EGA" followed by your gateway IP address

TCP SOCKET ASSIGNMENT

You need to select a value for the TCP port used. Using a value lower than 1024 is not recommended. The default value is "22300".

Send the command "ESO" followed by the number you wish to employ, then **restart the combiner** (toggle the power switch off and on).

Refer to chapter 7-2 for detailed information about these commands.

2-6 How to install the software suite

The control software allows the user to monitor and control several laser sources at once.

Oxxius software is compatible with the following operating systems:

- Windows 7 (32-bit and 64-bit versions),
- Windows 8 (32-bit and 64-bit versions),
- Windows 10

Microsoft .NET 3.5 framework is required. If it is not installed, you will be asked to download and install it.

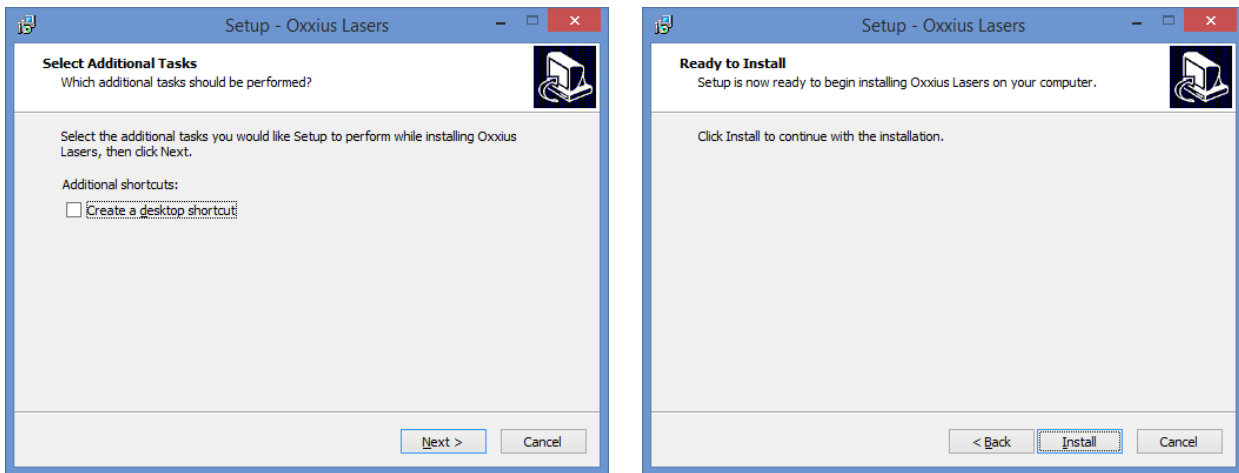
FIRST STEP: INSTALLING THE COMMAND SOFTWARE

Oxxius control software is installed by running the setup.exe file located on the USB flash drive provided with the laser.

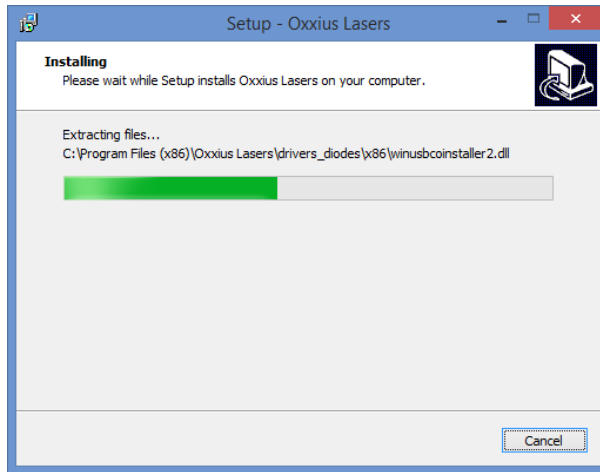
Alternatively, you can download the latest version of our control software from the following URL:

<http://www.oxxius.com/download/f09512dd.exe>

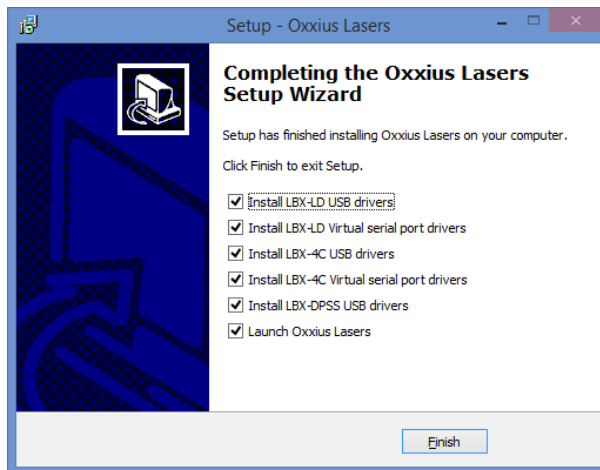
Executing the file “setup.exe” will prompt a standard installation wizard:



Click « Next », then “Install”.



Finally, the installation suggests to install the USB drivers (see the screenshot below). Proceed to do so.



Depending on the operating system of the computer, it might be necessary to restart the computer. A warning dialog box might appear on 64-bit operating systems.

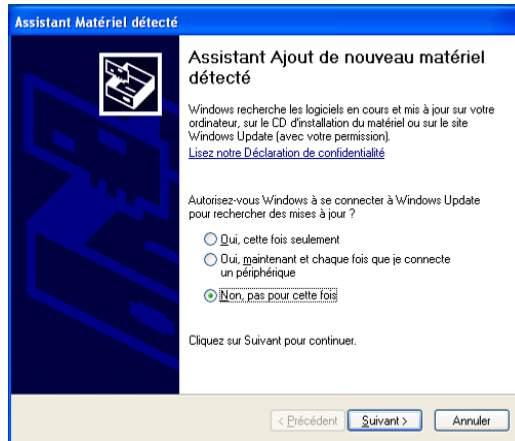
Press “Finish” to close the wizard and complete the installation.

SECOND STEP: DEVICE INSTALLATION OVER A USB PORT

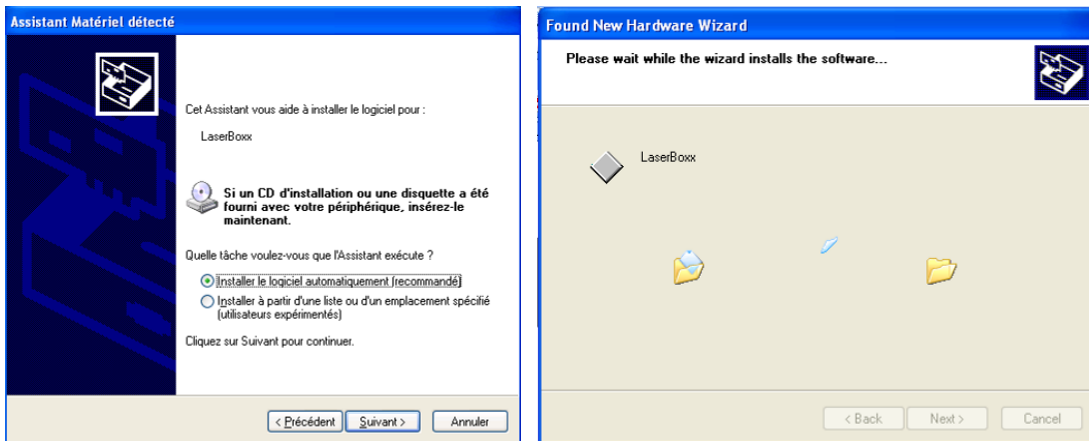
Using the USB interface of the L1C unit will first require that this former is detected by the operating system.

- Connect the USB cable between the L1C on one end, and your computer on the other end,
- Turn on the supply voltage of the L1C,
- Depending on the operating system, the installation is either automatic or requires some confirmations

- If prompted, do not authorize Windows to connect to Windows Update (as in the screenshot below),

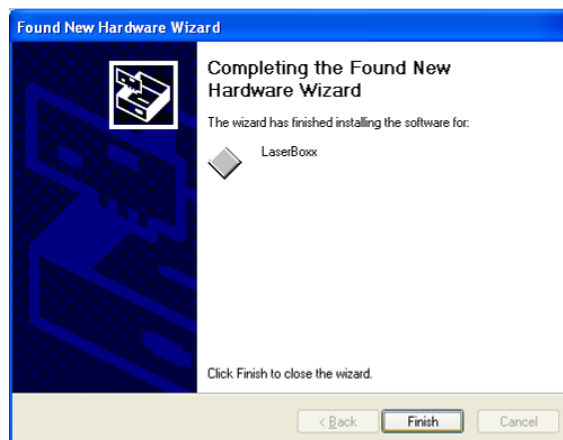


Force your operating system to install the software automatically,



Windows will be copying the driver files onto your computer.

The installation process is finished when the following message appears:



You are now ready to use the USB port of your L1C.

3. OPERATION

This section describes the principle of operation of the L1C, as well as the way to operate it.

The laser module is assumed to be correctly installed and connected. Refer to the previous section, “Starting up”, if necessary.

3-1 Principle of operation

The L1C-MPA embeds a laser source and a MPA module. The laser source is either a LaserBoxx LBX or a LaserBoxx LCX, releasing an optical signal exhibiting a narrow spectral bandwidth, hence referred as “single longitudinal mode” or SLM.

The MPA consists of optical elements being moved against each other so that the power throughput can be modified while the SLM aspect of the optical signal is maintained. Finally, an optical shutter makes sure that no light exits the aperture when the set point is nil.

3-2 How to operate the L1C: the essential functions

HOW TO POWER UP THE L1C

- Plug the power cord of the power supply into your mains socket,
- Power the controller on by pressing the main power switch on the right-hand side of the rear panel,
- Check that the appropriate security measures relative to laser radiation are enforced (refer to section 1, “Safety Information”), then activate the emission by turning the actuated key master control clockwise on the remote control,

DANGER:

LASER RADIATION



From the moment the emission key is turned on, the laser emission may be released any time from the different output channels.

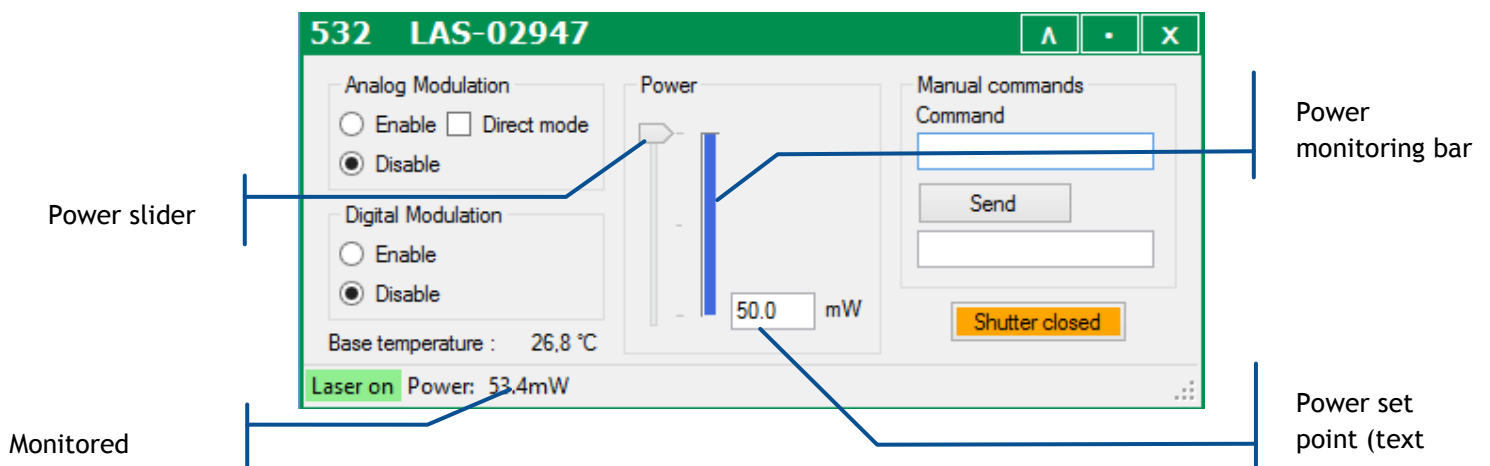
- Depending on its model, the laser source will require a warm-up period (up to two minutes for a LBX, up to ten minutes for a LCX). The status indicator on the remote-control blinks during this period.
- Past the warm-up period, the laser will start emitting. The status indicator is lit in solid green when all the activated sources emit steadily. To release the beam, open the shutter using the switch on the front panel.

NOTES

- The level of power emitted depends on the configuration of the L1C. Refer to “How to set the power levels” below and to the following chapter: “Configuring the L1C”.
- If an error occurs on the source, the alarm indicator on the remote control will be lit in solid red. Use the GUI to identify the cause of this alarm.

HOW TO SET THE POWER LEVEL

Open the control panel of the laser source, then locate the shutter activating button and the command console (as in the picture below):

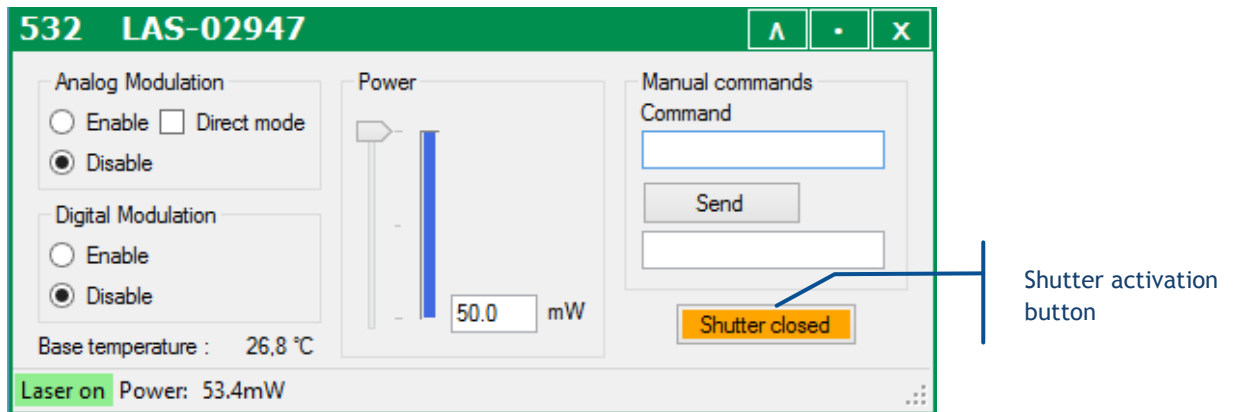


- Click in the text box and type a new power set point. Validate by pressing the “Enter” key.
- Alternatively, you can click and drag the slider to a new value. The text box below should reflect this new value.

HOW TO ACTIVATE THE SHUTTER

The electro-mechanical shutter inside the L1C can be activated through one the following methods:

- Using the control software: open the control window and locate the shutter activation button (as in the picture below)



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

- Alternatively, send the following commands to the L1C:
 - o “SH 1” to open the shutter,
 - o “SH 0” to close the shutter

NOTES

- In addition to this electro-mechanical shutter, a manual shutter is present at the front side of the L1C
- On the remote control, pressing the “shutter” switch to its “closed” position will force all the electro-mechanical shutters closed.

HOW TO POWER DOWN THE L1C

Here is the sequence to shut down the L1C:

- Turn the master control key off (anti-clockwise) on the remote control,
- Power the BTC-AOM off by pressing the main power switch,
- Unplug the power cord of the power supply from your mains socket

RESUMING THE EMISSION AFTER AN UNCOMMON INTERRUPTION

In the event where an alarm is raised or if the interlock circuit is opened, the emission is then interrupted in a manner that is considered to be “uncommon”, and the unit is locked.

The resume sequence is as follows:

1. On class 4 laser units only: it is first necessary to first turn the actuated key master control off (counter-clockwise) then on. On class 3b lasers sources, leaving the key on is enough.

2. Any of the following actions will resume the emission:
 - Using RS-232 or USB communication port, send the command “DL 0”. The emission can now be resumed using the command “DL 1”
 - Using the software interface, re-activate the laser using the button ‘Reset’

3-3 How to configure the L1C

A complete operation setup should consist in:

- Setting the power of the laser source (referring to the previous chapter 3-2),
- Configuring the modulation functions,
- Configuring the input/output port

The following paragraphs explain these steps in details.

MODULATION FUNCTIONS

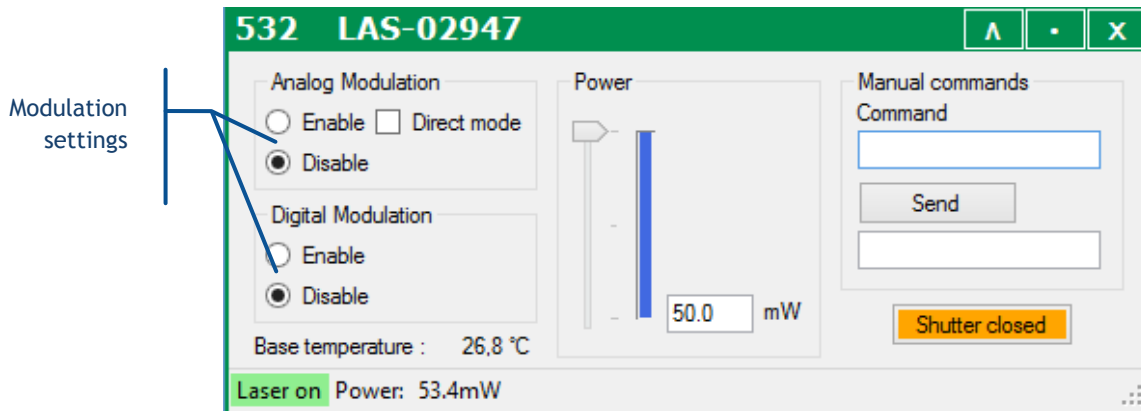
The optical output can be modulated according to incoming electrical signals:

- The analog modulation functions allow the user to deliver an output power proportionally to the input voltage: 0V for a nil power, 5V for the maximal power
- The digital modulation function delivers an output power according to two states (“on” and “off”): 0V for a nil power, 5V for the maximal power

Once the (physical) signal connections are established, the user needs to configure these modulation functions on each laser source.

Using the GUI:

- Open the main panel of the L1C and locate the modulation set boxes (as in the picture below)



Select the appropriate boxes if you need to enable (or disable) the analog modulation, the digital modulation, or both.

NOTE

For the analog modulation specifically, the input signal is pre-processed so as to obtain a linear response of the optical power with regard to the input signal. Ticking the box “Direct mode” will skip this pre-processing and render the native characteristics of the AOM.

Alternatively, the software commands “AM” and “TTL”, when sent to this specific laser source, will perform the same selection. Refer to the chapter 7-2 for a detailed description of these commands.

INPUT/OUTPUT PORT

This port is used to drive miscellaneous components inside the L1C. The user can configure (or “map”) some of its inputs to some specific functions.

Here is the pin assignment of this port:

Table 3-1: Pin assignment of the I/O port

Pin number	Signal name and function	Direction	Description	Voltage range
1	Programmable input number 1	Input		0V to +5V
2	Programmable input number 2	Input		0V to +5V
3	Blanking function	Input	Equivalent to the “blanking” input on the rear panel of the controller	0V to +5V
4	Laser ready	Output	Indicates that all laser sources are ready for emission.	TTL low: Laser is not ready TTL high: Laser is ready
5	Analog input number 1	Input	Equivalent to the analog input number 1 on the rear panel of the controller	0V to +5V
6	Analog input number 2	Input	Equivalent to the analog input number 2 on the rear panel of the controller	0V to +5V

7	Analog input number 3	Input	Unused	
8	Analog input number 4	Input	Unused	
9	Analog input number 5	Input	Unused	0V to +5V
10	Analog input number 6	Input	Unused	0V to +5V
11	Programmable input number 3	Input	Unused	0V to +5V
12	Programmable input number 4	Input	Unused	0V to +5V
13	Programmable input number 5	Input	Unused	0V to +5V
14	Programmable input number 6	Input	Unused	0V to +5V
15	Programmable input number 7	Input	Unused	0V to +5V
16	Digital ground	Ground	0V: ground of pins number 1 to 4, 11 to 15, 18 and 24.	0V
17	Reference voltage	Output	+5VDC reference voltage	+5.0V
18-23	Analog ground	Ground	0V: ground of pins number 5 to 10	0V
24	Programmable input number 8	Input	Unused	0V to +5V
25	Digital Ground	Ground	0V: ground of pins number 1 to 4, 11 to 15, 18 and 24.	0V
Shell	Ground	Ground		0V

The following table lists the functions available for mapping (on the programmable inputs number 1 to 7). Some of these functions refer to optional components.

Table 3-2: Available functions on the programmable pins

Function number	Function name	Description
0	Nil	No effect
5	Shutter for source #1	+5V: open the electro-mechanical shutter on the L1C number 1 0V: close that shutter
6	Shutter for source #2	+5V: open the electro-mechanical shutter on the L1C number 2 0V: close that shutter

In order to perform the mapping of a function with a programmable pin, send the software command “IO” to the controller. For example, send the command “IO 15 5” to map the function “LCX shutter #1” on pin number 15 (programmable input number 7).

3-4 Using the control software

RUNNING THE CONTROL PROGRAM

Launch the executable file from your “Program” menu or from the installation directory. On start-up, the first window appearing in “Oxxius laser” lists the devices detected on the USB ports (figure 3-3).

The L1C appears as a standalone unit in this list. Select it and click on the “Connect” button. This will open individual windows on the main frame: each of them represents one of the elements composing the L1C.

Figure 3-3: “Oxxius laser” start-up window

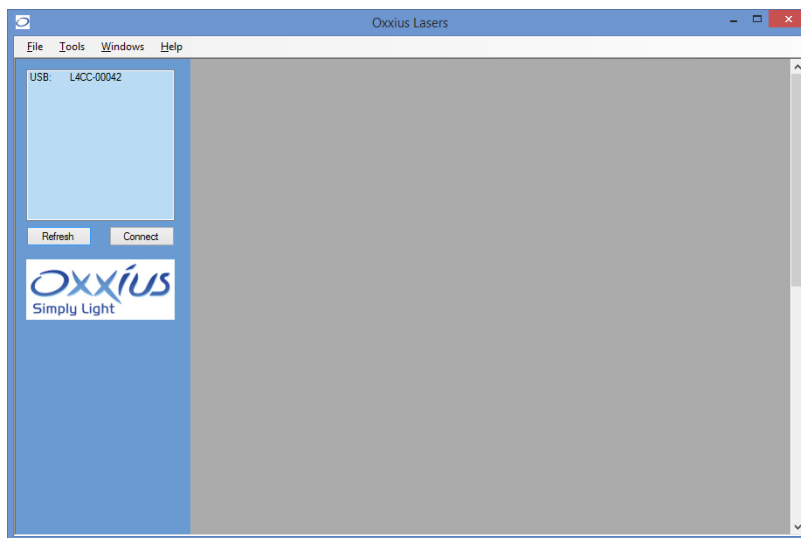
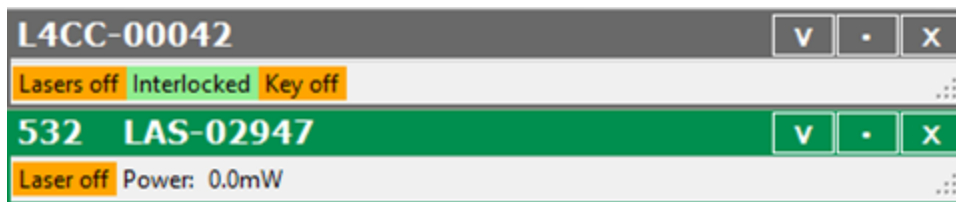


Figure 3-4: Control window for a L1C unit



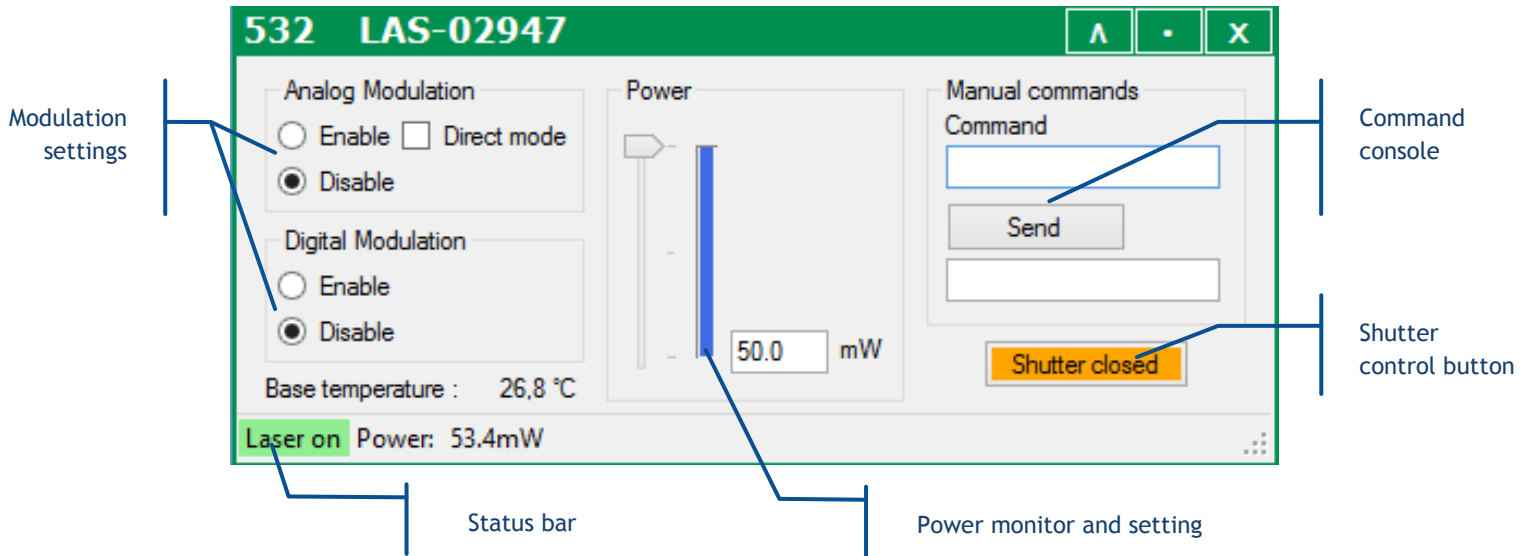
The top window controls the L1C as a whole, while the following windows represent its laser source (LBX or LCX). Each of these windows is titled with the emitted wavelength (if relevant) and the serial number of this unit (the L1C unit or its laser source),

Click on the V-shaped button on the right-hand side to expand each window.

Click on the same button (“^”) one more time to collapse the window.

THE CONTROL WINDOW OF A LCX LASER SOURCE

Here is the windows representing a LCX laser source:



This control panel consists of the following elements:

- A pair of buttons to enable or disable the modulation functions (if these functions are available),
- Two text boxes to send and receive software commands,
- An indicator displaying the measured output power,
- A pair of box and a slider to modify this output power (if this function is available),
- A status bar to indicate the laser status and the output power

Refer specifically to the LCX user manual for detailed information about the status bar and the command console.

SENDING QUERIES AND COMMANDS

Software queries and commands can be entered manually using the command box. To do so, type your query inside the box, then validate it by pressing the "Enter" key or by clicking the "Send" button below. Some control windows (for the LBX in particular) may require the user to first click on the "Show console" button in order to display the command box.

The requested unit will deliver its answer in the text box immediately below:

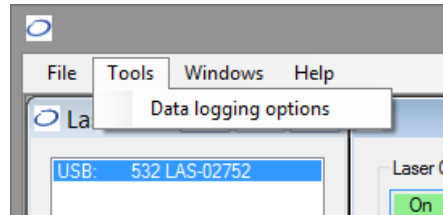
- "OK" to a command it has acknowledged,
- "???" to a query or command which syntax is not understood

Please refer to chapter 6-5, “Software commands” for the list of these queries and commands.

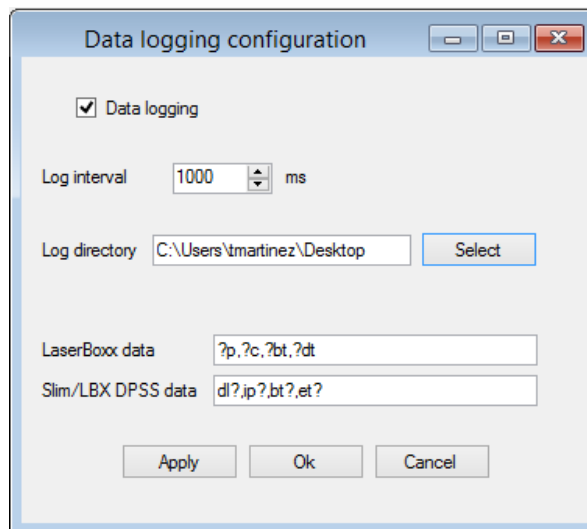
DATA LOGGING

Data logging is a function that allows the user to record the functional status of the L1C over time.

This function first needs to be configured: click on the “Tools” menu and select “Data logging options.”



This will open a separate configuration window:



From top to bottom, here are the elements present inside this window:

- Tick the box called “Data logging” to activate (or deactivate) data logging,
- The “log interval” determines how often the L1C will be 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: Make sure that this location is a directory for which you have the appropriate rights (file creation and write access). Failing to do so will result in an error when the record is launched.

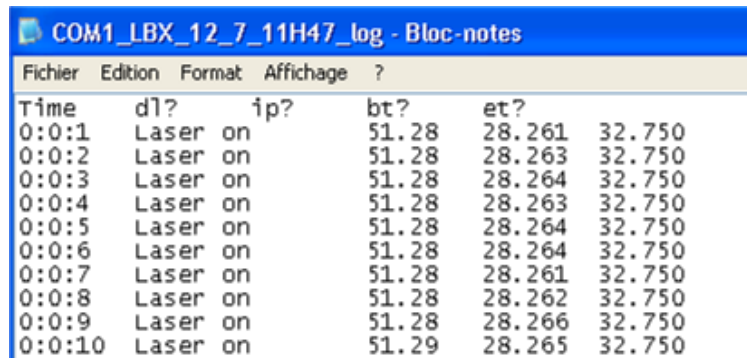
- The two following boxes contain the set of queries the laser sources will be polled for. Edit the box named “LaserBoxx data” by listing the queries you need to record on your LBX units. Edit

the box named “DPSS data” by listing the queries you need to record on your LCX units. In both lists, the separator is a comma “,”.

- Click on the “Ok” button once you are done.

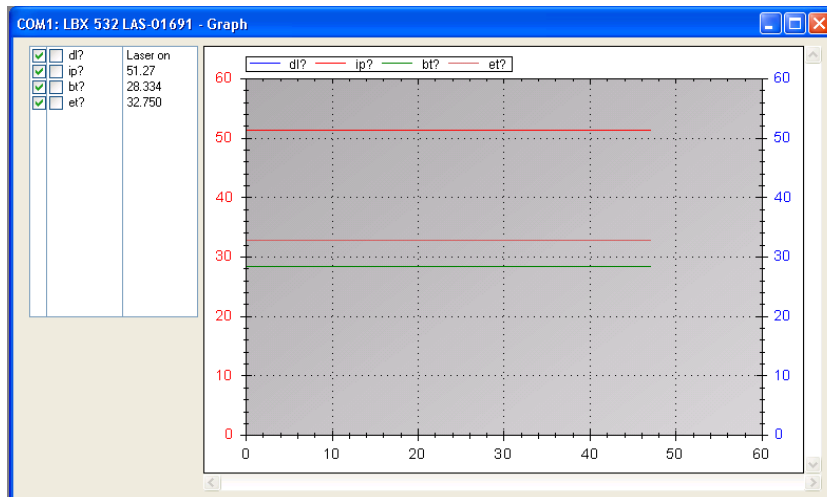
This will create a file named `COMXX-LBX-MM_DD_HHHH_log` in the record directory, where “XX” is the number of communication port (identical to the one appearing in the laser list), “MM” is the current month, “DD” the current day and “HHHH” the current time.

The syntax of this record is plain text, so that it can be opened by any text editor as in the following example:



Time	dl?	ip?	bt?	et?
0:0:1	Laser on		51.28	28.261 32.750
0:0:2	Laser on		51.28	28.263 32.750
0:0:3	Laser on		51.28	28.264 32.750
0:0:4	Laser on		51.28	28.263 32.750
0:0:5	Laser on		51.28	28.264 32.750
0:0:6	Laser on		51.28	28.264 32.750
0:0:7	Laser on		51.28	28.261 32.750
0:0:8	Laser on		51.28	28.262 32.750
0:0:9	Laser on		51.28	28.266 32.750
0:0:10	Laser on		51.29	28.265 32.750

It is also possible to visualize the logged parameters in real time using the “Graph” button in the command panel. This will open a separate window displaying the recorded parameters as curves against time (on abscissa):



The frame on the top left lists the parameters that may appear on the graph, and their current value.

Here are some basic controls:

- Tick on the boxes left to each of the parameters polled to make its curve appear the left axis, or on the right axis or to remove it from the displayed curves.
- Use the left mouse button inside the curve frame to draw a zoom window.
- Use the right mouse button inside the curve frame to open a dedicated menu for zoom and display
- Focus function: leave your mouse on a single curve to see the values (coordinates) of the nearest point belonging to this curve

4. ADVANCED OPERATIONS

This section describes how to use the control software, how to control the L1C through the electrical interface, and how to adjust the coupling of the laser in an optical fiber.

4-1 Using Oxxius software to operate the L1C

It is possible to control the LaserBoxx remotely using a computer, using either a serial port (RS-232 protocol) or a USB port (USB protocol or serial communication through virtualization).

The control software allows the user to monitor and control several LaserBoxx modules at once.

COMPUTER REQUIREMENTS

Oxxius software is compatible with the following operating systems:

- Windows XP SP2 (32-bit version),
- Windows Vista (32-bit and 64-bit versions),
- Windows 7 (32-bit and 64-bit versions),
- Windows 8 (32-bit and 64-bit versions),
- Windows 10

Microsoft .NET 3.5 framework is required. If it is not installed, you will be asked to download and install it.

INSTALLING THE SOFTWARE SUITE

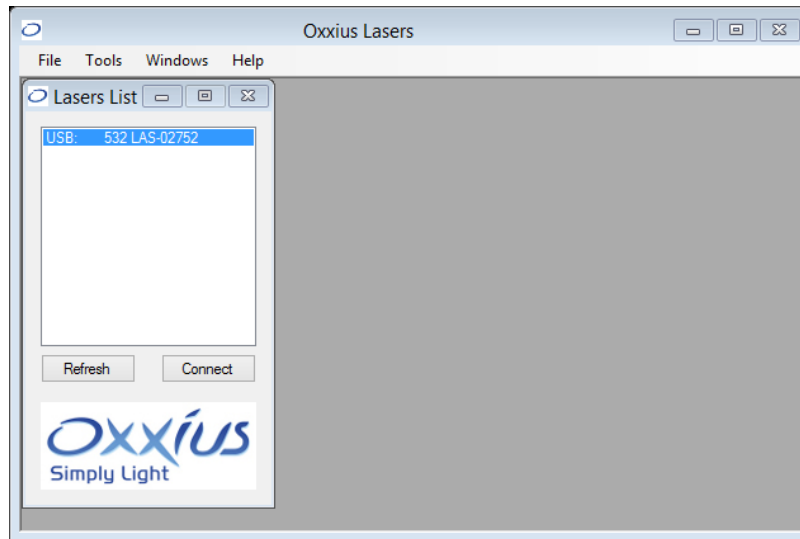
Refer to section 2, paragraph 2-6 to install the command software and the necessary drivers.

DESCRIPTION OF THE INTERFACE PANEL

Launch the executable file from your “Program” menu or from the installation directory. On start-up, the first window appearing in “Oxxius laser” lists the devices detected on the USB ports:

- Units connected through USB appear automatically on the laser list,

- Units 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.



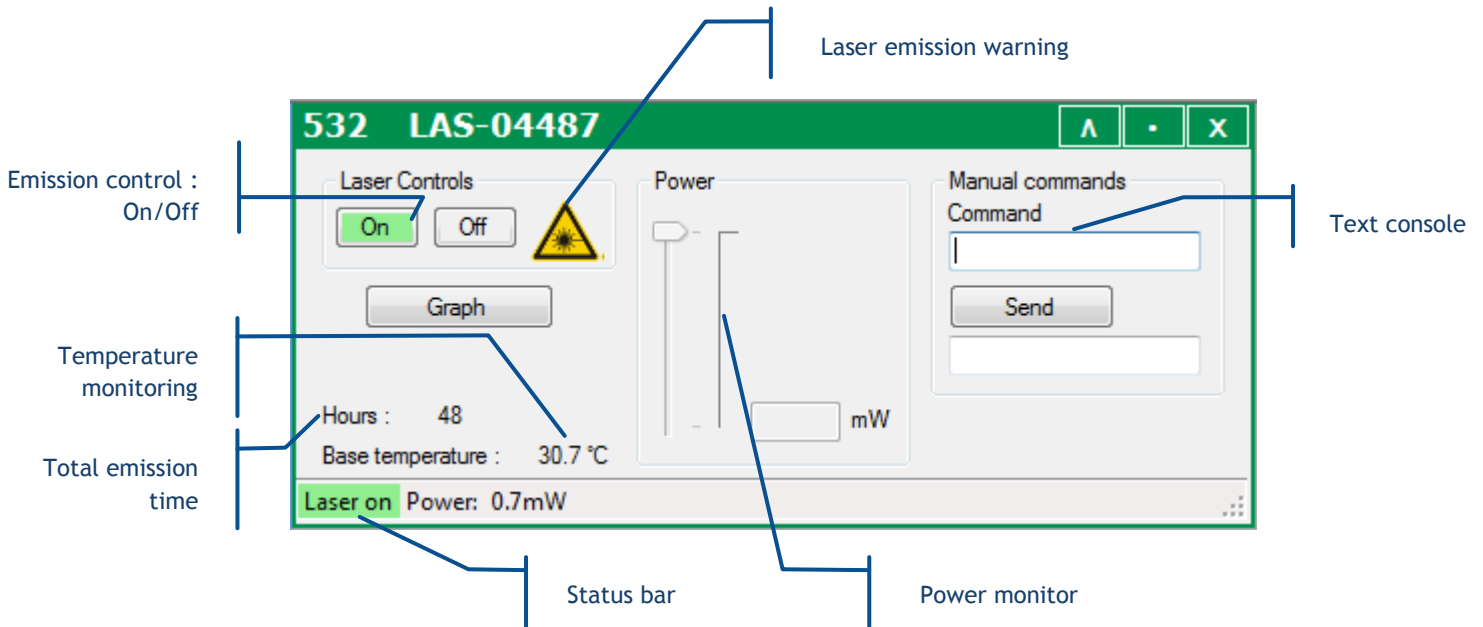
Each laser is identified on the list by its communication port, model, emission wavelength and serial number.

Select one laser on the list and click on the “Connect” button. Alternatively, double-clicking on the line will also open a control panel.

DESCRIPTION OF THE CONTROL PANEL

Here is the window representing the laser source embedded inside the L1C:

Figure 4-1: Control panel of a LaserBoxx laser source



The control panel consists of the following elements:

- Buttons to control the laser emission,
- A picture to indicate the emission (laser radiation warning),
- A text console to send and receive software commands,
- Indicators displaying the measured output power, the monitored temperature and the total emission time,
- A box and a slider to modify the output power,
- A status bar to indicate the laser status, the output power

USING THE CONTROL PANEL

To start the emission, click on the "On" button. The output can be adjusted (on specific models) using the slider or entering a set-point into the box.

The status of the laser is displayed at the bottom-left corner of the window.

Priority management to command the emission

The actuated key master control and the “Laser controls” buttons on the GUI both drive the laser emission. As a result a priority scheme has been enforced to avoid conflicts:

- On start-up, the unit reacts to the actuated key master control or the “enable” pin,
- As soon as one of the “Laser controls” buttons is pressed or one of the “enable” software commands (“DL 0”, “DL 1” or “DL 2”) is received, the priority is given to these commands and consequently the signals on the “enable” pin are ignored,
- Different possibilities are available to revert this situation: either send the “RST” command to the laser, or turn off the supply power

SENDING QUERIES AND COMMANDS

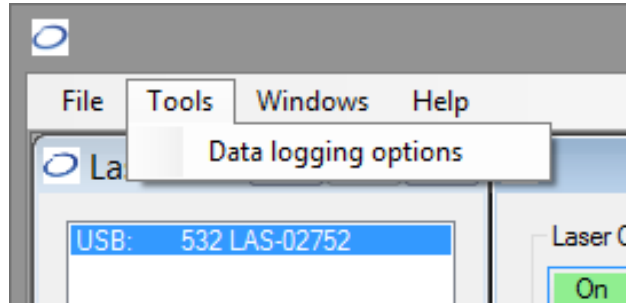
Communication with the laser source is performed by transmitting queries and commands. Any query or commands can be entered manually using the command box. Please refer to the Annex B, “software commands” for the list of these commands. Type your query inside the box, then press “Enter” or press the button “Send”. Answers are displayed in the box below.

- The laser unit will answer “????” to a query or a command which syntax is not understood.
- The laser unit will answer “OK” to a command which has been acknowledged
- A query which has been acknowledged by the laser returns the queried value or chain of characters

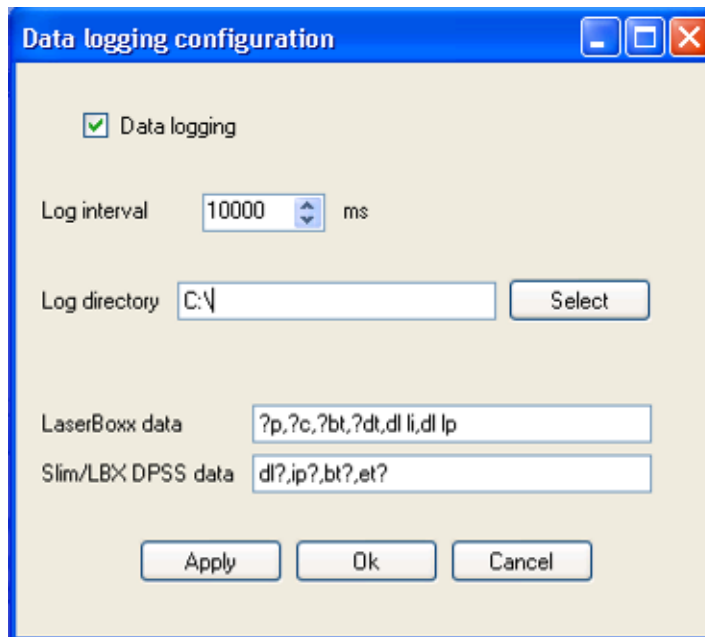
DATA LOGGING

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

To do so, it is first necessary to configure this function: first click on the “Tools” menu and select “Data logging options.”



This will open a separate configuration window.

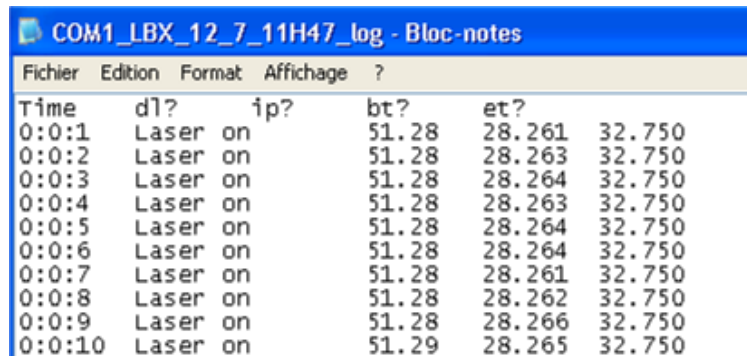


From top to bottom, here are the elements present inside this window:

- Tick the box called “Data logging” to enable or disable data logging,
- The “log interval” determines how often the LaserBoxx will be polled for data. The default value is “1000 ms”.
- The “log directory” is where the record file will be created and the data will be saved. Click on the “Select” button to change this directory.
- **Warning:** Make sure that this location is a directory you have the appropriate rights for (to create and modify a file). Failing to do so will result in an error when the record is launched.
- The two following boxes contain the set of queries the LaserBoxx will be polled for. Edit the box named “LaserBoxx data” by listing the queries you need to record (separated by a comma “,”).
- Click the “Ok” button once you are done.

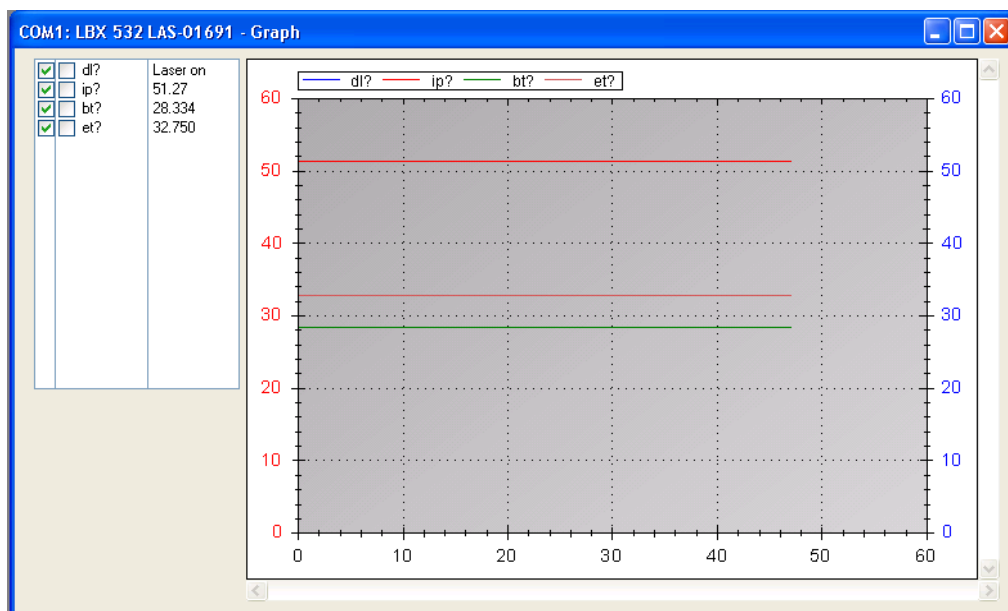
This will create a file named `COMXX-LBX-MM_DD_HHHH_log` in the record directory, where “XX” is the number of communication port (identical to the one appearing in the laser list), “MM” is the current month, “DD” the current day and “HHHH” the current time.

The syntax of this record is plain text, so that it can be opened by any text editor as in the following example:



Time	dl?	ip?	bt?	et?
0:0:1	Laser on		51.28	28.261 32.750
0:0:2	Laser on		51.28	28.263 32.750
0:0:3	Laser on		51.28	28.264 32.750
0:0:4	Laser on		51.28	28.263 32.750
0:0:5	Laser on		51.28	28.264 32.750
0:0:6	Laser on		51.28	28.264 32.750
0:0:7	Laser on		51.28	28.261 32.750
0:0:8	Laser on		51.28	28.262 32.750
0:0:9	Laser on		51.28	28.266 32.750
0:0:10	Laser on		51.29	28.265 32.750

It is also possible to visualize the logged parameters in real time using the “Graph” button in the command panel. This will open a separate window displaying the recorded parameters (ordinate) against time (abscissa).



The frame on the top left allows the user to select which parameter should appear on the graph, and on which axis. Tick on the boxes before each parameter to make its data on the left axis, on the right axis or on none of them.

4-2 LaserBoxx with fiber-coupling

When a LaserBoxx is provided with a fiber coupling option, a laser beam coupler is attached to the optical head. Its function is to inject the laser beam into the core of the delivery fiber. The alignment between this optical fiber and the laser beam is performed and tested at Oxxius' manufacturing facilities. However optimizing the coupling ratio might be required afterwards.

The following sections will describe how to use and adjust these elements.

COUPLING ON A SINGLE-MODE FIBER

Single mode (SM) or polarization maintaining (PM) fiber coupling are options that employ a beam coupler from Schäfter and Kirschhoff.

More information is available on www.SuKHamburg.de

The high quality of these couplers guaranties a long-term stability.

HANDLING PRECAUTIONS AND INSTALLATION

Optical fibers are made of glass and are fragile pieces of equipment. They are used under the form of a patchcord which protects the fiber from the most common sources of degradation. A specific attention is required with these delivery patchcords which should not be bent nor receive mechanical damage (shear stress, punching, etc.) under any circumstances.

The user is required to handle the patchcords and their connectors with care, and also to have the necessary tools and knowledge to inspect and clean the end tip of the fiber.

These tools are:

- A specific microscope to inspect the end tip of the fiber. Oxxius recommends using a 200x magnification microscope, as the "F1VM200" available from www.fiberinstrumensales.com
- Some consumables to clean the optical connectors. Oxxius recommends using "type A" CLETOP tools available from NTT-AT.

Installation

The fiber coupler is delivered installed and aligned onto the laser head.

In order to fix the laser head, use the same procedure as described in chapter 2-5, "Installing the laserhead".

WARNING: The coupling efficiency can be altered if you fix the laser head on a plate with an insufficient flatness.

USING THE COUPLED FIBER

To prevent damaging the fiber, check the ferrule it before each use and clean it if necessary. Use a fiber connector cap to protect the end face of the fiber whenever it is not in use.

Turn on the LaserBoxx (See section 3, “Operation”) and check your output power using an optical power-meter.

TROUBLESHOOTING

If your product do not reach the level measured at factory, please check the following points:

- **Fiber connector:**
 - o Check the end face of the fiber using a dedicated microscope
 - o Clean the connector using a connector cleaner (Warning: the laser emission must be absolutely be turned off during this operation)
 - o If the connector is damaged, replace the patchcord or re-polish its end face.

- **Patchcord external aspect:**

Check integrity of the patchcord (marks, small curvatures on the cable issue from transportation)

- **Mechanical mount:**
 - o If the flatness of the base is insufficient, it will induce a mechanical tilt on the LaserBoxx and modify the coupling efficiency.
 - o To check this, unscrew the three maintaining screws of the LaserBoxx and observe how the delivered power fluctuates. If the variations are important, the flatness of the mechanical mount needs to be improved.

- **Incident power:**
 - o Check the incoming power on the coupler using the software provided by Oxixus.
 - o If it is insufficient, adjust its value using one of the method described in section 3, “Operation”.

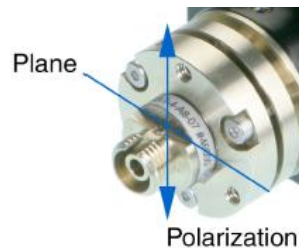
- **Measurement material:**
 - o Check that your powermeter is set to the correct wavelength, or check its calibration.

If after all these checks, the delivered fiber is not high enough (in other words: if the coupling ratio is insufficient), it is then necessary to readjust the coupling, referring to the following procedure.

COUPLING PROCEDURE

This procedure in this section explains how to maximize the coupling efficiency (i.e. the fraction of the lasers's power successfully injected into the fiber), for example when you need to change or disassemble the delivery fiber.

We recommend not to change the centration of the coupler holder and the coupler's orientation because the coupler holder is aligned with the beam in the factory and the fiber coupler's orientation is adjusted to be aligned with the laser's polarization.

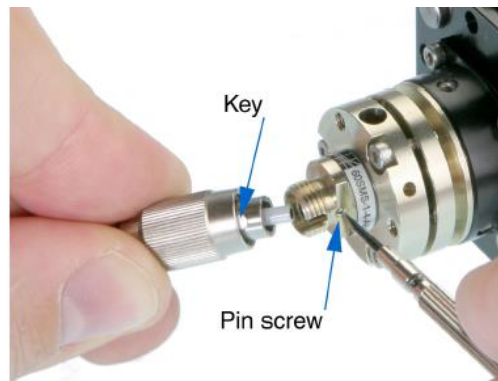


Attaching a single mode fiber cable to the laser beam coupler

Only use fiber cables terminated with FC-APC (8° angle) connectors as provided by Oxxius. To attach such a fiber:

- Make sure that the pin screw holding the connector ferrule is loosened and does not impair the insertion of the ferrule into its holder (see Figure 4-5). Failing to do so can damage the connector;
- Approach the fiber connector at an angle (as shown on Figure 4-5) and insert the ferrule into the beam coupler, carefully avoiding any contact on the ferrule's end face;
- Once the ferrule is inserted, align the connector's key with the notch on the coupler, then gently push the connector inside the coupler and lock the connector's box nut by rotating it to the right (do not use any tools to fasten the connector, use only your hand);
- Fasten the coupling nut of the connector completely;
- Slightly and gently fasten the pin screw in order to reduce the slackness of the ferrule inside the alignment sleeve. Be warned that fastening the screw too hard can affect the polarization state in the fiber and damage the screw.

Figure 4-2: Pin screw (coupler side) and connector's key



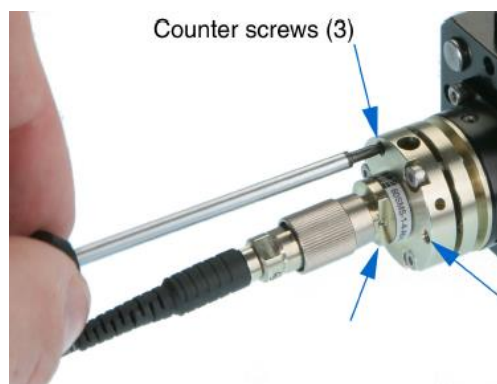
Finding a signal

To inject a laser beam into a fiber, one has to align the focus point of the coupling lens with the center of the fiber's core. Given the core size of a single-mode fiber (typically a few microns), the alignment procedure is painstaking and requires both patience and precision in the handling of the coupler.

You will need an optical power meter equipped to accept your fiber's connector and able to measure optical powers ranging from a few tens of μW to a few tens of mW .

Firstly, make sure that the three counter screws (see Figure 4-6) are loosened by 2 or 3 full turns.

Figure 4-3: Position of the counter-screws



Procedure:

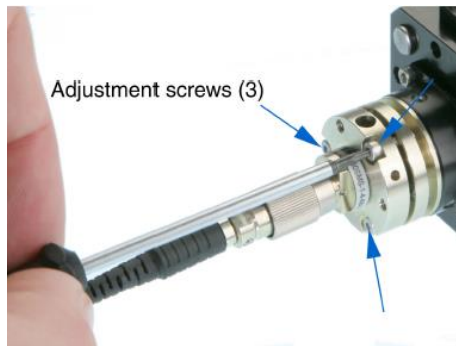
- Power up the laser, set the optical output to a value below 50mW and turn the emission on;



Warning: the laser is now emitting. Proper protection measures against laser light shall be enforced.

- Set your power meter to its smallest power range (so it can detect even small differences in optical power) and attach it to the fiber's end. Locate the adjustment screws (they have a 1.5 mm hex cylindrical head, see Figure 4-7) and turn them one by one (with an Allen 50HD-15 wrench) until the power meter's reading indicates that optical power has been detected. A good adjustment sequence should be so that any possible position is scanned once.

Figure 4-4: Position of the adjustments screws



It is sometimes useful to loosen a bit the box nut on the fiber connector and to pull back slightly the fiber connector. Some defocussing will happen and the light's spot on the connector end face is larger and therefore easier to find. Fasten the box nut again when you have detected optical power.

Increasing the signal

Once an optical signal is detected, the power meter's sensitivity shall be changed accordingly. The next step consists in maximizing the signal's power by turning the adjustment screws one by one.

Start with one adjustment screw and tighten it slowly until the optical signal reaches a relative maximum. Then fasten this first screw a little more so that the signal's power decreases by a few percents.

Repeat the operation with the next adjustment screws, proceeding in the same way. After adjusting the three screws, start a second round and re-adjust the first screw, and so on. Make sure to always adjust the screws in the same sequence (for example, (1) -> (2) -> (3) -> (1) -> (2) -> (3)). The maximum power level is typically achieved after three rounds of adjustment.

Be aware that repetitive squeaks indicate that a screw is tightened too strongly, a situation that should be avoided.

Before proceeding to the next step, check that the insertion losses (i.e. the difference between the laser's power settings and the output power as measured by the power meter at the fiber's end) do not exceed 100 mW.

Fine adjustment and locking

Take note of the power delivered at the output fiber, and compute the transmission ratio (i.e. the measured output power divided by the raw output power obtained at the same set point).

The fiber's coupler adjustment is now near its optimum and you can proceed with the final phase: achieving the maximum coupling efficiency by adjusting the three counter screws (the small pin screws, see figure 4-6)

Using the same procedure as before, start from a state where all three counter screws are equally loosened. Then tighten slowly the first counter screw until the optical signal reaches a relative maximum, and fasten it a little more so that the signal's power decreases slightly.

Repeat the operation with the other counter screws, proceeding in the same way. After adjusting the three screws, start a second round and re-adjust the first counter screw, and so on.

At the end of the last round, tighten the last counter screw so as to maximize the output power level.

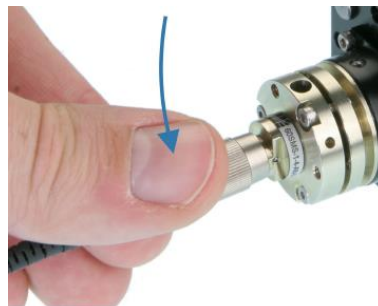
You can now gradually increase the output power up to its nominal set point. As a final check, make sure that the transmission ratio has not decreased.

Checking the alignment

A possible way to check the alignment's robustness is by pressing gently on the connector in all directions (see Figure 4-8): when thus pressing, the signal's power should decrease but it should then recover its initial value once the pressure is released.

If this is not the case, the coupler's alignment is not optimized. The test gives a hint about the direction where more pressure should be applied to the fiber (i.e. which counter screw should be tightened.) Use this information to re-optimize the coupling.

Figure 4-5: Checking the stability of the adjustment



COUPLING ON A MULTI-MODE FIBER

Fiber coupling on LaserBoxx is also available with multimode fibers. The standard fibers have a numerical aperture of 0.22, a core diameter of 50 microns. Contact Oxxius if you need to connect fibers of alternative specifications.

The coupler consists of a mechanical holder positioned inside the laser shutter. Refer to section 2-4 for a description of the laser shutter. On the front face of the holder are the screws that will define the alignment of the fiber against the beam. See figure 4-10.

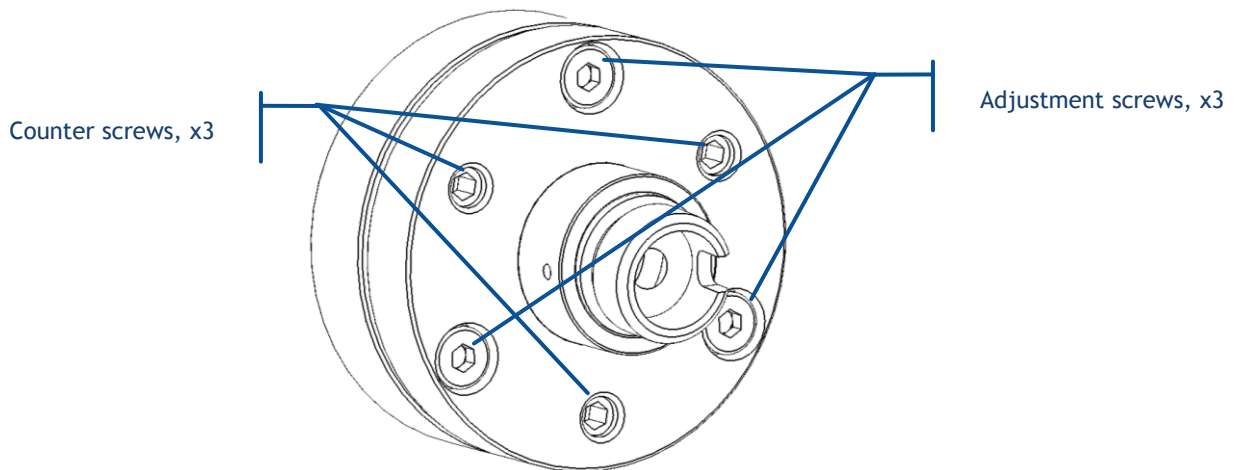
This procedure explains how to retrieve an optimal coupling efficiency.

WARNING



To avoid damaging the fiber end face, the following adjustment procedure should be performed at low optical power ($P \leq 40$ mW), using the “alignment mode” low power beam (refer to section 3, “Operation” for detailed information).

Figure 4-6: Position of the adjustment screws and counter-screws



- The mechanical holder has been centered with regards to the beam (using the positioning screws of the shutter). This operation is performed at Oxxius and we recommend not to disturb this positioning.
- Unscrew slightly each counter screws by two turns,
- The next steps consists in maximizing the signal's power by turning the adjustment screws one by one:

- Start with one adjustment screw and steer it slowly until the optical signal reaches a relative maximum. Continue steering this screw a little more so that the power decreases by a few percents.
 - Repeat the operation with the next adjustment screws, proceeding using the same maneuver. After having the three screws adjusted, start a second round and re-adjust the first screw, and so on. Make sure to always adjust the screws in the same sequence (for example, (1) -> (2) -> (3) -> (1) -> (2) -> (3)). The maximum power level is typically achieved after three rounds of adjustment.
- Secure the optimum position (at maximal power) by tightening the counter screws,
 - Your transmission ratio is now maximized

5. TROUBLESHOOTING

This chapter describes the main issues occurring on the L1C, the way to identify and solve them.

Warning



Attempting to open the L1C or its controller is likely to result in damages and will void the product's warranty.

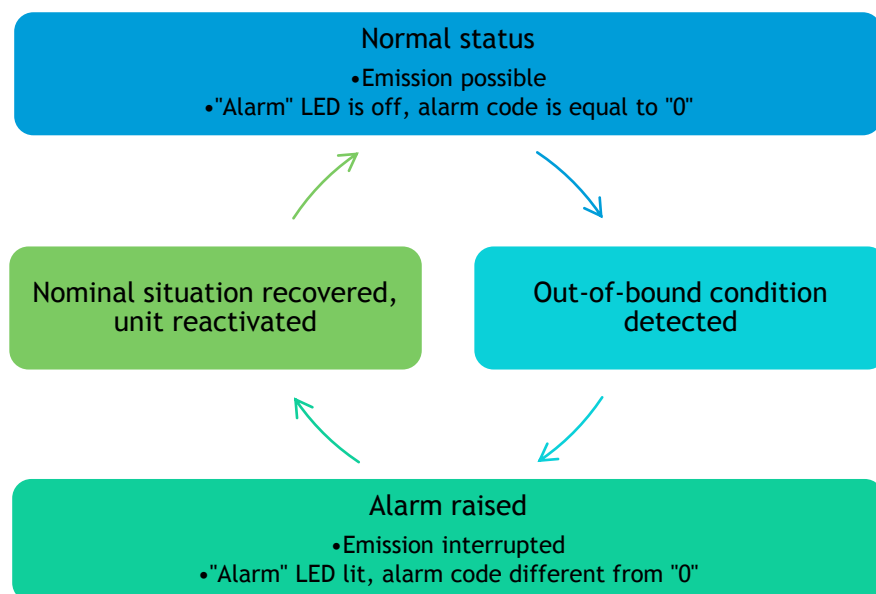
5-1 Alarms detailed

Alarms are a category of status informing of off-limits operational conditions. When an alarm is raised, laser operation is not possible until the cause of the alarm is fixed. Resuming the emission requires that the unit is re-activated by the emission key.

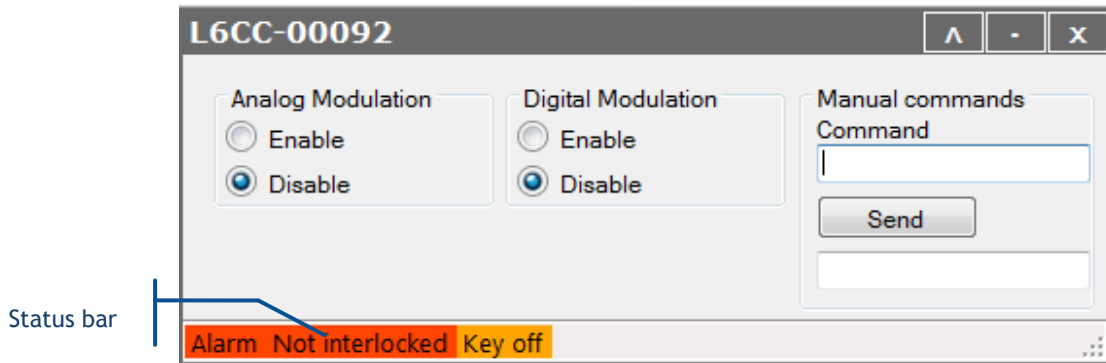
An alarm status is expressed to the user by any of these means:

- the "Alarm" LED in solid red on the remote control (refer to section 2, paragraph 2.4 for a description of the remote control),
- the software query "AL?" return the specific identification of the alarm

Chart 5.1 Alarm status and their transition sequences



Once an alarm is raised, it is recommended to identify it by connecting the L1C to our GUI software. A description of the alarm is displayed in the status bar of the L1C control window.



The possible sources of alarms and recommended measures are detailed in the following table:

Table 5.2 Alarm status detailed for a L1C

Description	Cause for the alarm	Action required
No alarm	None	None
Power supply	The supply voltage of the unit is outside its specified range. Refer to section 2 and to your specification sheet for allowable voltage ranges	Check the input voltage by measuring the voltage at the output terminals of your power supply
Interlock	The interlock circuit is open	Check the continuity of the interlock circuit

In addition to that list, alarms that are raised from the laser source will be elevated to the L1C. In this case, the user should open the control window of the said laser source and refer to the user manual of that source in order to identify the nature of the alarm.

Once an alarm is raised, the emission is interrupted and can be resumed only once the cause of the alarm is cleared.

5-2 Recovering missing power levels

This section mostly refers to output channels that are terminated by an optical fiber.

A specific attention is required with the delivery patch cable which should not be bent nor receive mechanical damage (shear stress, punching, etc.) under any circumstances.

The user is required to handle the patch cable and their connectors with care, and also to have the necessary tools and knowledge to inspect and clean the end tip of the fiber.

These tools are:

- A specific microscope to inspect the end tip of the fiber. Oxxius recommends using a 200x or 400x magnification microscope.
- Some consumables to clean the optical connectors. Oxxius recommends using “type A” CLETOP tools available from NTT-AT.

If, under normal operating conditions, the output power seems to be lower than its original value, then the following steps will help you identifying its cause:

Issue observed	What to do
Output is nil at the end of the delivery fiber	<ol style="list-style-type: none"> 1) Start by inspecting the external aspect of the patch cable, looking for steep bend curves or mechanical damages. These might be the sign of a damaged optical fiber. If that is the case, the patch cable needs to be replaced 2) Inspect both optical connectors of the delivery fiber using a dedicated microscope (refer to the following chapter for detailed guidance). Clean them if necessary. If one of the end facets is damaged near the fiber core, then the optical connector needs to be re-polished, or replaced. 3) Try readjusting the fiber coupler in order to increase the throughput. Refer to the chapter 4-3.
Insufficient power at the end of the delivery fiber	<ol style="list-style-type: none"> 1) Inspect both optical connectors of the delivery fiber using a dedicated microscope (refer to the following chapter for detailed guidance). Clean them if necessary. If one of the end facets is damaged near the fiber core, then the optical connector needs to be re-polished, or replaced. 2) Try readjusting the fiber coupler in order to increase the throughput. Refer to the following chapter 4-3.
The projected beam is not round, distorted	Inspect the delivery optical connectors using a dedicated microscope (refer to the following chapter for detailed guidance). Clean it if necessary. If the end facet is damaged near the fiber core, then this optical connector needs to be re-polished, or replaced.

5-3 Uninstalling and repacking procedures

If your product does not seem to be operating correctly, please take contact with your local representative for support.

If a unit needs to be returned, it is necessary to obtain a returned merchandise authorization (RMA) from Oxxius prior to returning the product.

5-4 Oxxius Worldwide contacts

Your local representative can be found on our website: www.oxxius.com

Corporate headquarters:

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: support@oxxius.com

6. WARRANTY AND CERTIFICATION

6-1 Standard warranty

Limited Lifetime Warranty

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

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 patchcords 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.

6-2 Declaration of conformity



The manufacturer: Oxxius France
Address: 4, rue Louis de Broglie
22300 Lannion

Declares that the following products:

LCX laser source, LPX laser sources, LBX laser sources, LSX laser sources

Detailed references or models:

LCX-wwwS/L-ppp-CSB-OE/PPA/PPF
LPX-wwwS/L-ppp-CSB-OE/PPA/PPF
LBX-www-ppp-ELL/CSB/HPE-OE/PPA
LBX-wwwS-ppp-CIR/EIS-OE/PPF
LSX-wwwS-ppp-ISO-OE/PPF,

where “www” stands for the emission wavelength (expressed in nm), and “ppp” for power (in mW),

Are certified according to the following standards:

Low voltage directive: Directive 2014/35/EU (February 2014)
NF EN 61010-1/A1 February 2019

Electromagnetic compatibility (EMC): Directive 2014/30/EU (February 2014)
IEC 61326-1 Ed 2 (2012)
NF EN 61000-3-2 NF EN 61000-3-3
NF EN 61000-4-2 NF EN 61000-4-4
NF EN 61000-4-5 NF EN 61000-4-6
NF EN 61000-4-11 (for « plug and play » models)
NF EN 61000-4-3 (for “OEM” and « plug and play » models)

Laser safety: IEC 60825-1 Ed.3 / 2014-05

Signature

A handwritten signature in black ink, appearing to be 'Thierry Georges', written over a horizontal line.

(Thierry Georges, PDG (CEO), Lannion, August 2019)

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 Resources for developers

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

USB COMMUNICATION

The memory stick contains a library to drive an Oxxius LaserBoxx with USB port. It can be used with either Visual C++, Visual C#, Visual Basic, Labview or any other languages supporting “.NET” libraries.

The file “LaserBoxxUsbHelp.chm” contains the corresponding documentation for this library.

You will also find a simple example program based on Labview version 8.6.

MICROMANAGER SUPPORT

The L1C is supported by μ Manager, the open-source microscopy software. The relevant Device Adapter is named “Oxxius combiner”.

To proceed, it is necessary to turn this former into a virtual serial port using the command “CDC 1”. Refer to the following chapter, “Software commands” for detailed information concerning this command.

For detailed information about de Device Adapters designed for the BTC-AOM, please consult the homepage of the project: micro-manager.org .

7-2 Software commands

COMMANDS FOR THE BTC-AOM

The following tables lists the set of queries and commands to be sent to the BTC-AOM.

Using an Ethernet connection, the commands must be terminated by a LF character (Line Feed, ASCII 10). The returned strings are also terminated by a LF character.

Once a command is successfully received and processed, the acknowledgement message “OK” is returned. If the entered command or query is not understood by the unit, the following error message is returned: “????”

Communication and identification:

Purpose	Query	Syntax and examples
Sets the configuration of the USB port. The BTC-AOM needs to be restarted after this variable has been modified.	CDC	“CDC 0” (CDC,<space>,0) Configure the port for standard USB protocol “CDC 1” (CDC,<space>,1) Configure the port as a virtual serial port
Retrieves the configuration of the USB port	?CDC	“0” Standard USB protocol “1” USB port configured as a virtual serial port
Enables the IP address assignment of the BTC-AOM through the DHCP	DHCP	“DHCP 0” (DHCP,<space>,0) Disables the DHCP-based assignment. The IP address, subnet mask and gateway have to be configured statically, using the following commands “DHCP 1” (DHCP,<space>,1) Enables the DHCP-based assignment
Retrieves the status of the IP assignment method	?DHCP	“0” static assignment “1” DHCP-based assignment
Assigns the IP address of the BTC-AOM (for a static IP assignment)	EIP	“EIP 192.168.1.10” Assigns the IP address to 192.168.1.10
Retrieves the assigned IP address	?EIP	“192.168.1.10”
Assigns a gateway IP address (for a static IP assignment)	EGA	“EGA 192.168.1.1” Assigns the gateway IP address to 192.168.1.1
Retrieves the assigned gateway IP address	?EGA	“192.168.1.1”
Assigns the subnet mask of the BTC-AOM (for a static IP assignment)	EMA	“EMA 255.255.255.0” Assigns the subnet mask to 255.255.255.0
Retrieves the assigned subnet mask	?EMA	“255.255.255.0”

Sets the TCP socket number. The BTC-AOM needs to be restarted after this variable has been modified.	ESO	“ESO 22300” Assigns the communication socket port to 22300.
Retrieves the communication socket port	?ESO	“22300” is the default value
Retrieves the serial number of the BTC-AOM unit	HID?	“LNC-XXXXXX”
Retrieves the model of the source on slot n (where n equals either 1 or 2)	INF? n	“LCX-561-100” for a LCX LaserBoxx emitting 100mW at 561nm
Retrieves the firmware version of the BTC-AOM	?SV	“1.0.17”

Configuration and status:

Purpose	Query	Syntax and examples
Selects the analog modulation, and the mode of operation of all linked L1C units	AM	<p>AM 0 (AM,<space>,0): The analog modulation functions are disabled. The AOM is driven exclusively from software commands. Use the command “P” to set the output power.</p> <p>AM 1 (AM,<space>,1): The analog modulation functions are enabled on all L1C units. The AOM is driven by the analog modulation signal, but its maximum value is set using the command “P” below:</p> <ul style="list-style-type: none"> - When a voltage of 0V is applied, the output power is nil, - When a voltage of 5V is applied, the output power equal the value set using the command “P” <p>In this mode of operation, the modulation function between the input voltage and the output power is linearized.</p> <p>AM 2 (AM,<space>,2): The analog modulation functions are enabled on all L1C units. The AOM is driven exclusively by the analog modulation signal, its maximum value being the power delivered by the laser source linked to that AOM. In this mode of operation, the modulation function between the input voltage and the output power is not linearized (direct access).</p>
Set the “autostart” function on all L1C sources	AS	<p>“AS 0” Configure all the sources not to emit on start-up, once the emission key is turned. Software commands will have to be sent to launch the emission</p> <p>“AS 1” Configure all the sources to emit on start-up, once the emission key is turned (provided that the conditions are met for emission)</p>

Retrieves the status of the interlock circuit	?INT	<p>“0” Interlock open, laser emission is not possible</p> <p>“1” Interlock closed, laser emission is possible</p>
Retrieves the status of actuated key master control	KEY?	<p>“0” the key is off, laser emission is not possible</p> <p>“1” the key is on, laser emission is possible</p>
Sends the command “CMD” to the L1C unit on slot n (where n equals either 1 or 2). Refer to the specific commands for the LCX in the following table.	Ln CMD	<p>L1 AM 1 (L1,<space>,AM,<space>,1): enables the analog modulation on laser source number 1</p> <p>L2 INF? (L2,<space>,INF?): Get the model name of source number 2</p>
Retrieves the status of the BTC-AOM	?ST	<p>“Lasers off” when the actuated key master control is off</p> <p>“Lasers on” when the actuated key master control is on and all the sources in use are emitting</p> <p>“Starting-up” when at least on laser sources in use is in “starting-up” status</p> <p>“Alarm” when at least one of the sources is in “alarm” status</p> <p>“Stand-by” when all laser sources are in “stand-by” status</p> <p>“Blanking” when the blanking function is activated</p>
Sets the bias voltage v on the AOM n (where n equals 1 or 2, and v is between 0 and 50). This value determines the extinction contrast of the AOM. We recommend a value of 20 for v.	TA n v	TA 1 20 (TA,<space>,1,<space>,20): sets the bias voltage to 20 on the AOM 1.
Retrieves the value of the bias voltage on AOM n (where n equals 1 or 2).	?TA n	“20”
Selects the digital modulation, and the mode of operation of all linked L1C units	TTL	<p>TTL 0 (TTL,<space>,0): The digital modulation functions are disabled on all linked L1C units.</p> <p>TTL 1 (TTL,<space>,1): The digital modulation functions are enabled on all L1C units. The AOM is driven by an external modulation signal, but its maximum value is set using the command “PLn” below:</p> <ul style="list-style-type: none"> - When a voltage of 0V is applied, the output power is nil, - When a voltage of 5V is applied, the output power equal the value set using the command “PLn”

Power and operational settings:

Purpose	Query	Syntax and examples
Sets the power set point on source number n (where n equals either 1 or 2). On sources linked to a modulator (AOM,	PLn	PL1 10.1 (PL1,<space>,10.1) sets the power of laser source L1 at 10.1mW

MPA), the set point of that modulator will be affected. The argument is an absolute optical power.		
Retrieves the power set point on source number n (where n equals either 1 or 2). On sources linked to a modulator (AOM, MPA), the set point of that modulator will be returned.	?PLn	“40.0” for a set point of 40.0 mW
Sets the power set point on source number n (where n equals either 1 or 2). On sources linked to a modulator (AOM, MPA), sets the set point of that modulator. The argument is a percentage of the nominal power.	PPLn	PL2 25.2 (PL2,<space>,25.2) sets the power of laser source L3 at 25.2% of its nominal power
Retrieves the power set point on source number n (where n equals either 1 or 2), as a percentage of the nominal power. On sources linked to a modulator (AOM, MPA), the set point of that modulator will be returned.	?PPLn	“21.0” for a set point of 21.0 %
Open or close shutter on channel n (where n equals either 1 or 2)	SHn	SH1 1 (SH1,<space>,1): opens the shutter on channel 1 SH1 0 (SH1,<space>,0): closes the shutter on channel 1

SENDING COMMANDS TO THE INDIVIDUAL LASER SOURCES

It is possible to address to the individual LaserBoxx sources by sending command or queries to the BTC-AOM using the prefix “Ln”, where n is the number of the source to be addressed (“L1” for the first L1C, “L2” for the second L1C).

Communication and identification:

Purpose	Command	Syntax and examples
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-XXXXXX”, where XXXXX is a five-digit number
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 firmware version 1.6.8

Configuration and status:

Purpose	Command	Syntax and examples
Retrieves the temperature of the base plate of the laser head (expressed in Celsius degrees)	?BT	"22.1"
Activate or deactivate the CDRH-compliant five-second delay prior to laser emission. See section 1, "Safety information", for further details.	CDRH	CDRH 1 (CDRH,<space>,1): a five-second delay is enforced between the emission command and the actual emission, as per CDRH directives. CDRH 0 (CDRH,<space>,0): no delay is present between the emission command and the actual emission. The unit thus does not comply with CDRH directives.
Retrieves the status of CDRH-compliant five-second delay prior to laser emission. See section 1, "Safety information", for further details.	?CDRH	"1": a five-second delay is enforced between the emission command and the actual emission, as per CDRH directives. "0": no delay is present between the emission command and the actual emission. The unit thus does not comply with CDRH directives.
Retrieves the cause of the latest alarm (see section "Troubleshooting" for more information about alarms)	?F	"?F" returns a number corresponding to one of the following alarms: "0" : No alarm "1" : Diode current "2" : Laser power "3" : Power supply "4" : Module temperature "5" : Base temperature "7" : Interlock "8" : User-generated alarm (using the command RST)
Retrieves the laser operation time, in hours	?HH TM?	"49" "TIME= 49 hrs, 38 min"
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 supplying the laser head (expressed in Volts)	?IV	"6.601" for a voltage of 6.601 Volts
Retrieves the status of the emission key, or the "Key" signal on the DE-15 electrical interface	?KEY	"0" Signal low, laser emission is not activated "1" Signal high, laser emission is activated
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)		<p>“2” : stand-by phase</p> <p>“3” : Emission ON</p> <p>“5” : Alarm present</p> <p>“3” : Sleep mode</p> <p>“7” : Searching for SLM point</p>
Re-initialize the unit	RST	RST 0 (RST,<space>,0) Resets the microcontroller
Switches the temperature regulation loop ON or OFF. This regulation loop is necessary for the emission to occur. Switching it off helps reducing the power consumption.	T	<p>T 0 (T,<space>,0): switches the regulation loop off</p> <p>T 1 (T,<space>,1): switches the emission on</p>
Retrieves the status of the temperature regulation loop	?T	<p>“0” Temperature regulation loop is deactivated</p> <p>“1” Temperature regulation loop is activated</p>

Power and operational settings:

Purpose	Command	Result and syntax
Sets the laser diode current, then saves this value as the new default. Use on LBX LaserBoxx only.	C	C 40 (C,<space>,40) sets the optical power at 40% of the nominal current. Values allowed between 0% and 125%.
Sets the laser diode current, but does not record this value in memory, thus sparing stress on the internal EEPROM. Prefer this command to “C” if you need to change the current at high frequency (ten times per second or higher). Use on LBX LaserBoxx only.	CM	CM 40 (CM,<space>,40) sets the optical power at 40% of the nominal current. Values allowed between 0% and 125%.
Retrieves the monitored current of the laser	?C	“550.4” for 550.4 mA
Control of the laser emission	DL	<p>DL 0 (DL,<space>,0): switches the emission off</p> <p>DL 1 (DL,<space>,1): switches the emission on</p>
Retrieves the emission status	?L	<p>“0” Emission is off</p> <p>“1” Emission is off</p> <p>“2” Emission is on at low power</p>

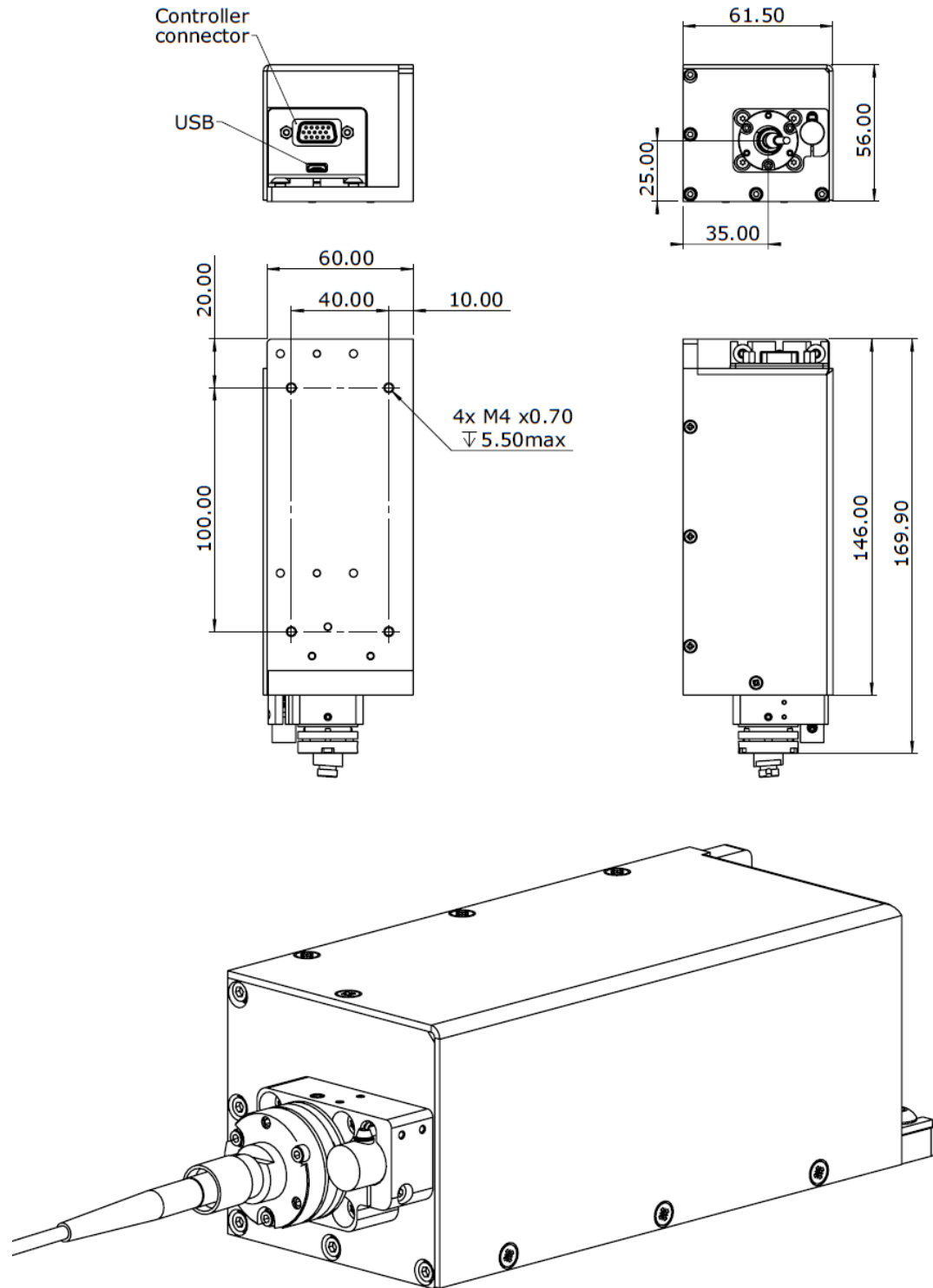
Modifies the power set point (for models that accept power adjustment)	IP	IP 100 (IP,<space>,100) sets the optical power at 100% of the nominal power. IP 50 (IP,<space>,50) sets the optical power at 50% of the nominal power.
Retrieves the laser's measured output power (in milliwatts)	?P	"53.6"
Opens or close the (optional) electro-mechanical shutter	SH	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	"40.0"

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: "????"

7-3 Mechanical drawings

L1C LASER HEAD



BTC-AOM

