Laser combiner
User manual

L6Cc models – Six-slot combiner for LaserBoxx sources

REVISION HISTORY

1.0	First release	Release date: June 2017
1.1	Added description of the APC and ACC loops	Release date: July 2017

TABLE OF CONTENTS

PREFACE

AUDIENCE

This manual should be read by all personnel who install or operate the L6Cc combiner.

Important

Read this manual carefully before operating the combiner 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 to use the laser sources safely
2	Getting started	Describes the packing list, the environment the unit should be used in, and the install procedure
3	Operation	Describes the elements of the laser source and how to operate it
4	Troubleshooting	Instructions about to solve operation-related issues
5	Warranty and certification	Details the warranty applied on this device and the conformity to related standards
6	Technical documents	Miscellaneous technical information

OTHER USEFUL PUBLICATIONS

- LBX LaserBoxx User Manual, published by Oxxius S.A.
- LCX LaserBoxx User Manual, published by Oxxius S.A.

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 the use of 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 the laser system. It is of utmost importance that personnel working with the system read, understand and observe the information and instructions in this manual.

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

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 death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or 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 lasers 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 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 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 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 combiner in “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. (Laser Products – Conformance with IEC 60825-1 and IEC 60601-2-22; Guidance for Industry and FDA Staff (Laser Notice No. 50)).

The combiner 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 combiner, OEM version, is used.

DESCRIPTION OF HAZARD CLASSES

The combiner belong 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 laser sources.

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 combiner (and its remote control if any). 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 combiner.

Figure 1-2: Location of the labels on the L6Cc combiner

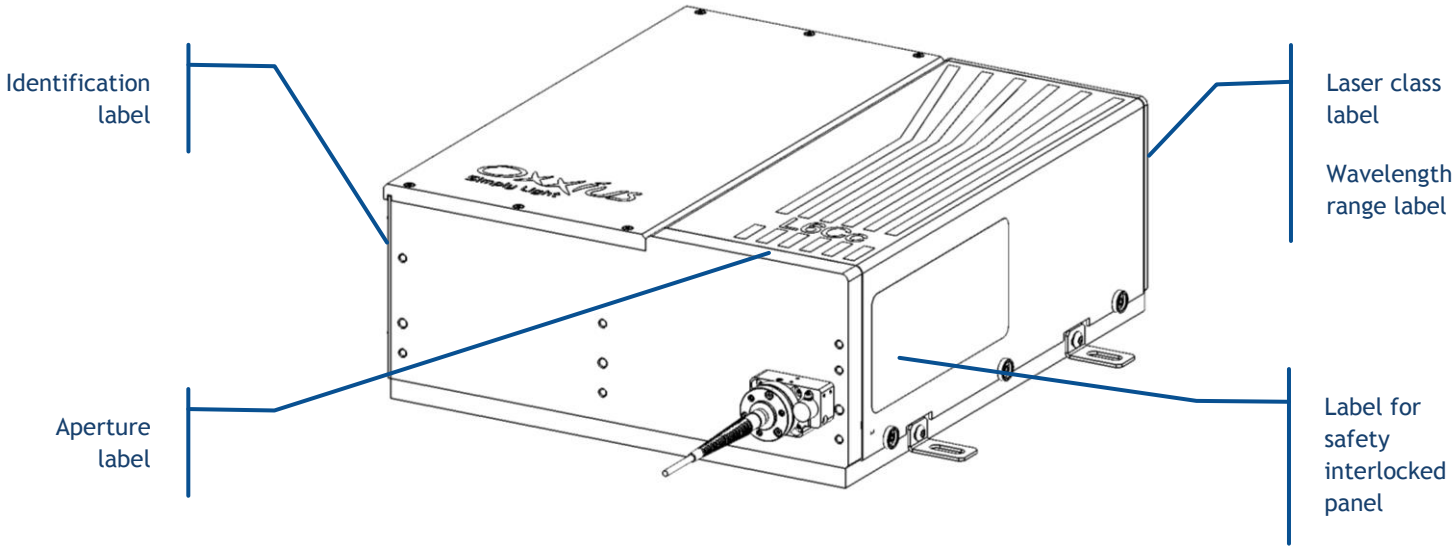


Figure 1-3: Aperture label

Figure 1-4: Laser class label

Figure 1-5: Wavelength range label

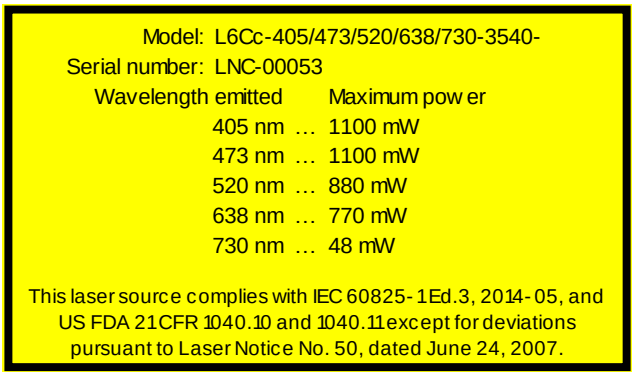


Figure 1-6: Identification label

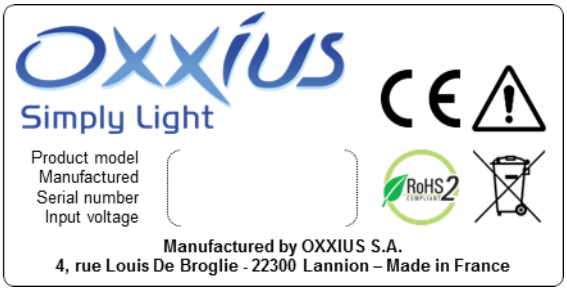


Figure 1-7: Label for safety interlocked panel

APERTURE LOCATION

The laser radiation is generated within a protective housing which should only be opened by trained operators. A label indicates the position of the laser beam output.

INTERLOCK

The combiner are provided with an accessible interlock circuit, terminated by dedicated terminals. When this circuit is open, the laser emission is not possible.

ACTUATED KEY MASTER CONTROL

Combiner controllers are provided with an actuated key master control. This lock and key control the emission. The laser emission is not possible when the key is absent from the lock, or in “OFF” position. The key is removable only when in “OFF” position.

EMISSION WARNING INDICATORS

Combiner controllers are provided with an emission indicator located on the remote control. 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

One or several mechanical shutters, present on the output aperture of the combiner, allows for a complete extinction of the beam.

INTERLOCKED PANEL FOR MAINTENANCE

The combiner has a panel accessible for maintenance. This panel is connected to an interlock circuit that will shut off the emission as the panel is open, in order to avoid the exposure to laser radiations of hazardous levels. This panel is indicated by the label on figure 1-7.

1-2 Electrical safety

The L6Cc combiner 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 heads contains indium used as a heat conductor. Indium is toxic; do not open the laser heads.

ROHS 2 COMPLIANCE

Oxxius products comply with RoHS 2 directive.

1-4 Decommissioning and disposal

If the laser will be definitively taken out of service and decommissioned, disconnect and remove all signal and power cables.

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 check the functionalities and to install the combiner.

2-1 Overview

THE L6CC LASER COMBINER

The L6Cc combiner is a platform that embeds up to six LaserBoxx sources and combines them in a single output. This output beam can be made to propagate in free space, or through one or several optical fibers. The L6Cc platform can embed other components for additional functionalities, including some acousto-optic modulators, or optical filters.

ABOUT 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,
- elliptic, circular beams or fiber-coupled output beams,
- 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 embed a monolithic diode-pumped solid state (DPSS) lasers,
- The LBX LaserBoxx are models that embed a semiconductor laser diode.

“PLUG AND PLAY” AND “OEM” VERSIONS

The L6Cc combiners exist in two versions:

- “Plug and play” versions are meant to be accessed physically by the user, typically in a laboratory or a “bench-top” environment. It offers a direct access to most of the functions and to some important safety features. Refer to section 1, “Safety information” for a detailed list of the safety features and the relevant standard compliance.

- Original Equipment Manufacturer (or “OEM”) versions are designed for integration into an industrial device or system. These versions generally do not include all the safety feature present in their “Plug and Play” counterparts.

Warning

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

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

2-2 Operating environment

In compliance with IEC EN 61010-1 standard, the Plug and Play combiner 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 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 L6Cc combiner 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 L6Cc 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 combiner 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 L6Cc combiner.

Table 2-1: Packing list and accessories of the L6Cc combiner, « Plug and Play » version

Name	Quantity
Laser bench including laser source and optical elements	1
Remote control	1
Power cord	1
USB cable (“A to B” type)	1
Laser emission key for the remote control	2
USB Flash drive	1
This user manual	1
User manual for LBX LaserBoxx models	1
User manual for LCX LaserBoxx models	1

UNPACKING

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

Please contact your representative if you have to report any damage (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 combiner 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 controller

FIBER-TERMINATED OUTPUTS

A specific attention is required with the delivery fiber which should not be bent nor receive mechanical damage (shear stress, punching, etc.) under any circumstances. Optical fibers are made of glass and are fragile pieces of equipment. The user is required to handle the delivery fiber and its optical connector with care and to have the necessary tools and knowledge to inspect and clean the end tip of the fiber.

2-4 Elements description

LASER HEAD

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

Figure 2-2: Front view of the laser head

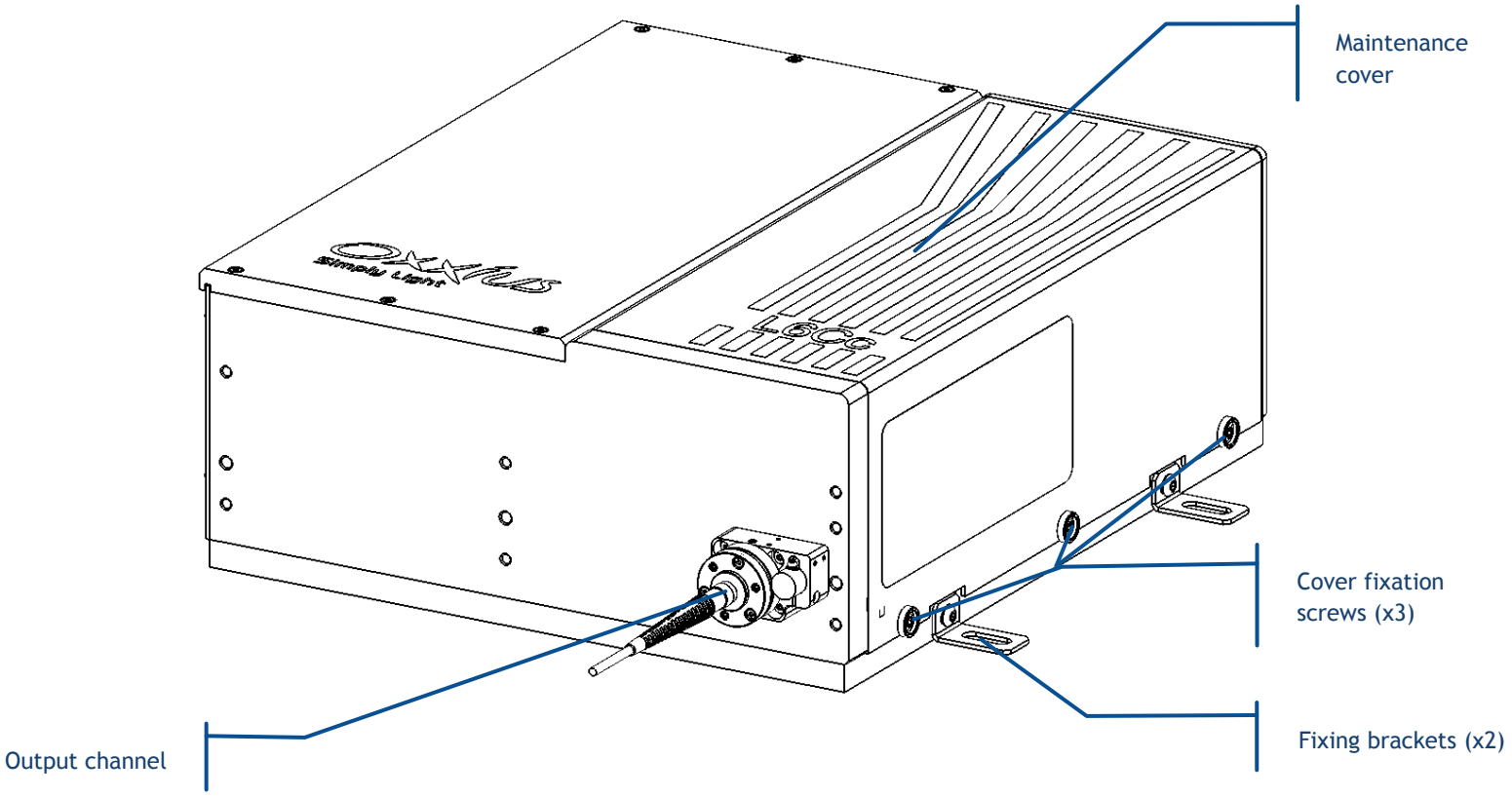


Figure 2-3: Rear view of the laser head

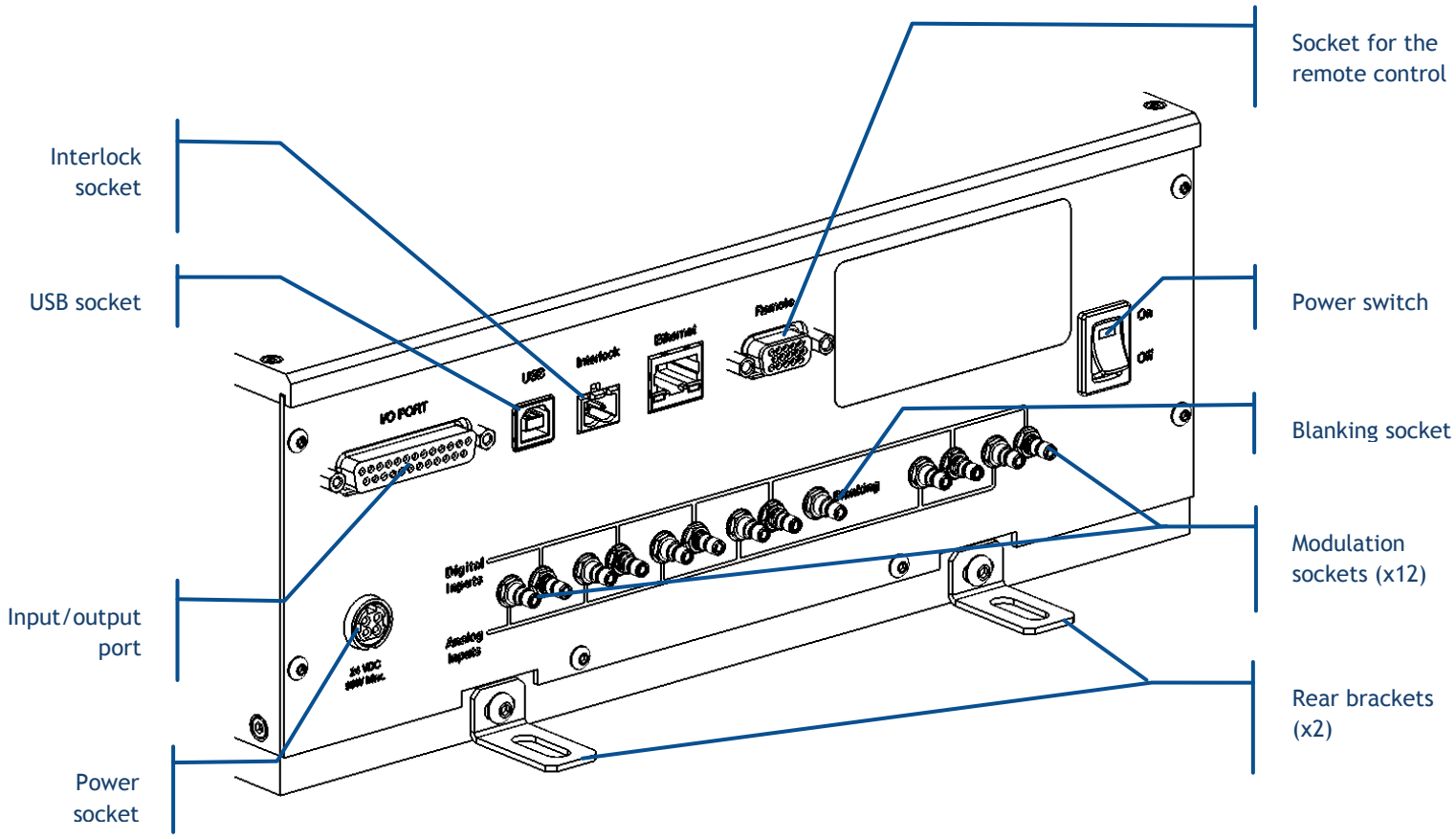
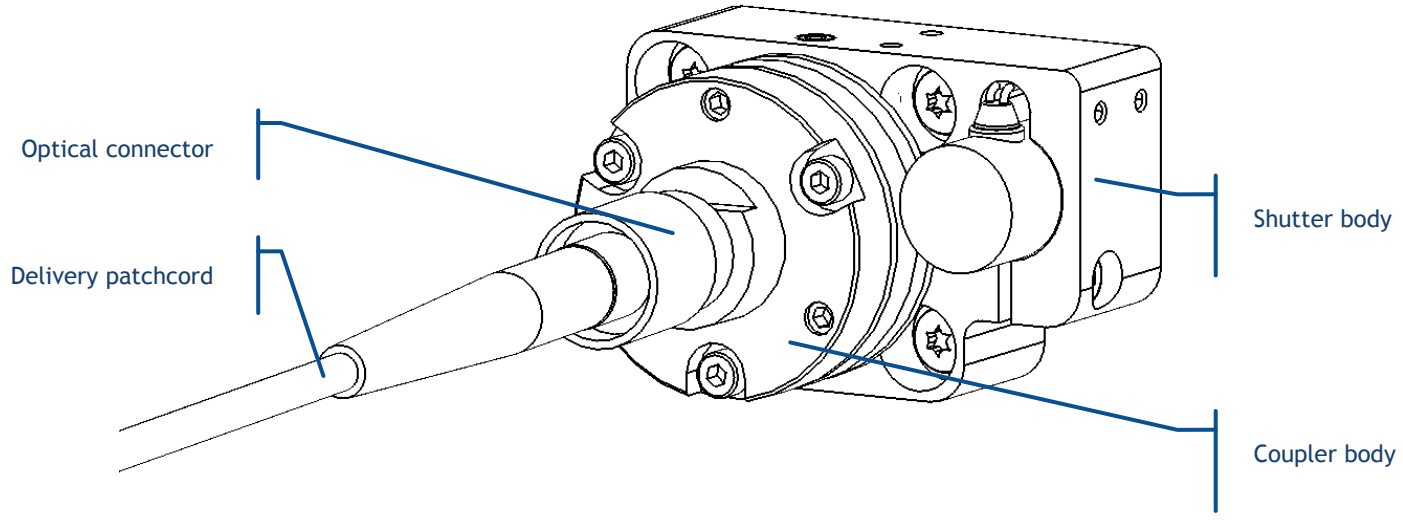


Figure 2-4: Output channel, detailed



The following elements are accessible to the user:

- **Maintenance cover**: this cover is designed to allow access to the optical elements for maintenance. It acts as a protective medium against the laser radiations.

- **Cover fixation screws**: these two screws are holding the cover onto the base plate.

- **Output channel**: the combined laser beams will be concentrated at this aperture and transmitted into the delivery fiber. It consists of the following elements:

    - **Optical shutter:** This device is used to prevent any light from entering the delivery fiber. It also acts to support the fiber coupler and to define its position with regard to the laser beams
    - **Fiber coupler:** this component focusses the laser beams into the delivery fiber
    - **Optical connector:** this element is used to lock the optical fiber in position into the fiber coupler.
    - **Optical patchcord:** this removable component holds and protects the delivery fiber.

- **Rear and front brackets**: the combiner be fixed to a supporting base using these brackets.

- **Remote control connection cable**: when a remotely controlled shutter is present inside the laser bench, its supply cable escapes through this aperture.

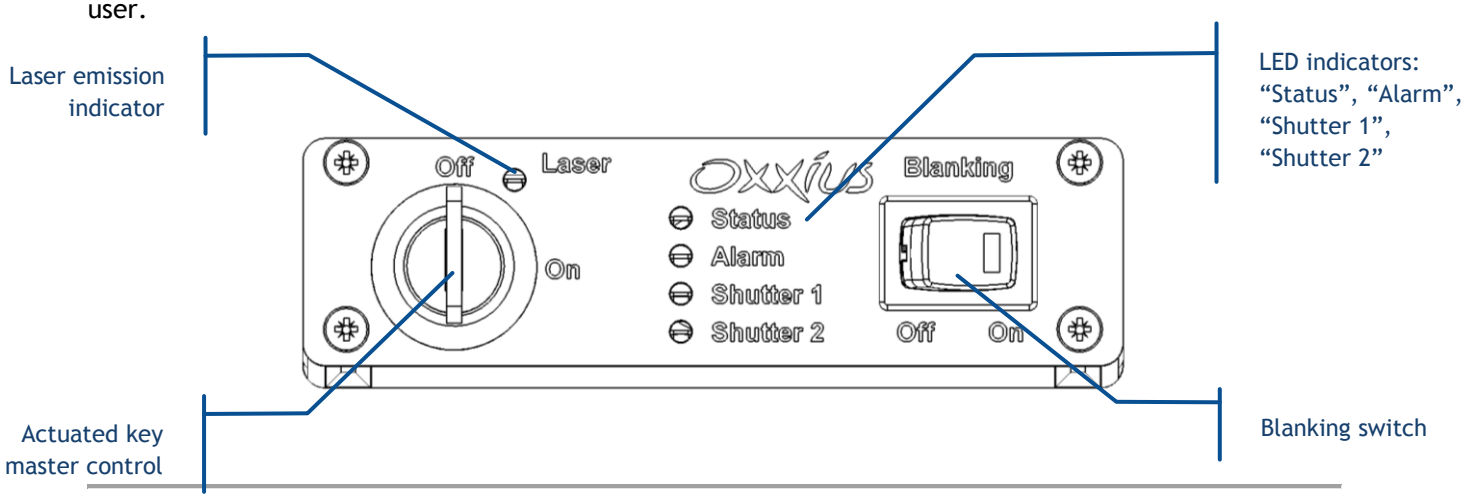
- **Interlock port**: connect your remote interlock circuit to this socket. Refer to the section “Safety information” for further information about the remote interlock circuit.

- **USB socket**: use this socket to connect the L6Cc combiner to a personal computer

- **Input/Output control port**: use this socket to drive some of the inner components of the combiner (optical shutters, modulators or other functions).

REMOTE CONTROL

A remote control is plugged on the L6Cc and brings some of the essential control elements closer to the user.



- **Actuated key master control:** 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 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 (the white color being used so that to be visible through most protective eyewear). In accordance with CDRH recommendations, this indicator is blinking 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 that the device is turned on.

- **"Alarm" indicator:** This indicator is a red LED indicating a warning or an alarm on the device.

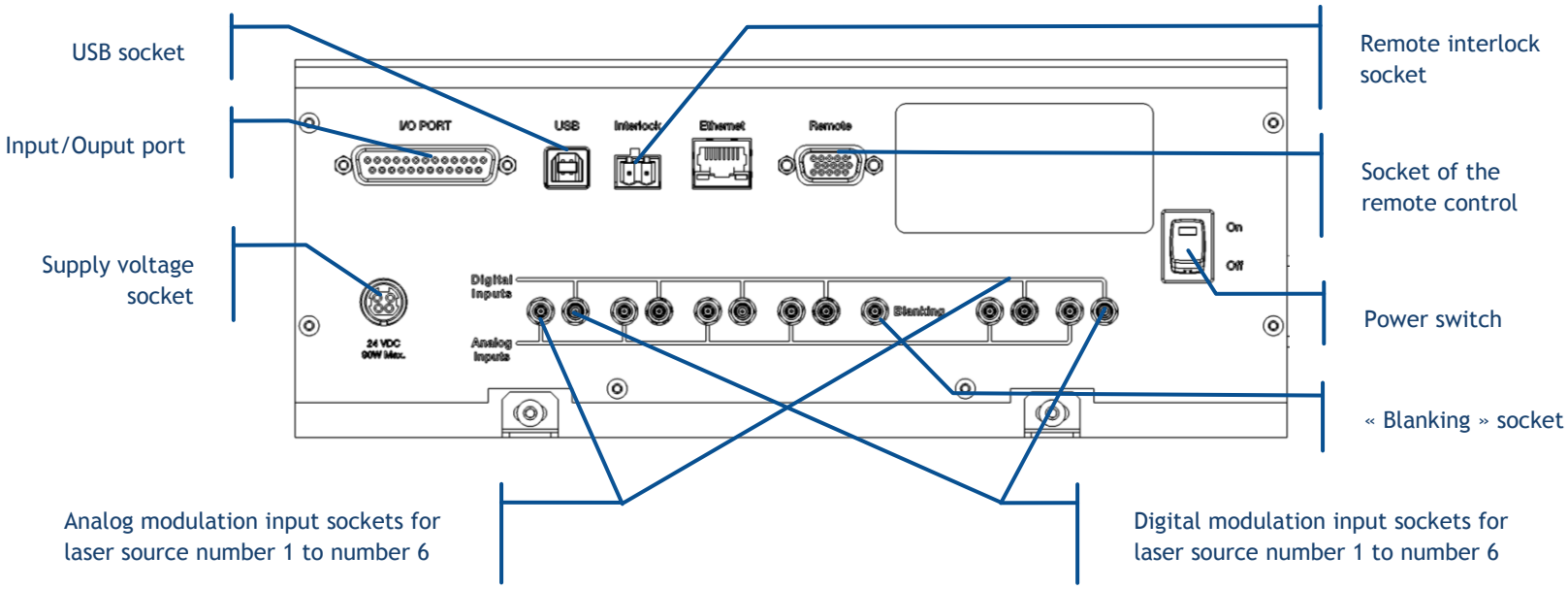
- **"Shutter 1" and "Shutter 2" indicators:** This indicator is a white LED indicating the status of these shutters. The LED is lit when the shutter is open, unlit when the shutter is closed.

- **"Blanking" switch and indicator:** This switch activates the "blanking" function, which is a function designed to shut off all the laser radiation exiting the L6Cc. The LED indicator is lit when the blanking is activated.

REAR PANEL (DETAILED)

Here are the elements accessible on the rear panel of the combiner.

Figure 2-6: Rear panel of the L6Cc Combiner



The following elements are accessible to the user:

- **Input / output port:** This port allows the user to access to miscellaneous functions of the controller using electrical signals
- **USB socket:** This socket is used to communicate with each of the laser sources.
- **Remote interlock socket:** the laser emission is disabled when the circuit between those terminals is open. This port is usually used in conjunction with a door or a panel to control the access to the irradiated area. A couple of mating connectors is provided with the combiner to close this circuit, allowing the emission.
- **Analog input sockets (laser number 1 to number 6):** 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 (laser number 1 to number 6):** These inputs are used to quickly turn the optical power on and off by applying a digital signal. Refer to section 4, “Advanced operation” for detailed information, and to the product specifications of each source concerning the modulation characteristics.

- **Supply voltage socket:** Input for power supply.
- **Socket for the remote control:** Connect the remote control on this socket.
- **Socket for the blanking function:** This is used to activate the blanking function, shutting down all the laser sources at once.

2-5 Installing the combiner

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 (from the rear panel), or by disconnecting the supply connector from its socket (from the rear panel).
- No user adjustment is possible from the rear panel of the L6Cc, or inside each individual LaserBoxx sources. Any attempt to open these elements might damage them and will void the warranty.

MECHANICAL INTERFACING

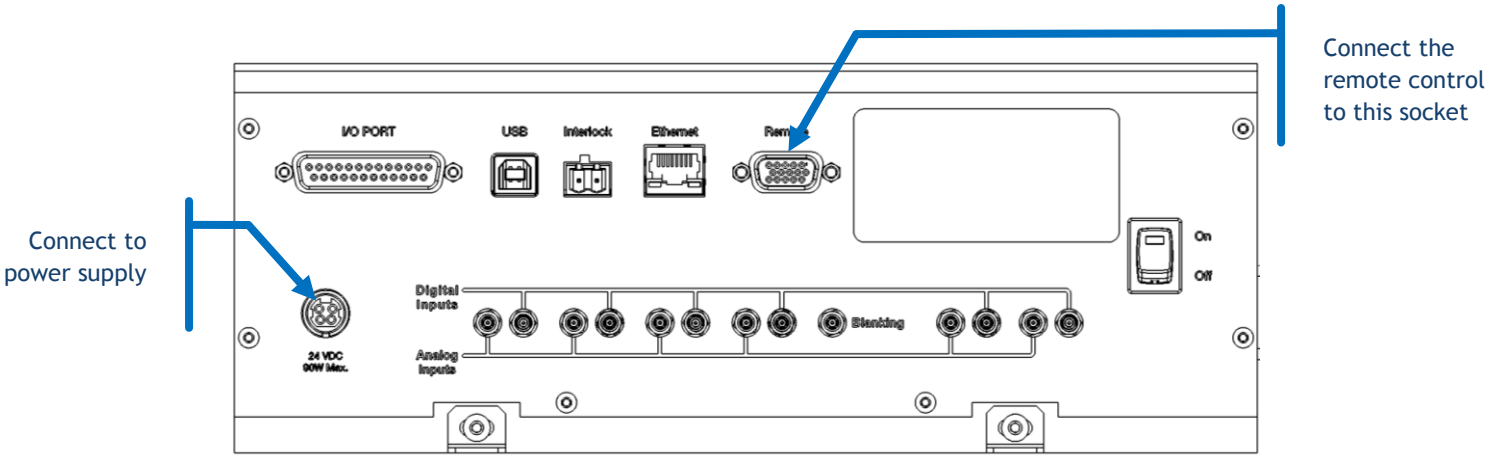
The laser bench should be fixed to a metallic base which flatness is better than 0.05 mm. This requirement ensures that no excessive constraint is applied to the L6Cc. Standard machining of opto-mechanical components will typically meet this requirement.

OPTICAL OUTPUT(S)

Connect the optical connector of each of both channels to your own light path. Make sure to fasten the threaded ring of each optical connector.

ELECTRICAL CONNECTIONS

- Plug the remote control to the rear panel of the L6Cc
- Plug the power supply to the rear panel of the L6Cc



CHARACTERISTICS OF THE POWER SUPPLY

The power supply provided for the L6Cc has the following characteristics:

- Output voltage (direct current): 24 Volts
- Power rating: 120 Watts

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

Input:

- Voltage: 100/240 VAC
- Frequency: 50/60 Hz
- Protective ground

Output:

- Voltage (direct current): 24 Volts
- Power: 120 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 the plug and play L6Cc meets these requirements.

Warning

For electrical safety, Oxxius 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.

SIGNAL CONNECTIONS

- 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 interlock wire (provided) to short-circuit these pins.
- Analog modulation signals: connect your own sources of analog (0-5V) signals to each input socket.
- Digital modulation signals: connect your own sources of digital (TTL) signals to each input socket.
- Blanking signals: connect your own source of digital (TTL) signals to this socket.

COMMUNICATION

All the LaserBoxx units are to be accessed using the USB socket located on the rear side of the combiner. The required cable is a standard “USB A to B” cable (see figure 2-19 below).

Figure 2-10: USB A to B connection cable

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

2-6 Installing 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.

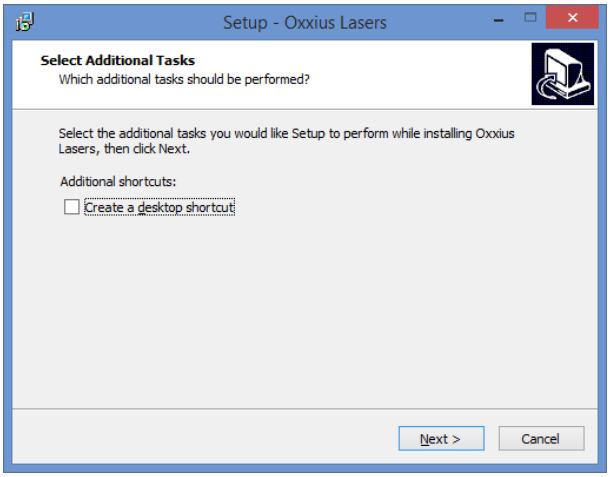
FIRST STEP: INSTALLING THE COMMAND SOFTWARE

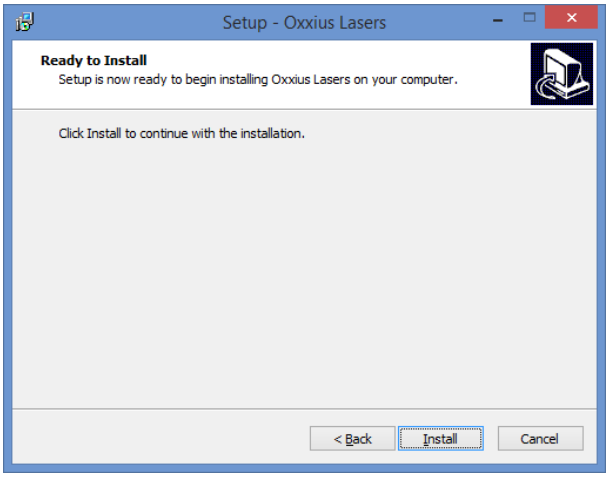
Oxxius control software is installed by running the setup.exe file located on the USB flash drive provided with the laser.

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

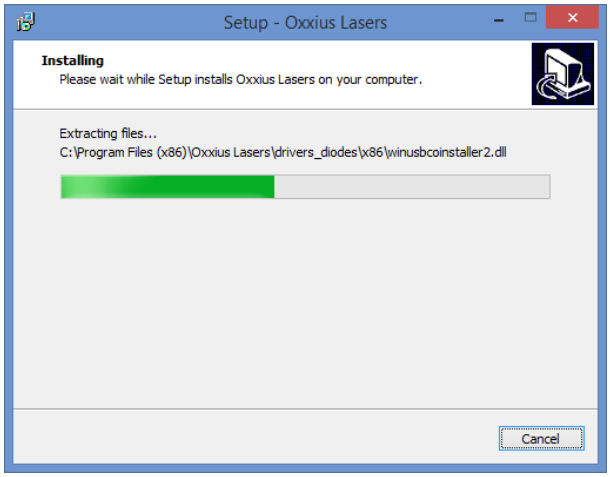
WWW.OXXIUS.COM/DOWNLOAD/F09512DD.EXE

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

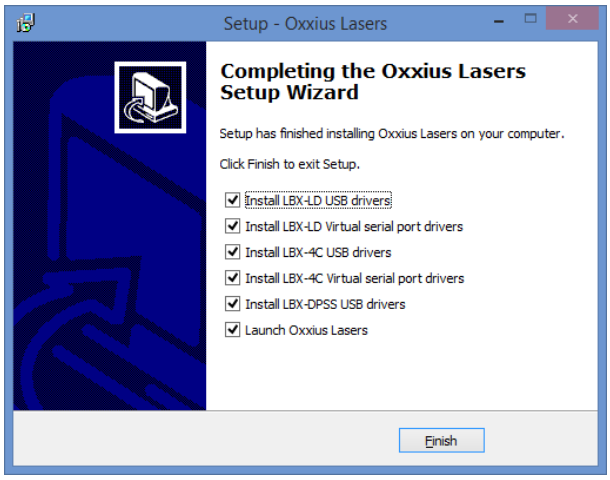




Click « Next », then “Install”.



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.

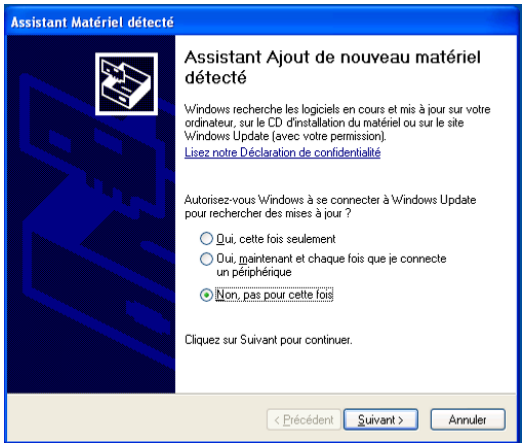
Press “Finish” to close the wizard and complete the installation.

SECOND STEP: DEVICE INSTALLATION OVER A USB PORT

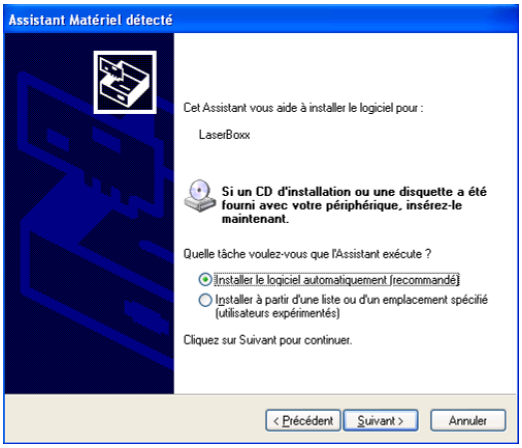
Using the USB interface of the combiner unit will first require that this former is detected by the operating system.

- Connect the USB cable between the combiner on one end, and your computer on the other end,
- Turn on the supply voltage of the combiner,

- 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 bellow),

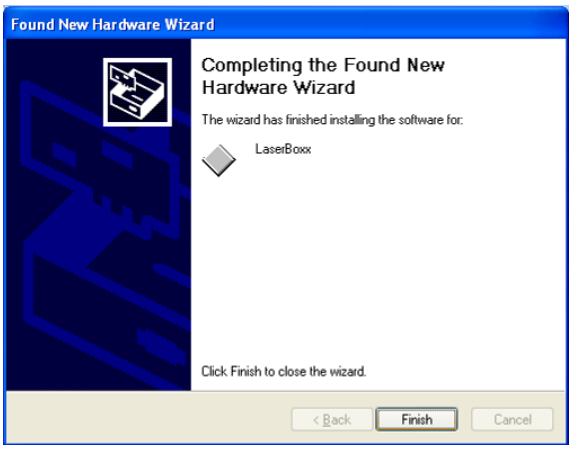


Force your operating system to install the software automatically,



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 combiner.

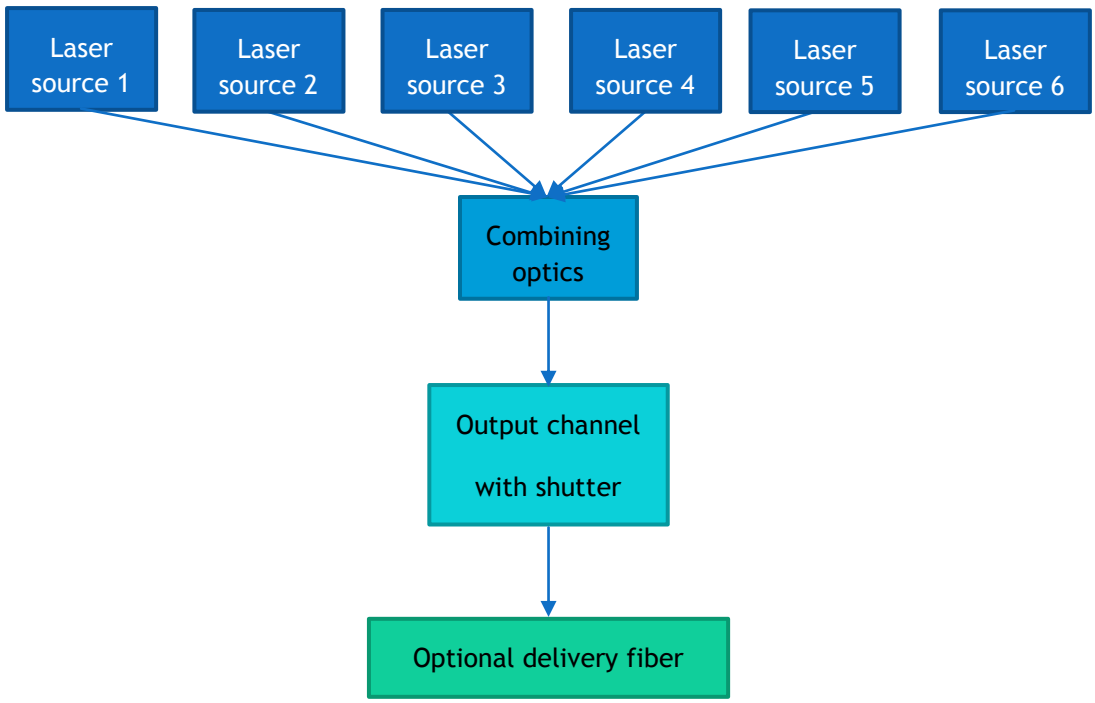
3. OPERATION

This section describes the principle of operation of the L6Cc combiner, as well as the way to operate and configure it.

3-1 Principle of operation

The combiner is composed of the following functions:

- The laser sources emit an optical signal, each on a separate beam,
- The combining optics merge these beams into a single beam geometry,
- The output channel is fitted with a shutter to completely block the output light when necessary,
- As an option, an optical fiber delivers the combined beams to the far end of the patchcord.



Each of these laser sources can either be:

- A LBX model,
- A LCX model, linked to acousto-optic modulator (AOM), or
- A LCX model, without AOM

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

NOTE

Most of the procedures described in this chapter rely on using Oxxius' graphical user interface (GUI); refer to chapter 3-4 for an exhaustive description of this GUI.

HOW TO POWER UP THE COMBINER

Here is the sequence to power up the L6Cc:

- Plug the power cord of the power supply into your mains socket,

- Power the optical bench on by pressing the main power switch on the right hand side of the rear panel,

- Check that the required security measures against laser radiation are enforced, then activate the emission by turning the actuated key master control clockwise on the remote control,

- Depending on its model, each 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, each laser will release its optical output. The status indicator is lit in solid green when all the activated sources emit steadily. Open the shutter on the output channel to release the beam (see the following paragraph "How to activate the shutters").

NOTES

- All the laser sources are activated as per their initial settings. Refer to the paragraph "Selective deactivation of the laser sources" below to turn off some of them.

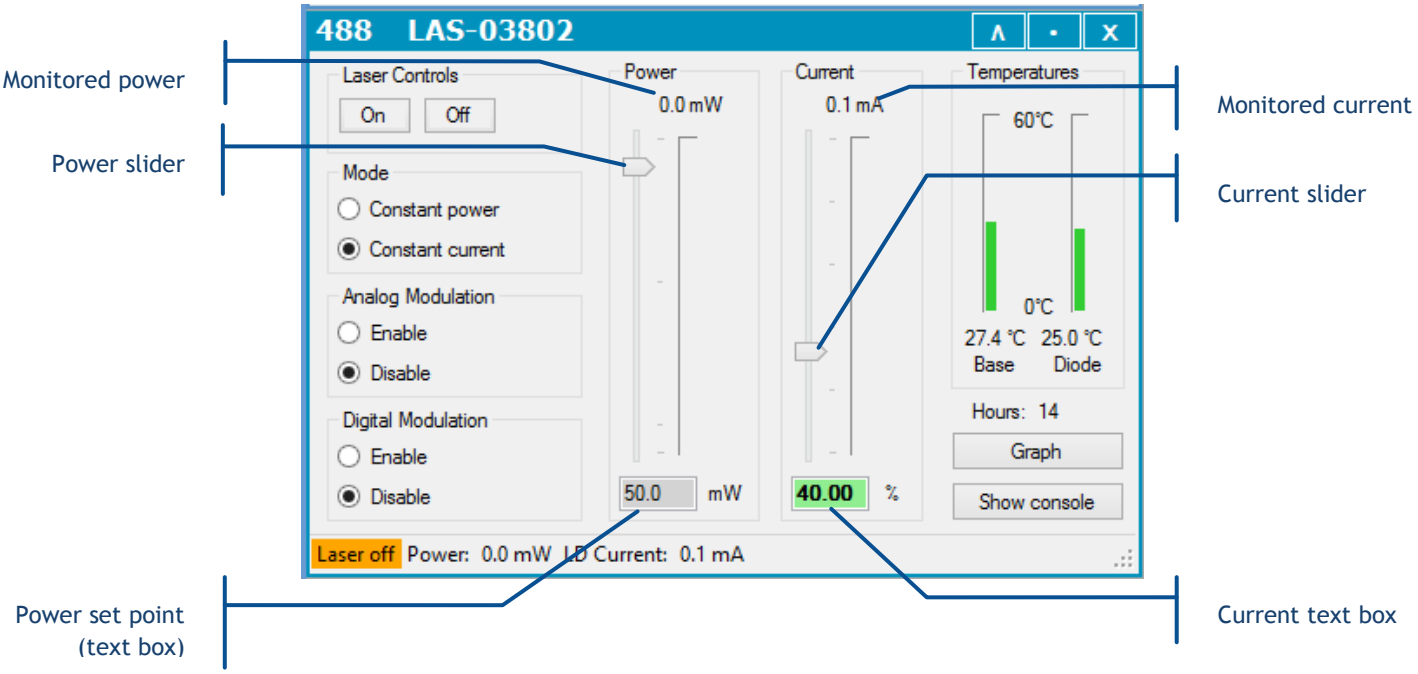
- The optical power emitted by each source depends on the configuration of the laser. Refer to "How to set the power levels" below and to the following chapter: "How to configure of the combiner".

- If an error occurs on any laser source, the "Alarm" indicator on the remote control turns in solid red.

HOW TO SET THE POWER LEVELS

Using the GUI, open the control window of the laser you wish to configure, then proceed as follows:

- On a LBX laser source :
    - Locate the power slider and text box (if the unit is in constant power mode), or the current slider and text box (if the unit is in constant current mode, as in the picture below),

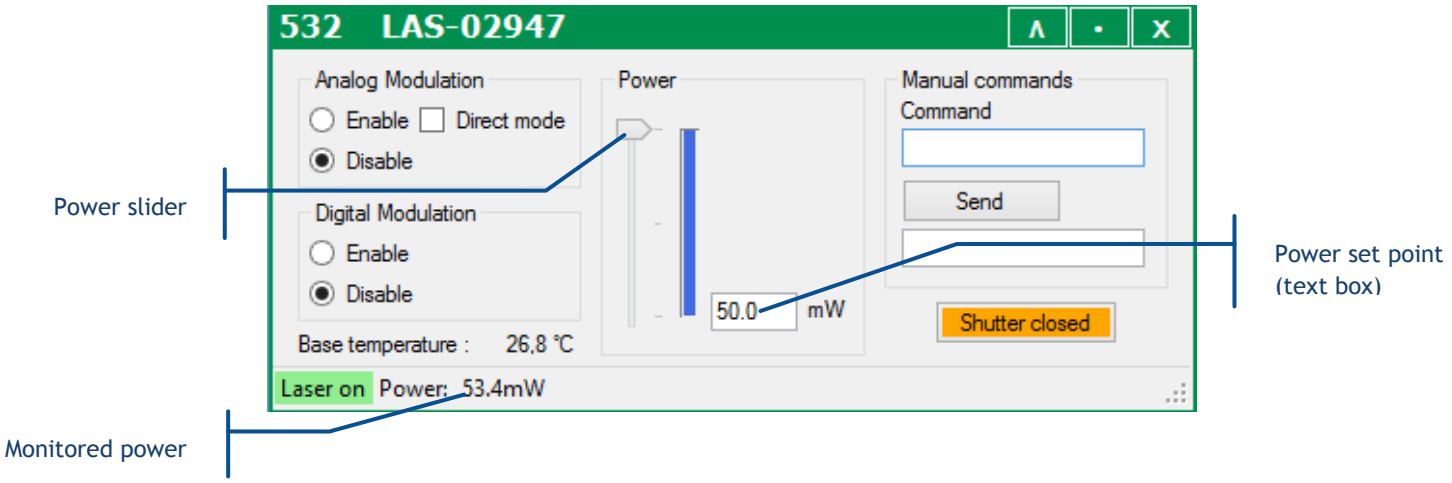


    - Click in the text box and type a new power (or current) set point. Validate by pressing the “Enter” key.
    - Alternatively, you can click and drag the slider to modify the power (or pump current) set point. This new value will be translated into the text box.
    - Alternatively, you can use the software commands “P” or “PM” (to set the optical power) and “C” or “CM” (to set the current)
    - Check that the actual power (or current), monitored at the top of the bar, is actually following this new set point.

- On the LCX laser sources:

  The power is modified either by an external AOM, or by an optional power adjustment function (referenced as “OPT-PWR”). Check the detailed specifications of each of these functions on the datasheet of your model.

    - Locate the power slider and text box on the control window,



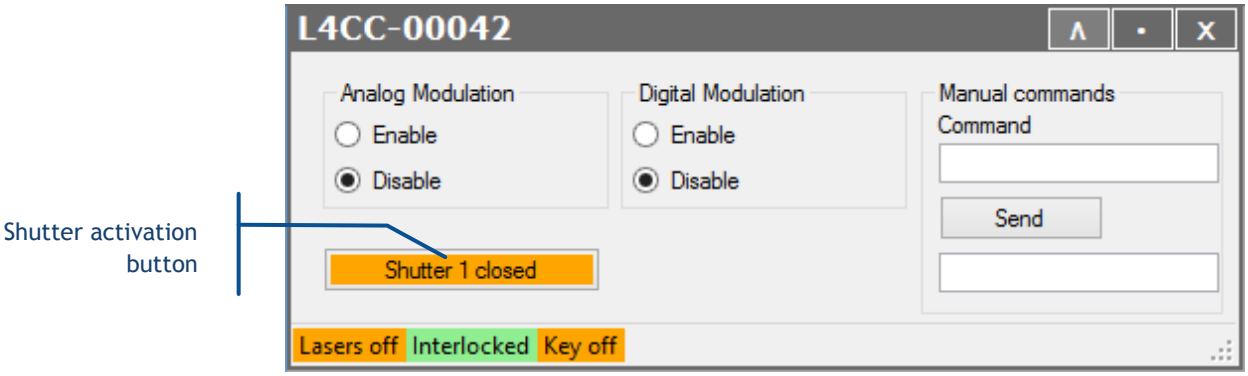
- Click in the text box and type a new power set point. Validate by pressing the "Enter" key.
- Alternatively, you can click and drag the slider to modify the power set point. This new value will be translated into the text box.
- Check that the actual power (measured at the output of the combiner) has been modified accordingly. With the power adjustment function, it might take up to 20 seconds for the LCX to reach its new set point.

HOW TO ACTIVATE THE SHUTTERS

Optical shutters are devices that are inserted on the light patch and completely absorb the beam when activated. On standard L6Cc configurations, there is one shutter at the output channel, plus one shutter installed on each LCX laser source.

OUTPUT CHANNEL SHUTTER

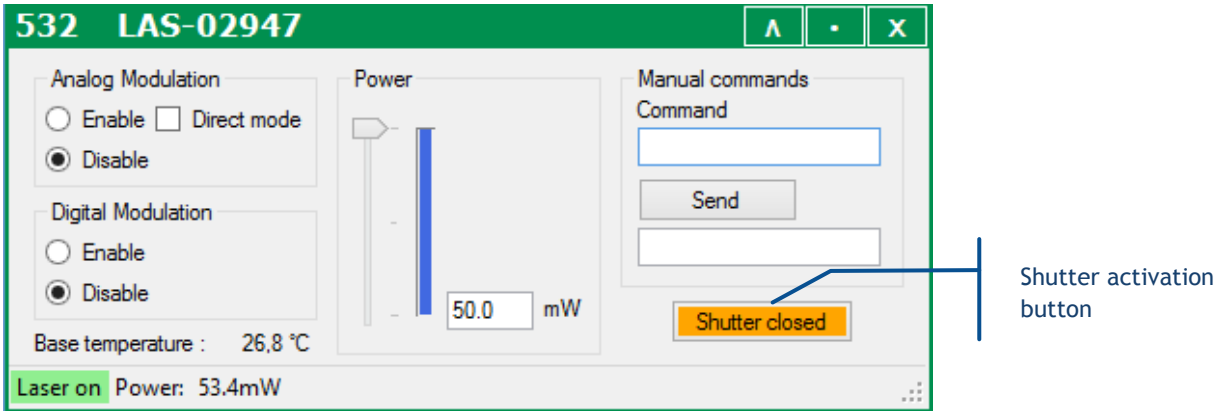
- Open the main panel of the L6Cc combiner and locate the shutter activation button (as in the picture below)



- 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 combiner:
    - “SH1 1” to open the first shutter,
    - “SH1 0” to close the first shutter,
    - “SH2 1” to open the second shutter,
    - “SH2 0” to close the second shutter
- Alternatively, use the input/output port located at the rear side of the combiner:
    - Connect your signal generator to the pin 1 (for shutter number 1) or pin 2 (for shutter number 2),
    - Open the shutter by applying a +5V voltage on the pin. Close it by applying 0V. Leaving this circuit open will also close the shutter.

SHUTTER OF THE LCX UNIT

- 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 LCX:
    - “DL 1” to open the shutter,
    - “DL 0” to close the shutter
- Alternatively, use the input/output port located at the rear side of the combiner:
    - Connect your signal generator to the pin 13 (for the first LCX) or pin 14 (for the second LCX),
    - Open the shutter by applying a +5V voltage on the pin. Close it by applying 0V. Leaving this circuit open will also close the shutter.

HOW TO SHUT OFF THE OPTICAL SIGNALS (BLANKING FUNCTION)

The output of the L6Cc can be temporary shut off using the blanking function. It can be activated by either of these methods:

- Press the “Blanking” switch located at the front of the remote control. Note that the visual indicator embedded in this switch is lit when blanking is activated, and turned off when blanking is deactivated.

Alternatively,

- Connect your signal generator to the “blanking” input socket located at the rear panel of the controller,
- Activate the function (in other words: turn the emission off) by applying a +5V voltage on the socket. Deactivate it by applying 0V.

Warning

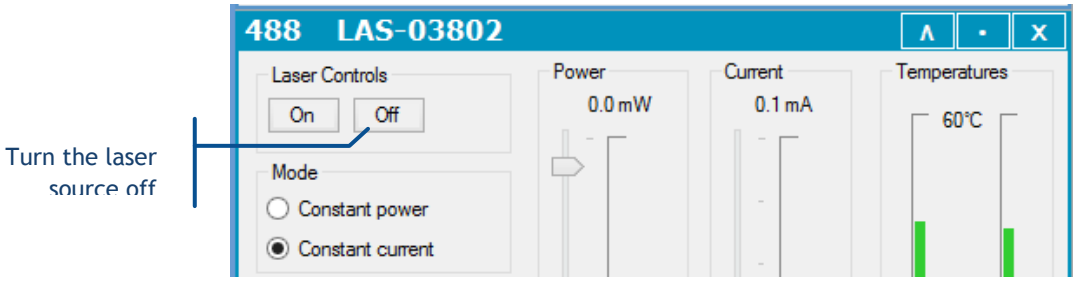
From a laser safety point of view, the blanking function is not designed to provide a reliable guard against the laser radiations.

If you need to ensure the safety of the L6Cc output, use either the actuated key master control or the remote interlock to shut off any laser emission.

SELECTIVE DEACTIVATION OF THE LASER SOURCES

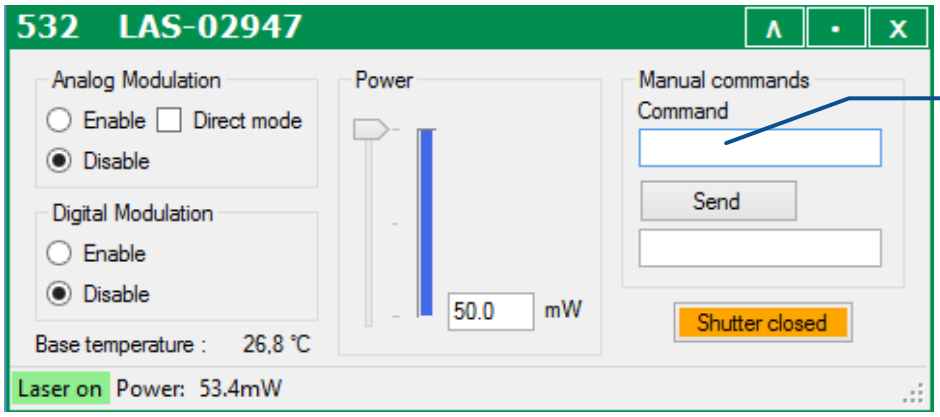
It is possible to deactivate each laser sources to avoid an unnecessary consumption. Using the interface software, open the control window of the laser you wish to turn off, then proceed as follows:

- On a LBX laser source (or a LCX without AOM) : press the button “Off” on the top left corner



You can re-activate this source by opening the console and entering the command “RST 1”.

- On a LCX laser source: enter the command “L 0” in the console.



You can re-activate this situation by entering the command "L 1".

HOW TO POWER DOWN THE COMBINER

Here is the sequence to shut down the controller:

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

3-3 How to configure the combiner

This chapter describes how to configure the L6Cc combiner in accordance to one's application.

A complete operation setup should consist in:

- Setting the power or current on each laser source (referring to the previous chapter 3-2),
- Configuring the modulation schemes,
- Configuring the output channel(s)

The following paragraphs explain these steps in details.

MODULATION FUNCTIONS

The optical output of each of the laser source can be modulated according to incoming electrical signals:

- The analog modulation functions allow to deliver an output power that is proportional to the input voltage : 0V for a nil power, 5V for the maximal power

- The digital modulation functions 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 activate (or deactivate) these modulation functions on each laser source.

IMPORTANT CHARACTERISTICS OF THE MODULATION FUNCTIONS

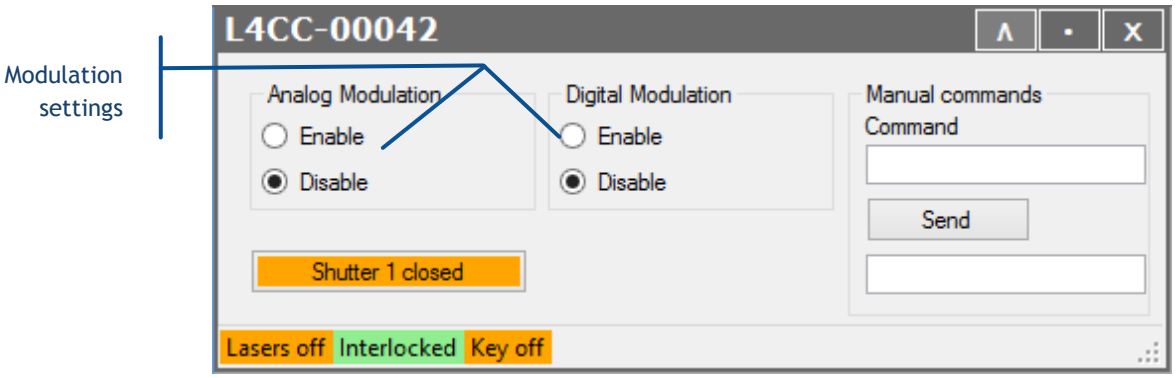
- On LBX laser sources, the analog modulation function can be used either in constant current or in constant power mode. Depending on the mode selected, the input modulation signal will drive either the optical power or the pump current of the laser source.
  - The digital modulation function, however, is only available in constant current mode.
  - Refer to the following paragraph for detailed information about these control loops.

- The maximum power available on modulation corresponds to the power set point (or current set point). For example, with a power set point of 50% the analog modulation will allow for signal outputs between 0% and 50% of the nominal power.

- If an input socket is left unconnected, then the modulation input signal will be nil.

Using the GUI, you can configure the modulation settings for all sources at once:

- Open the main panel of the L6Cc combiner and locate the modulation set boxes (as in the picture below)

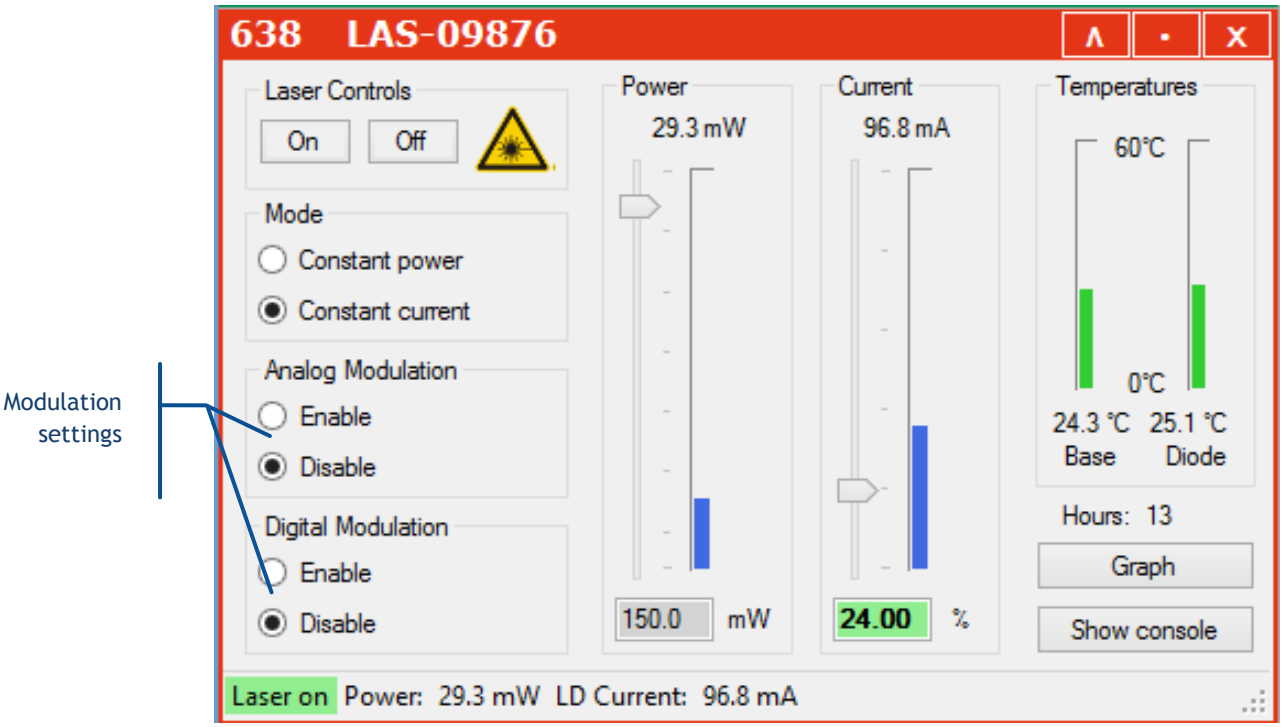


- Select the appropriate box(es) if you need to enable (or disable) the analog modulation, the digital modulation, or both. These settings will be cascaded down to each laser source.

- Alternatively, the software commands “AM” and “TTL” will perform the same selection. Refer to the chapter 6-5 for a detailed description of these commands.

If you need to set the laser sources individually, proceed as follows:

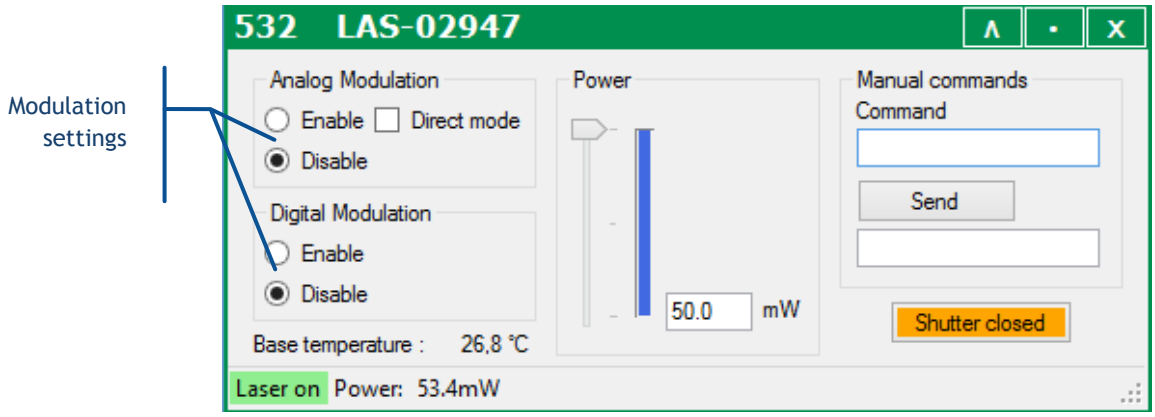
- On LBX laser sources: Open the main panel of the this source and locate the modulation set boxes (as in the picture below)



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

Alternatively, the software commands “AM” and “TTL”, when sent to this specific laser source, will perform the same selection. Refer to the chapter 6-5 for a detailed description of these commands.

- On LCX laser sources with an AOM: Open the main panel of the L6Cc combiner and locate the modulation set boxes (as in the picture below)



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

NOTE

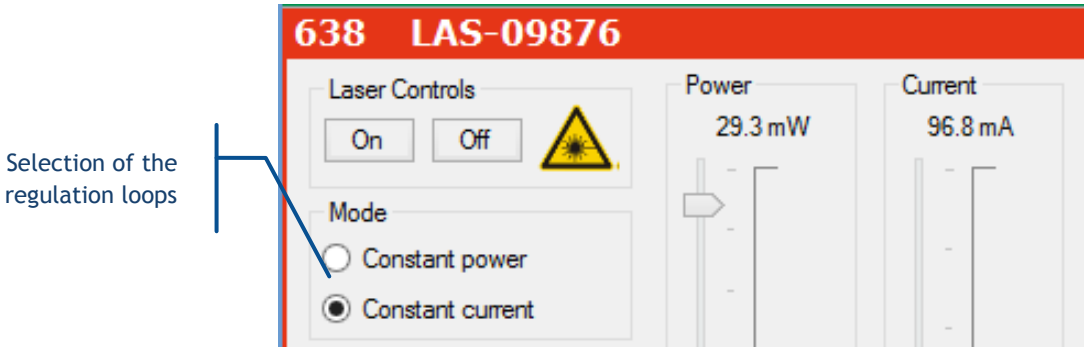
For the analog modulation specifically, the input signal is pre-processed so as to obtain a linear response of the optical power with regard to the input signal. Ticking the box “Direct mode” will skip this pre-processing and render the native characteristics of the AOM.

Alternatively, the software commands “AM” and “TTL”, when sent to this specific laser source, will perform the same selection. Refer to the chapter 6-5 for a detailed description of these commands.

HOW TO CONFIGURE THE POWER CONTROL LOOPS

Refer to paragraph 6-3, “Modulation in detail”, for more information concerning the control loops.

Using the GUI, you can configure the control loop of each LBX laser source: open the main panel of your source and locate the appropriate set boxes (as in the picture below)



Select the appropriate box if you need to use the constant power or constant current control loop.

Alternatively, send the following commands to the unit:

- "ACC 1" to set the constant current control loop,
- "APC 1" to set the constant power control loop

COMPONENT CONTROL PORT

This port is used to drive miscellaneous components inside the L6Cc combiner. 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 Component Control Port

Pin number	Signal name and function	Direction	Description	Voltage range
1	Programmable input number 1	Input	By defauft, this input is mapped to "Shutter #1"	0V to +5V
2	Programmable input number 2	Input	By defauft, this input is mapped to "Shutter #2"	0V to +5V
3	Blanking function	Input	Equivalent to the "blanking" input on the rear panel of the combiner	0V to +5V
4	Laser ready	Output	Indicates that all laser sources are ready for emission.	TTL low: Laser not ready TTL high: Laser ready
5	Analog input number 1	Input	Equivalent to the analog input number 1 on the rear panel of the combiner	0V to +5V
6	Analog input number 2	Input	Equivalent to the analog input number 2 on the rear panel of the combiner	0V to +5V
7	Analog input number 3	Input	Equivalent to the analog input number 3 on the rear panel of the combiner	0V to +5V
8	Analog input number 4	Input	Equivalent to the analog input number 4 on the rear panel of the combiner	0V to +5V
9	Analog input number 5	Input	Additional analog input port	0V to +5V
10	Analog input number 6	Input	Additional analog input port	0V to +5V
11	Programmable input number 3	Input	By defauft, this input is mapped to "Shutter interlock # 1"	0V to +5V
12	Programmable input number 4	Input	By defauft, this input is mapped to "Shutter interlock # 2"	0V to +5V
13	Programmable input number 5	Input	By defauft, this input is mapped to "LCX shutter # 1"	0V to +5V
14	Programmable input number 6	Input	By defauft, this input is mapped to "LCX shutter # 2"	0V to +5V
15	Programmable input number 7	Input		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		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

Here are the functions available for mapping (some of them refer to optional components):

Table 3-2: Available functions on the programmable pins

Mapping number	Function name	Description
0	Nil	No effect
1	Shutter #1	+5V: activate shutter number 1 0V: deactivate shutter number 1
2	Shutter #2	+5V: activate shutter number 2 0V: deactivate shutter number 2
3	Shutter interlock #1	+5V: enables the activation of shutter number 1 through function “Shutter #1” 0V: Shutter number 1 is always closed, “Shutter #1” is ineffective
4	Shutter interlock #2	+5V: enables the activation of shutter number 1 through function “Shutter #2” 0V: Shutter number 1 is always closed, “Shutter #2” is ineffective
5	LCX shutter #1	+5V: activate the shutter on LCX number 1 0V: deactivate the shutter on LCX number 1
6	LCX shutter #2	+5V: activate the shutter on LCX number 2 0V: deactivate the shutter on LCX number 2
7	Mirror #1	+5V: activate mirror number 1 0V: deactivate mirror number 1
8	Mirror #2	+5V: activate mirror number 2 0V: deactivate mirror number 2
9	Wheel b1	Less significant bit to code the position of a multi-slot wheel
10	Wheel b2	Second bit to code the position of a multi-slot wheel
11	Wheel b3	Most significant bit to code the position of a multi-slot wheel
12	N/A	Reserved for future use

In order to perform the mapping of a function with a programmable pin, send the software command “IO” to the L6Cc.

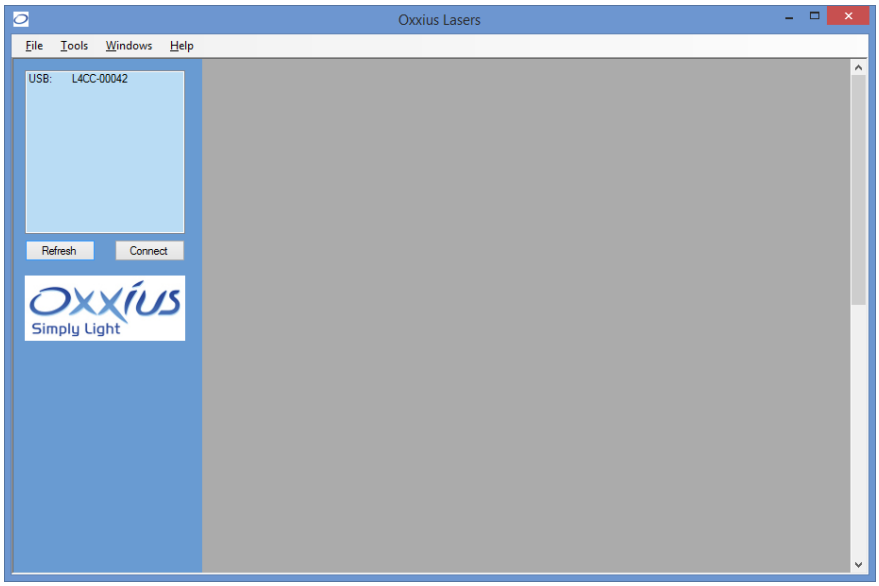
For example, send the command “IO 15 5” to map the function “LCX shutter #1” on pin number 15 (programmable input number 7).

3-4 Using the control software

RUNNING THE CONTROL PROGRAM

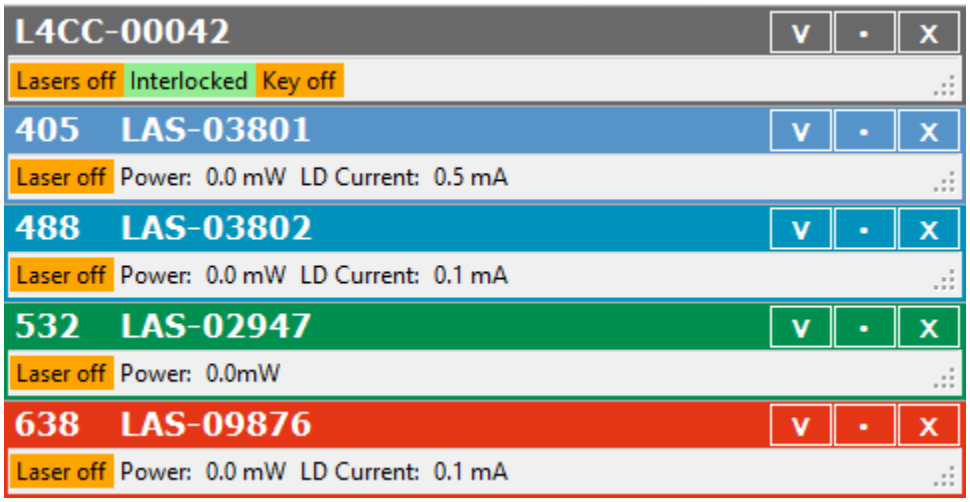
Launch the executable file from your “Program” menu or from the installation directory. On start-up, the first window appearing in “Oxxius laser” lists the devices detected on the USB ports.

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



The L6Cc combiner 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 L6Cc.

Figure 3-4: Control window for an individual LaserBoxx unit



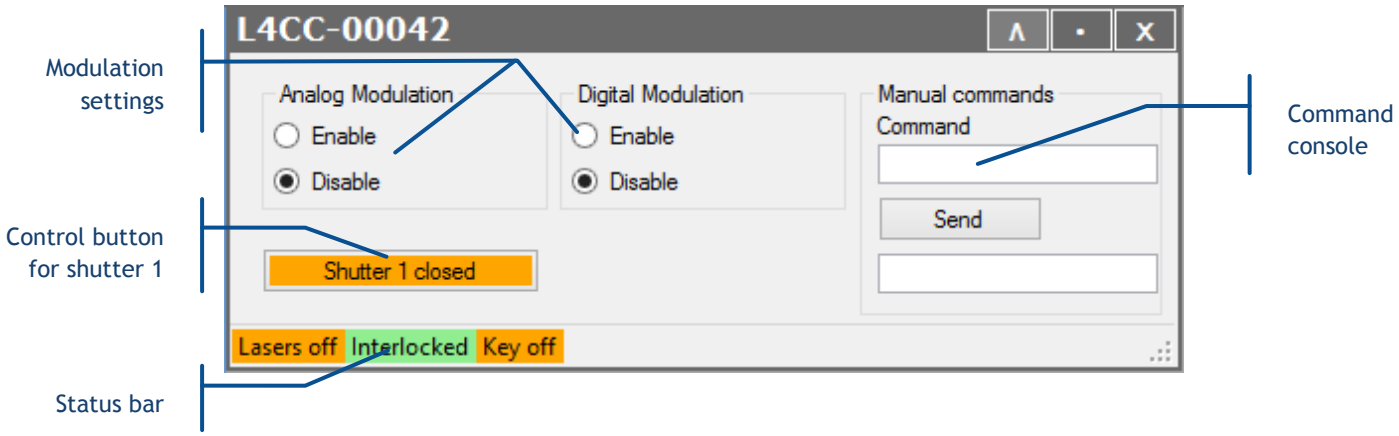
The top window controls the L6Cc combiner as a whole, while the following windows represent each laser source individually. Each of these windows is titled with the serial number of its respective unit (laser source or combiner), and the emitted wavelength (if relevant).

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

Click on the same button ("Λ") one more time to collapse the window.

THE COMBINER CONTROL WINDOW

When expanded, the combiner control window looks as follows:

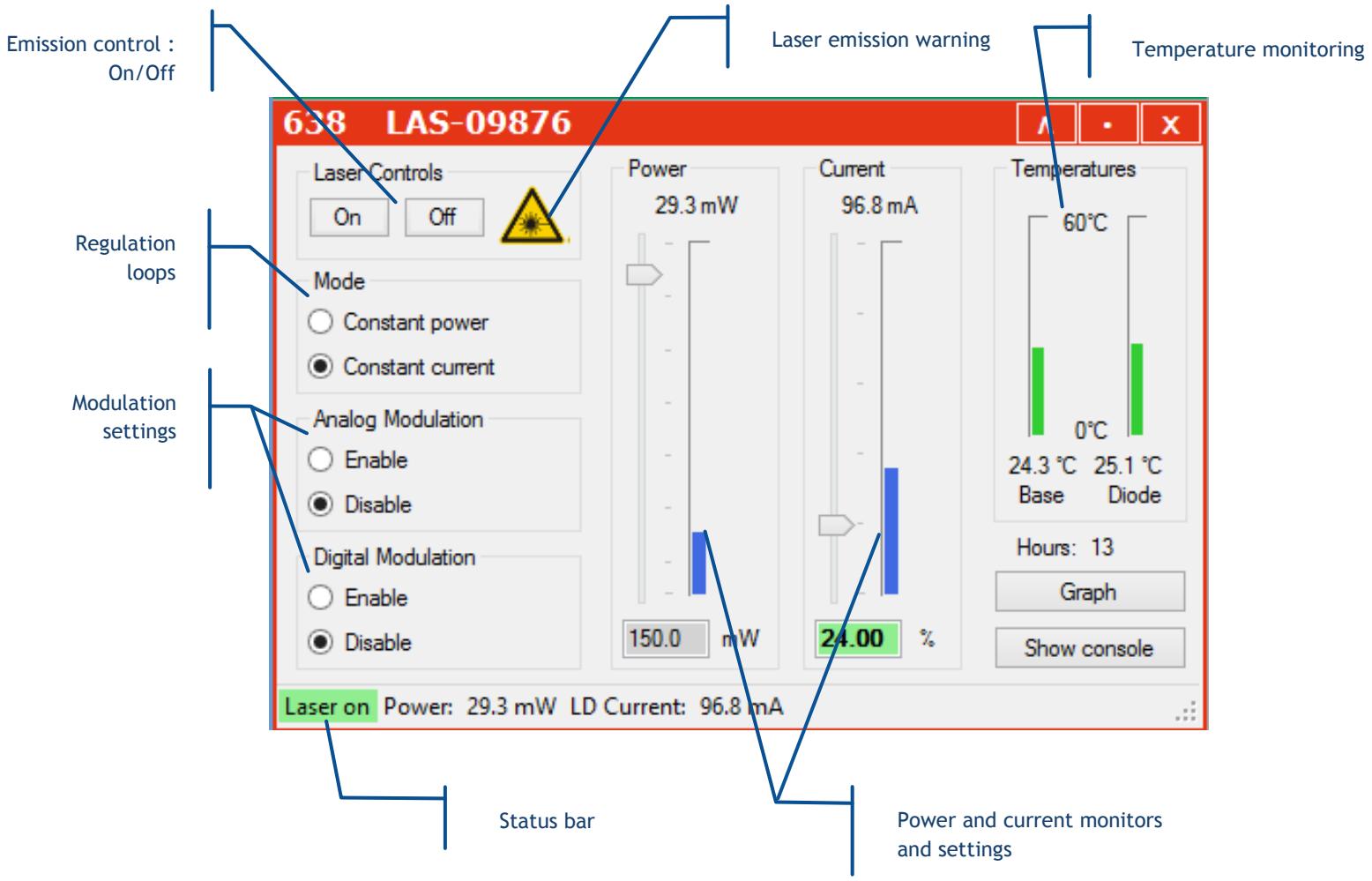


It consists of:

- A pair of buttons to enable or disable the modulation functions (on all laser sources),
- Two text boxes to send and receive some software commands,
- A button to open or close the shutter on each output channel,
- A status bar indicating the general status of the laser sources, the status of the interlock circuit and the status of the emission key

THE CONTROL WINDOW OF A LBX LASER SOURCE

When expanded, the windows representing a LBX laser source look as follows:



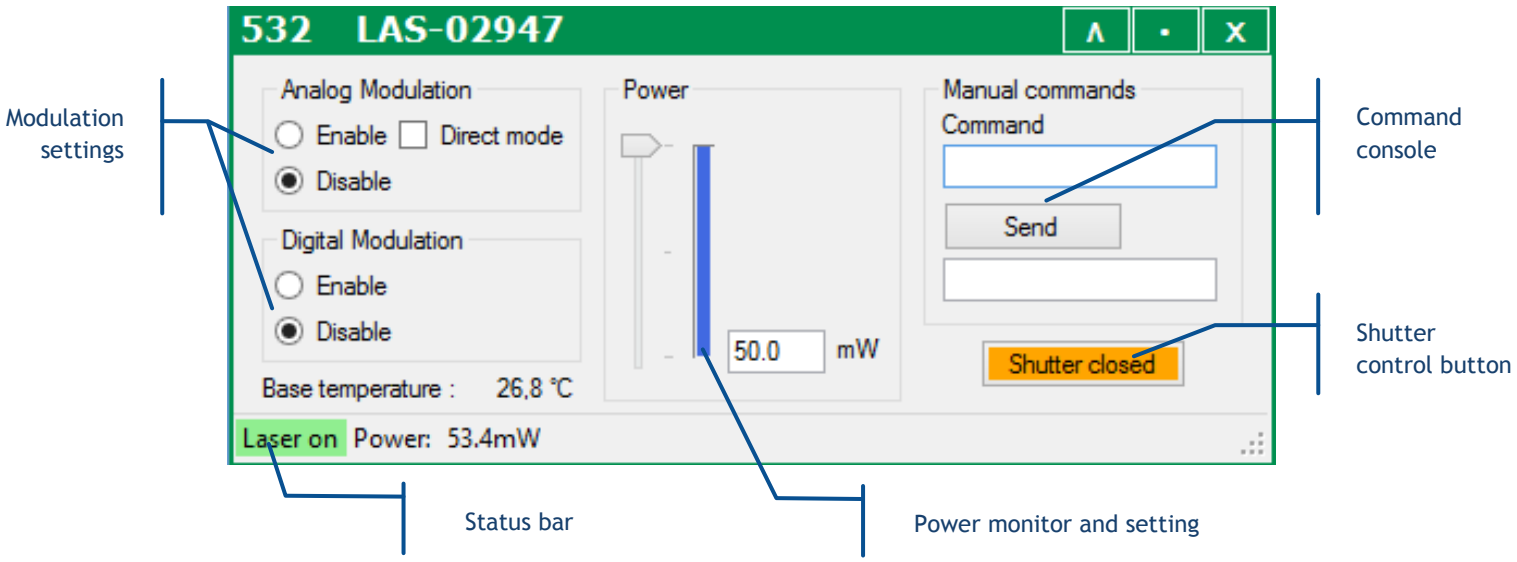
This control panel consists of the following elements:

- Two buttons to control the laser emission (on /off),
- A picture to indicate the emission (laser radiation warning),
- Two text boxes to send and receive software commands,
- Some indicators displaying the measured output power, diode current and the monitored temperatures,
- A pair of boxes and sliders to modify the output power and the diode current,
- A status bar to indicate the laser status, the output power and the pump current

Refer specifically to the LBX user manual for detailed information about this control 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

Communication with the combiner or a laser source is performed by transmitting queries and commands. Any query or commands can be entered manually using the command box. On the LBX: Click on the “Console” button to make the console box appear, then type your query inside the box, and finally press the Enter key or click the button “Send”. Answers are displayed in the box immediately below.

- The laser unit will answer “OK” to a command which has been acknowledged,

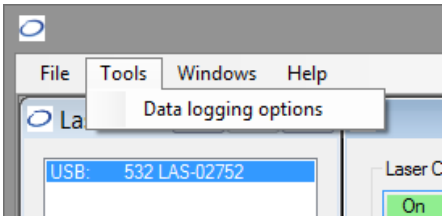
- A query which has been acknowledged by the laser returns the queried value or chain of characters
- The laser unit will answer “????” to a query or command which syntax is not understood.

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

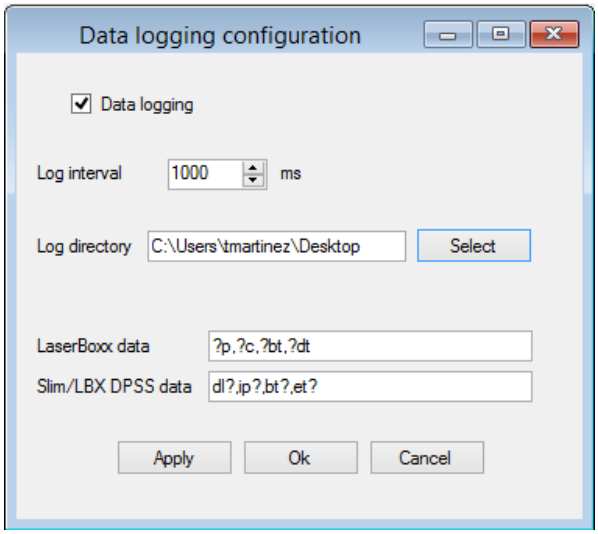
DATA LOGGING

Data logging is a function that allows the user to record the functional status of the LaserBoxx 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 data logging,
- The “log interval” determines how often the combiner 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.

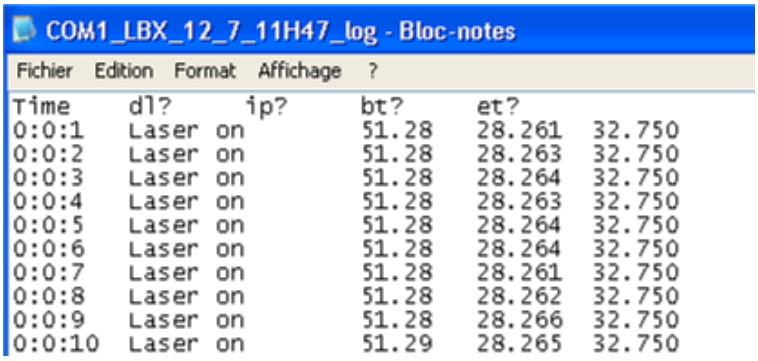
NOTE: Make sure that this location is a directory for which you have the appropriate rights (file creation and write access). Failing to do so will result in an error when the record is launched.

- 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 “,”.

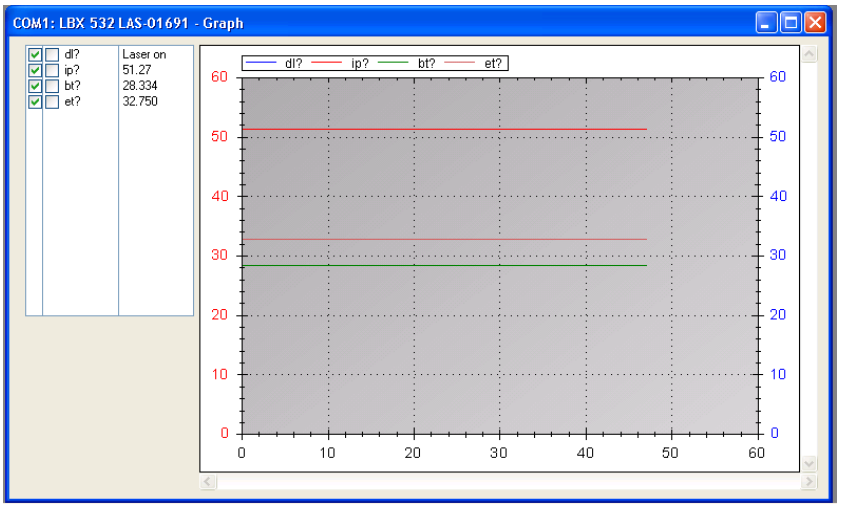
- Click on the “Ok” button once you are done.

This will create a file named `COM`**`XX`**`-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:



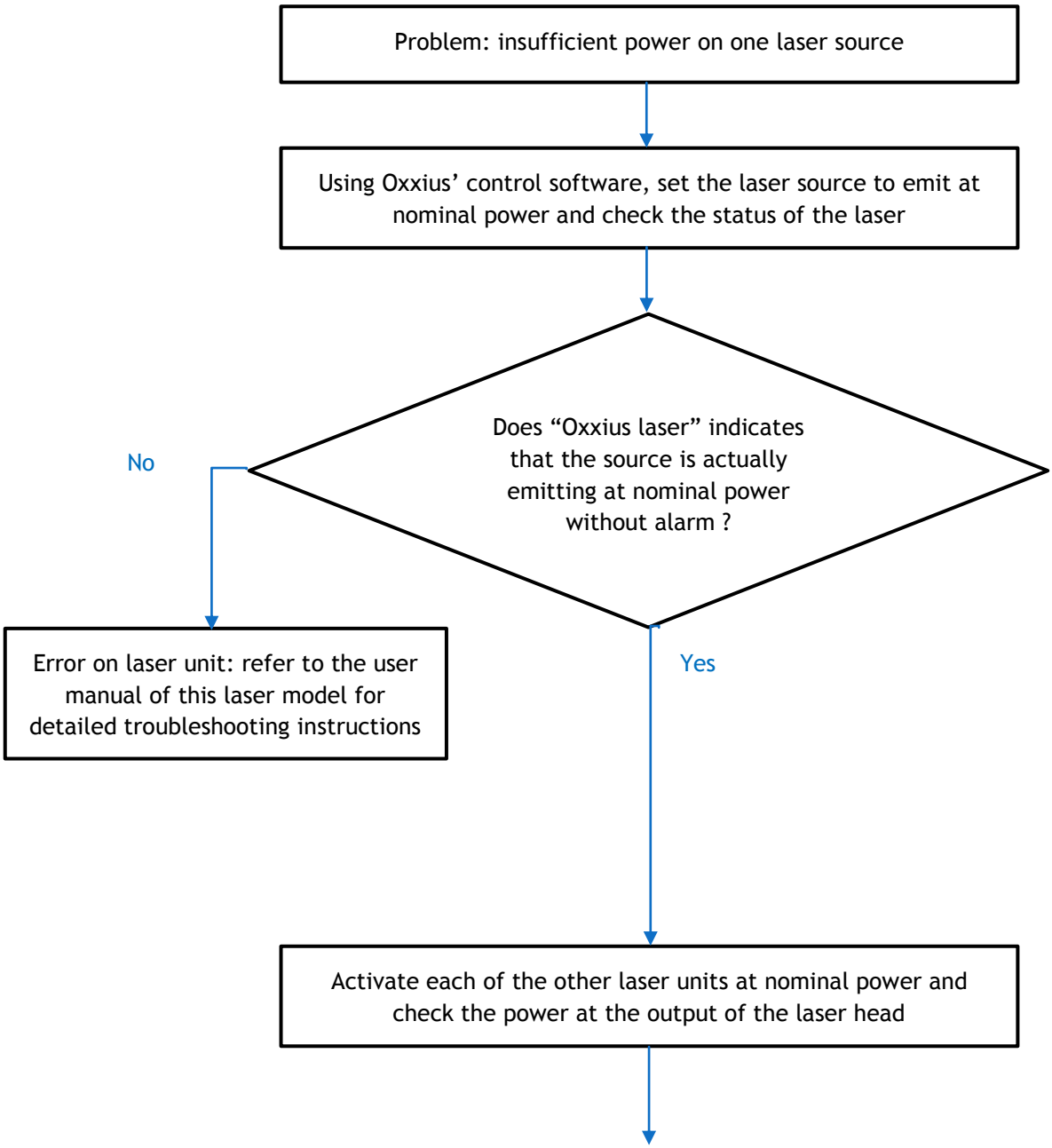
It is also possible to visualize the logged parameters in real time using the “Graph” button in the command panel. This will open a separate window displaying the recorded parameters (ordinate) against time (abscissa).

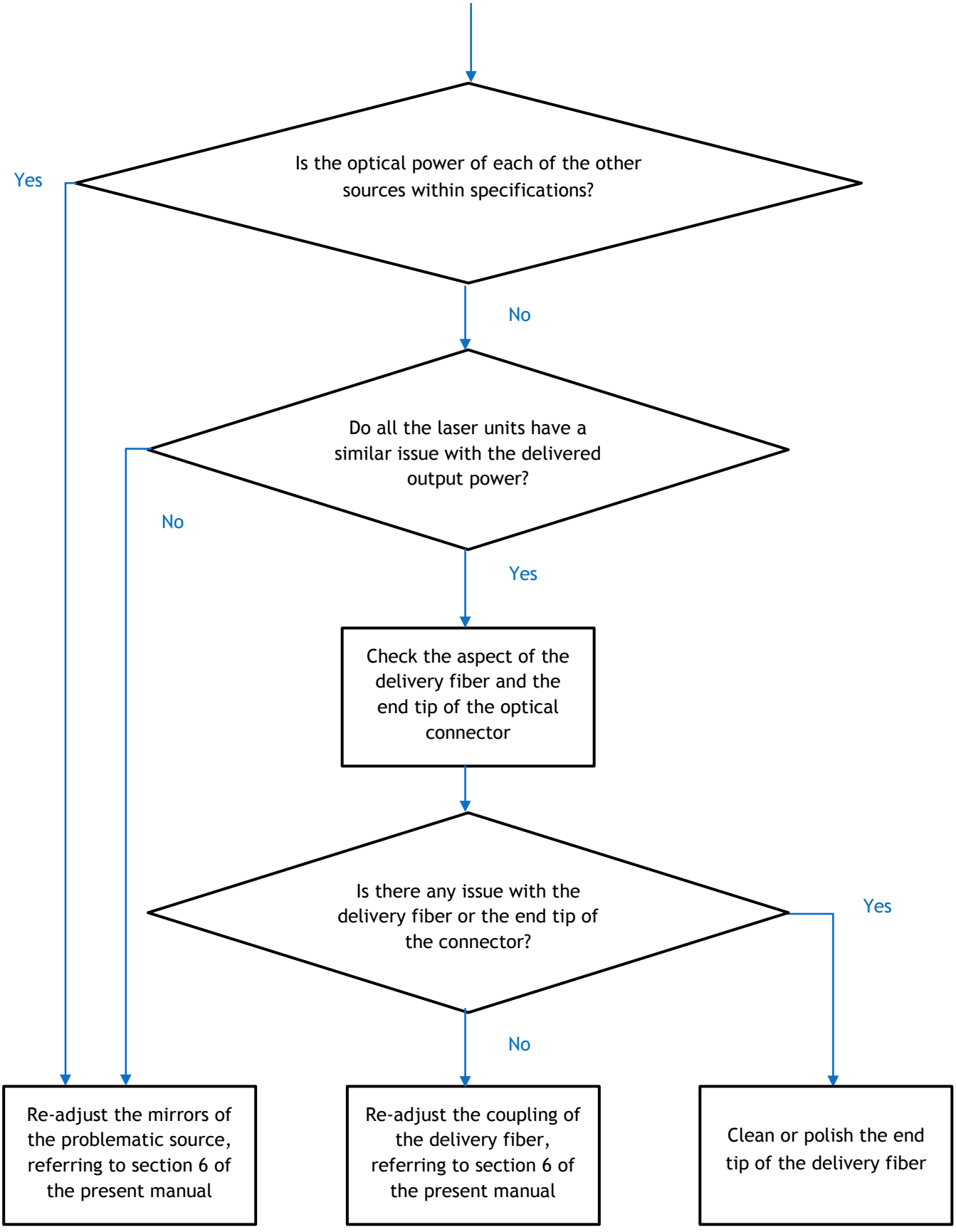


The frame on the top left allows the user to select which parameter should appear on the graph, and on which axis. Tick on the boxes before each parameter to make its data on the left axis, on the right axis or on none of them.

4. TROUBLESHOOTING AND MAINTENANCE

The following chart describes the main issues occurring on the combiner, the way to identify and solve them.




Is the optical power of each of the other sources within specifications?
Yes
No
Do all the laser units have a similar issue with the delivered output power?
No
Yes
Check the aspect of the delivery fiber and the end tip of the optical connector
Is there any issue with the delivery fiber or the end tip of the connector?
Yes
No
Re-adjust the mirrors of the problematic source, referring to section 6 of the present manual
Re-adjust the coupling of the delivery fiber, referring to section 6 of the present manual
Clean or polish the end tip of the delivery fiber

5. WARRANTY AND CERTIFICATION

5-1 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.

5-2 Declaration of conformity

CE **Certificate**

Manufacturer: Oxxius France

Adress: 4, rue Louis de Broglie
22300 Lannion

Declares that the following products:

Name of products: LCX lasers, LBX lasers

References or models:

LCX products

LCX-wwwS-ppp-CIR/CSB-OE/PP

LCX-wwwL-ppp-CIR/CSB-OE/PP

LBX products

LBX-www-ppp-ELL/CSB/HPE-OE/PP

LBX-wwwS-ppp-ELL/CSB-OE/PP

www for wavelength [in nm], ppp for power [in mW]

Are certified according to the following standard(s):

Electrical safety:	Directive 2006/95/EC (2006/12/12)
	NF EN 61010-1 June 2010 Edition
EMC:	Directive 2004/108/EC (December 2004)
	IEC 61326-1 Ed 2 (2012)
	NF EN 61000-3-2 (P&P)
	NF EN 61000-3-3 (P&P)
	NF EN 61000-4-2 (P&P)
	NF EN 61000-4-3 (OEM and P&P)
	NF EN 61000-4-4 (P&P)
	NF EN 61000-4-5 (P&P)
	NF EN 61000-4-6 (P&P)
	NF EN 61000-4-11 (P&P)
Laser:	IEC 60825-1 Ed 2 / 2007-03 (P&P)

Signature

_____

(Thierry Georges, PDG (CEO), Lannion, September 2014

6. TECHNICAL DOCUMENTS

This section describes the inner elements of this device and the process to optimize the delivered optical power. It also includes the mechanical drawings of the combiner and a list of the software commands and queries.

6-1 Inner elements of the laser bench

The following elements are present inside the optical head of the L6Cc (see figure 6-1):

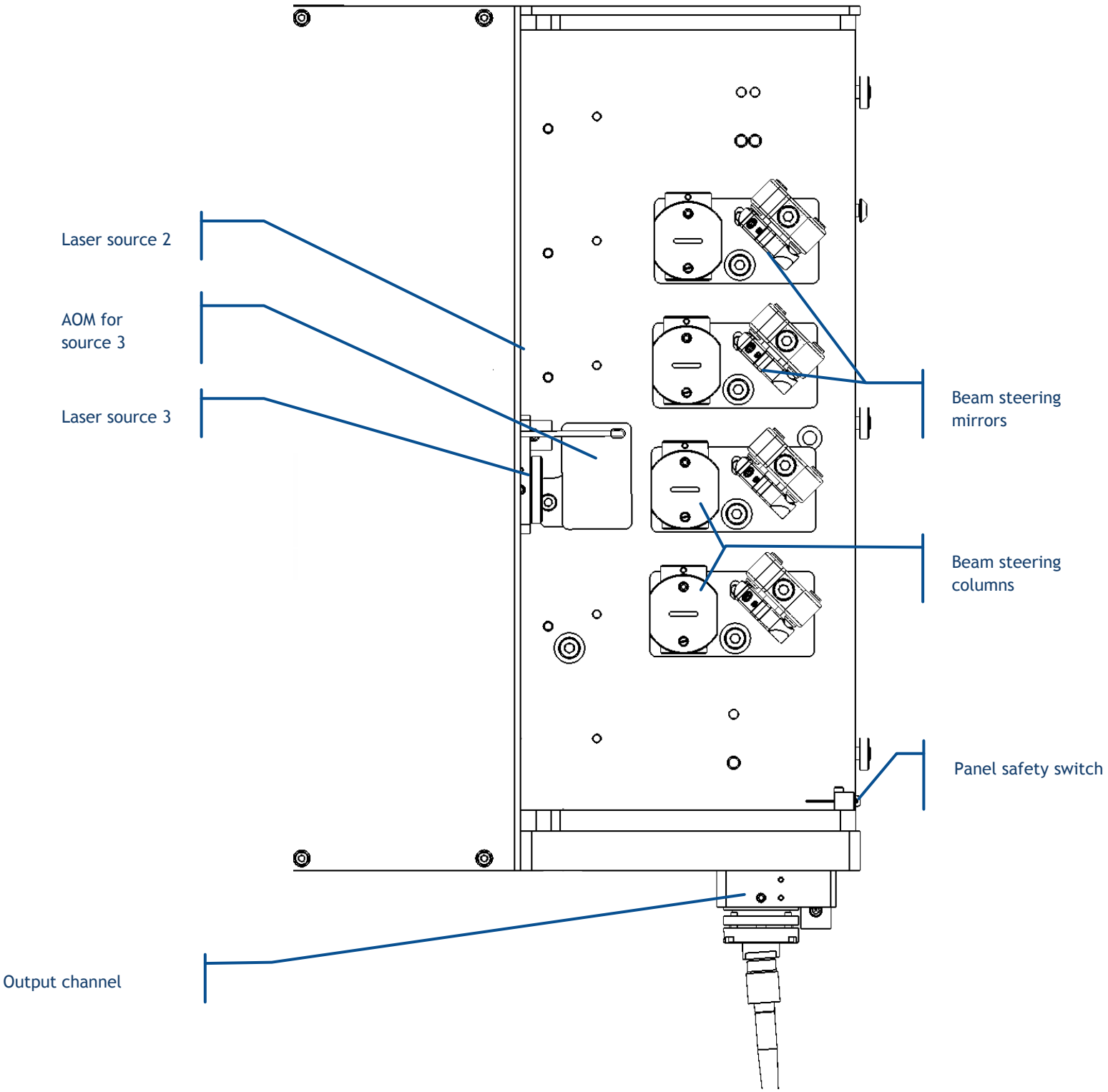
- the Laserboxx sources (LBX and/or LCX),
- one or several acousto-optic modulators (AOM),
- some optical elements that combine the laser beams into the same geometry,
- optionally, the fiber coupling system

Each laser source emits an output beam directed on the steering mirrors. These steering mirrors deflect each beam precisely into the output aperture.

In most configurations, the LCX laser source is paired with the AOM in order to modulate its optical output. The resulting beam is also steered by a set of mirrors into the output channel.

If the option is present, fiber coupling system finally acts to focus the incoming beams into the output fiber at once.

Figure 6-1: Inner elements of the combiner (example with four sources)



6-2 Optimizing the coupling ratio

If, for any reason, the output power seems to be lower than its original value, then it might be necessary to optimize the coupling ratio of the laser sources. This is achieved by re-adjusting the steering elements or the coupling system.

To do so, the following material is necessary:

- An optical power-meter adapted to the range of power and wavelengths to be measured (typically a few hundreds of milliwatts from 375nm to 980nm)
- Some individual protections against laser radiation. At this purpose, refer to each laser source and check its emission wavelength and maximum power.
- The screw drivers and Allen keys provided with the combiner. Refer to the packing list in the first section of this document.

Warning

Adjusting the mirrors is done by accessing them directly. Be sure to process with care:

- Wear the laser protection equipment adapted to the emitting laser source
- Operate in a dust-free environment,
- Never touch the mirrors or other optical elements on their active surface

Proceed through the following steps:

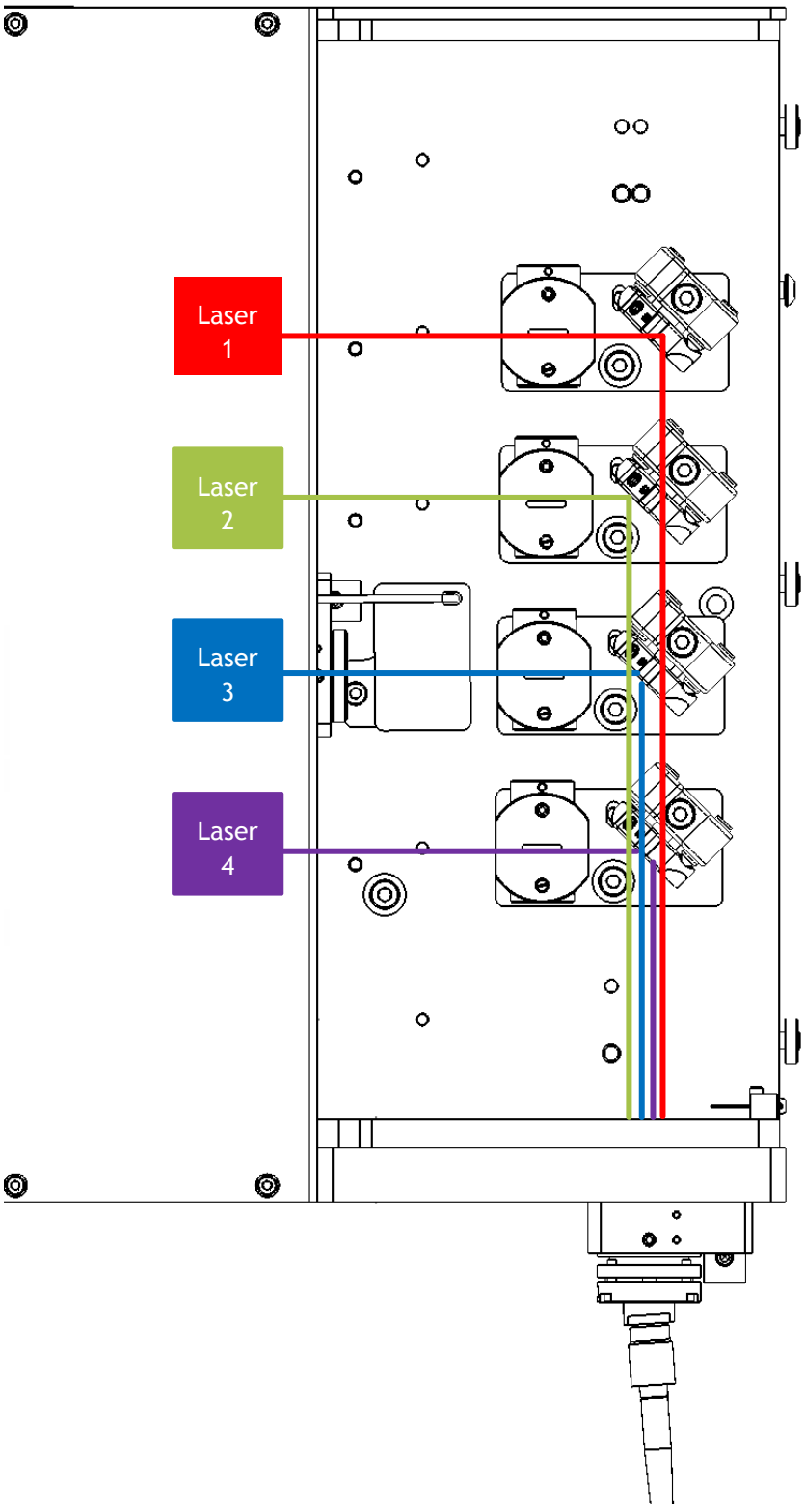
1. Install your power-meter at the optical output (using the optical connector of the delivery fiber)

2. Power up the combiner and wear your protection equipment against the laser radiation

3. Remove the top cover of the optical head using the two screws on its side. Note that the safety switch will then inhibit the laser emission, as stated on the warning label

4. De-activate the safety interlock by pushing the panel safety switch set. Be careful as the emission will be resumed instantaneously.

Figure 6-2: Layout of the laser bench with optical beams down to the fiber coupler

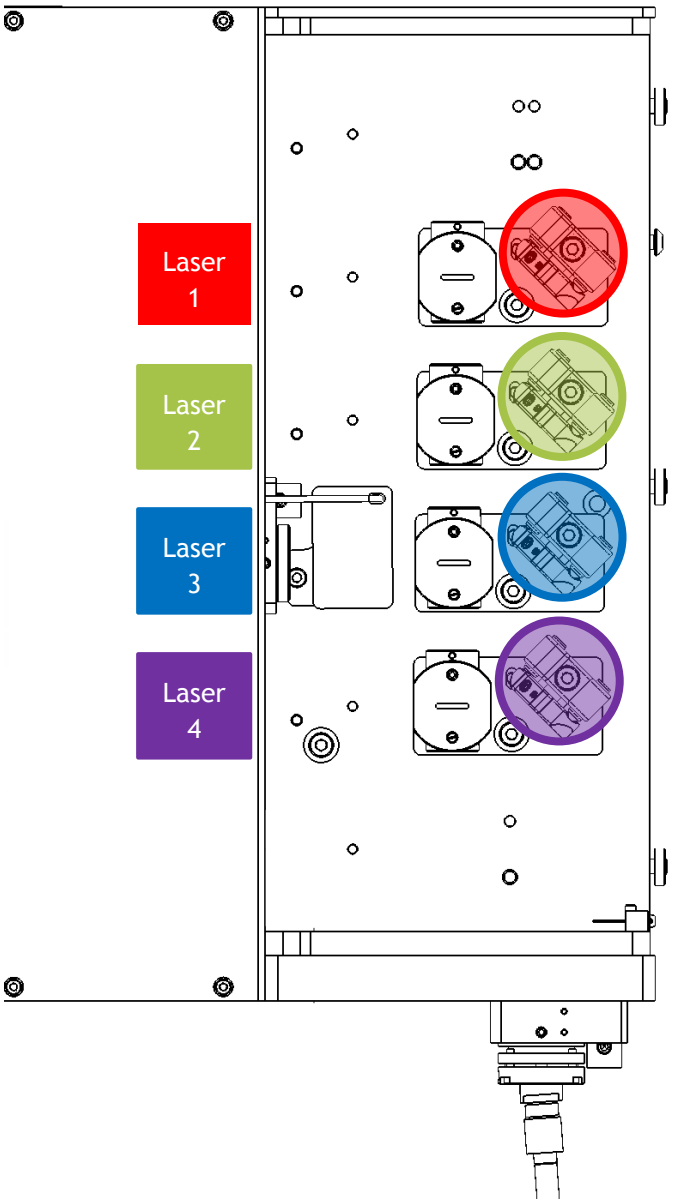


5. The laser source which is closest to the output aperture acts as the reference source (laser 4 in our example above). If the output power of this source is lower than usual, or if the power of all sources is lower than usual, then it might be necessary to readjust the coupling of the delivery fiber itself. To do so, refer to the user manual of the LBX and follow the procedure described in chapter 4-3, “Fiber coupling option, SM/PM fiber”.

6. Once this coupling is confirmed as good, the output power of the reference laser source should be within specifications. It is now necessary to check the adjustment of the remaining sources. Proceed to the next step.

7. If –for example- the source number 2 requires an adjustment, then it will be necessary to fine-tune the steering elements. Start by identifying the pair of mirrors implied with each sources (refereeing to figure 6-3).

Figure 6-3: Laser sources with their respective pair or steering mirrors



8. Turn on the laser source that requires adjustment. Change your power-meter settings in accordance with its emission wavelength.

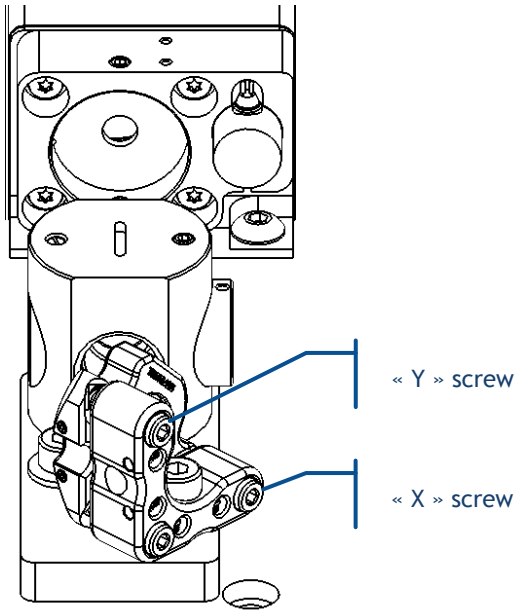
Caution

Be sure to wear protective equipment against laser radiation: at this stage, the panel safety switch should be by-passed (see step 4) and the laser is ready to emit without restriction.

Keep in mind that the tools used during this procedure will likely cut the beam path and send scattered light in any directions

9. Each beam can be adjusted using its corresponding steering mirror. This mirror holds three screws, among which two of them only will be used: one for steering in the vertical plane (referred to “X” screw), another for steering in the horizontal plane (referred to “Y” screw). The method consists in adjusting both “X” and “Y” screws so as to steer the beam back in position.

Figure 6-4: A steering mirror with its “X” and “Y” screws



10. Insert a 2-mm Allen key in the “X” screws depicted in figure 6-4

11. Rotate the “X” screw in both directions until the power-meter reaches a maximum. Note down the value of this local maximum.

12. Proceed the same way with the “Y” screw: rotate it until a local maximum is reached.

13. Rotate the “X” screw again in search for the maximum: it should be higher or equal than the value you noted down on step 11, and within specifications.

14. Repeat this procedure with the remaining sources if necessary (back to step 7)

When all the output power have reached their nominal value, your combiner is optimized.

6-3 Modulation in details

This chapter will provide detailed information about the regulation loops, power tuning and the modulation functions.

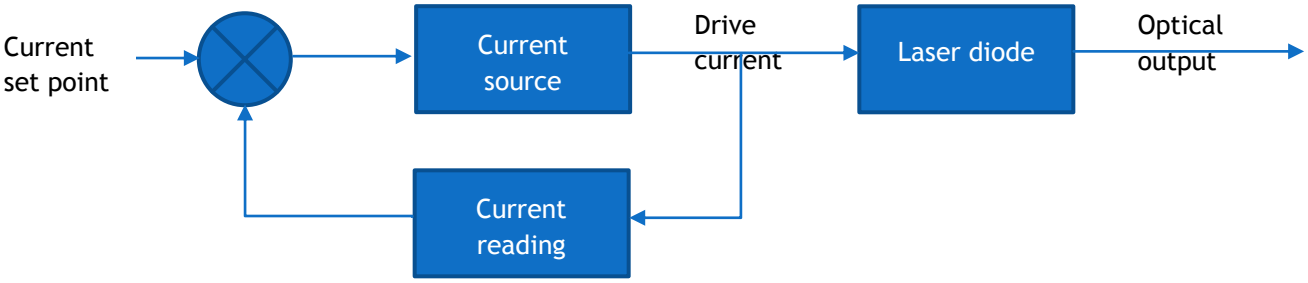
THE POWER REGULATION LOOPS

The LaserBoxx laser sources operate by releasing an optical signal against a given set point. Two different control methods exist to regulate the optical signal.

AUTOMATIC CURRENT CONTROL

Using this control loop, the user sets a pump current that will drive the laser diode. The control loop consists in acting so that the actual current is equal to the user-defined set-point.

Here is its block diagram:



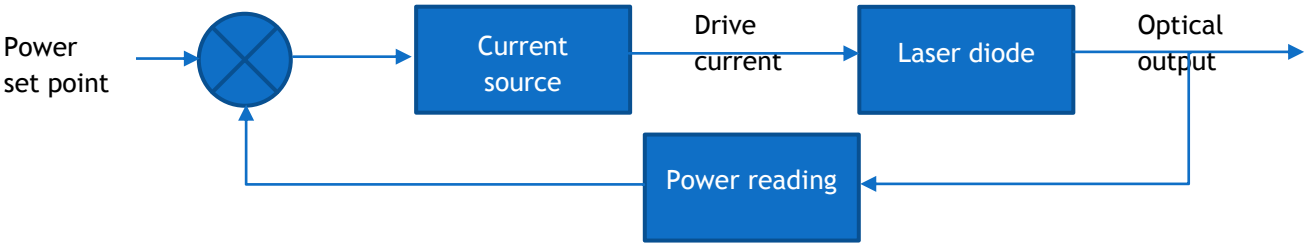
This loop allows for a tight control over both the current and the temperature of the laser diode, and is therefore advisable in applications where, for example, a good wavelength stability is required.

Note that the ACC loop is unavailable on the LCX laser sources.

AUTOMATIC POWER CONTROL

Using this control loop, the user sets the optical power to be released by the laser head. The control loop consists in acting so that the actual power is equal to the user-defined set-point.

Here is its block diagram:



The APC loop offers the best performance for a stable the optical power, since it is able to react against eventual deviations.

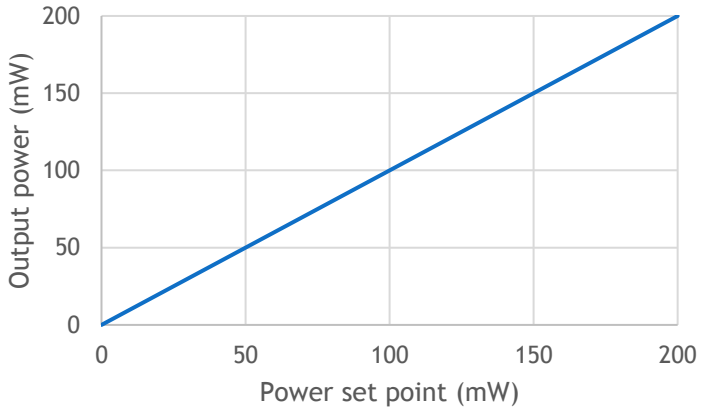
POWER VERSUS CURRENT CHARACTERISTICS AND MODULATION

Here are the typical characteristic functions obtained when driving the laser using one of these methods:

- setting an internal (=software) set point,
- applying an external signal for analog modulation, or
- applying an external signal for digital modulation

APC MODE, INTERNAL SET POINT

Here is a typical characteristic curve of a LaserBoxx LBX or LCX driven by an internal set point, in APC mode:

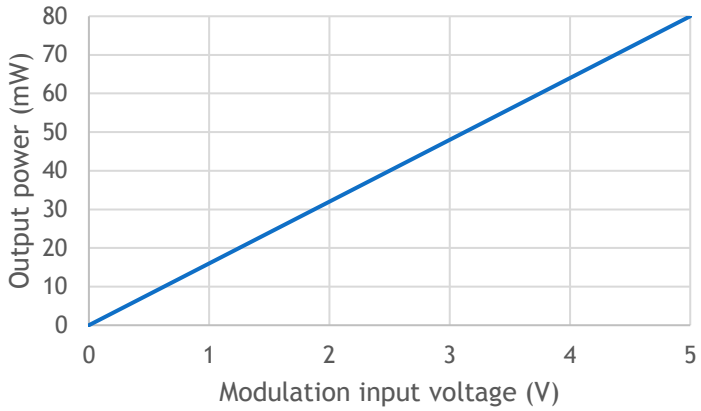


The characteristic curve is linear between 0mW and the nominal power, the effect of the APC loop being that the monitored power is strictly equal to the power set point. Note that the exact value of the nominal power (200mW in the example above) is specified on the manufacturing test report of each unit.

Reading or setting the optical power in done in milliwatt.

APC MODE, ANALOG MODULATION

Here is a typical characteristic curve of a LaserBoxx LBX or LCX modulated by an external voltage, in APC mode:

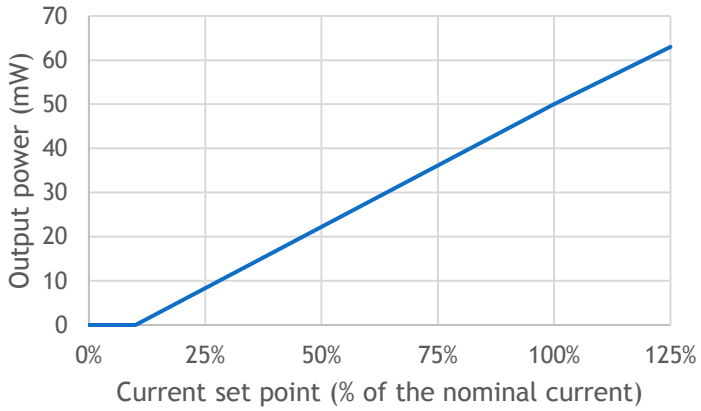


The characteristic curve is linear between 0V and 5V, the maximum reachable value being the last internal set point entered (80mW in the example above).

Refer to the specifications of your combiner for exact speed and modulation characteristics.

ACC MODE, INTERNAL SET POINT

Here is a typical characteristic curve of a LaserBoxx LBX driven by an internal set point, in ACC mode:



The characteristic curve is as follows:

- The output power almost nil between 0mA and the threshold current,
- From the threshold current and above, the relationship between the current and the optical power is linear
- The maximum allowable value is 125% of the nominal current

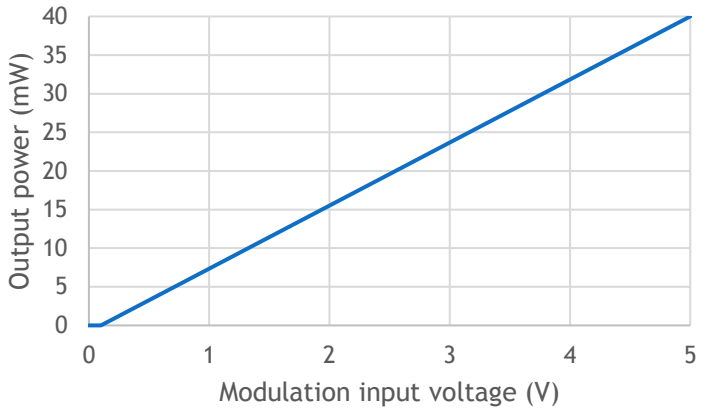
The value of the threshold current is model-dependent, there is no typical value for it. The nominal current is defined as the current that induces emission at nominal power (50mW in the example above).

When setting the current, the unit used is the percentage of the nominal current. When reading the current, the returned value is expressed in milliAmperes.

Although the setting of “100%” is designed to drive the LBX at nominal power at the beginning of the unit’s lifespan, the user is allowed to set this current up to 125% of the nominal current in order to cope for a potential loss of efficiency due to aging.

ACC MODE, ANALOG MODULATION

Here is a typical characteristic curve of a LaserBoxx LBX driven by an external voltage, in ACC mode:



The characteristic curve is as follows:

- The output power almost nil between 0V and a threshold voltage (unit-dependent),
- From that threshold voltage and above, the relationship between the input voltage and the optical power is linear

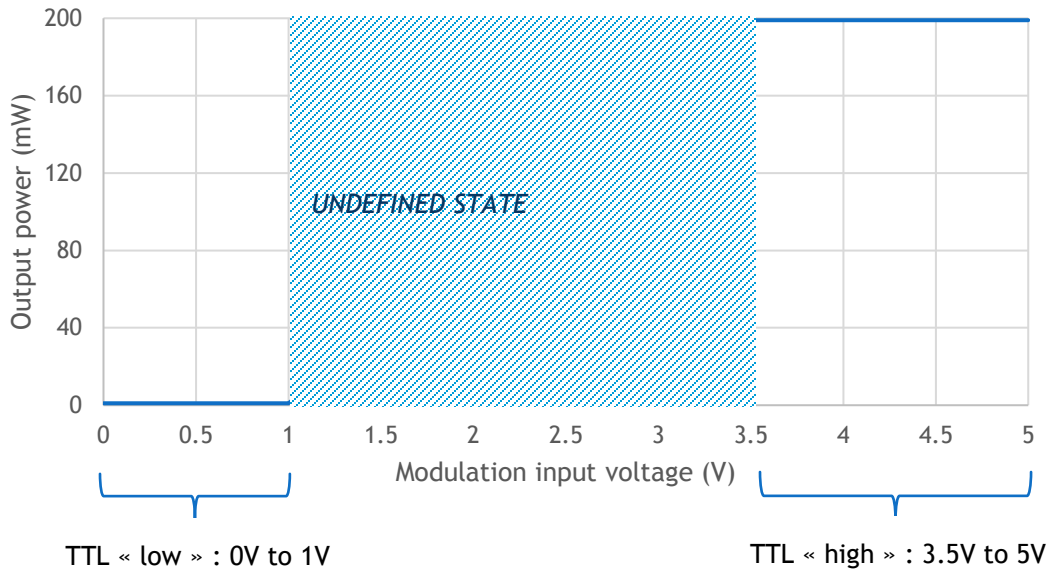
The units are optimized so that their threshold voltage is set to the lowest possible value, typically 0.1V.

The maximum reachable value is the last current set point entered (80% in this example).

DIGITAL HIGH-SPEED MODULATION

The digital modulation allows for a high-speed, binary modulation driven by a signal to be applied on the rear panel of the combiner.

Here is a typical characteristic curve of a LaserBoxx LBX or LCX modulated by this scheme:

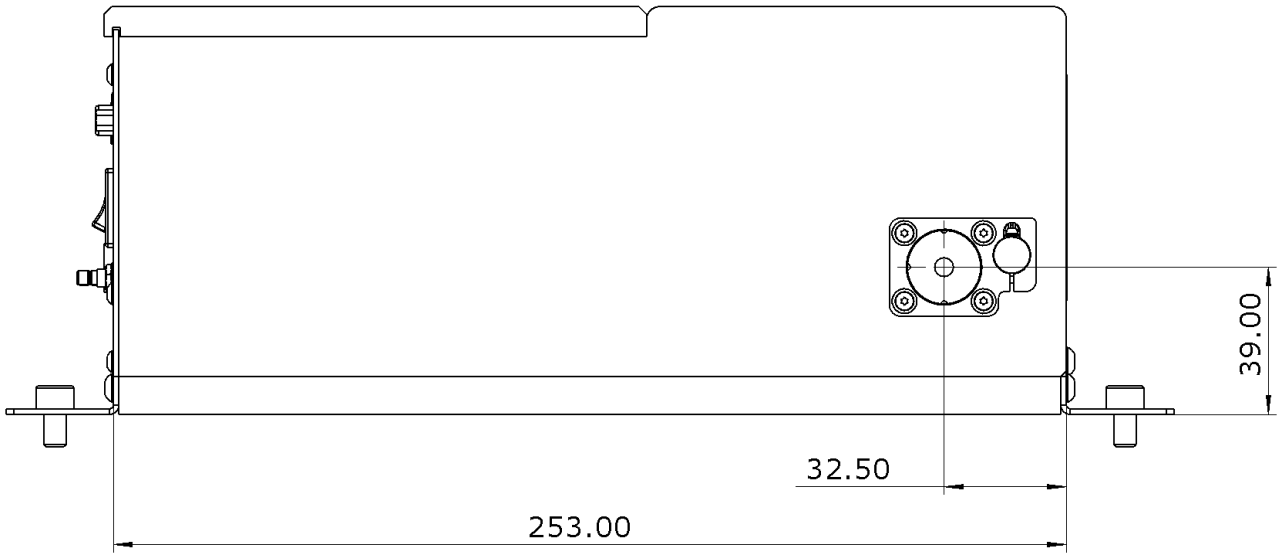


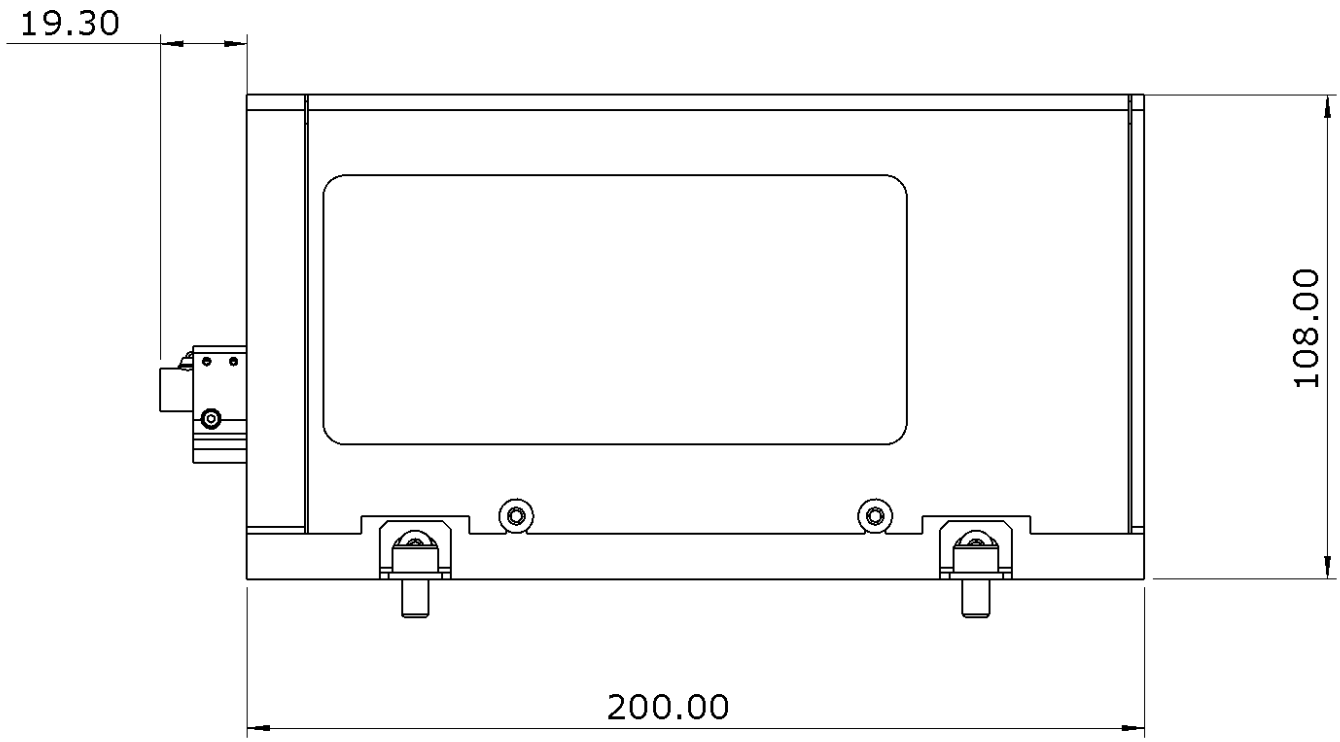
A TTL “low” voltage will result in a nil power, while TTL “high” voltage will have the laser source to emit according to the last current set point entered.

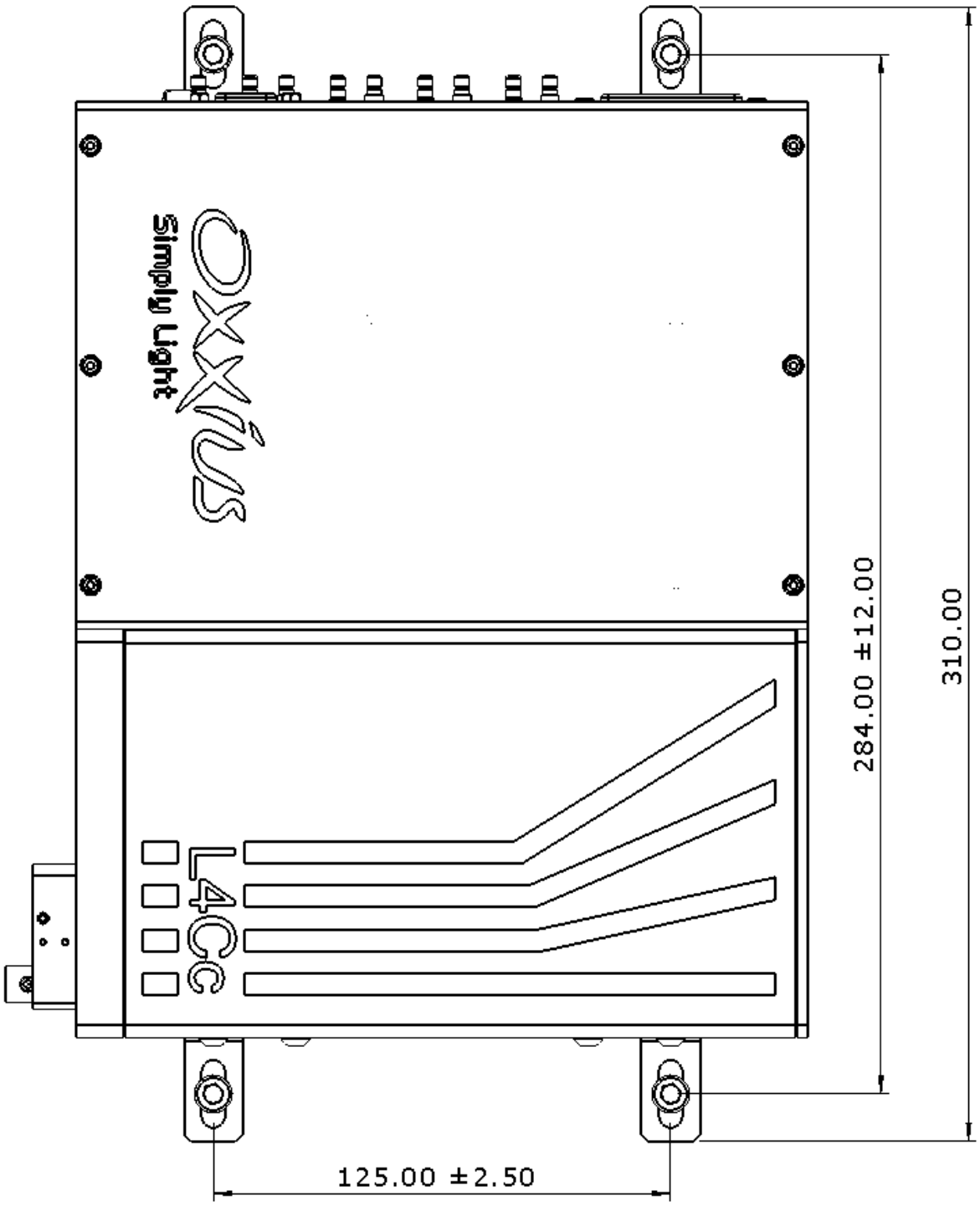
Refer to the specifications of your combiner for exact speed and modulation characteristics.

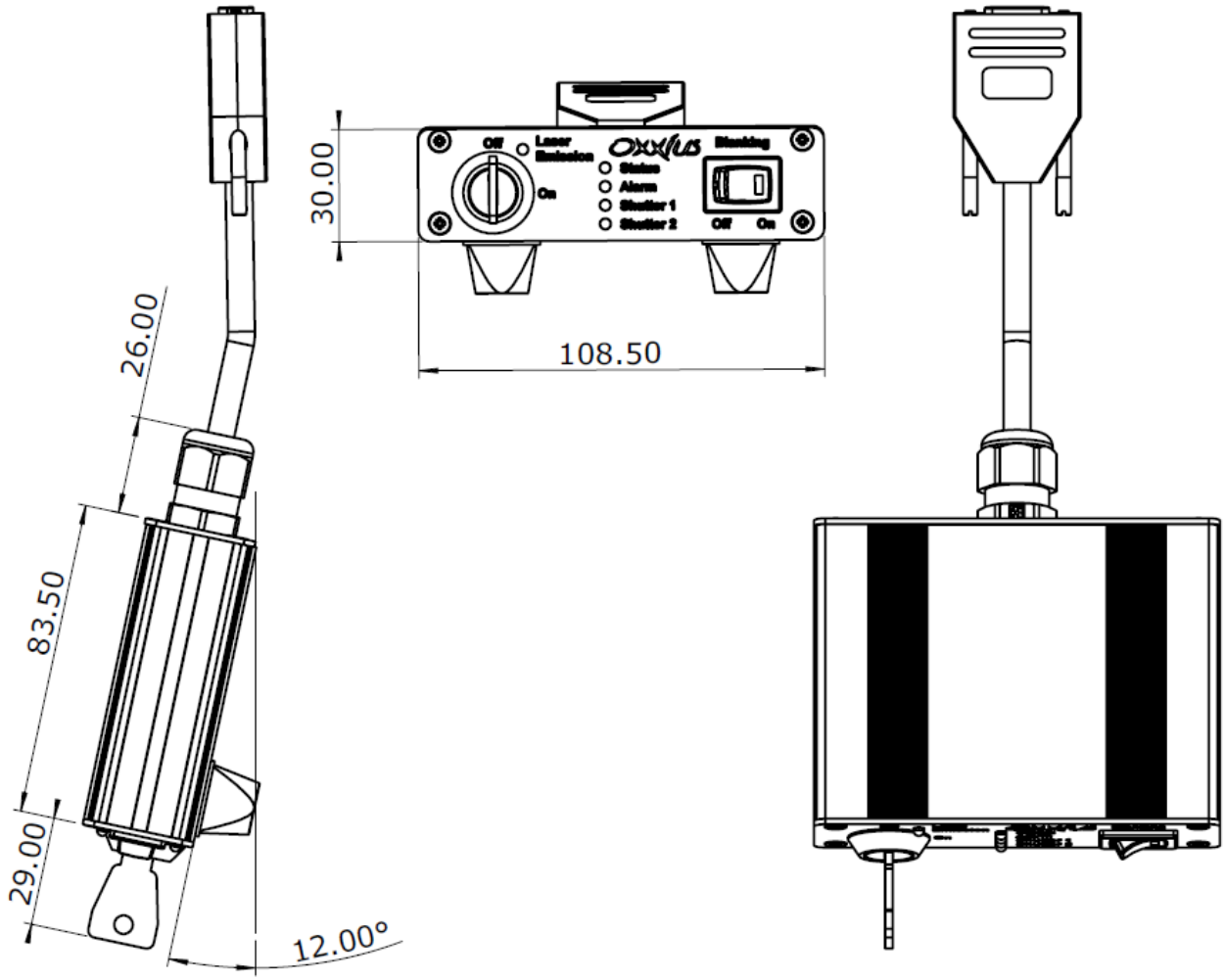
6-4 Mechanical drawings

LASER BENCH






Simply Light
OXYUS
L4CC
284.00 ±12.00
310.00
125.00 ±2.50


30.00
108.50
26.00
83.50
29.00
12.00°
Off
Laser Radiation
On
Oxxius
Blanking
Status
Alarm
Shutter 1
Shutter 2
Off
On

6-5 Software commands and queries

GLOBAL COMMANDS FOR THE COMBINER

The following tables lists the set of queries and commands to be sent to the combiner:

Purpose	Query	Result and syntax
Retrieves the configuration of the USB port	?CDC	"0" Standard USB "1" USB port configured as a virtual serial port
Retrieves the status of the interlock circuit	?INT	"0" Interlock open, laser emission is not possible "1" Interlock closed, laser emission is possible
Retrieves the serial number of the unit	HID?	"LNC-XXXXX"
Retrieves the status of actuated key master control	KEY?	"0" the key is off, laser emission is not possible "1" the key is on, laser emission is possible
Retrieves the power set point on the first AOM	?SP	"40.0" for 40.0 mW
Retrieves the status of the combiner	?ST	"Lasers off" when all laser sources are off "Starting-up" when at least on laser sources is in "starting-up" status "Lasers on" when all laser sources are emitting "Alarm" when at least on laser sources is in "alarm" status "Stand-by" when all laser sources are in "stand-by" status "Blanking" when the blanking function is activated

Purpose	Command	Syntax and examples
Sets the regulation loop (see also "APC")	ACC	ACC 1 (ACC,<space>,1): set the ACC mode on all LBX units ACC 0 (ACC,<space>,0): set the APC mode on all LBX units
Selects the mode of operation of the AOM	AM	AM 0 (AM,<space>,0): The AOM is driven exclusively from software commands. Use the command "P" below to set the output power.

		AM 1 (AM,<space>,1): The AOM is driven by the analog modulation signal, but its maximum value is set using the command "P" below: - 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" In this mode of operation, the modulation function between the input voltage and the output power is linearized. AM 2 (AM,<space>,2): 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).
Sets the configuration of the USB port	CDC	"CDC 0" Sets to standard USB protocol "CDC 1" Configure the port as a virtual serial port
Sends an arbitrary command to laser source number n (where n equals 1, 2, 3 or 4)	Ln CMD	L1 AM 1 (L1,<space>,AM,<space>,1): enables the analog modulation on laser source number 1 L3 RST 0 (L3,<space>,RST,<space>,0): Resets the laser source number 3
Activate or deactivate the shutter n (where n equals 0 or 1)	SHn	SH0 1 (SH0,<space>,1): open the shutter "0" SH0 0 (SH0,<space>,0): close the shutter "0"
Sets the power of the AOM	P	P 40 (P,<space>,40) sets the optical power at 40mW
Sets the bias voltage on the AOM. This value determines the extinction contrast of the AOM	TA 1	TA 1 20 (TA,<space>,1,<space>,20): sets the bias voltage to 20mA (a recommended value).

After having received and successfully processed a command, an acknowledgement message "OK" is returned.

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

SENDING COMMANDS TO INDIVIDUAL LASER SOURCES

It is possible to address to the individual LaserBoxx sources by sending command or queries to the combiner using the prefix "Ln", where n is the number of the source that needs to be addressed (1 to 6).

COMMAND AND QUERIES FOR THE LCX LASERBOXX

The following tables lists the set of queries and commands to be sent to the laser:

Purpose	Query (and aliases)	Result and syntax
Retrieves the temperature of the base plate of the laser head (expressed in Celsius degrees)	?BT BT?	"22.1" "22.1 C"
Retrieves the configuration of the USB port	?CDC	"0" Standard USB "1" USB port configured as a virtual serial port
Retrieves the status of CDRH-compliant five-second delay prior to laser emission. See section 1, "Safety information", for further details.	?CDRH 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 AL?	"?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) AL? returns one of the following messages: "Laser Head Temperature" "Interlock" "Power Supply" "Other" "No alarm"
Retrieves the laser operation time, in hours	?HH TM?	"49" "TIME= 49 hrs, 38 min"

Retrieves the unit's serial number	?HID HID?	"LAS-XXXXX", 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 status of the interlock circuit	?INT INT? ?LCK	"0" Interlock open, laser emission is not authorized "1" Interlock closed, laser emission is authorized
Measures the voltage suppling the laser head (expressed in Volts)	?IV VA?	"6.601" "6.168 V"
Retrieves the status of the emission key, or the "Key" signal on the DE-15 electrical interface	?KEY KEY?	"0" Signal low, laser emission is not activated "1" Signal high, laser emission is activated
Retrieves the emission status	?L	"0" Emission is off "1" Emission is off "2" Emission is on at low power
Retrieves the laser's measured output power (in milliwatts)	?P IP?	"53.6" "53.6 mW"
Retrieves the temperature of the electronic board embedded inside the laser head (expressed in Celsius degrees)	?PST ET?	"33.6" "33.6 C"
Retrieves the laser's power set point (in milliwatts)	?SP	"40.0"
Queries the state of the laser module (see section "Troubleshooting" for more information concerning the laser status)	?STA DL?	?STA returns a number corresponding to one of the following status: "1" : Warm-up phase "2" : stand-by phase "3" : Emission ON "5" : Alarm present "3" : Sleep mode "7" : Searching for SLM point "DL?" returns one of the following text messages: "Laser off" "Setting temperature" "Waiting for stabilization" "Starting up" "Laser on"

		"Laser alarm"
Retrieves the version of the embedded software	?SV VE?	"1.6.8" for firmware version 1.6.8
Retrieves the status of the temperature regulation loop	?T T?	"0" Temperature regulation loop is deactivated "1" Temperature regulation loop is activated

Purpose	**Command (and aliases)**	**Syntax and examples**
Configuration of the USB port: standard or virtual serial port	CDC	CDC 0 (CDC,<space>,0): Standard USB CDC 1 (CDC,<space>,1): USB port configured as a virtual serial port
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.
Control of the laser emission	DL L	DL 0 (DL,<space>,0): switches the emission off DL 1 (DL,<space>,1): switches the emission on DL 2 (DL,<space>,2): switches the emission on at low power for optical alignment purpose
Modifies the power set point (for models that accept power adjustment)	IP P	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. P 250.3 (P,<space>,250,<dot>,3) sets the optical power at 250.3mW
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	T 0 (T,<space>,0): switches the regulation loop off T 1 (T,<space>,1): switches the emission on

Purpose	Query (and aliases)	Result and syntax
Retrieves the regulation loop. See also "?APC".	?ACC ?ANA	"1" when the ACC mode is set "0" when the ACC mode is not set
Retrieves the status for analog modulation	?AM ?EXT	"1" when the external modulation is engaged "0" when the set point is internal
Retrieves the regulation loop. See also "?ACC".	?APC	"1" when the APC mode is set "0" when the APC mode is not set
Retrieves the temperature of the base plate of the laser head	?BT	"22.1" for 22.1°C
Retrieves the monitored current of the laser diode	?C	"550.4" for 550.4 mA
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 status for digital high-speed modulation	?CW	"1" when engaged "0" when disabled
Retrieves the diode temperature set point.	?DST	"25.000" for 25.000°C
Retrieves the monitored diode temperature.	?DT	"25.0" for 25.0°C
Alarm codes: retrieves the cause of the last alarm raised (see also section "Troubleshooting" for more information about alarms)	?F	Returns a number corresponding to one of the following alarms: "0" : No alarm "1" : Diode current "2" : Laser power "3" : Power supply "4" : Diode temperature "5" : Base temperature "7" : Interlock
Retrieves the laser operation time, in hours	?HH	"49" for 49 hours. The increment interval in one minute.

Retrieves the unit's serial number and wavelength	?HID	"LAS-XXXXX,LLL", where XXXXX is the serial number (over five digits), and LLL is the central emission wavelength.
Retrieves the status of the interlock circuit	?INT ?LCK	"0" Interlock open, laser emission is not authorized "1" Interlock closed, laser emission is authorized
Retrieves the measured voltage suppling the laser head (expressed in Volts)	?IV	"6.601" for 6.601V.
Retrieves the emission status	?L	"0" Emission is off "1" Emission is on
Retrieves the maximum allowable laser current	?MAXLC	"1300.0" for 1300.0 mA
Retrieves the maximum allowable laser power	?MAXLP	"600.0" for 600.0 mW
Retrieves the measured optical power	?P	"53.6" for 53.6 mW
Retrieves the temperature of the microcontroller inside the laser head	?PST	"33.6" for 33.6°C
Retrieves the current set point	?SC	"400.0" for 400.0 mA
Retrieves the optical power set point	?SP	"40.0" for 40.0 mW
Queries the operating status (see section "Troubleshooting" for more information concerning the laser status)	?STA	?STA returns a number corresponding to one of the following status: "1" : Warm-up phase "2" : Stand-by phase "3" : Emission ON "4" : Internal error raised "5" : Alarm present "6" : Sleep mode (see also the query "?T")
Retrieves the version of the embedded software	?SV	"3.2.8" for firmware version 3.2.8
Retrieves the status of the temperature regulation loop	?T ?SS	"0" Temperature regulation loop is deactivated, unit is in "sleep" mode "1" Temperature regulation loop is activated

Purpose	**Command (and aliases)**	**Syntax and examples**
Sets the regulation loop (see also "APC")	ACC ANA	ACC 1 (ACC,<space>,1): set the ACC mode ACC 0 (ACC,<space>,0): set the APC mode
Sets the analog modulation	AM	AM 1 (AM,<space>,1): enables the analog modulation

	EXT	`AM 0` (AM,<space>,0): disables the analog modulation
Sets the regulation loop (see also “ACC”)	APC	`APC 1` (APC,<space>,1): set the APC mode `APC 0` (APC,<space>,0): set the ACC mode
Sets the laser diode current, then saves this value as the new default.	C	`C 40` (C,<space>,40) sets the optical power at 40% of the nominal current. Values allowed between 0% and 125%.
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.
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).	CM	`CM 40` (CM,<space>,40) sets the optical power at 40% of the nominal current. Values allowed between 0% and 125%.
Sets the digital high-speed modulation	CW	`CW 1` (CW,<space>,1): disables the digital modulation `CW 0` (CW,<space>,0): enables the digital modulation
Lasr emission control	L	`L 0` (L,<space>,0): switches the emission off `L 1` (L,<space>,1): switches the emission on
Sets the laser power, then saves this value as the new default.	P	`P 20` (P,<space>,20) sets the optical power at 20mW. Values allowed between 0 and the maximum power (see the query ?MAXLP).
Sets the laser power, but does not record this value in memory, thus sparing stress on the internal EEPROM. Prefer this command to “P” if you need to change the power at high frequency (ten times per second or higher).	PM	`PM 20` (PM,<space>,20) sets the optical power at 20mW. Values allowed between 0 and the maximum power (see the query ?MAXLP).
Clears the alarms	RST	`RST` clears any alarm (see chapter 3-4)
Resets the laser unit	RST	`RST 0` (RST,<space>,0): resets the laser unit (see chapter 4-1, paragraph “Emission control”
Switches the temperature regulation loop ON or OFF. This regulation loop is necessary for the emission to occur. Switching it off reduces the power consumption.	T	`T 0` (T,<space>,0): switches the regulation loop off, and sets the operating status to “sleep” mode (see “STA”). `T 1` (T,<space>,1): switches the regulation loop back on. The unit is no longer in “sleep” mode.
Sets the digital high-speed modulation	TTL	`TTL 1` (TTL,<space>,1): enables the digital modulation `TTL 0` (TTL,<space>,0): disables the digital modulation