



UV, VISIBLE and NIR laser solutions

# LASER COMBINER USER MANUAL

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## L4Cc and L6Cc models

Four-slot and six-slot combiners for LaserBoxx sources

REVISION HISTORY

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1.20	First release	Release date: July 2018
1.21	M-Dual and fast-mirror modules added	September 2018
1.40	Flip mirror added	January 2019
1.45	MPA functions added	March 2019
1.60	Ethernet communication added	April 2020
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# 1. SAFETY INFORMATION

To use the products safely, follow the instructions provided here. Keep the product documentation nearby and offer it to other users. Contact Oxxius or your local representative if you have any question, or if some parts of this manual are not understood.

## QUALIFICATION AND TRAINING OF PERSONNEL

Personnel who operate the combiner must be adequately trained and qualified for the work concerned and should have read and understood this manual. The user must understand the potential dangers presented by a laser equipment and observe the recommendations of this manual. These users also have a sound knowledge of at least one of the languages in which the interfaces and the product documentation are available.

## SIGNAL WORDS IN THE DOCUMENTATION

The following sidebars point out a risk that the operator needs to be aware of. The signal word indicates the severity of the safety hazard and how likely it will occur if the safety precautions are not followed.

### WARNING - CAUTION - NOTICE



**WARNING:** Describes a potentially hazardous situation, that could result in serious injury if not avoided.

**CAUTION:** Describes a potentially hazardous situation, that could result in minor or moderate injury if not avoided.

**NOTICE:** Describes a potential risk of damage, that could result in damage to the supported product or to other property.

## 1-1 Safety instructions

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the data sheet and the manuals. If you are unsure about the appropriate use, contact Oxxius customer service.

In these safety instructions, the term “product” covers the L4Cc or L6Cc combiner and its accessories (patch cables, etc.).

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## LIFTING AND CARRYING THE COMBINER

Check the data sheet for the maximum weight of the instrument. A single person can carry a load of up to 18 kg safely depending on age, gender and physical condition. If your combiner is heavier than 18 kg, do not move or carry it by yourself.

Use the handles to move or carry the parcel. Do not grab the mounted accessories when moving the product; they are not designed to carry the weight of the instrument.

To move the instrument safely, you can use lifting or transporting equipment such as lift trucks and forklifts. Follow the instructions provided by the equipment manufacturer.

---

## OPERATING SITE

Only use the product indoors. The product casing is not waterproof; water that enters can electrically connect the casing with live parts, which can lead to electric shock.

The product is suitable for pollution degree 2 environments where nonconductive contamination can occur. For more information on environmental conditions such as ambient temperature and humidity, see the data sheet.

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:

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

## ELECTROSTATIC DISCHARGES (ESD)

ESD are created when friction over objects create a deficit or an excess of charge. When this discharge occurs, the voltages involved are high enough to damage electronic circuits.

The combiners 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.).

---

## CONNECTING TO POWER AND GROUNDING

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

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

Take the following measures for your safety:

Before switching on the product, ensure that the voltage and frequency indicated on the product match the available power source.

- Only use the power cable delivered with the product. It complies with country-specific safety requirements. Only insert the plug into an outlet with protective conductor terminal.
- Only use intact cables and route them carefully so that they cannot be damaged. Check the power cables regularly to ensure that they are undamaged. Also ensure that nobody can trip over loose cables.
- 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 the local standard
  - Connector type on device side: C13
  - Current Rating: 10 A
- Use the power supply that is delivered with the product or that is recommended in the product documentation or a power supply that conforms to the country-specific regulations.
- Ensure that you can disconnect the product from the power source at any time. Pull the power plug to disconnect the product. The power plug must be easily accessible. If the product is integrated into a system that does not meet these requirements, provide an easily accessible circuit breaker at the system level.

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## HOW TO CLEAN THE PRODUCT

Use a dry, lint-free cloth to clean the product. When cleaning, keep in mind that the casing is not waterproof. Do not use liquid cleaning agents.

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## LASER SAFETY

The L4Cc and L6Cc are sources of laser radiations, which present specific dangers.

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 can build stable interferences: vivid patterns that are more intense than non-coherent light of the same wavelength and power,
- Laser beams are often collimated or have a low divergence, 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:

- Ocular trauma: a collimated laser beam, focused by the eye lens, can create an extremely intense light over the retina, even more intense than what would result from a direct viewing of the sun. Such exposure can lead to a permanent damage of the vision.
- Thermal injury: following the absorption of laser energy, the tissue proteins are denatured due to the temperature rise. Tissue damage results from this kind of exposure.
- 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 ultraviolet radiation (200nm to 315 nm) for any exposure time or "blue light" visible radiation (400nm to 550nm) when exposures are longer than 10 seconds.

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

Photobiological spectral domain	Effects on the eye	Effects on the skin
Ultraviolet 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

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## 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).

Standard combiner models either belong to class 3B or class 4.

- Class 3B laser sources: laser products that are normally hazardous when intraocular beam 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 intraocular beam 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.

Please refer to the Manufacturing Test Report (MTR) of your product for detailed information about the laser classification of your combiner.

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.

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## SAFETY GUIDELINES

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

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

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

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## 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.

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

The combiner, in its Plug-and-Play version, complies with all the requirements of the European Laser Safety Standard 60825-1, dated May 2014, and with US FDA CFR 1040.10 and 1040.11, except for deviations pursuant to Laser Notice N° 56, dated May 19, 2019. (Laser Notice No. 56).

The combiner, in its “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.

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## 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 combiners

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## LABELLING (ADVISORY LABELS)

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.

See the following paragraph, “Labels on the product”.

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## APERTURE LOCATION

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

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## REMOTE INTERLOCK

This function is usually used in conjunction with a door or a panel in order to control the access to the irradiated area. The combiner features the remote interlock from a dedicated socket on the rear panel (refer to chapter 3-2, “Instrument tour”). The laser emission is disabled as long as both terminals of the connector are not electrically connected.

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## ACTUATED KEY MASTER CONTROL

The combiner is provided with an actuated key master control on its remote control (refer to chapter 2-4, “Instrument tour”). This lock and key control the emission. The laser emission is not possible when the key is absent from the lock, or when in “OFF” position. The key is removable only when in “OFF” position.

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## EMISSION WARNING INDICATOR

Combiner controllers are provided with an emission indicator located on the remote control (refer to chapter 2-4, “Instrument tour”). 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.

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## OPTICAL SHUTTER

Mechanical shutters, located at each output aperture of the combiner, allows for a complete extinction of the beam.

## INTERLOCKED PANEL FOR MAINTENANCE

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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 Labels on the product

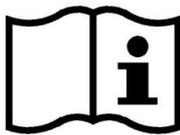
Labels on the casing inform about:

- Personal and laser safety,
- Product and environment safety,
- Identification of the product

Do not remove nor tear these labels.

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### LABELS REGARDING PRODUCT AND ENVIRONMENT SAFETY



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



Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its service life.

For more information, refer to chapter 5-6, "Disposal".



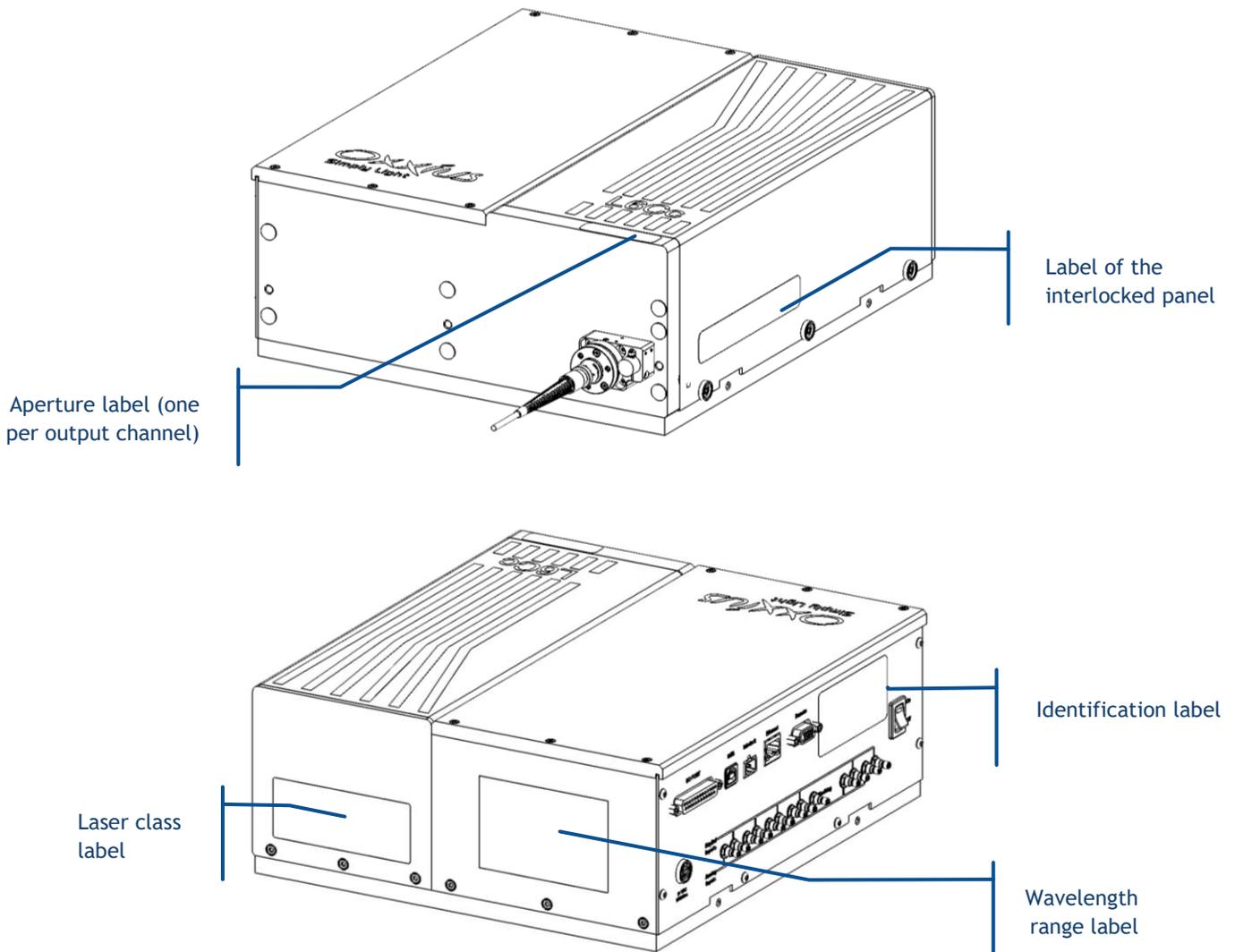
 This pictogram stands for "direct current".

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### LABELS REGARDING LASER SAFETY

The labels present on the laser head inform about the laser class, the laser aperture location and the emission characteristics. Refer to the following figures to locate these labels on the combiner.

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



LASER APERTURE LABEL



This label indicates the aperture from where the laser emission will propagate. There is one label aside each aperture.

LASER CLASS LABEL



This label indicates the class of the combiner as a laser source, and warns about the potential hazards in case of exposure to the radiation.



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



This pictogram urges the user to avoid any unprotected ocular contact with the beam



This pictogram urges the user to avoid any incidence of the beam over his or her unprotected body.

### LASER WAVELENGTH LABEL

Wavelength emitted	Maximum power
405 nm ...	120 mW
488 nm ...	240 mW
532 nm ...	350 mW
638 nm ...	120 mW

Complies with IEC 60825-1 Ed.3, 2014-05, and US FDA 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

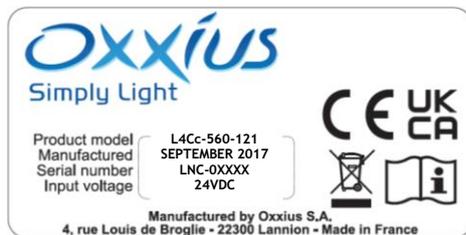
This label indicates what are the accessible wavelengths, and their respective powers. This power is written as the maximum value the user can have access to during operation or maintenance, it is therefore expected to be a larger value than the nominal power of the laser. This label also indicates the compliance of the combiner with the main laser safety standards (IEC 60825-1 and US FDA CFR 1040.10, 1040.11).

### LABEL OF THE INTERLOCKED PANEL

**DANGER - CLASS 4 LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED  
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION**

This label indicates the nature and the class of the radiation that can be accessed to once the maintenance panel is removed and the interlocks are defeated.

### IDENTIFICATION LABEL



This label indicates the product model, its serial number, its month and year of manufacture.

## 2. PREFACE

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### THE OXXIUS LASER COMBINER

Oxxius laser combiner is a platform that embeds several sources and combines them in a single output. These laser sources can be either Laserboxx models from Oxxius, or models from third-party suppliers.

- The L4Cc combiner can house up to four laser sources and two acousto-optic modulators
- The L6Cc combiner can house up to six laser sources and two acousto-optic modulators

The output beam can be available either in free space, or delivered through one or several optical fibers.

The acousto-optic modulators (or “AOM”) are used to modulate the output of fixed-power laser sources, which is typically the case of the diode-pumped solid-state (or “DPSS”) lasers.

This platform can feature other optional components or modules for additional functionalities:

- “clean-up” filters (OPT-CLUP)
- modules for switching the output beam between several channels (MDL-FLPM and MDL-FSTM)
- modules for splitting the output beam to several channels (MDL-MDUAL and MDL-SPLIT)
- ... and so on

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

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

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### PLUG-AND-PLAY AND “OEM” VERSIONS

The combiners exist in two versions:

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

## 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 combiner is integrated must comply with the laser safety standards listed in section "Warranty and certification".

Oxxius shall bear no responsibility for a lack of compliance with the applicable safety standards or local regulations, in the event where a plug-and-play combiner would be used without its dedicated remote control.

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## INTENDED USE

The L4Cc and L6Cc combiner are intended for delivering optical signals in industrial, and laboratory environments. Use the product only for its designated purpose. Observe the operating conditions and performance limits stated in the data sheet.

# 3. GETTING STARTED

## 3-1 Preparing for use

Please use the following information when setting up the instrument for the first time, or when changing its operating site.

### OPERATING SITE

The combiner should be unpacked and installed in an area satisfying the following conditions:

- a dust-free area,
- an area free from vibrations
- an area protected from large temperature variations (for example under the flow of an air conditioner)

For information on environmental conditions such as ambient temperature and humidity, refer to “Operating site” on section 1.

### ELECTROMAGNETIC COMPATIBILITY CLASS

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the L4Cc or L6Ccc combiners is “class A”. Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments. If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

### MECHANICAL AND THERMAL CONSIDERATIONS

The combiner generates some heat while in operation. Refer to the following cases depending on your requirements.

### COMBINER MOUNTED ON A STANDARD OXXIUS HEATSINK

The laser head can be fitted with an optional heatsink (ACX-HTSK-L4CC or ACX-HTSK-L6CC). These accessories ensure a sufficient dissipation while maintaining the laser head at a fixed temperature, thus improving its overall stability.

Place the product on a stable, flat and level surface. Ensure that the surface can support the weight of the product. For information on the weight, see the data sheet.

### CAUTION



- Do not apply a shearing effort on the feet, as it might damage them.
- The top surface is not meant for stacking. Do not stack another product on top of the combiner.

## NOTICE



Overheating can impair the product's operation. Prevent overheating as follows:

- Keep a minimum distance of 10 cm between the fan openings of the heatsink and any object in the vicinity.
- Do not place the laser head next to heat-generating equipment

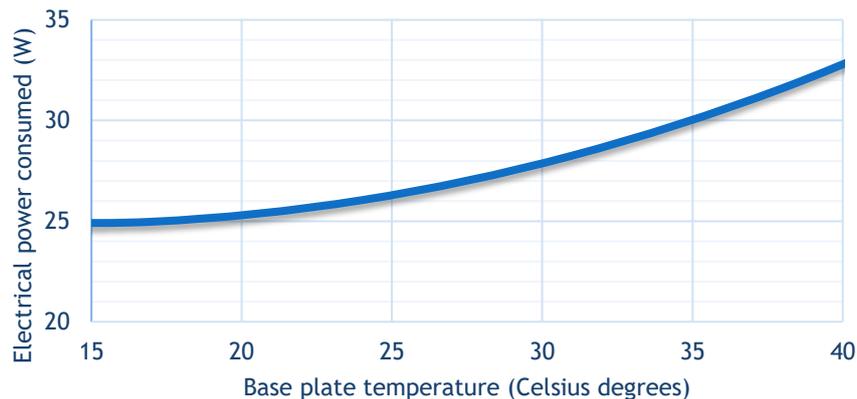
### COMBINER FIXED ON A HEAT-DISSIPATING SUPPORT

The laser head can be fixed to a flat base, provided that heat dissipation is effective through it. An optical table or a milled baseplate typically meets these requirements.

Refer to chapter 7-5 for detailed drawings of the laser head. L-shaped flanges are provided with M6 screws to fix the combiner to a 1-inch or 25-mm pitch grid.

The amount of heat released is sharply increasing as the temperature of the laser head is itself increasing. As an illustration, here is the electrical power consumed by a typical combiner against the temperature of its base plate:

Figure 3-1: Power consumption of a typical L4C combiner (405nm, 488nm, 561nm, 640nm, total optical power: 400mW)



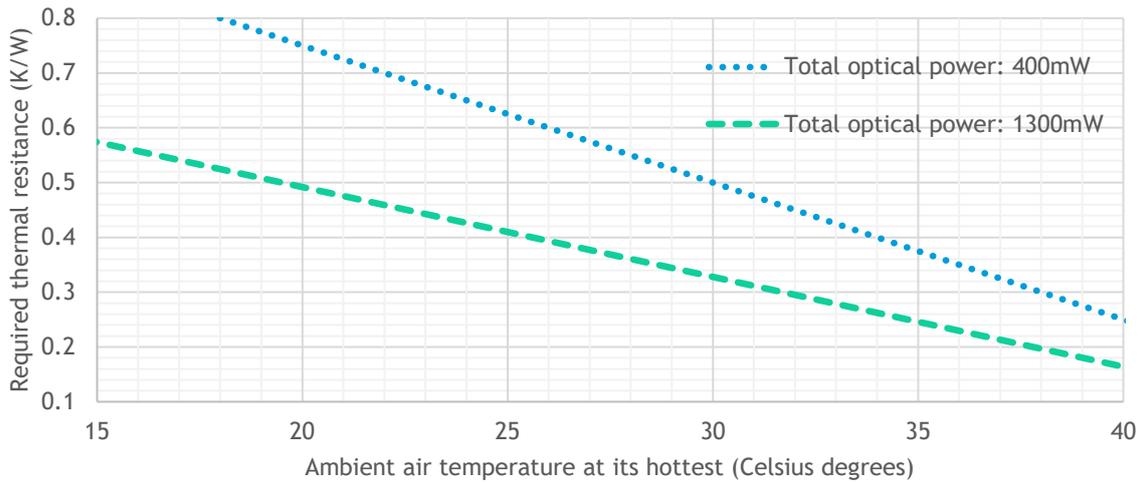
Noticeable features of this characteristic are:

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

For those reasons, the supporting medium must ensure a proper dissipation of the generated heat. This is the purpose of the standard heatsinks described in the previous paragraph.

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

Figure 3-2: Typical power consumption of a typical L4Cc combiners (405nm, 488nm, 561nm+AOM, 640nm)



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

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#### RACK-MOUNTED COMBINER

The combiner and its accessories can be installed in a 19-inches rack using a rack adapter kit, such as the ACX-RACK-L4CC. If you mount product in a rack, ensure that the rack has a sufficient load capacity. Observe the specifications of the rack manufacturer.

Please contact your local representative to obtain the compatible references and the mass of your combiner.

#### ABOUT OPTICAL FIBERS

A specific attention is required with fiber optic patch cables, which should not, under any circumstances, be bent nor receive mechanical damage (shear stress, punching, etc.). An optical fiber is made of glass and is a fragile component. The user is required to handle the patch cable and their optical connectors with care, as well as to have the necessary tools and knowledge to inspect and clean the end tip of the optical connector. These tools are:

- A specific microscope to inspect the end tip of the fiber. Oxixus recommends using a 200x magnification microscope, such as the “FS201” available from [www.thorlabs.com](http://www.thorlabs.com)
- Some consumables to clean the optical connectors. Oxixus recommends using lint-free wiping material, such as the “type A” CLETOP tools available from NTT-AT.

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#### LIFTING AND CARRYING

Refer to “Lifting and carrying the instrument” on section 1.

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#### UNPACKING AND INSTALLING

1. Unpack the product carefully.

2. Retain the original packing material. Use it when transporting or shipping the product later.
  3. Using the delivery notes, and the following table 3-1, check the equipment for completeness.
  4. Check the equipment for damage.
- If the delivery is incomplete or equipment is damaged, contact your local representative.

Table 3-3: Packing list and accessories of the laser combiner, plug-and-play version

Name	Quantity
Laser head (laser sources included)	1
Remote control	1
Country-specific power cord	1
USB cable (“A to B” type)	1
Laser emission key for the remote control	2
Mating connector (short-circuit) for the safety interlock	1
Mating connector for the I/O port (for shutter arming)	1
Angle brackets and M6 x 10mm fixing screws	4
USB Flash drive	1
Printed Manufacturing Test Report	1
This user manual	1

## 3-2 Instrument tour

### LASER HEAD

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

Figure 3-4: Front view of the laser head of the L4Cc combiner (free space output)

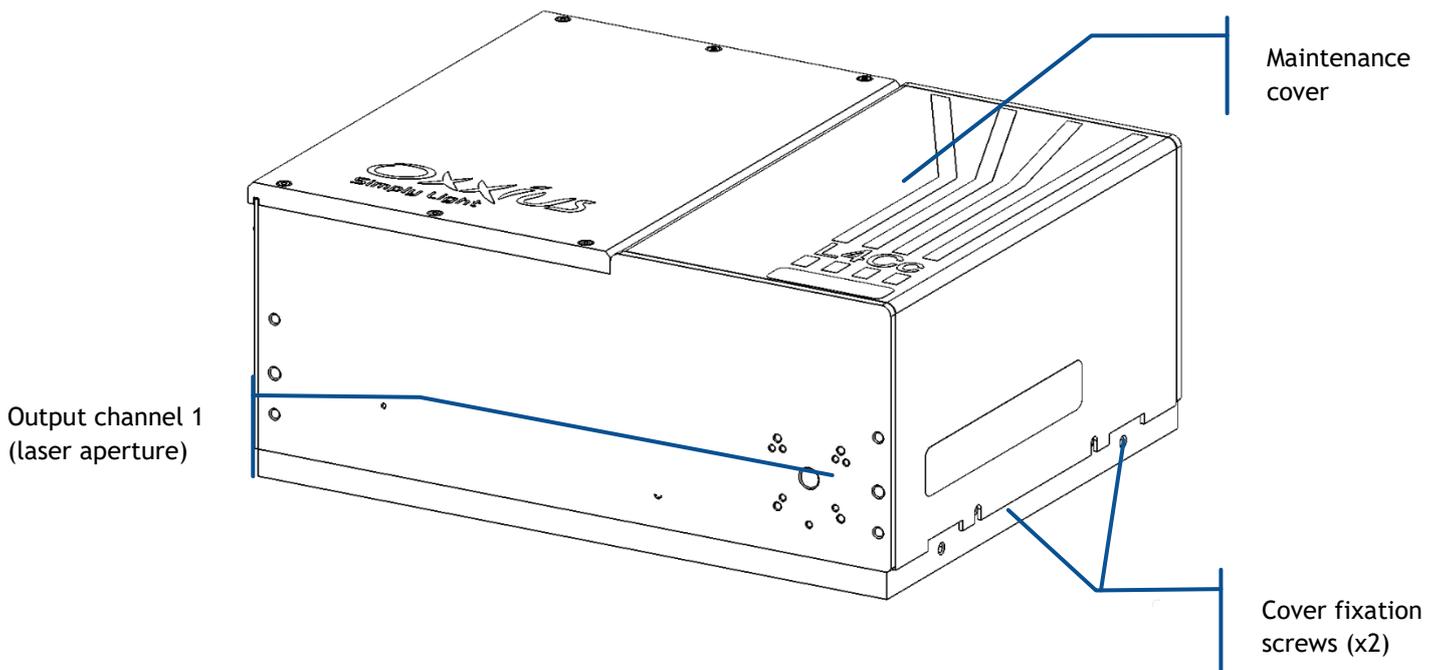


Figure 3-5: Detailed output channel with an optional fiber coupling system

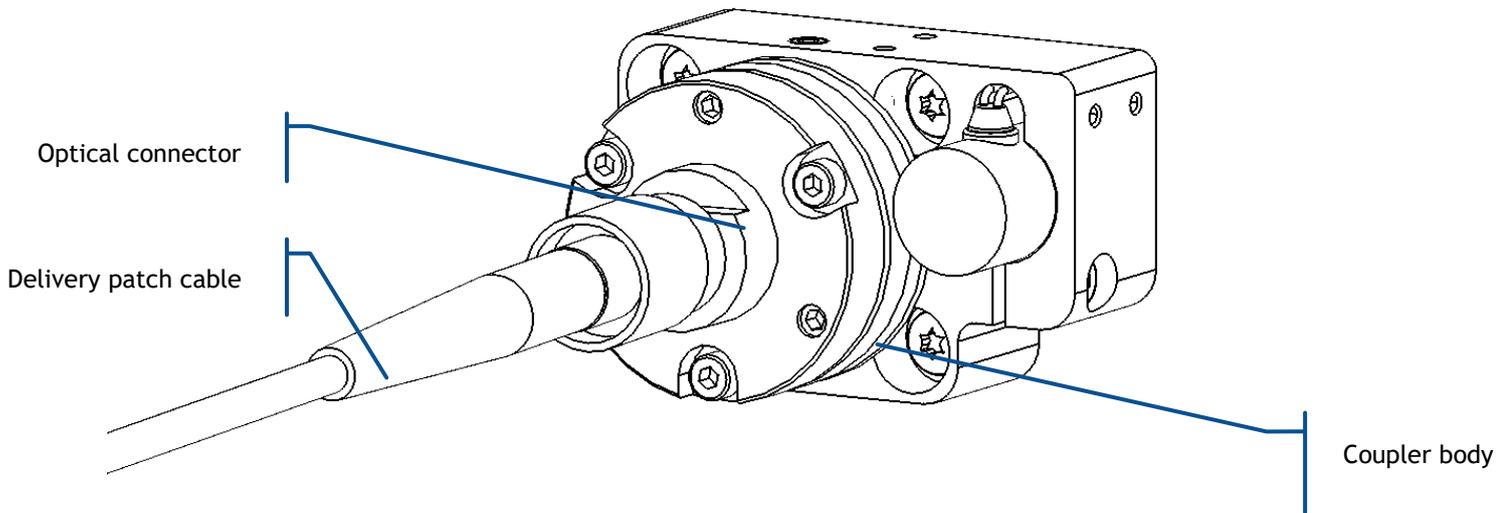
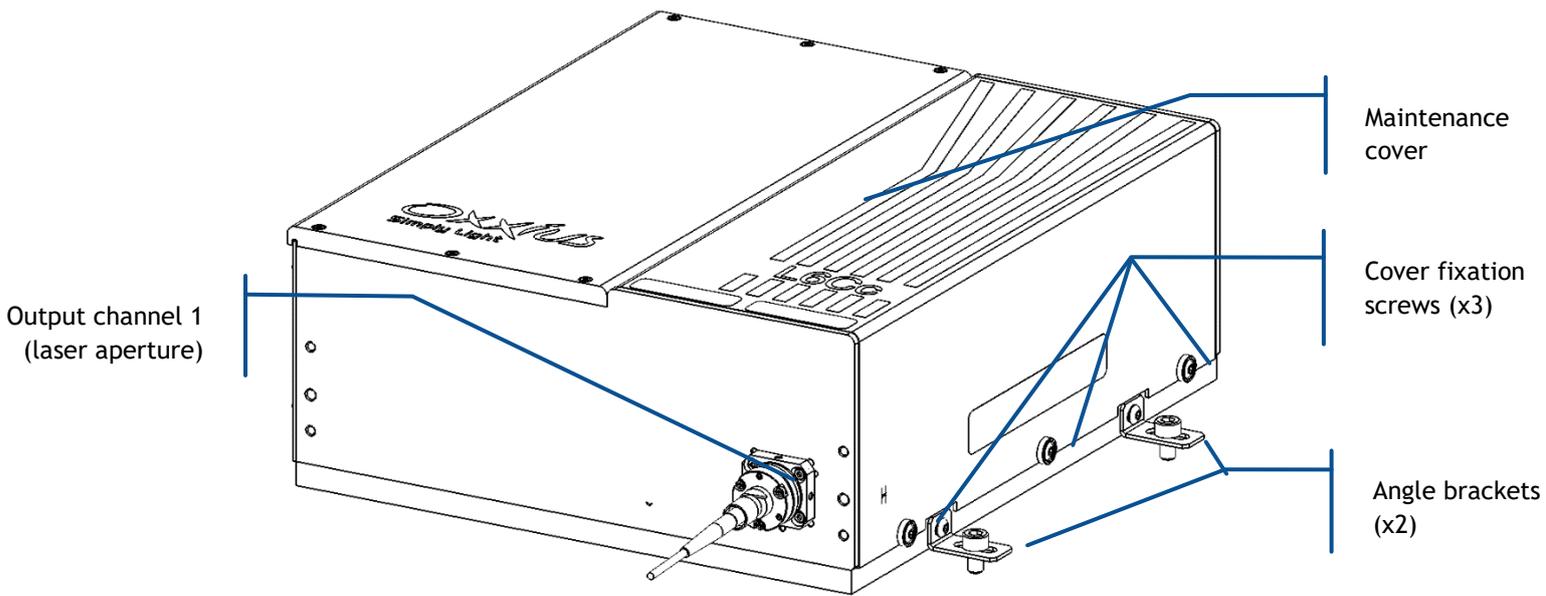


Figure 3-6: Front view of the laser head of the L6Cc combiner (with a fiber coupling system)

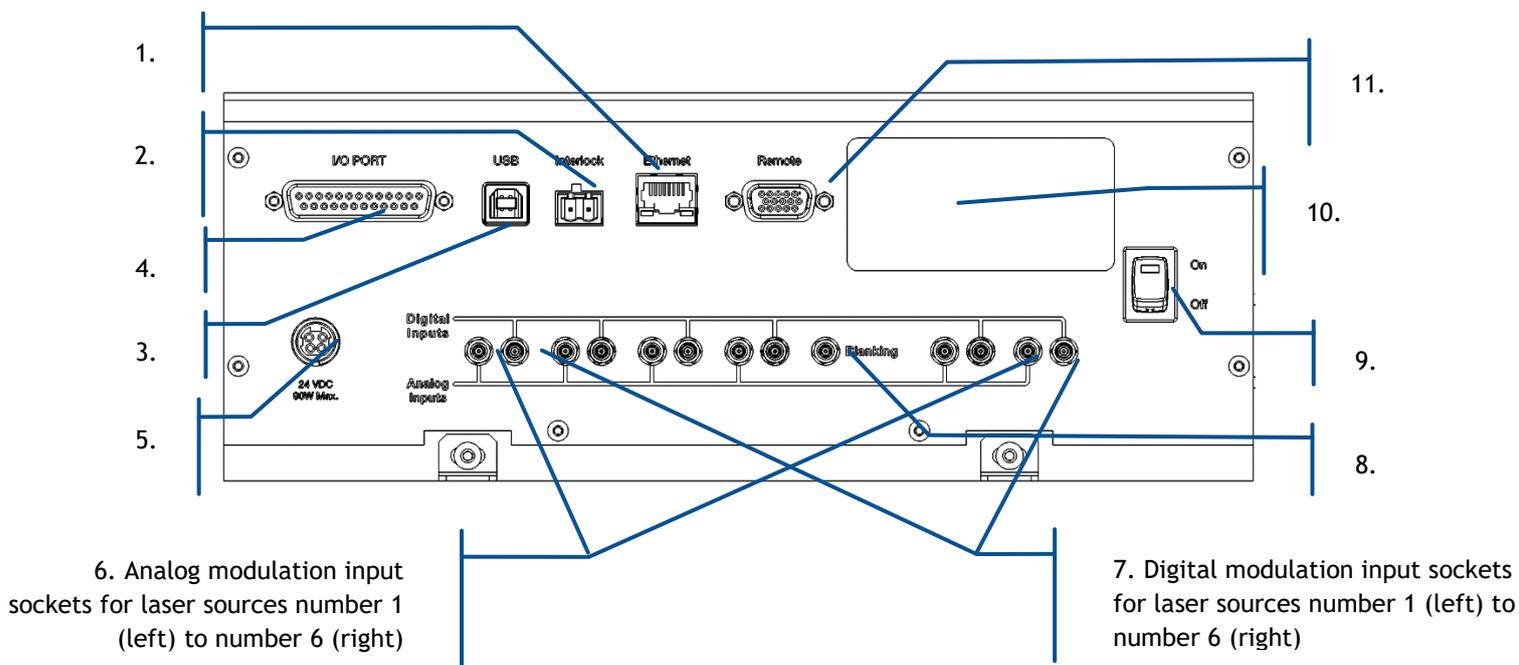


The following elements are accessible to the user:

- **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. A safety mechanism halts the laser emission when this cover is opened.
- **Cover fixation screws:** these screws are holding the cover onto the base plate.
- **Output channel:** the combined laser beams are concentrated at this aperture and possibly transmitted into a delivery fiber. It consists of the following elements:

- **Optical shutter:** When activated, this device is used to prevent any light from being released out from the output channel. It is driven by either electrical signals or software commands
- **Fiber coupling system (option):** This system is designed to release the optical output into a delivery fiber. It is composed of:
  - **The coupler,** which focusses the laser beams into the optical fiber
  - **The optical connector,** used to lock the optical fiber in position into the fiber coupler
  - **The optical patch cable:** this removable component holds and protects the delivery fiber.
- **Rear and front angle brackets:** the combiner can be fixed to a supporting base using these brackets.

Figure 3-7: Rear panel of the L6Cc combiner



The following elements are accessible from the rear panel:

1. **Ethernet:** 8-pin, RJ-45 socket to connect the combiner to a Local Area Network (LAN), based on either 10 or 100BASE-T Ethernet. The linking cable must be shorter than 100 meters. The use of a category 5 cable is recommended.
2. **Interlock:** 2-pin socket used to connect the combiner to your own remote interlock circuit. Refer to section 1, “Safety information”, for more information concerning the remote interlock.
3. **USB 2.0 type A interface** to control or monitor the combiner using a personal computer. The required cable is a standard “USB A to B” cable, with a length not exceeding 3 meters. Refer to the following chapter for the procedure detailing the software installation on a host computer.

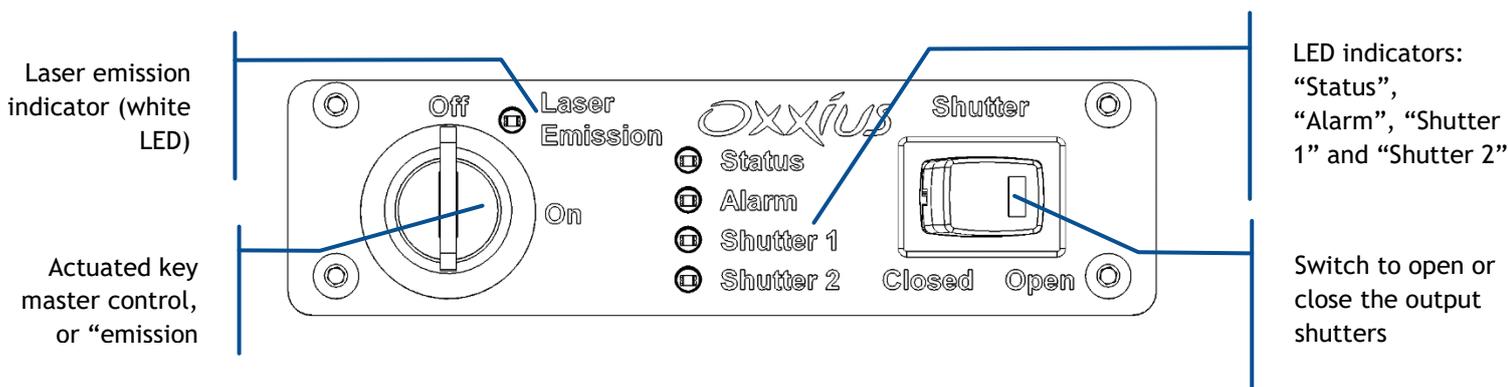
4. **I/O port:** 25-pin DSub socket used to access to miscellaneous input and output functions of the combiner by applying appropriate electrical signals. The connecting cable can be a non-shielded cable, but with a length not exceeding 3 meters. Refer to chapter 3.3, “How to configure the combiner” for a detailed description of the accessible functions.
5. **Supply voltage socket:** Input socket for the power supply.
6. **Analog input sockets:** These inputs are used to control the optical power by applying an analog voltage. Refer to section 4, “Advanced operation” for detailed information, and to the product specifications of each source concerning the modulation characteristics. The L4Cc model has four sockets, while the L6Cc model has six of them.
7. **Digital input sockets:** These inputs are used to modulate the optical power on and off by applying a digital signal (0V or 5V). Refer to section 4, “Advanced operation” for detailed information, and to the product specifications of each source concerning the modulation characteristics. The L4Cc model has four sockets, while the L6Cc model has six of them.
8. **Blanking:** This is used to activate the blanking function, shutting down all the laser sources at once.
9. This is the main switch to power on the combiner
10. This label specifies the model, serial number, manufacturing date and supply voltage of the unit.
11. **Remote:** 15-pin DSub socket to connect the remote control to this socket.

---

## REMOTE CONTROL

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

Figure 3-8: Front panel of remote control



- **Actuated key master control:** Also referred as the “Emission key”. A class 3B or class 4 laser system must incorporate a key-operated control. The key is removable and laser radiation is not accessible when the key is removed. When the unit is ready, turning the key on will start the laser emission.
- **Laser emission indicator:** This indicator is a light-emitting diode (LED) which lights in solid white when the key control is switched on, indicating that the emission is enabled. It is located on the remote control so that it can be seen without requiring the user to face the laser radiation, and its white color is meant to be visible through most protective eyewear. In accordance with CDRH

recommendations, this indicator blinks five seconds prior to the actual laser emission, in order to warn about the imminent hazard.

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

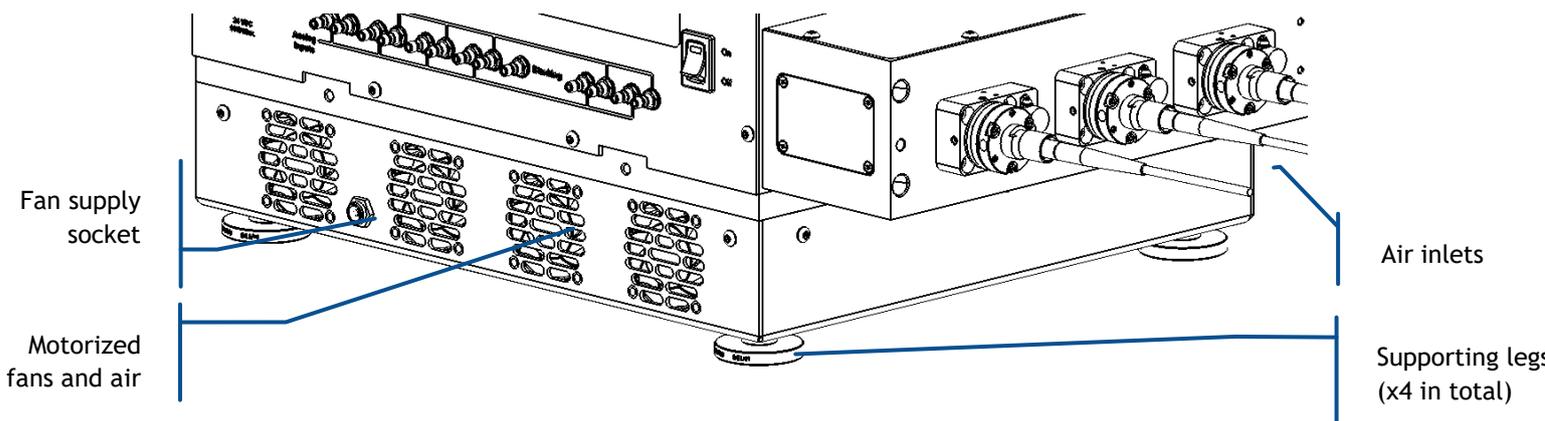
- **“Status” indicator:** This indicator is a green LED indicating the status of the combiner:
  - o It is unlit when none of the laser sources is enabled for emission,
  - o It is lit solid when all the sources that are enabled for emission are emitting and stabilized,
  - o It is blinking when, amongst the sources that are enabled for emission, at least one of them is under stabilization
- **“Alarm” indicator:** This indicator is a red LED that, when lit solid, indicates either the presence of an alarm on one the laser sources, or that the interlock circuit is open.
- **“Shutter 1” and “Shutter 2” indicators:** Each of these indicators is a white LED indicating the status of the corresponding shutters. The LED is lit when the shutter is open, unlit when it is closed.
- **Shutter switch and indicator:** When this switch is on its “Closed” position, all the output shutters are forced closed, regardless of their command signal. The LED indicator is lit when this shutter is on its “Open” position.

---

## HEATSINK OPTION (ACX-HTSK-L4CC OR ACX-HTSK-L6CC)

An optional heatsink is available to ensure a stable operation of the laser head.

Figure 3-9: Rear view of the heatsink



Here are the accessible elements on the heatsink:

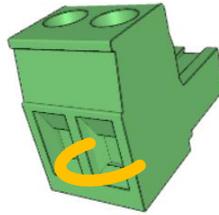
- **Air inlet and outlet:** ambient air will flow through these apertures and transfer the excess heat. Do not block these apertures and leave at least 5 cm around them to ensure a sufficient air flow.
- **Fan supply socket:** Input for the motorized fan inducing the air flow.
- **Supporting legs:** These legs are used to support the laser bench. Rotate them if you need to adjust their height.

## 3-3 Installation

### SIGNAL CONNECTIONS

- Connect the remote control to the rear panel of the laser head.
- Connect your remote interlock circuit to the “Interlock” pins on the rear panel of the combiner. If you are not using an interlock circuit, use the mating connector (provided) to short-circuit these pins.

Figure 3-10: Mating connector with shunt wire



#### WARNING



Using a shunt wire inside the mating connector will defeat the interlock circuit. As a result, the user will no longer be able to use this interlock circuit as a safeguard against accidental exposure to the laser beam.

- Shutter arming: the I/O port features a specific safety function named the shutter arming circuit, which overrides the other shutter commands. Apply 5V on pins 11 and 12 in order to arm the shutters and allow for their control. Applying 0V to these pins, or leaving them disconnected, will prevent the shutters from opening. Refer to table 4-1 for detailed information about the I/O port. Alternatively, the DB-25 mating connector (provided) can be plugged in order to shunt these pins and keep the shutters armed.

#### WARNING



Using this mating connector will defeat the shutter arming circuit. As a result, the user will no longer be able to use this function as a safeguard against accidental exposure to the laser beam.

- Analog and digital modulation signals, blanking signal: connect your own sources of signals to each of the input sockets. Refer to the test report of the combiner to understand the assignment between the laser sources and their modulation ports.
  - o Voltage range: 0 to +5 Volts
  - o Impedance: 500 Ohms

- Mating connector: SMB male connector. An example of mating assembly can be found under the reference “BPSMBP1.5M174” over <https://ccsukltd.co.uk>

## CONNECTING TO POWER

1. Observe the safety instructions described in section 1, "Safety Information".
2. Plug the output cable of the power supply to the power socket on the rear panel of the combiner. Plug the AC power cable into the AC power connector of the power supply. Only use the AC power cable delivered with the product.



3. Plug the AC power cable into a power outlet with ground contact.

The power supply provided with the combiner have the following characteristics:

	L6Cc or L4Cc combiner
Output voltage	24 Volts ===
Power rating	160 Watts

### WARNING



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

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

Input	Output
Voltage: 100-240 VAC	Voltage: 24 Volts ===
Frequency: 50-60 Hz	Power (minimum): 160 W
Protective ground	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 supplies provided with the plug-and-play L4Cc and L6Cc meet these requirements.

---

## OPTICAL OUTPUT(S)

### DANGER LASER RADIATION HAZARD



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

### CAUTION OPTICAL FEEDBACK



The laser sources composing the combiner can be damaged by optical feedback, especially the LBX models emitting in the red and infrared spectrum.

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

Oxxius recommends his users to take the following precautions when working with the combiner:

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

### FIBER-TERMINATED OUTPUTS:

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

## 3-4 Software suite

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

Oxxius software is compatible with the following operating systems:

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

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

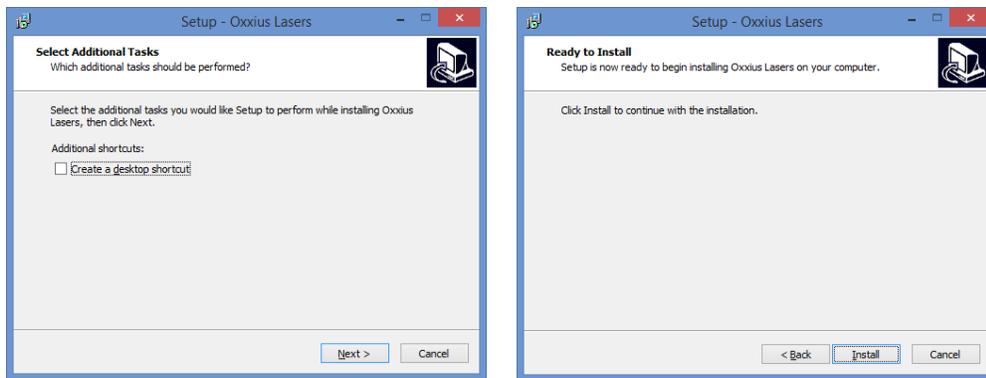
### FIRST STEP: INSTALLING THE COMMAND SOFTWARE

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

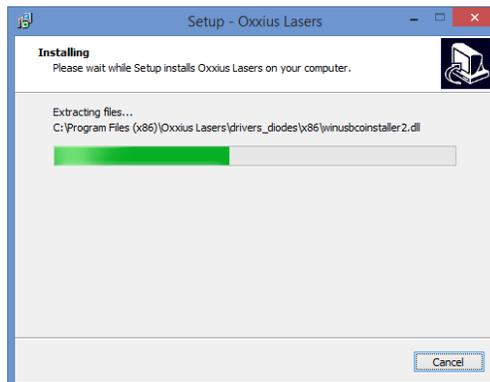
Alternatively, you can download the latest version of our control software from the following URL:

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

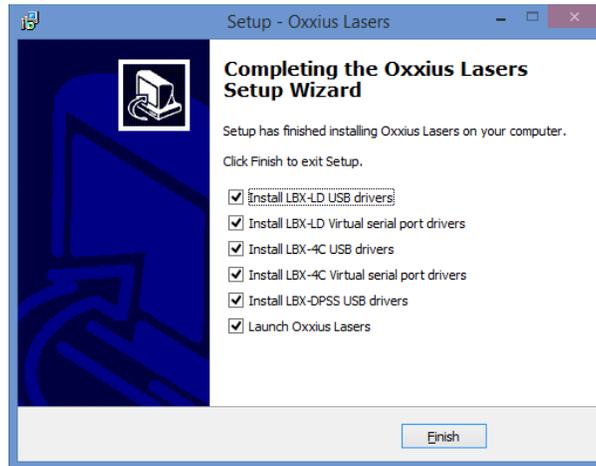
Executing the file “setup.exe” will prompt a standard installation wizard:



Click « Next », then “Install”.



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



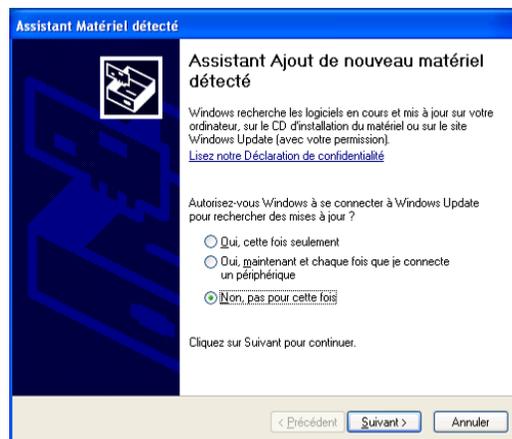
Depending on the operating system of the computer, it might be necessary to restart the computer. A warning dialog box might appear on 64-bit operating systems.

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

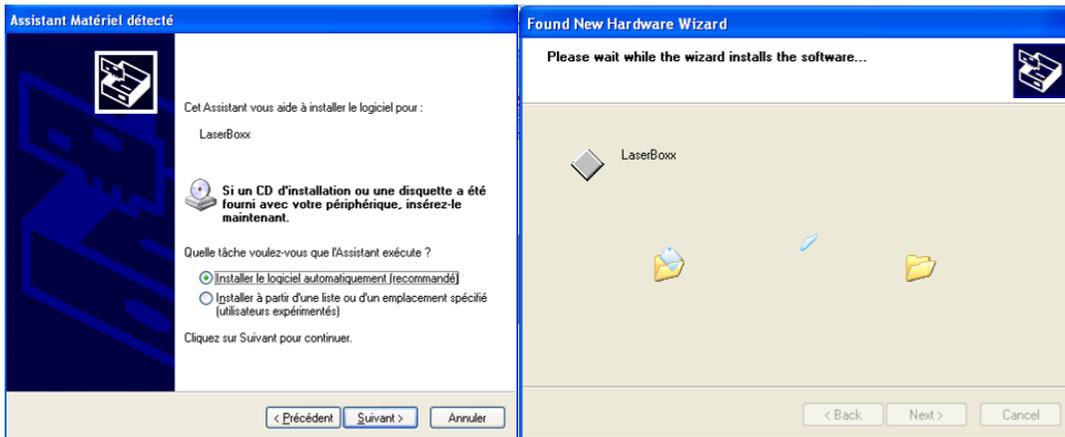
## SECOND STEP: DEVICE INSTALLATION OVER A USB PORT

Using the USB interface of the 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.

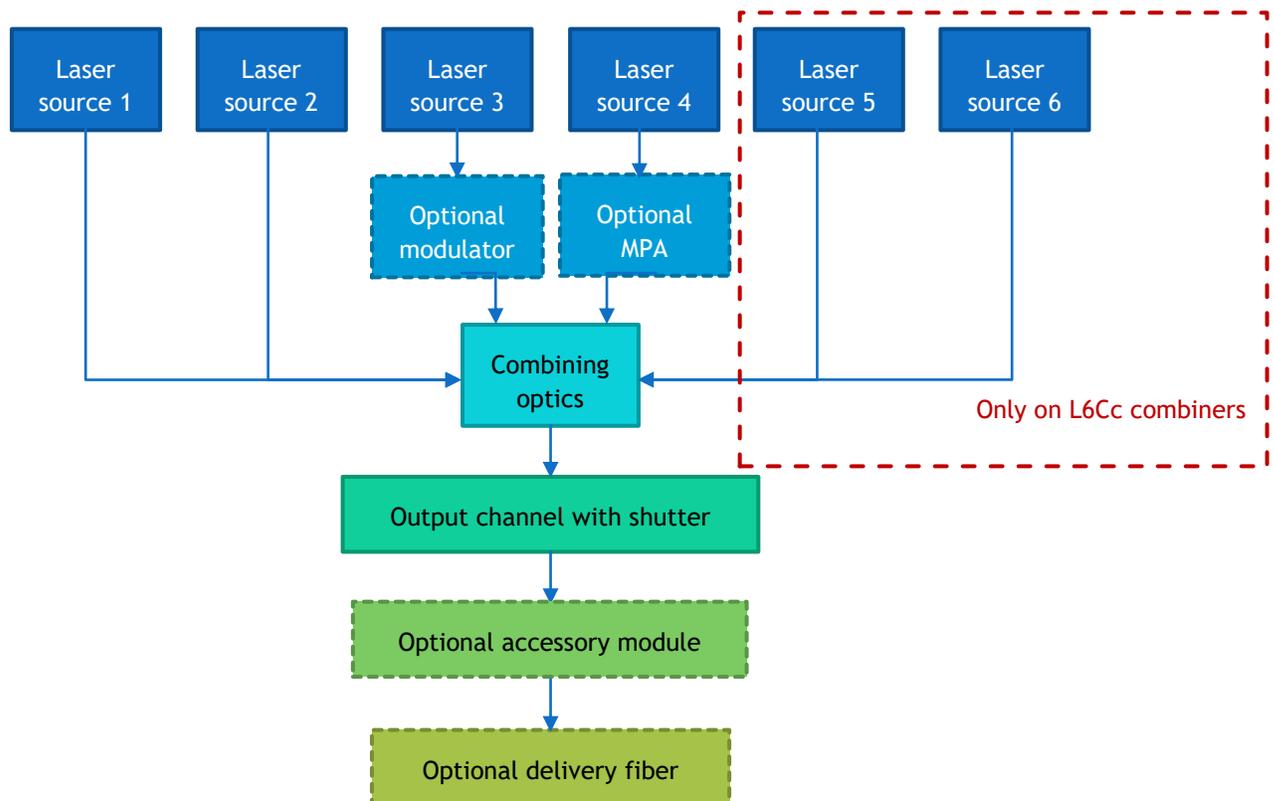
# 4. OPERATING BASICS

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

## 4-1 Principle of operation

The combiner is composed of the following functions:

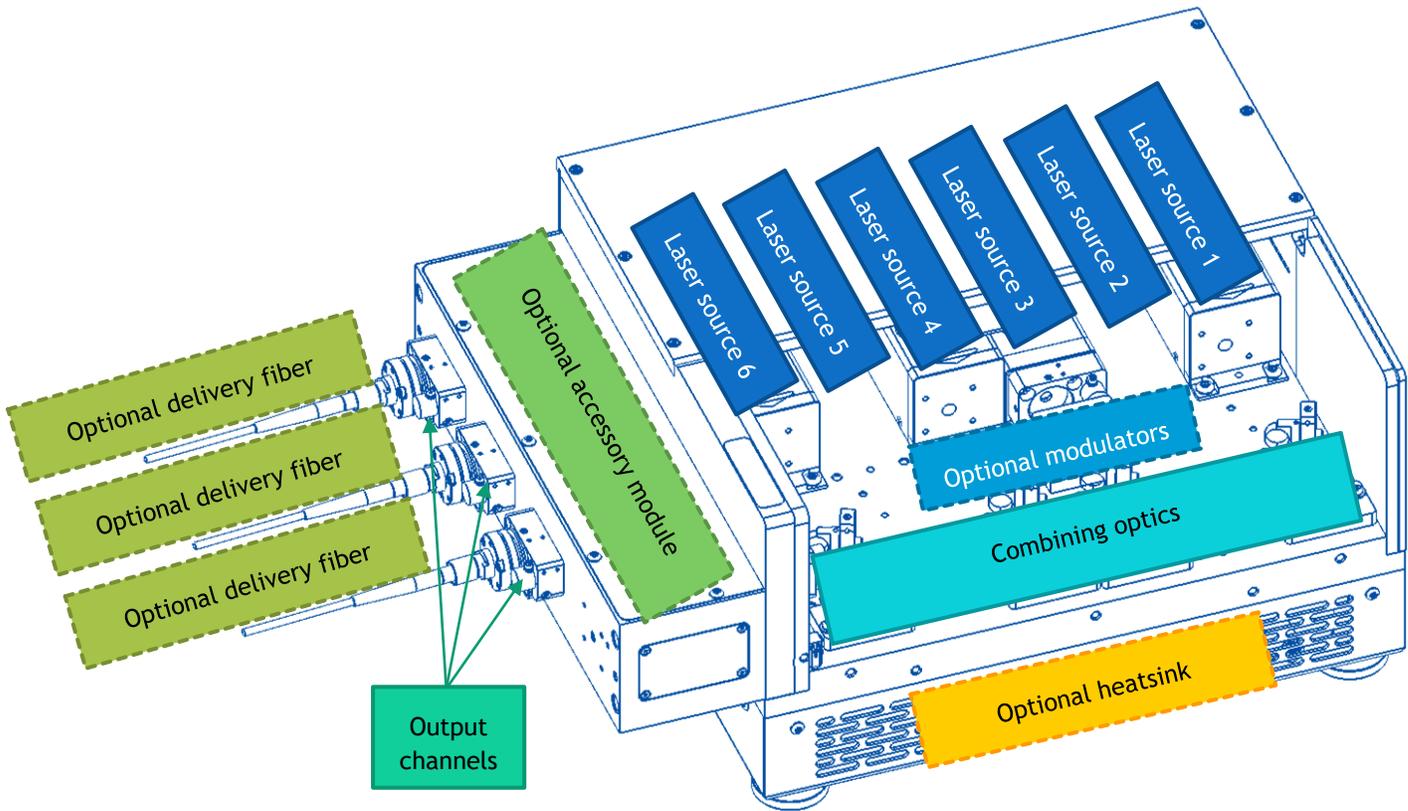
- Each laser source emits its optical output on a separate beam,
- Some of these beams can be modulated or attenuated by some optional components: acousto-optic modulator (AOM) or a motorized power attenuator (MPA),
- The combining optics merge these beams into a single beam geometry, and steers them towards the output channel
- The output channel is fitted with a shutter able to completely block the output light,
- As an option, an optical fiber delivers the combined beams to the far end of a patch cable.



Each of these laser sources can either be:

- A LaserBoxx model (LBX, LCX, LPX, LSX),
- A third-party source (Coherent OBIS™, CNI MGL series, and others)

Each of them can be optionally linked to either an AOM or an MPA for modulation or power adjustment. Here is an example of how each of these components are located inside an L6Cc combiner:



Note that the laser sources are numbered starting from the farthest slot from the exit aperture. Refer to the Manufacturing Test Report of your combiner to locate each laser source.

## 4-2 How to operate the combiner: the essential functions

### NOTE

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

---

## HOW TO POWER UP THE COMBINER

- 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 appropriate security measures relative to laser radiation are enforced (refer to section 1, “Safety Information”), then activate the emission by turning the actuated key master control clockwise on the remote control,

### DANGER

### LASER RADIATION



As soon as the remote interlock is defeated and the emission key is turned on, the laser emission can be released any time from the different output channels.

- 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 or a LPX). The status indicator on the remote-control blinks during this period.
- Past the warm-up period, each laser will start emitting. 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 (refer to the following paragraph “How to activate the shutters”).

### NOTES

- All the laser sources are activated on start-up as per their default setting. In order to turn off these sources, refer to the following paragraphs “Selective deactivation of the laser sources” and “Configuring the combiner”.
- The amount of power emitted by each source depends on its configuration. Refer to “How to set the power levels” below and to the following chapter: “Configuring the combiner”.
- If an error occurs on any of the sources, the alarm indicator on the remote control will be lit in solid red. Use the GUI to identify the cause of this alarm.

---

## HOW TO ACTIVATE THE SHUTTERS

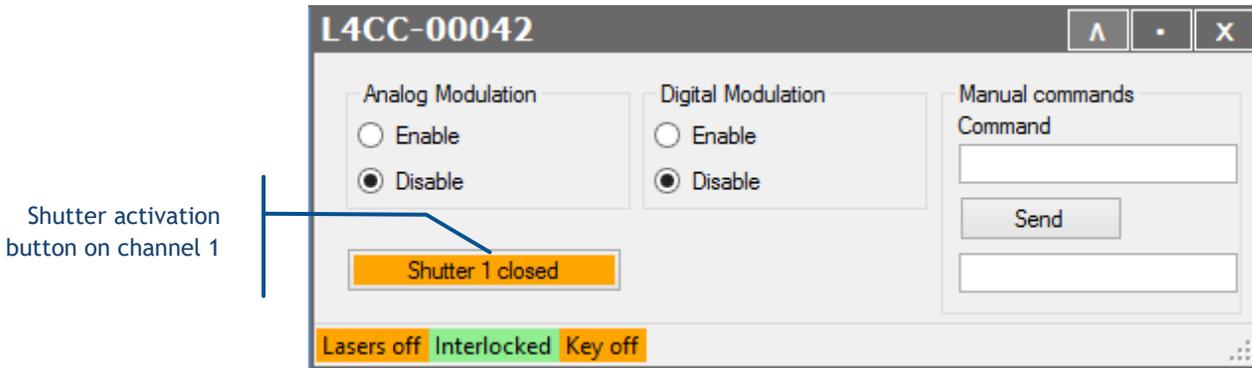
Optical shutters are devices that are inserted on the light path and completely absorb the beam when activated. On a standard configuration, there is one shutter on each of the output channels, in addition to one shutter on each of the LCX laser sources.

## SHUTTERS ON THE OUTPUT CHANNELS

The output channel shutters are driven either the GUI (or software commands), or through the input/output (“I/O”) port (the DB-25 connector at the rear side of the combiner). Please refer to the following chapter, “Configuring the combiner”.

If you are driving the shutter using the GUI software:

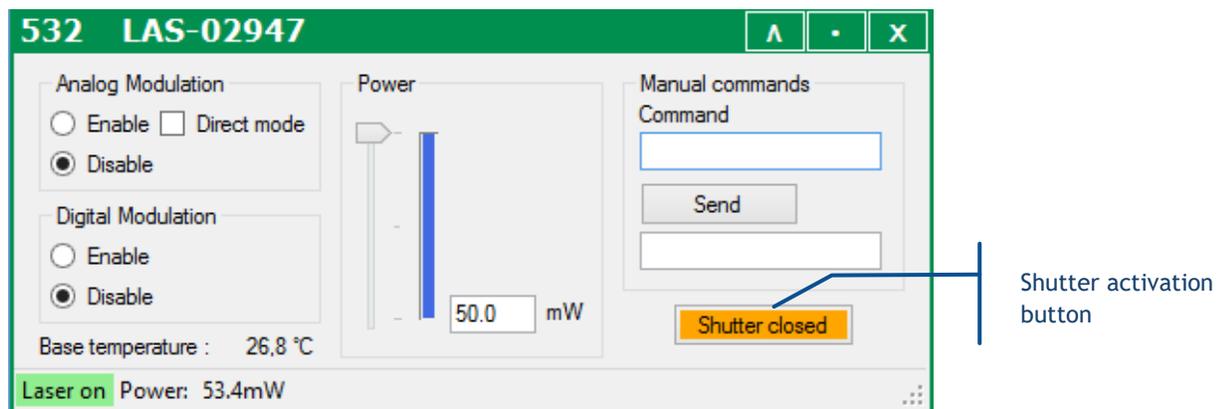
- Open the main panel of the combiner and locate the shutter activation button (as in the picture below)



## SHUTTER ON THE LCX AND LPX SOURCES

LCX and LPX units are set with a shutter in order to a full extinction when required. Note that the shutter remains closed during the start-up sequence, and as long as the emission is not stabilized (“Laser On” state).

- Open the control window of the LCX you need to activate and locate the shutter activation button (as in the picture below)

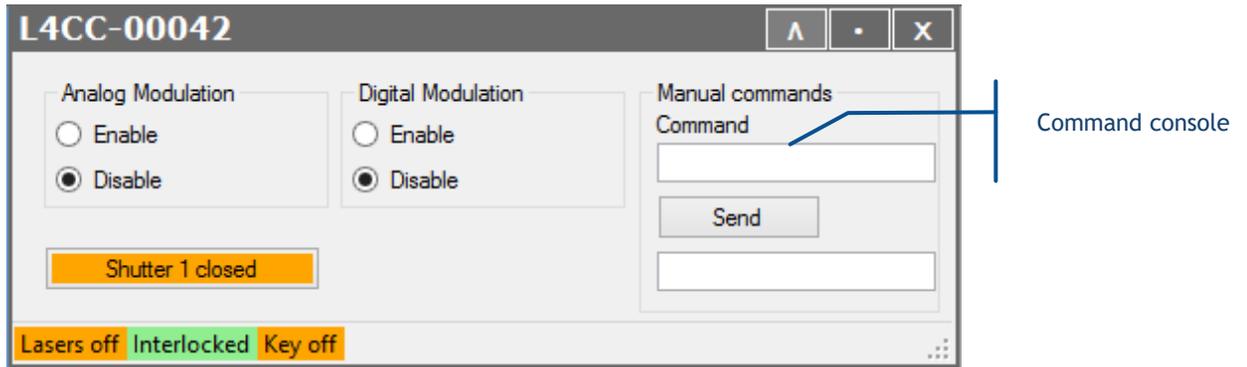


- The button text describes the current states of the shutter. Press the button to modify this state (open or closed).

---

## HOW TO SET THE POWER LEVELS

Using the GUI, open the control window of the combiner, then send the appropriate commands on the console:



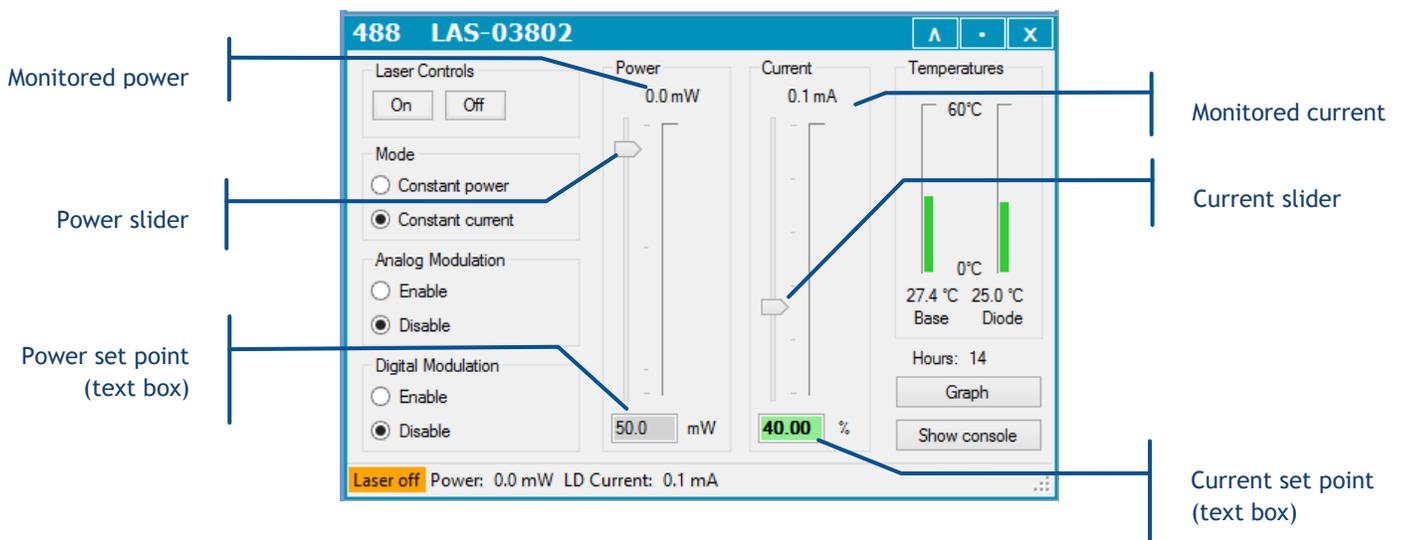
The command is “IPn p”, where n is the number of the concerned laser source (from 1 to 6), and p the percentage of power to set (from 0 to 100, “100” representing the nominal power).

For example:

- “IP1 100” to set 100% of the nominal power on laser source number 1,
- “IP2 0” to set a nil power on laser source number 2,
- “IP4 20” to set 20% of the nominal power laser source number 4

It is also possible to open the control window of the concerned laser source:

- On a LBX laser source:
  - o 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),

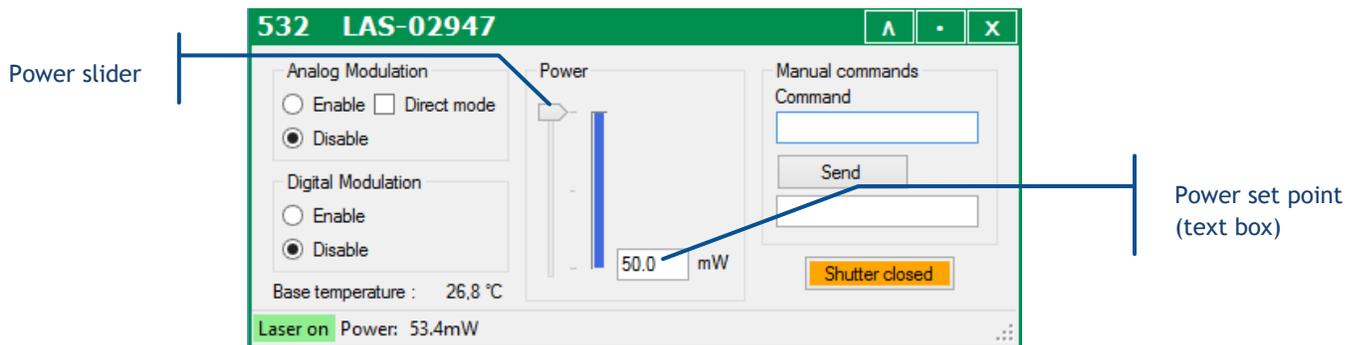


- Click in the text box and type a new power (or current) set point. Validate by pressing the “Enter” key.
- Alternatively, you can click and drag the slider to modify the power (or pump current) set point. This new value will be transcribed into the text box.

- On a LCX (or LPX) laser source:

The power is modified either by an external AOM, by a MPA, or by an optional power adjustment function (named “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. If a modulator is installed, the modification will occur within milliseconds. When working with the power adjustment function, it might take up to 20 seconds for the LCX to reach its new set point.

---

## HOW TO SHUT OFF THE OPTICAL SIGNALS (BLANKING FUNCTION)

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

- Press the “Blanking” switch located on the front panel of the remote control. Note that the visual indicator embedded in this switch is lit when blanking is activated. Similarly, this indicator is unlit when blanking is deactivated (and the sources are emitting).

## WARNING

## BLANKING AND LASER SAFETY



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 combiner output, use either the actuated key master control or the remote interlock to shut off any laser emission.

## SELECTIVE DEACTIVATION OF THE LASER SOURCES

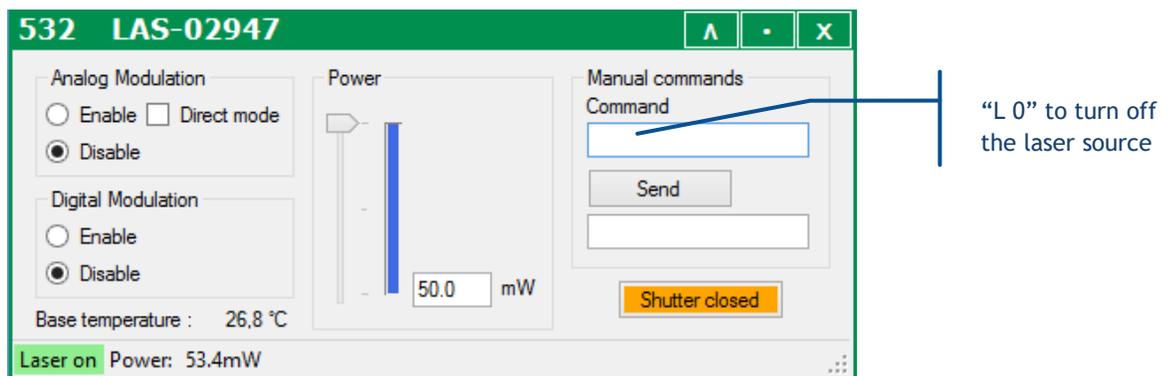
It is possible to deactivate each laser sources to avoid unnecessary power consumption. Using the interface software, open the control window of the laser you wish to turn off, then proceed as follows:

- 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 source 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

## 4-3 How to configure the combiner

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

A complete operation setup should consist in:

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

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

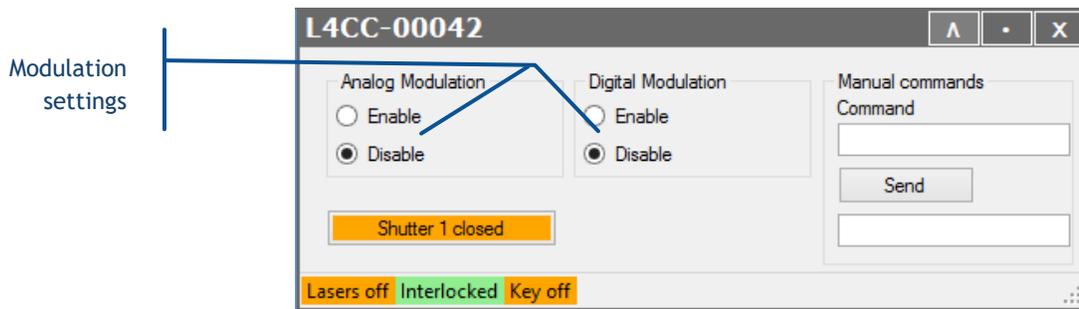
### IMPORTANT CHARACTERISTICS OF THE MODULATION FUNCTIONS

- On LBX laser sources, the analog modulation function can be used either in constant current or in constant power mode. Depending on this selection, 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 paragraph 6-3, "Modulation in detail", for detailed information about these control loops.

- The maximum power available on modulation is determined by the power set point (or the 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:

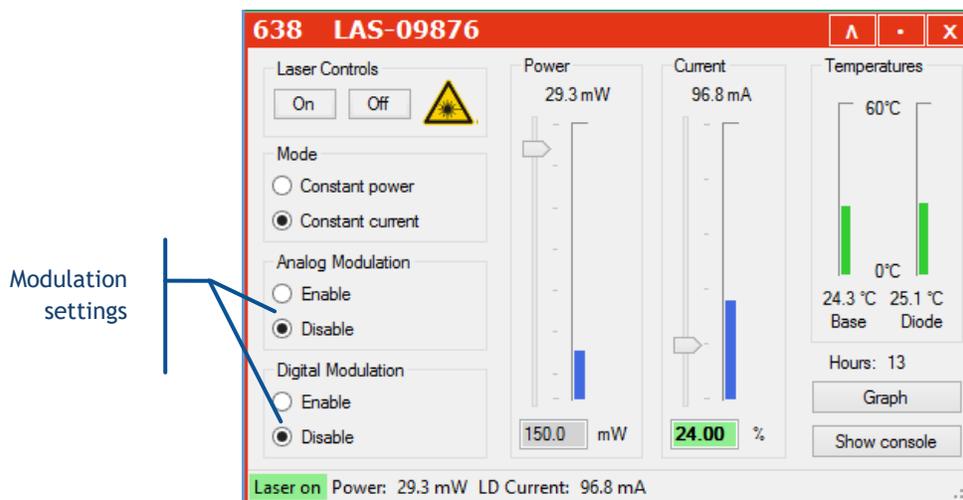
- Open the main panel of the combiner and locate the modulation set boxes (as in the picture below)



- 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.

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

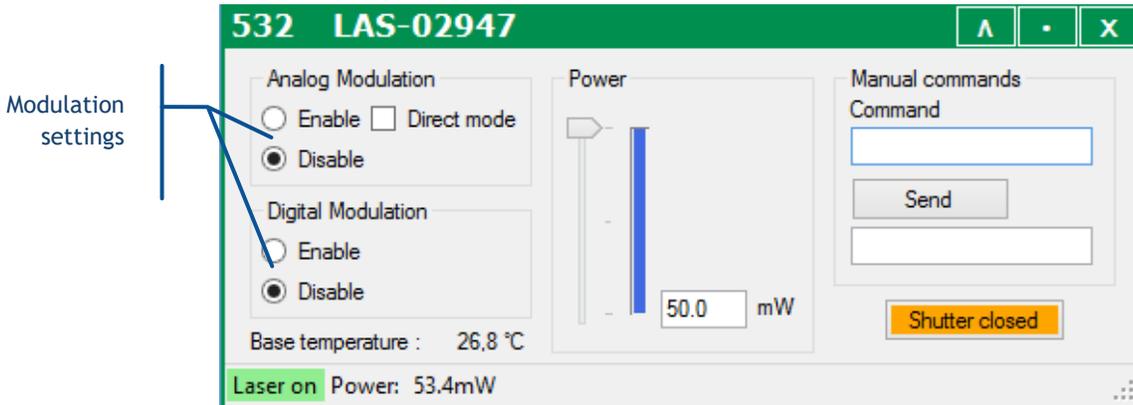
- On LBX laser sources: Open the main panel of this source and locate the modulation set boxes (as in the picture below)



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 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 in order to yield 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.

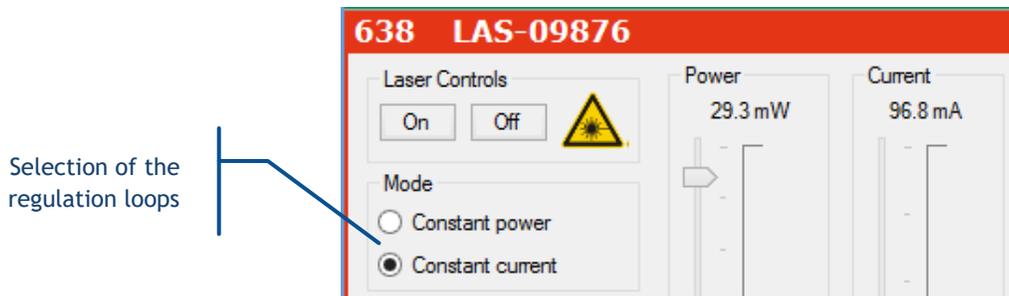
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## HOW TO CONFIGURE THE POWER CONTROL LOOPS

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.



On the OBIS laser source: The control loops are configured with the same set of commands as for the modulation functions. Refer to the preceding paragraph, “Modulation functions”, to learn about these functions.

---

## SELECTIVE ACTIVATION ON START-UP

It is possible to configure whether an individual laser source should start emitting upon start-up (in other words: when the emission key is turned on). To do so, use the software command “SE” in the console of the source you wish to control:

- Enter the command “SE 1” to have the unit emitting on start-up
- Enter the command “SE 0” to prevent the unit from emitting on start-up. Emission will then be available on demand.

---

## INPUT/OUTPUT PORT

This port can be used to drive the laser sources, shutters and miscellaneous components of the combiner. Some of its inputs are configurable; the user can assign them to specific functions.

Here is the pin assignment of this port:

**Table 4-1: Pin assignment of the I/O port**

Pin number	Signal name and function	Direction	Description	Voltage range
1	Programmable input number 1	Input	By default, this input is mapped to “Shutter #1”	0V to +5V
2	Programmable input number 2	Input	By default, 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 is not ready TTL high: Laser is ready
5	Analog input number 1	Input	Equivalent to the analog input number 1 on the rear panel of the 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 default, this input is mapped to “Shutter interlock # 1”	0V to +5V
12	Programmable input number 4	Input	By default, this input is mapped to “Shutter interlock # 2”	0V to +5V
13	Programmable input number 5	Input	By default, this input is mapped to “LCX shutter # 1”	0V to +5V
14	Programmable input number 6	Input	By default, 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

Concerning the programmable inputs number 1 to 7: these inputs can be assigned to functions and operate some components of the combiner (some of which are optional). See the next paragraph, “Configuration software”, to learn more about these functions.

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

## 4-4 Configuration software

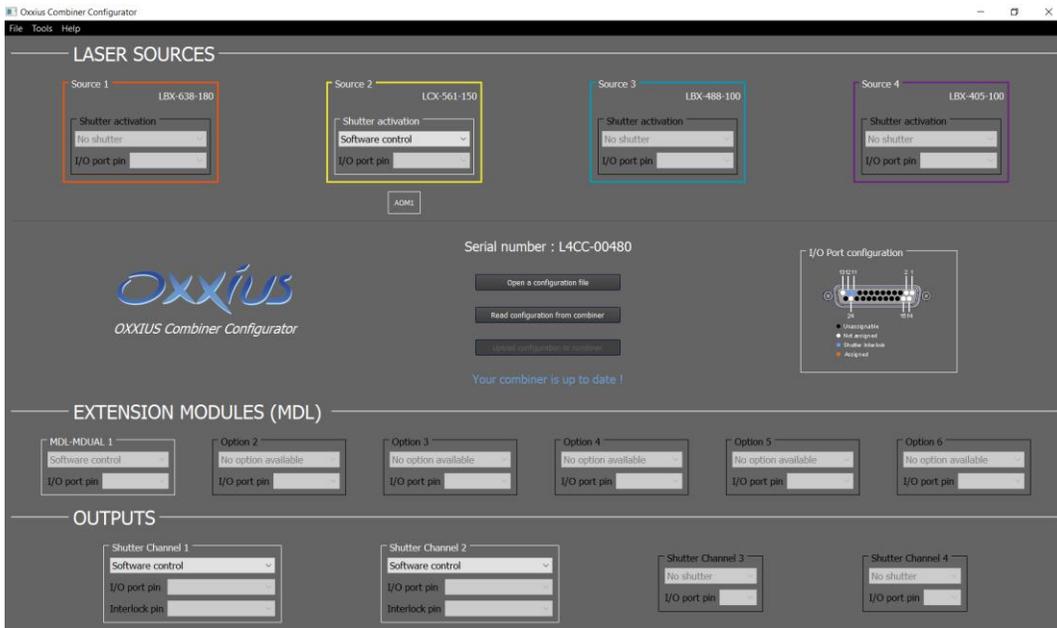
Oxxius Combiner Configurator (“OCC”) is a tool meant to configure the components of a combiner, accessible from the USB memory stick delivered along the combiner.

### RUNNING THE CONTROL PROGRAM

OCC requires a direct link to the combiner, such as the USB link. Please close any program communicating with the combiner before attempting to launch OCC.

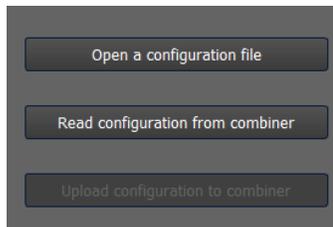
On start-up, OCC attempts to auto-detect the combiner. If successful, the main window should look as in the following figure.

Figure 4-3: OCC main panel



The elements of interest on this panel are:

- The buttons to save the combiner’s configuration, or to load it from a file:



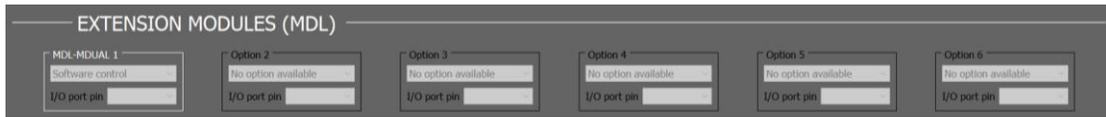
- the serial number of the detected combiner:

Serial number : L4CC-00480

- the laser sources and possibly the shutters and modulators that are attached to them:



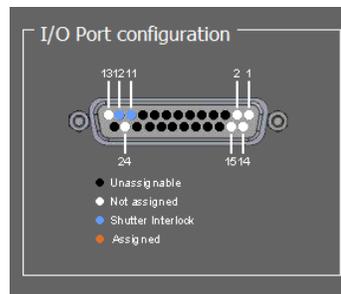
- the optional extension modules:



- the output shutters:



- a diagram summarizing the pins on the I/O port, and their assignment:




---

## SAVING AND LOADING A CONFIGURATION

On start-up, OCC establishes the communication with a linked combiner, retrieves its configuration, then displays it on the main panel. The user can modify this configuration, update it to the combiner, or export it to a text file.

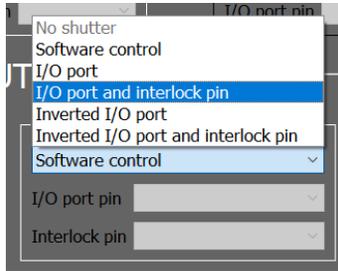
- The button “Read configuration from combiner” updates the main panel according to the current configuration of the combiner.
- The button “Open a configuration file” allows the user to update the panel with a file accessible from the host computer.
- Press the button “Update configuration to combiner” to update the configuration of the combiner with the contents of the main panel

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## MODIFYING THE CONFIGURATION

---

### SHUTTER CONTROL

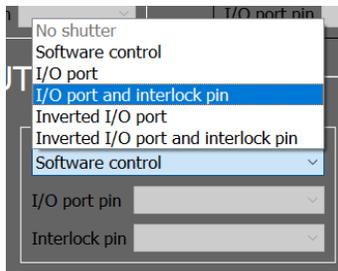


Click on “Shutter activation” and select one of the control sources:

- from software commands, or
- from signal received from the I/O port. The boxes underneath allow the user to select the pin number on the I/O port. The diagram of the I/O port will be updated accordingly.

---

## EXTENSION MODULES



Click on the name of the module that you need to configure, then select one of the control sources:

- from software commands, or
- from signal received from the I/O port. The boxes underneath allow the user to select the pin number on the I/O port. The diagram of the I/O port will be updated accordingly.

## 4-5 Using the control software

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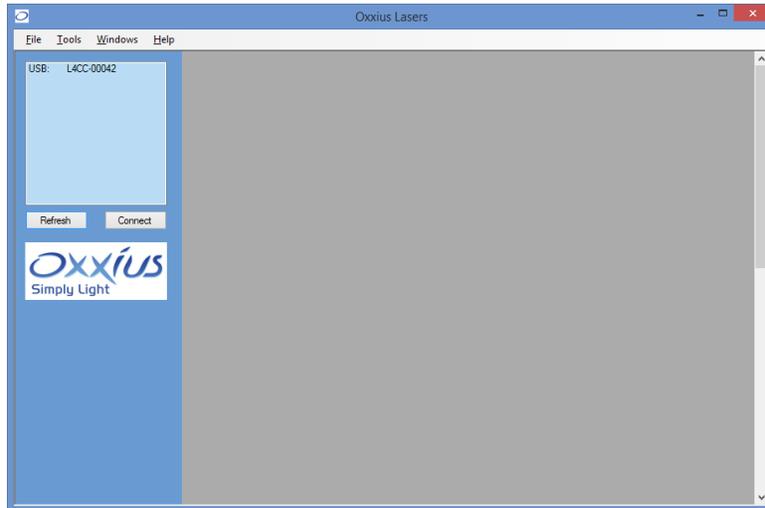
### RUNNING THE CONTROL PROGRAM

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#### DEVICE DETECTION

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

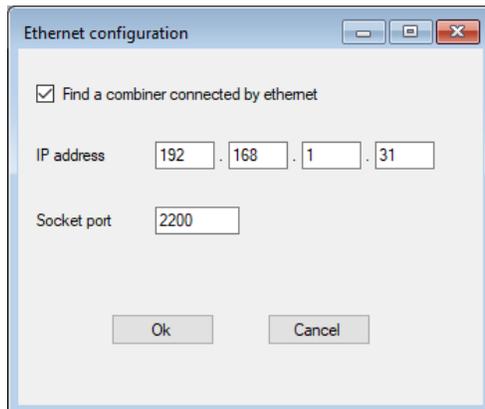
Figure 4-4: “Oxxius laser” start-up window



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### CONFIGURATION FOR AN ETHERNET-BASED COMMUNICATION

Open the configuration menu from the “Tool”/”Ethernet configuration” top menu.



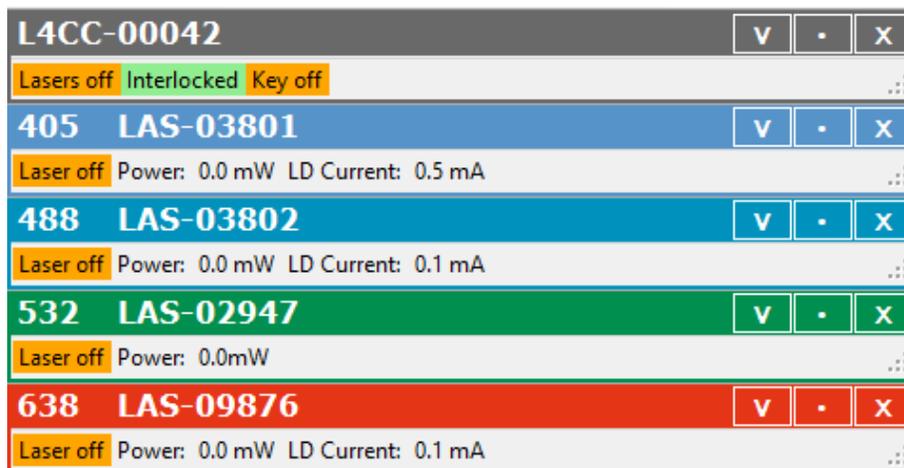
Tick the “Find a combiner...” button, then enter the IP address and socket port of the target combiner. Validate by pressing “OK”; the configuration window will close itself. Click on the “Refresh” button, the combiner should then appear in the list of detected devices.

---

### CONNECTING TO A DETECTED COMBINER

The 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 combiner.

Figure 4-5: Control window for an individual LaserBoxx unit



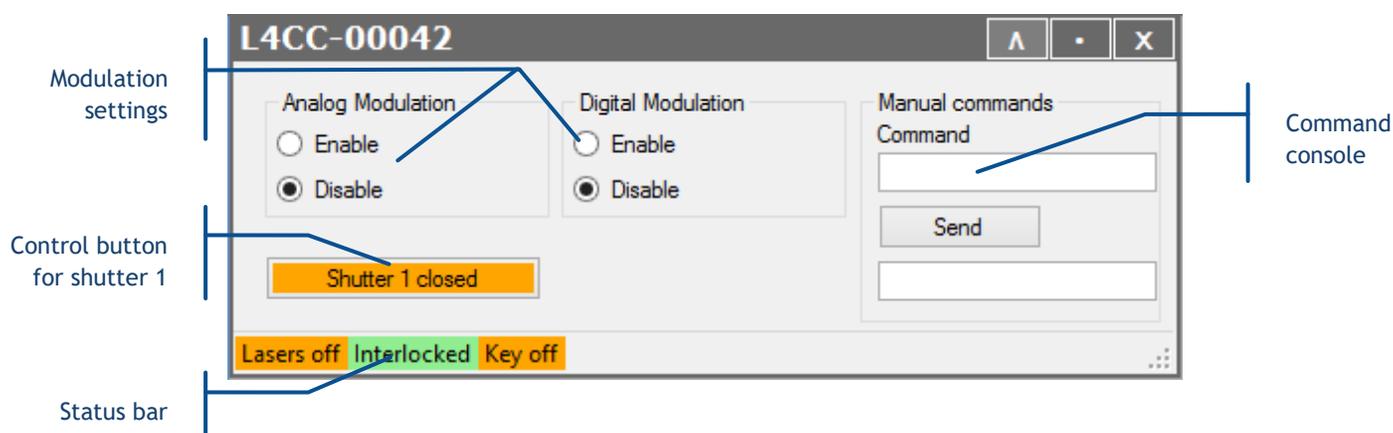
The top window controls the combiner as a whole, while the following windows represent each laser source individually. Each of these windows is titled with the emitted wavelength (if relevant) and the serial number of this unit (whether it is a combiner or an individual laser).

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

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

#### THE COMBINER CONTROL WINDOW

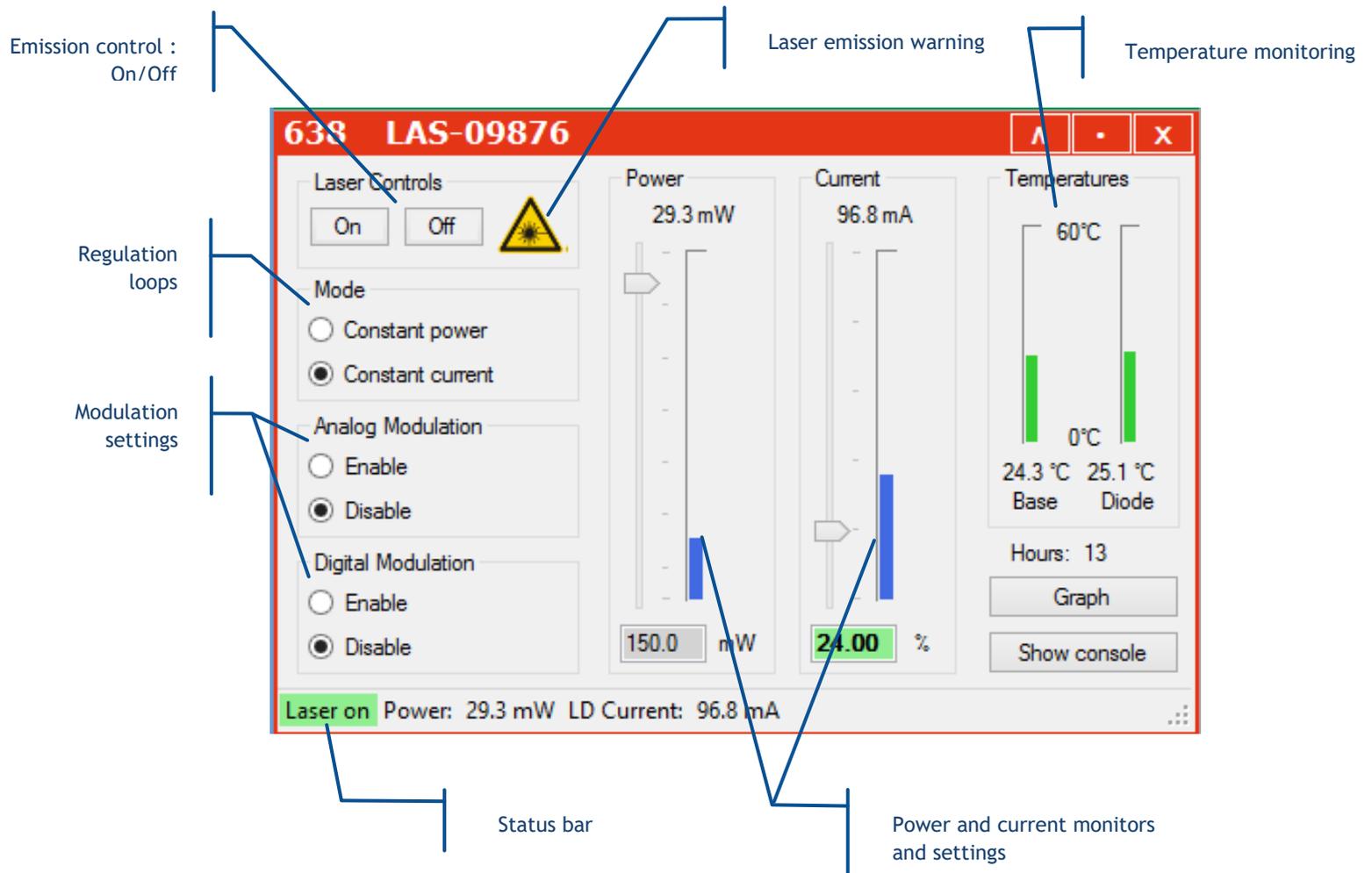
When expanded, the combiner control window looks as follows:



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



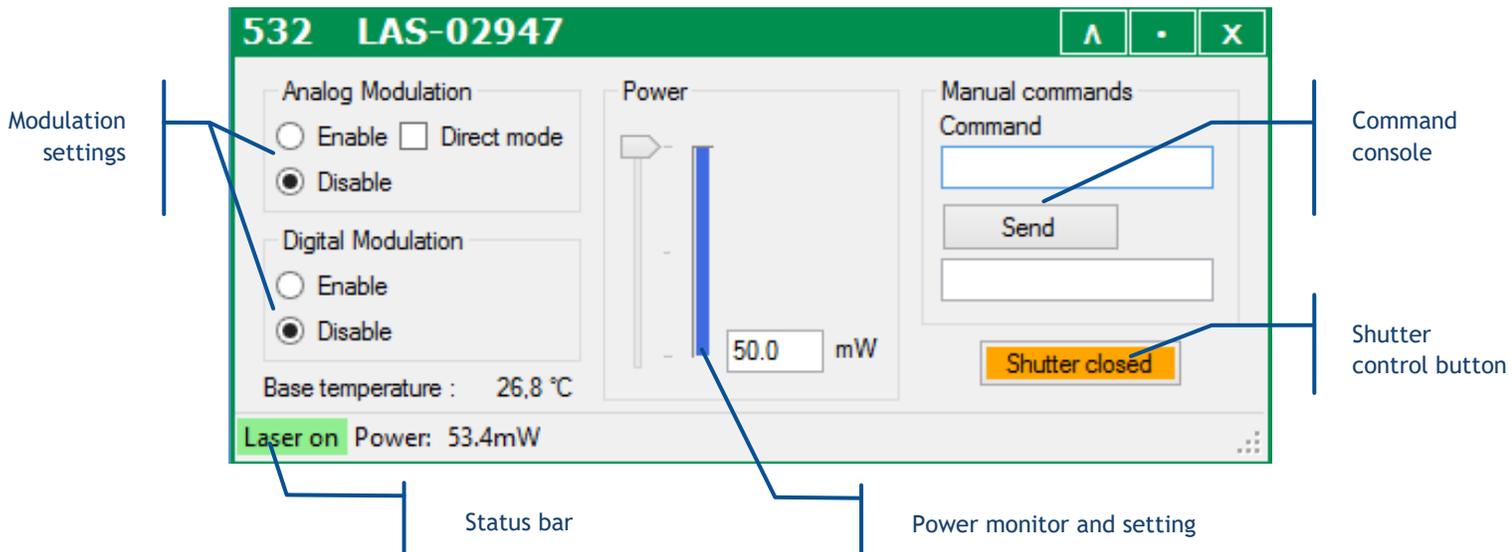
This control panel consists of the following elements:

- 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 OR LPX LASER SOURCE



This control panel consists of the following elements:

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

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

---

## SENDING QUERIES AND COMMANDS

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

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

- An acknowledged command will result in the string "OK" returned, or in the same command echoed back. For example, "PL4 50" will result in the answer "P=50.0".
- A syntax that is not understood will result in the answer "????"

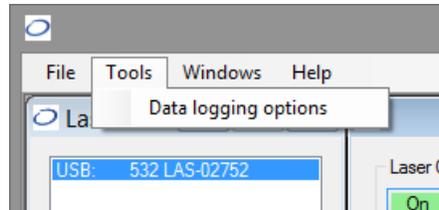
Please refer to chapter 6-5, "Software commands" for the list of these queries and commands.

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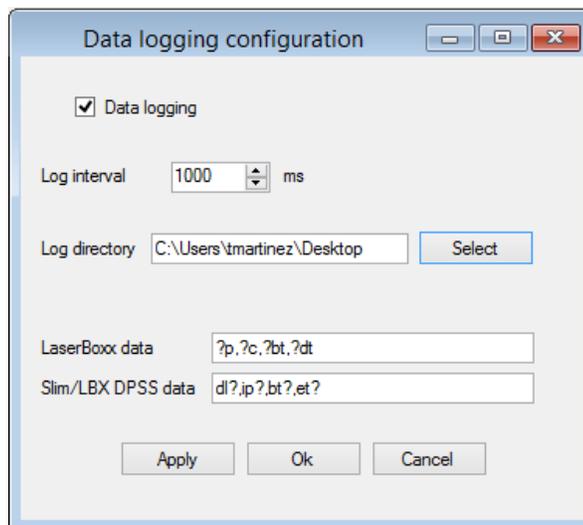
## DATA LOGGING

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

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



This will open a separate configuration window:



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

- Tick the box called “Data logging” to activate (or deactivate) data logging,
- The “log interval” determines how often the 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.

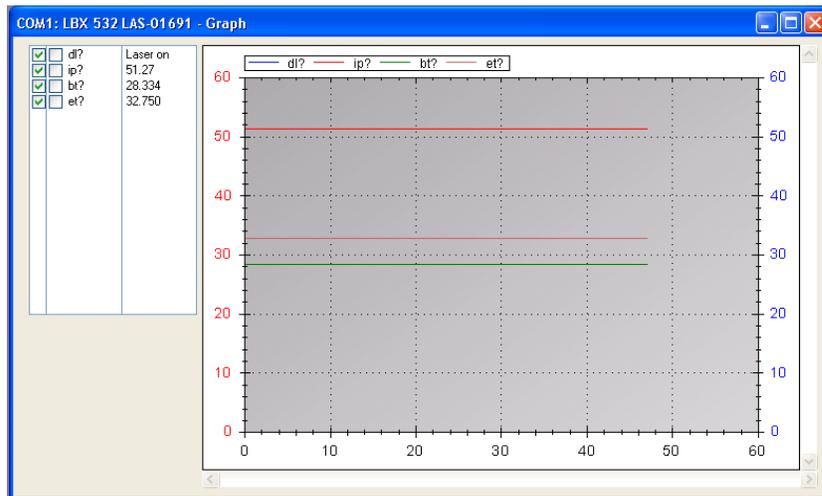
- The two following boxes contain the set of queries the laser sources will be polled for. Edit the box named “LaserBoxx data” by listing the queries you need to record on your LBX units. Edit the box named “DPSS data” by listing the queries you need to record on your LCX units. In both lists, the separator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

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

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



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

Here are some basic controls:

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

# 5. MAINTENANCE AND TROUBLESHOOTING

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

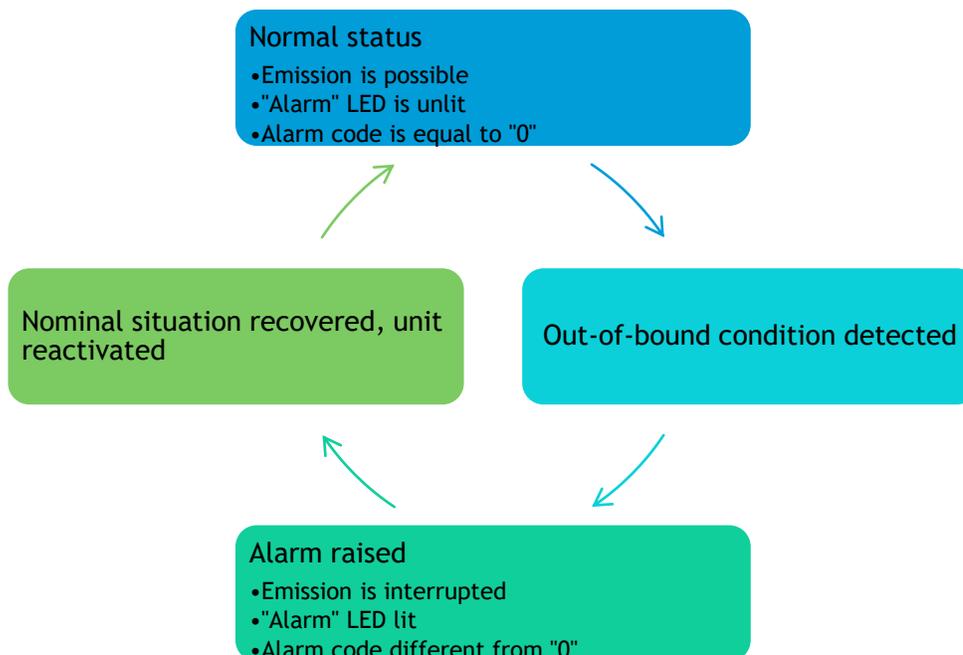
## 5-1 Combiner under alarm

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

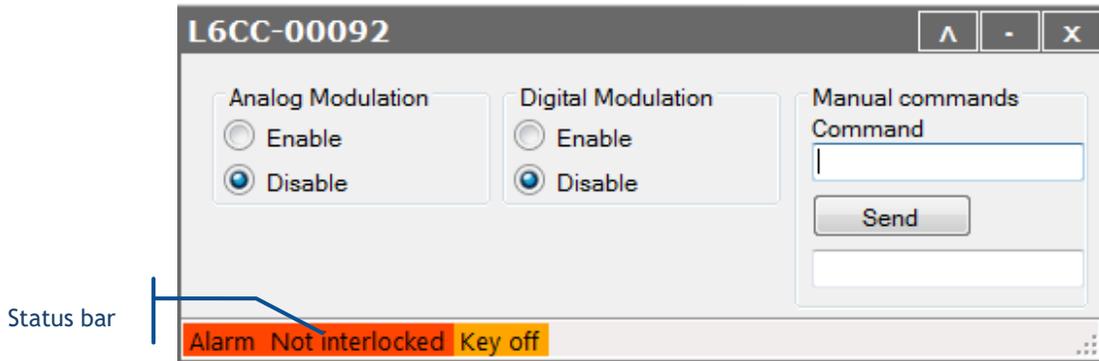
An alarm status is expressed to the user by any of these means:

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

Chart 5.1 Alarm status and their transition sequences



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



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

Table 5.2 Alarm status detailed for a combiner

Description	Cause for the alarm	Action required
No alarm	None	None
Power supply	The supply voltage of the unit is outside its specified range.  Refer to section 2 and to your specification sheet for allowable voltage ranges	Check the input voltage by measuring the voltage at the output terminals of your power supply
Temperature	One of the temperature sensors has monitored an out-of-bound value	Check the temperature of the base plate and make sure that it is within the specified limits of [15°C,40°C]  Query the alarm of each
Interlock	The interlock circuit is open	Check the continuity of the interlock circuit

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

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

## 5-2 Recovering missing power levels

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

A specific attention is required with the delivery patch cable which should not be bent nor receive mechanical damage (shear stress, punching, etc.) under any circumstances. The user is required to handle the patch cable and their connectors with care, and also to have the necessary tools and knowledge to inspect and clean the end tip of the fiber.

These tools are:

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

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

Issue observed	What to do
Output is nil at the end of the delivery fiber	<ol style="list-style-type: none"> <li>1) Start by inspecting the external aspect of the patch cable, looking for steep bend curves or mechanical damages. These might be the sign of a severed optical fiber. If that is the case, the patch cable needs to be replaced</li> <li>2) Inspect both optical connectors of the delivery fiber using a dedicated microscope (refer to the following chapter for detailed guidance). Clean them if necessary. If one of the end facets is damaged near the fiber core, then the optical connector needs to be re-polished, or replaced.</li> <li>3) Try readjusting the fiber coupler in order to increase the throughput. Refer to the following chapter, “Optimizing the coupling ratio”.</li> </ol>
Insufficient power on all laser sources	<ol style="list-style-type: none"> <li>1) Inspect both optical connectors of the delivery fiber using a dedicated microscope (refer to the following chapter for detailed guidance). Clean them if necessary. If one of the end facets is damaged near the fiber core, then the optical connector needs to be re-polished, or replaced.</li> <li>2) Try readjusting the fiber coupler in order to increase the throughput. Refer to the following chapter, “Optimizing the coupling ratio”.</li> </ol>
Insufficient power on only minority of laser sources	Try readjusting the beam steering optics of the affected sources. Refer to chapter 6.2, “Optimizing the delivered power”.

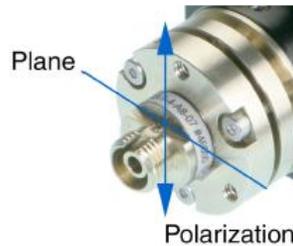
<p>The projected beam is not round, distorted</p>	<p>Inspect the delivery optical connectors using a dedicated microscope (refer to the following chapter for detailed guidance). Clean it if necessary. If the end facet is damaged near the fiber core, then this optical connector needs to be re-polished, or replaced.</p>
---	---

## 5-3 How to optimize the coupling ratio

The alignment between the laser beam and the delivery fiber is performed and tested at Oxixus' facilities. However, small adjustments might be necessary after positioning the system in its final location. The following paragraphs will describe how to use and adjust these elements.

### COUPLING ON A SINGLE-MODE FIBER

Single mode (SM) or polarization maintaining (PM) fiber coupling are options that employ a beam coupler from Schäfter and Kirschhoff. The high quality of these couplers guaranties a long-term stability. More information about these coupled is available on [www.SuKHamburg.de](http://www.SuKHamburg.de)



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

#### REQUIRED EQUIPMENT:

- A 1.5mm hexagonal key (provided)
- A 1.2mm flat screw driver (provided)
- 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; refer to the manufacturing test report),

Refer to the packing list in section 2, "Getting started".

### CAUTION SHUTTER AND COUPLER CENTRING



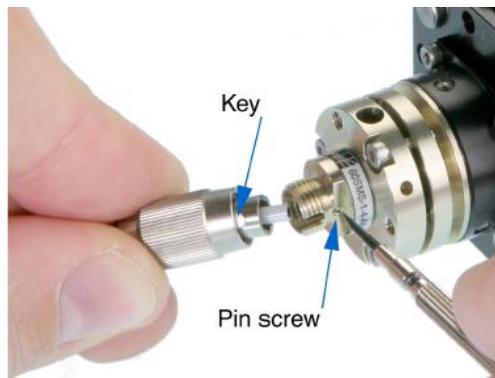
We recommend not to detach the shutter from its supporting base. Indeed, the shutter is aligned with regards to the the beam. This delicate alignment requires some specific tools (not provided).

## How to attach the fiber cable to the laser beam coupler

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

- Make sure that the pin screw holding the connector ferrule is loosened and does not impair the movement of the ferrule into its holder (see Figure 4-3). Failing to do so might damage the connector;
- Approach the fiber connector at an angle (as shown on Figure 4-3) and insert the ferrule into the beam coupler, carefully avoiding any contact on the ferrule's end face;
- Once the ferrule is inserted, align the connector's key with the notch on the coupler, then gently push the connector inside the coupler and lock the connector's box nut by rotating it to the right (do not use any tools to fasten the connector);
- Fasten the coupling nut of the connector completely;
- Slightly and gently fasten the pin screw in order to reduce the slackness of the ferrule inside the alignment sleeve. Be warned that fastening the screw too hard can affect the polarization state in the fiber and damage the screw.

Figure 5-3: Pin screw (coupler side) and connector's key



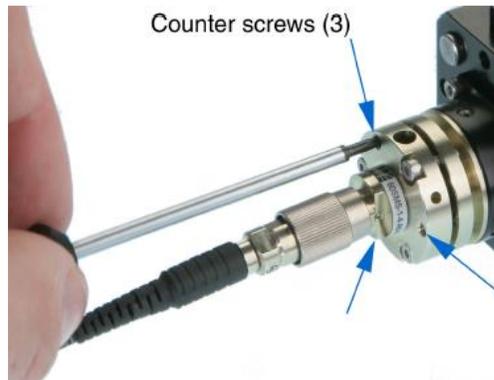
## Finding a signal

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

You will need an optical power meter equipped to accept your fiber's connector and able to measure optical powers ranging from a few tens of  $\mu\text{W}$  to a few tens of  $\text{mW}$ .

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

Figure 5-4: Position of the counter-screws



Procedure:

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

**WARNING**

**LASER RADIATION HAZARD**

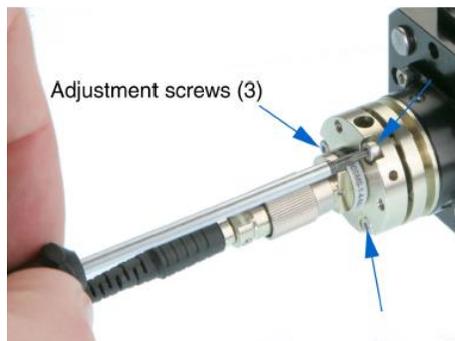


The laser is now emitting. Proper protection measures against laser light shall be enforced

To avoid damaging the fiber end face, the following adjustment procedure should be performed at low optical power (50mW or below)

- Set your power meter to its smallest power range (so it can detect even small differences in optical power) and attach it to the fiber's end. Locate the adjustment screws (1.5 mm hex cylindrical head, see Figure 4-5) and turn them one by one (with an Allen 50HD-15 wrench) until the power meter's reading indicates that optical power has been detected. A good adjustment sequence should be so that any possible position is scanned once.

Figure 5-5: Position of the adjustments screws



It is sometimes useful to slightly loosen the nut on the fiber connector, then to pull back slightly the fiber connector (after having loosen the ferule screw, then the connector nut). Thus doing, defocussing occurs so that the spot is easier to find. Fasten the box nut again when you have detected optical power.

### **Increasing the signal**

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

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

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

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

The coupling losses can be defined as being the difference between the power level monitored by the laser source and the power actually measured at the far end of your patchcord. Before proceeding to the next step, check that these coupling losses do not exceed 100 mW.

### **Fine adjustment and locking**

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

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

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

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

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

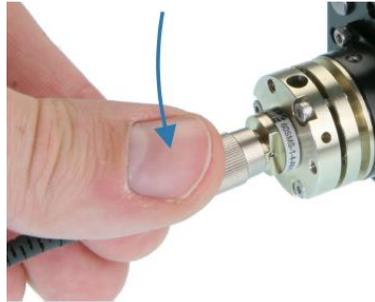
You can now gradually increase the output power up to its nominal set point. As a final check, make sure that the transmission ratio has not decreased.

### **Checking the alignment**

A possible way to check the alignment's robustness is by pressing gently on the connector in all directions (see Figure 4-6): when thus pressing, the signal's power should decrease but it should then recover its initial value once the pressure is released.

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

Figure 5-6: Checking the stability of the adjustment



## COUPLING ON A MULTI-MODE FIBER

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

The coupler consists of a mechanical holder positioned inside the laser shutter (referring to figure 4-7). On the front face of the holder are the screws that will define the alignment of the fiber against the beam.

This procedure explains how to retrieve an optimal coupling efficiency.

### WARNING

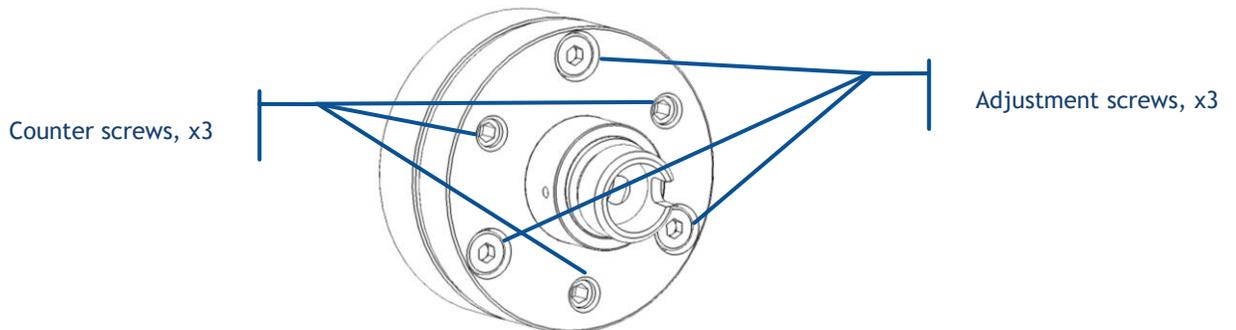
### LASER RADIATION HAZARD



Proper protection measures against laser light must be enforced.

To avoid damaging the fiber end face, the following adjustment procedure should be performed at low optical power (50mW or below)

Figure 5-7: Position of the adjustment screws and counter-screws



- The mechanical holder has been centered with regards to the beam (using the positioning screws of the shutter). This operation is performed at Oxxius and we recommend not to disturb this positioning.

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

## 5-4 Issues with back reflection

Some of the laser sources composing the combiner can sustain damage from optical feedback.

This damage occurs on semiconductor laser diodes when their output is collimated and subsequently retro-reflected. In these conditions, the retro-reflected beam focuses back onto the laser diode facet and can create a power density high enough to melt this facet. This results in an irreversible degradation of the laser. Once this process begins it is not possible to repair the laser, moreover this failure mechanism is not covered under Oxxius' standard warranty.

For this reason, Oxxius recommends the following precautions be taken when working with the beam released by a combiner:

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

Even if back-reflection does not harm all laser sources, it will likely disturb power monitoring and thus induce instabilities of the output. In order to assert this cause of instability it is recommended to start the emission while the output shutter(s) are closed (using a beam stop is also possible), then to note if the laser is more stable in these conditions.

## 5-5 Customer support

For a quick expert help with Oxxius products, contact your local representative or our customer support. Detailed information can be found on our website: [www.oxxius.com](http://www.oxxius.com)

### CORPORATE HEADQUARTERS:

Oxxius S.A.

4 rue Louis de Broglie

F-22300 Lannion, France

Phone: +33 296 48 53 75

Fax: +33 296 48 21 90

E-mail: [support@oxxius.com](mailto:support@oxxius.com)

## 5-6 Disposal

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

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



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



# 6. WARRANTY

## Limited Lifetime Warranty

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

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

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

## User's responsibilities

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

## Limitations of warranty

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

The following items are not covered by this warranty:

Any damage to the device resulting from customization or modification integrating products from others manufacturers,

Any device, whose serial number is missing, altered,

Any repairs or adjustments made by unauthorized people,

Any attempts to open the laser device,

Any use in improper environmental conditions (condensation, dust ...),

Any faulty customer equipment system,

Fiber patch cables and coupling optimization,

Scratches on optical output windows or on any other optical component supplied with options due to a bad cleaning method

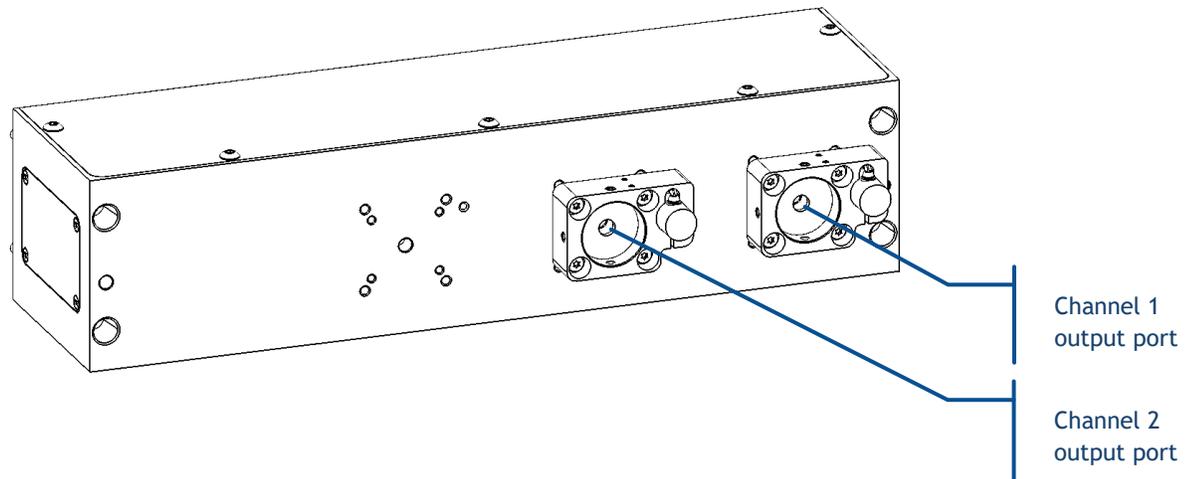
Repaired or replaced parts are warranted for the duration of the original warranty period only.

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

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

# 7. MODULES AND ACCESSORIES

## 7-1 Adjustable dual output MDL-MDUAL



---

### GENERAL DESCRIPTION

This module is located at the output of the combiner. It acts on the combined beam, splitting it into two separate beams, according to an adjustable split ratio. Both beams are delivered on distinctive output channels (1 and 2 in the figure above). The split ratio can be set between 0% and 100%.

---

### INSTALLATION

This module is fixed at the output of the combiner, pre-aligned with the combined beam.

---

### OPERATION

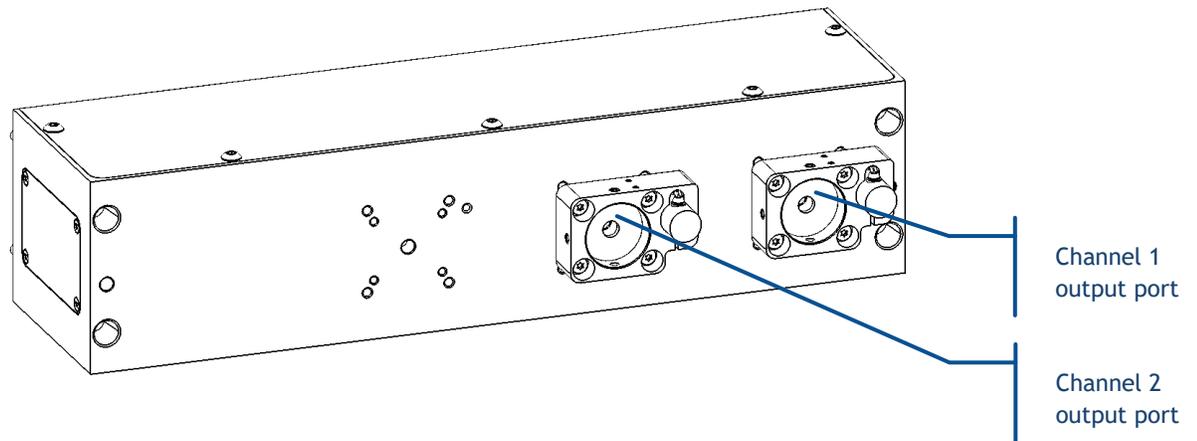
The power split ratio between both channels is adjusted by sending a software command to the combiner. Refer to the chapter 3-3 for detailed instructions about how to send such commands.

This command determines the transmission ratio on channel 1, while it is assumed that both channels exhibit complementary transmission ratios. For example, when setting channel 1 at 40%, it is assumed that the ratio on channel 2 will be  $100\% - 40\% = 60\%$ .

Here is the list of these commands:

Purpose	Command	Result
Sets the transmission ration of p percent on channel 1 (where p is a number from 0 to 100)	IPA p	IPA 40 (IPA, <space>,40) sets a transmission ratio of 40% on channel 1, 60% on channel 2.
Retrieves the transmission ratio on channel 1.	IPA	"80.0" for a transmission ratio of 80.0% on channel 1, 20.0% on channel 2

## 7-2 Motorized flip-mirror MDL-FLPM



### GENERAL DESCRIPTION

This module acts on the output channel of the connector. The beam entering the input port can either exit through channel 1 unaffected, or be entirely steered towards channel 2. Switching between two channels typically occurs in less than 0.5 second.

Each channel is also fitted with an electro-mechanical shutter.

### OPERATION

This module gives access to two functions:

- The mirror,
- The shutters present on each of the output channels

The galvanometric mirror accepts two positions:

- On its "High" position the beam is sent as such through the output port of channel 1,
- On its "Low" position the beam is steered towards channel 2

To activate the mirror using the Input/Output connector, send a digital signal (0V for "Low", +5V for "High") on pin number 24.

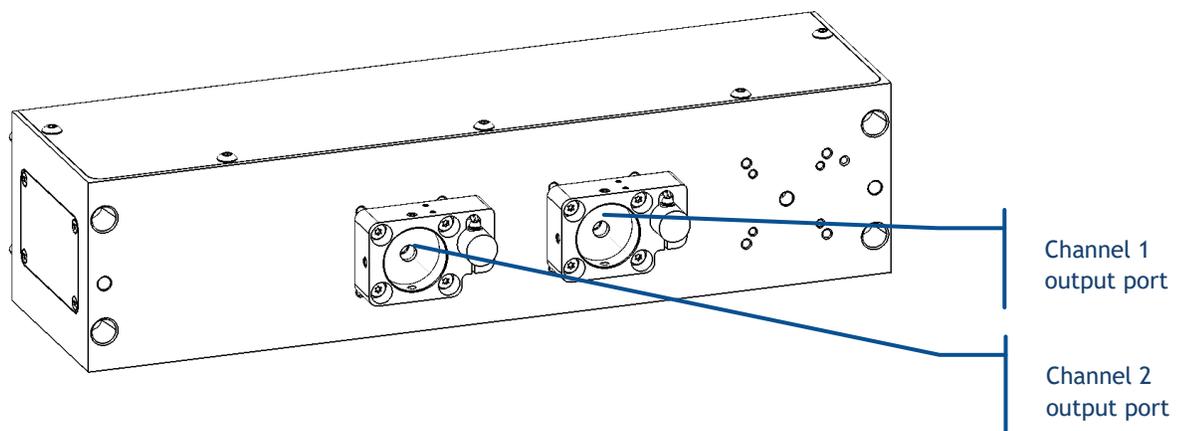
Alternatively, if the mirror is configured to receive software commands:

- Enter the command “FM1 1” to set it to “High” position (channel 1),
- Enter the command “FM1 0” to set it to “Low” position (channel 2),

Finally, the electro-mechanical shutter on each channel can be operated independently using software commands. Refer to chapter 3-3 about how to send commands to the combiner, using the combiner control window.

- Entering the command “SH1 0” will close the shutter on channel,
- Entering the command “SH1 1” will open the first shutter,
- Entering the command “SH2 0” will close the second shutter,
- Entering the command “SH2 1” will open the second shutter

## 7-3 Fast switch mirror MDL-FSTM



---

### GENERAL DESCRIPTION

This module is located at the output of the combiner. It acts on its output channel. The beam entering the input port can either exit through channel 1 unaffected, or be entirely steered towards channel 2.

Compared to the flip mirror option (see the previous paragraph), this module can be switched at a much higher pace, typically more than twenty times a second.

Each channel is also fitted with an electro-mechanical shutter.

---

### OPERATION

This module gives access to two functions:

- The galvanometric mirror,
- The shutters present on each of the output channels

The galvanometric mirror accepts two positions:

- On its “High” position the beam is sent as such through the output port of channel 1,
- On its “Low” position the beam is steered towards channel 2

To activate the mirror using the Input/Output connector, send a digital signal (0V for “Low”, +5V for “High”) on pin number 24.

Alternatively, if the mirror is configured to receive software commands:

- Enter the command “GA1 1” to set it to “High” position (channel 1),
- Enter the command “GA1 0” to set it to “Low” position (channel 2),

Finally, the electro-mechanical shutter on each channel can be operated independently using software commands. Refer to chapter 3-3 of the User Manual about how to send commands to the combiner, using the combiner control window.

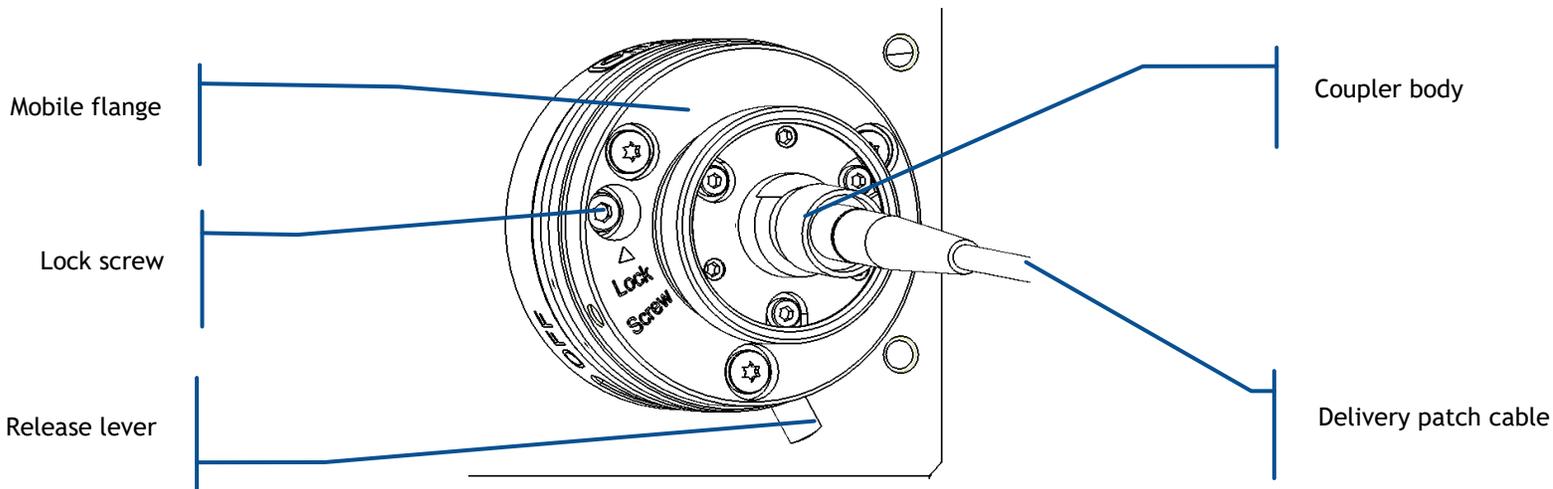
- Entering the command “SH1 0” will close the shutter on channel,
- Entering the command “SH1 1” will open the first shutter,
- Entering the command “SH2 0” will close the second shutter,
- Entering the command “SH2 1” will open the second shutter

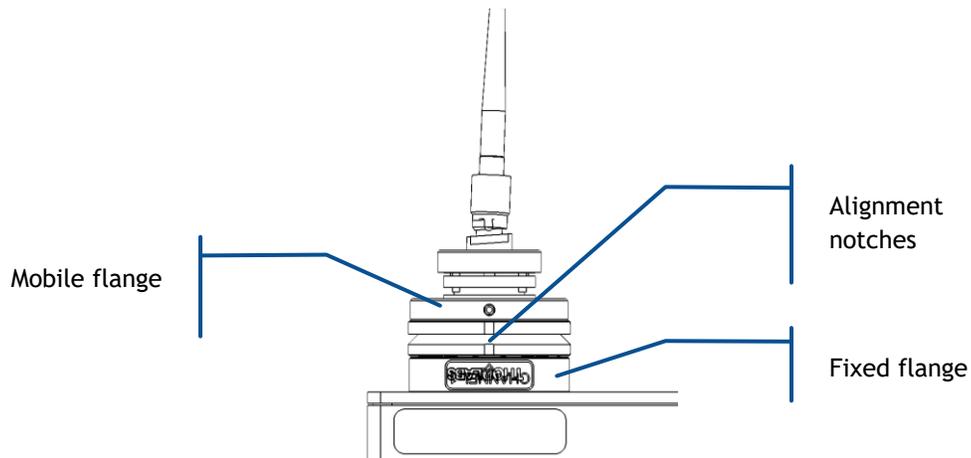
## 7-4 Repositionable fiber coupling system ACX-RFC

### GENERAL DESCRIPTION

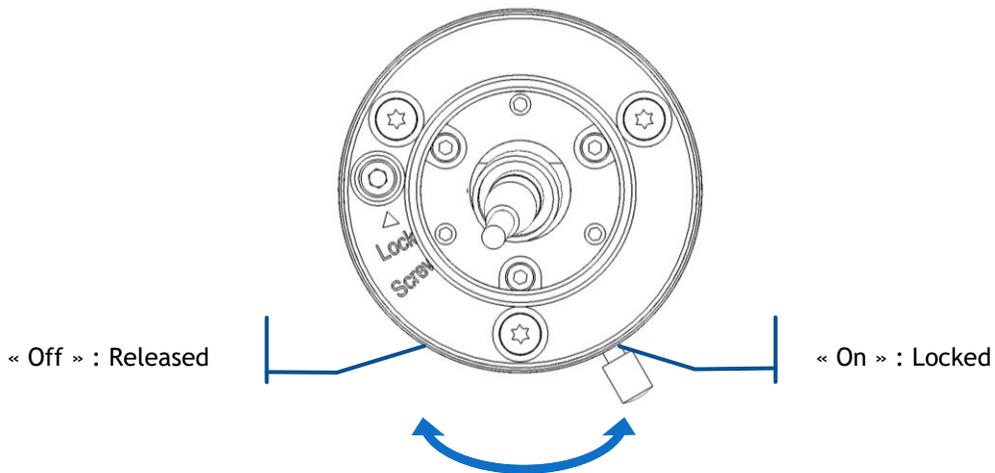
The repositionable fiber coupling system (RFC) is located between the output aperture of the combiner and a fiber coupling system. It allows the user to quickly remove or attach the fiber coupling system to the combiner, without requiring any additional adjustment.

Accessible elements on the repositionable fiber coupling system





- **Mobile flange:** this flange constitutes the repositionable part of the RFC. It can be put off when the release lever is in “off” position.
- **Lock screw:** this screw, when secured, prevents the RFC mobile flange from being accidentally disunited from the combiner.
- **Lever:** use this lever to lock or release the mobile flange. Note the two positions of the lever as in the following picture:



- **Cap cover:** this cap prevents dust from contaminating the coupler as the RFC is detached.

---

## INSTALLATION

This module is fixed at the output of the combiner, pre-aligned with the combined beam.

---

## OPERATION

### DANGER: LASER RADIATION



Make sure to turn off the laser emission any time the RFC is being manipulated.

#### HOW TO ATTACH AND SECURE THE RFC

1. Rotate the lever to its “OFF” position,
2. Position the mobile flange against the fixed flange using the alignment notches, then rotate the lever in its “ON” position,
3. Apply a gentle pressure on the mobile flange so as to make sure that it is firmly in position (or does not wobble),
4. Engage the Lock screw over 3 or 4 turns inside the fixed flange. The screw must prevent the mobile from being taken off, while not been completely tightened. Tightening this screw too firmly can degrade the coupling injection ratio.

#### HOW TO DETACH THE RFC

1. Loosen the Lock screw,
2. Move the lever in its “OFF” position,
3. Release the mobile flange,
4. Insert the cap cover inside the aperture of the mobile flange

# 8. 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.

## 8-1 Inner elements of the laser bench

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

- the laser sources,
- one or several acousto-optic modulators (AOM),
- one or several motorized power adjustment (MPA) modules,
- some optical elements to combine the beams into a single geometry,
- optionally, one or several fiber coupling systems,
- optionally, one or several clean-up filters

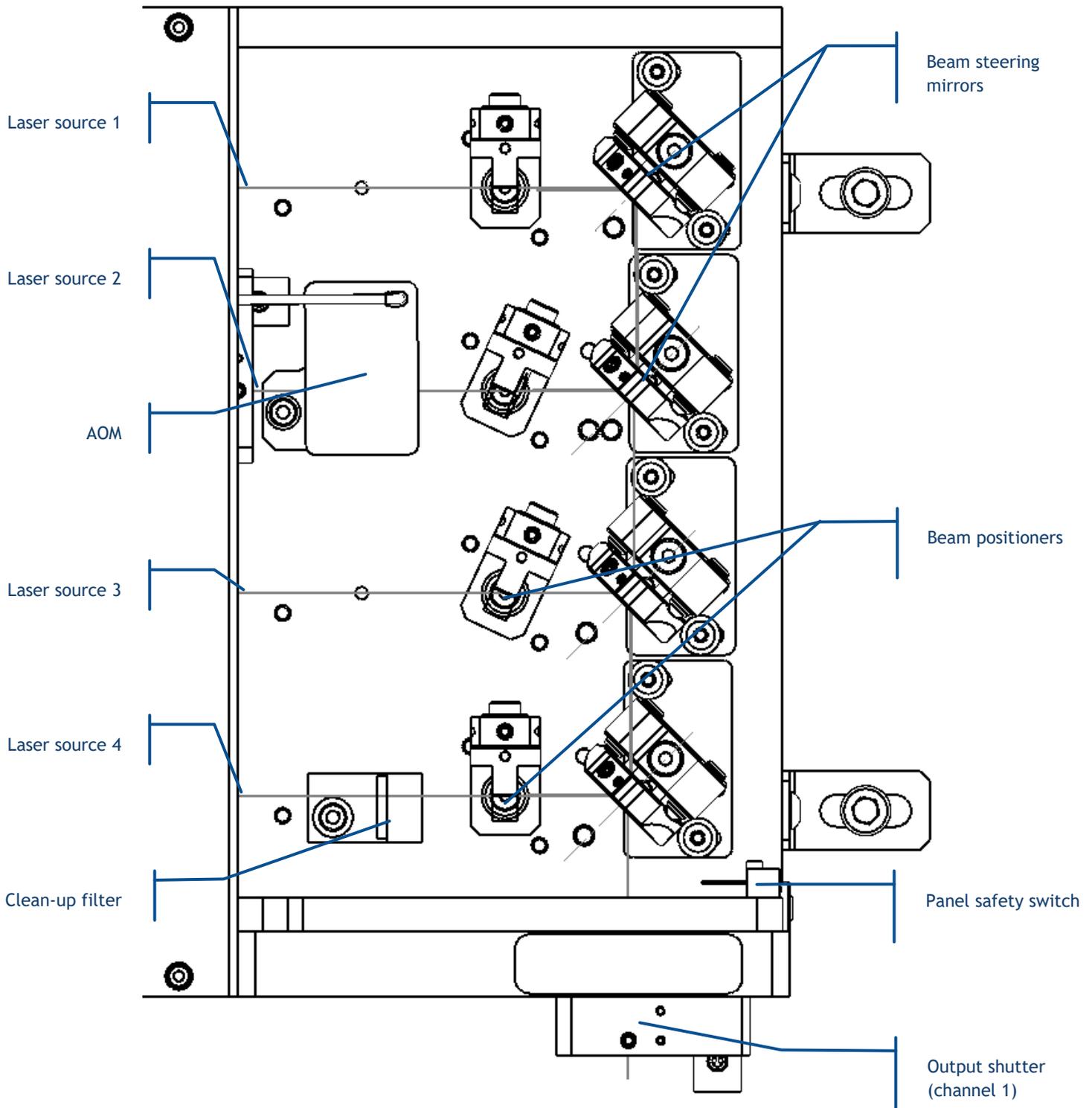
Each laser source emits an output beam directed on the optical elements.

If present, the clean-up filters cut off the unwanted part of the emission spectrum.

The steering mirrors deflect each beam precisely into a single geometry, towards the output aperture.

If present, the fiber coupling system finally acts to focus the incoming beams into the delivery fiber.

Figure 8-1: Inner elements of a combiner (example of an L4Cc with four sources)



## 8-2 Maintenance: how to optimizing the fiber injection

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.

### REQUIRED EQUIPMENT:

- 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; refer to the manufacturing test report for specific information about the emitted wavelengths),
- Some individual protections against laser radiation. At this purpose, refer to the wavelength range label and check its emission wavelength and maximum power. To located this label, refer to Section 1, “Safety Information”,
- A pair of hexagonal (“Allen”) keys: 1.5mm and 2mm.

Refer to the packing list in section 2, “Getting started”.

### Warning



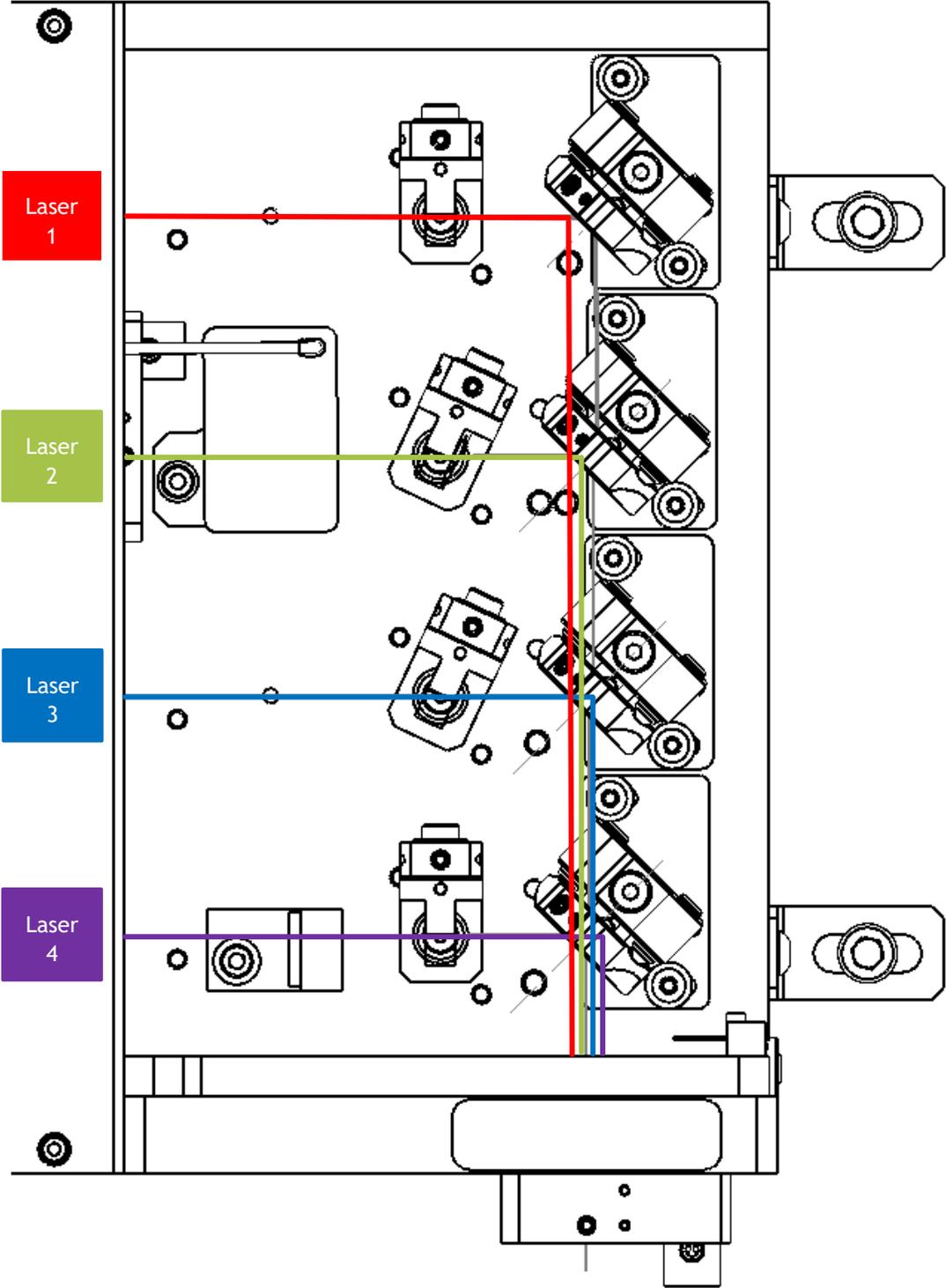
Adjusting the mirrors involves a direct access to the illuminated optics. Be sure to process with care:

- 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 output of the delivery fiber
2. Wear your protection equipment against the laser radiation, then power up the combiner
3. Remove the top cover of the optical head using the screws on its side. Note that the safety switch, released, will then inhibit the laser emission
4. De-activate the safety interlock by pushing the panel safety switch set. Be careful as the emission will be resumed instantaneously.

Figure 8-2: 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. To do so, proceed as described in chapter 4-3, “Optimizing the coupling ratio”

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

### Caution

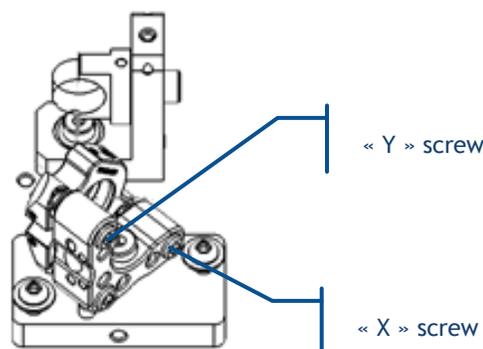
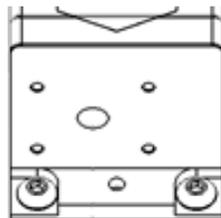


Be sure to wear protective equipment against laser radiation: at this stage, the panel safety switch should be by-passed (see step 4) and the laser is ready to emit without restriction.

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

9. Each beam can be first adjusted using its corresponding steering mirror. Two adjustment screws are used at this purpose: 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 8-3: A steering mirror with its “X” and “Y” screws

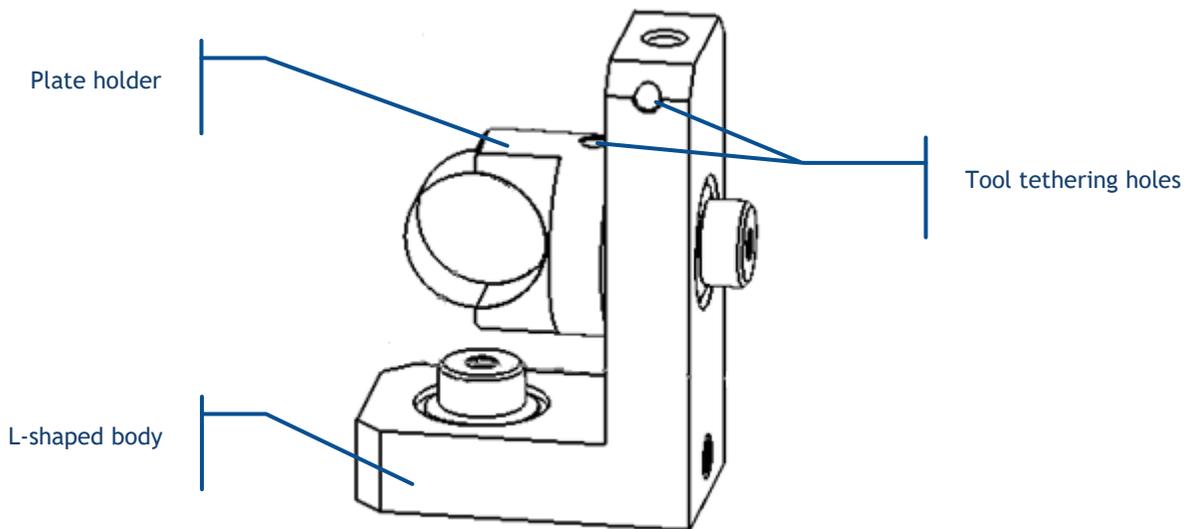


10. Insert a 2-mm Allen key in the “X” screws depicted in figure 6-3
11. Rotate the “X” screw in both directions until the power-meter reaches a maximum. Note down the value of this local maximum.
12. Proceed the same way with the “Y” screw: rotate it until a local maximum is reached.
13. Back to the “X” screw again: rotate it in search for the maximum value: it should be higher or equal than the value you noted down on step 11.
14. Adjust the beam positioner related to your laser source so as to maximize the delivered power. See the following paragraph for this procedure.
15. Repeat this procedure with the remaining sources if necessary (back to step 7 with another laser source, the closest from your reference source)

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

#### HOW TO ADJUST THE BEAM POSITIONER:

In conjunction to the beam steering mirror, the beam positioner uses a glass plate to translate the beam precisely in the geometrical center of the coupling lens.



Here are the steps to adjust this positioner while maximizing the injection throughput:

1. Insert your Allen key in the tethering hole at the top of the L-shaped body and rotate it in the horizontal plane while checking the delivered power; stop when you reach a maximum.

2. Similarly, insert your Allen key in the tethering hole at the top of the plate holder and rotate it in the vertical plane while checking the delivered power; stop when you reach a maximum.
3. Tighten the top and bottom locking screws back in position.

## 8-4 Modulation in details

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

---

### THE POWER REGULATION LOOPS

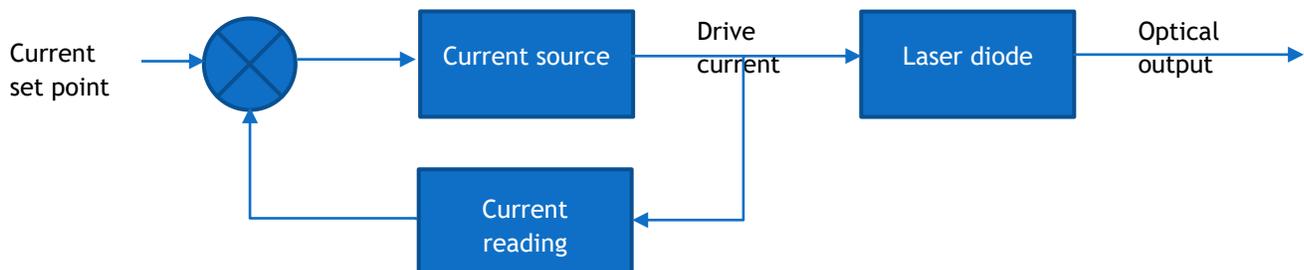
The LaserBoxx laser sources operate by releasing an optical signal against a given set point. Two different control methods exist to regulate the optical signal.

---

#### 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.

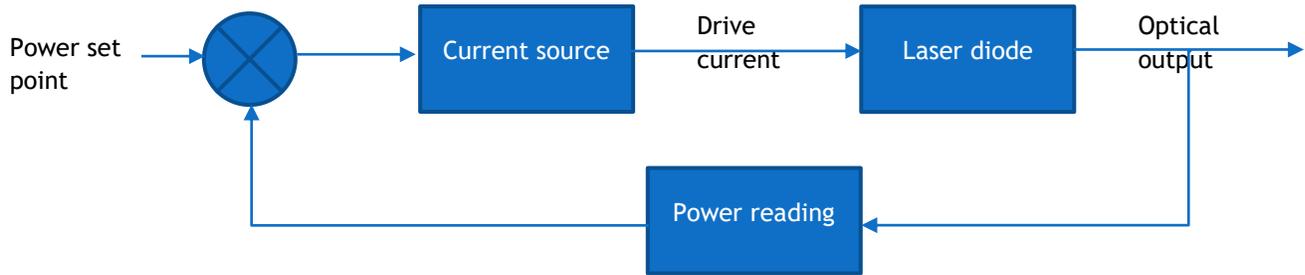
Note that the ACC loop is unavailable on the LCX laser sources.

---

#### 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

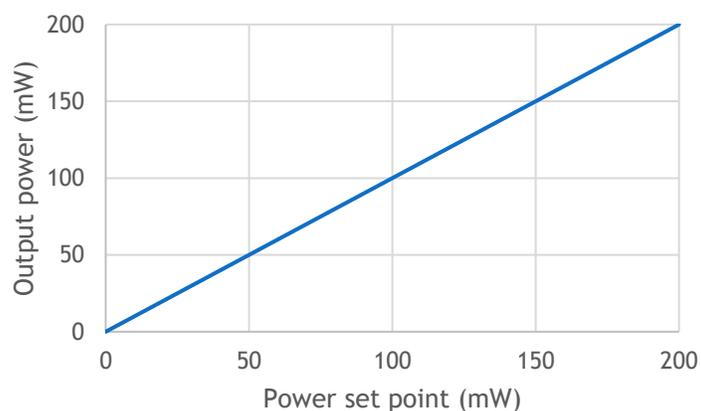
Here are the typical characteristic functions obtained when driving the laser using one of these methods:

- 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:



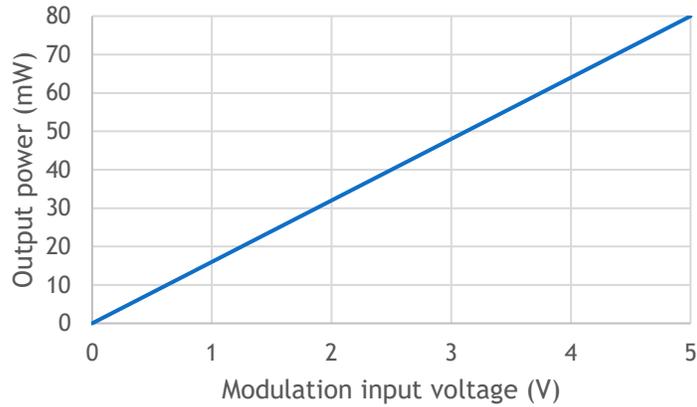
The characteristic curve is linear between 0mW and the nominal power, the effect of the APC loop being that the monitored power is strictly equal to the power set point. Note that the exact value of the nominal power (200mW in the example above) is specified on the manufacturing test report of each unit.

Reading or setting the optical power is 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:



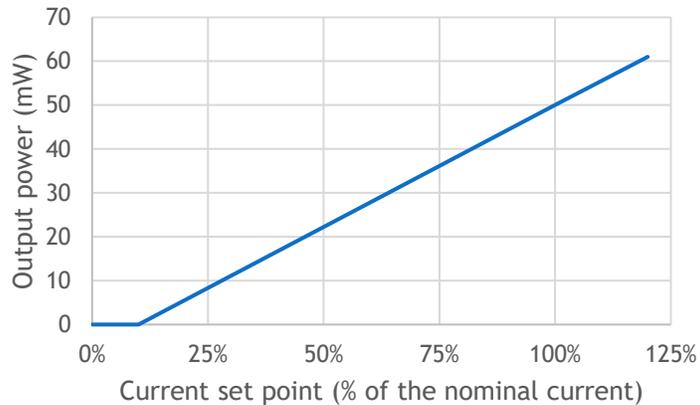
The characteristic curve is linear between 0V and 5V, the maximum reachable value being the last internal set point entered (80mW in the example above).

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 120% 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).

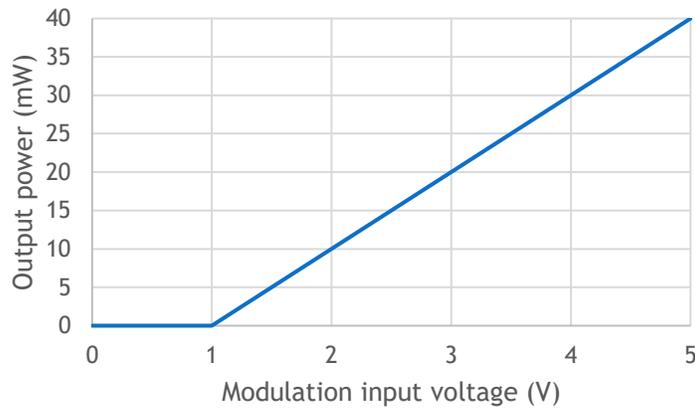
When setting the current, the unit used is the percentage of the nominal current. When reading the current, the returned value is expressed in milliAmperes.

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 120% 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.

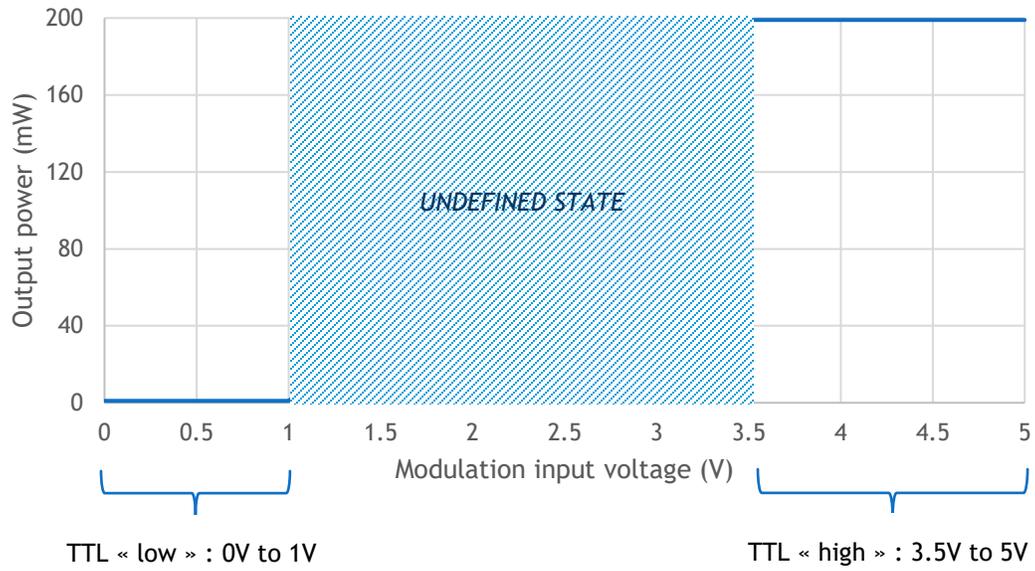
The maximum reachable value is the last current set point entered (80% in this example).

---

### 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:

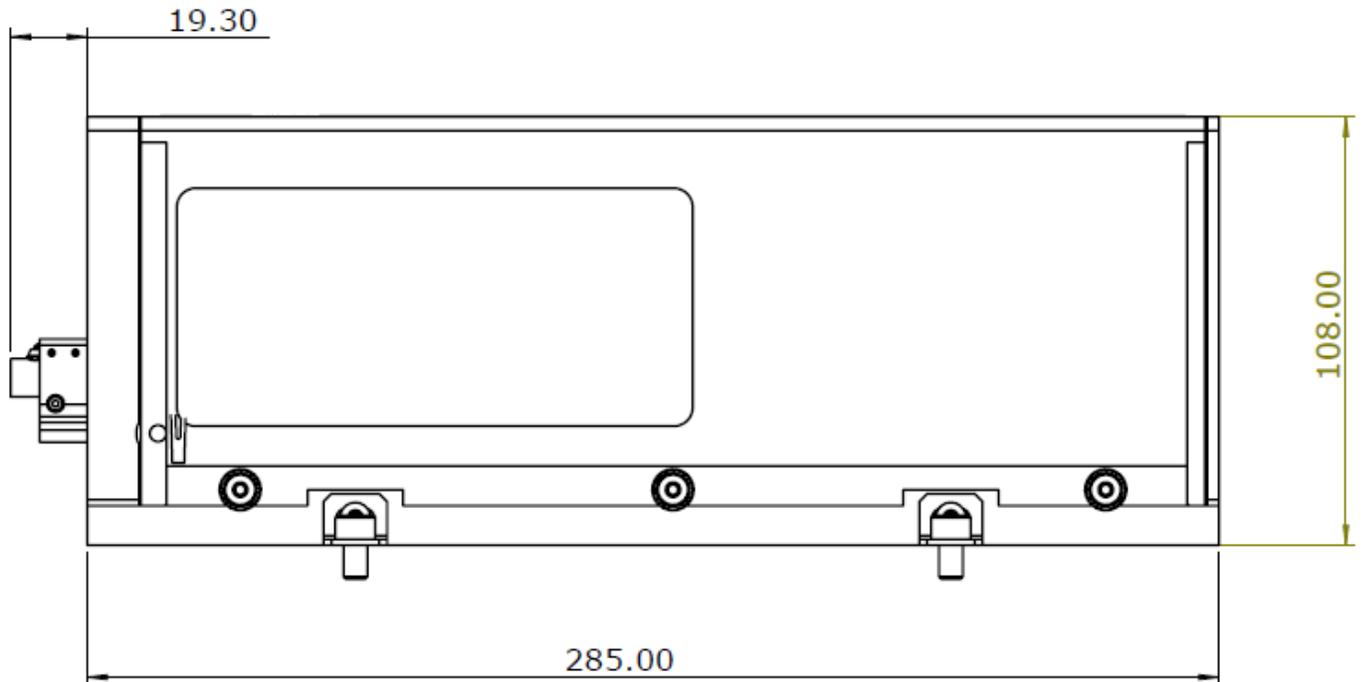
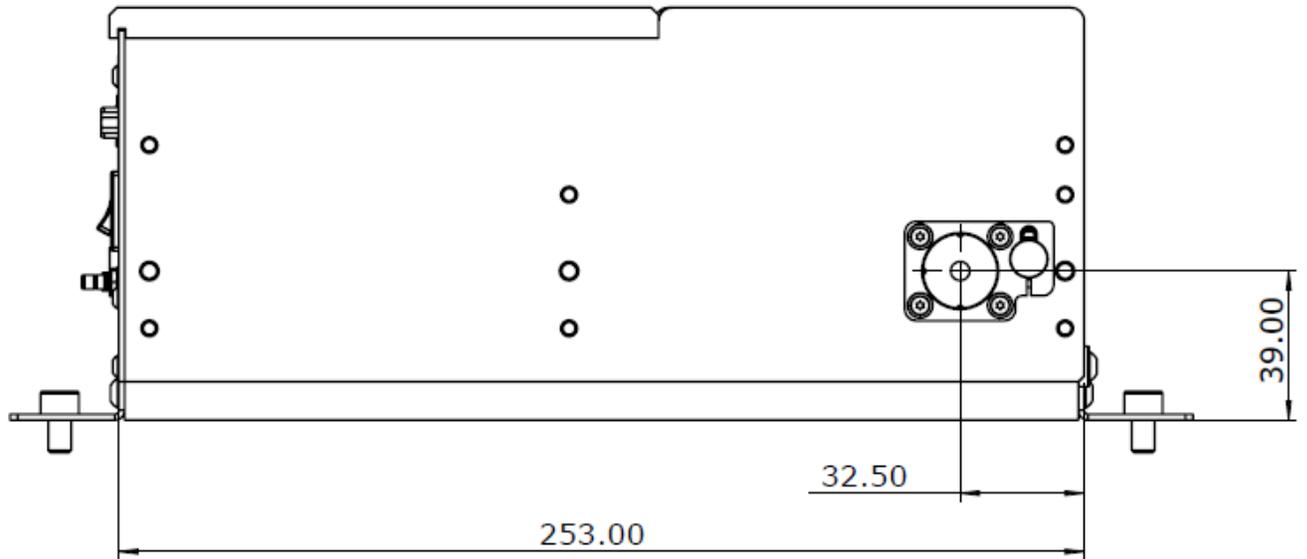


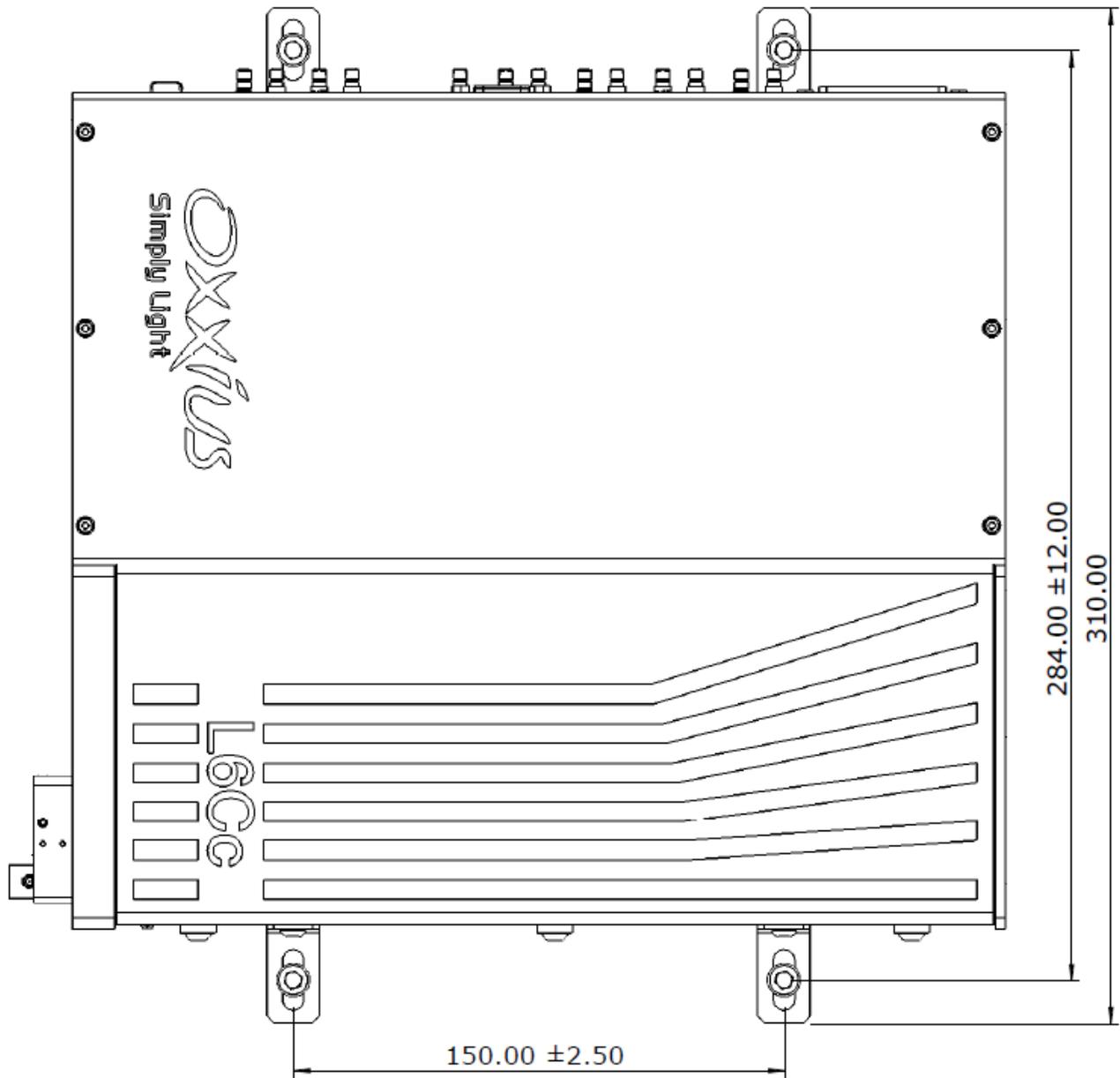
A TTL “low” voltage will result in a nil power, while TTL “high” voltage will have the laser source to emit according to the last current set point entered.

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

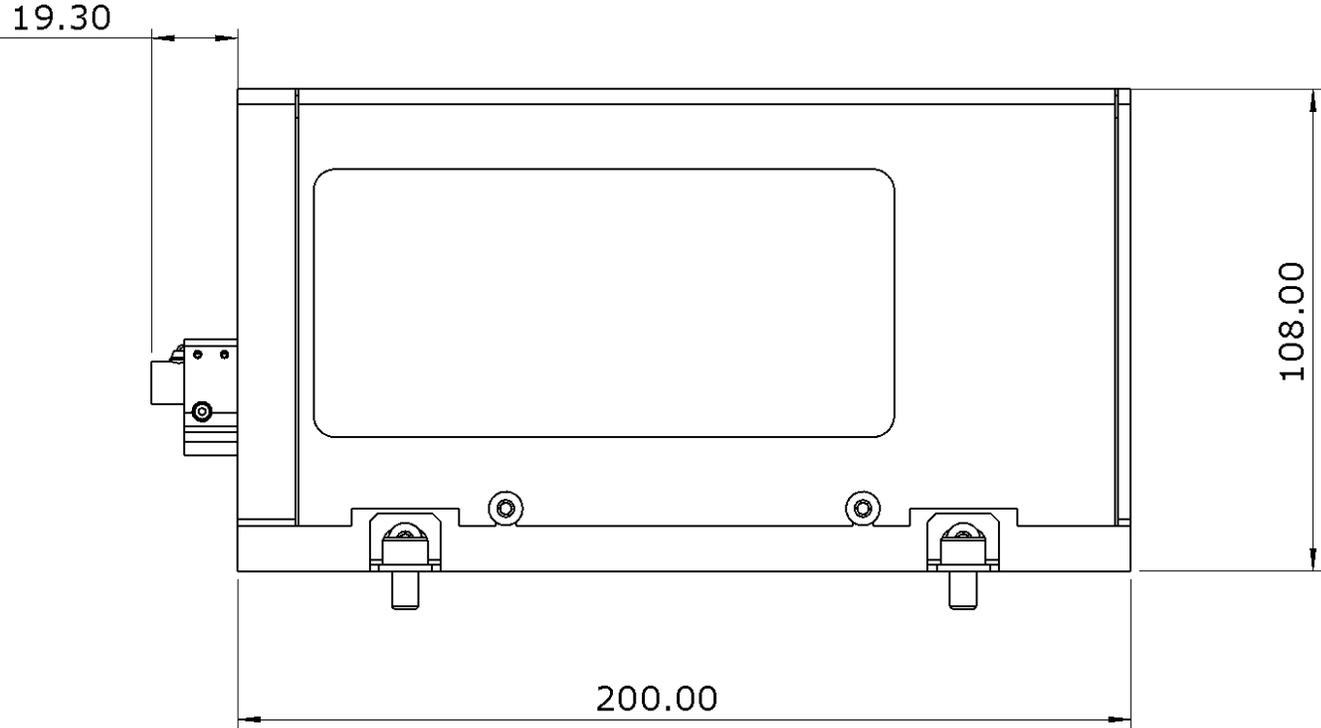
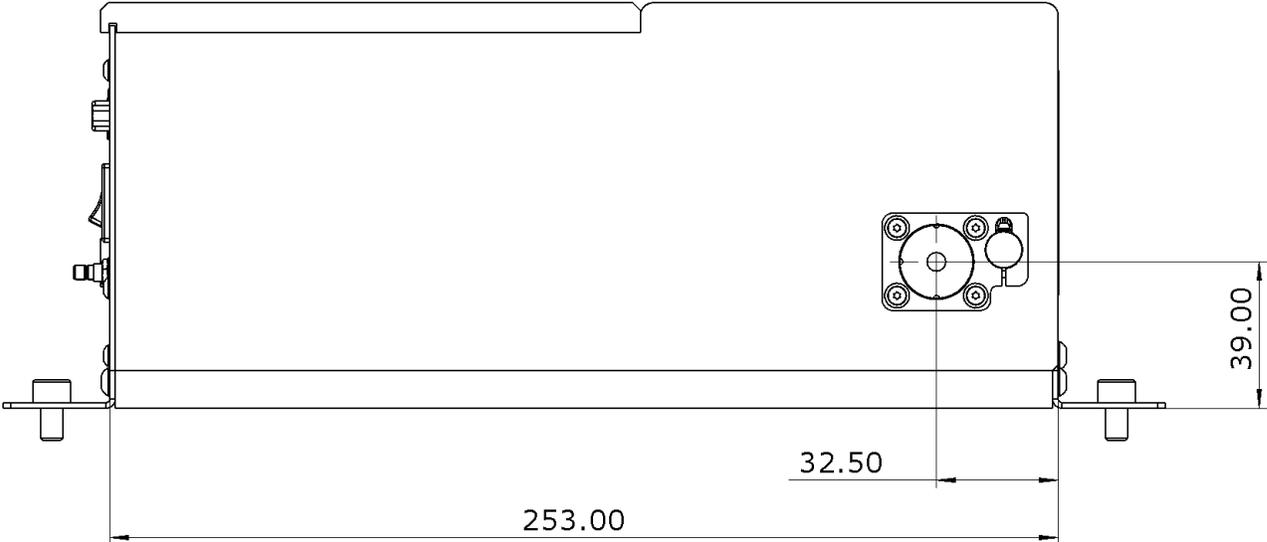
## 8-5 Mechanical drawings

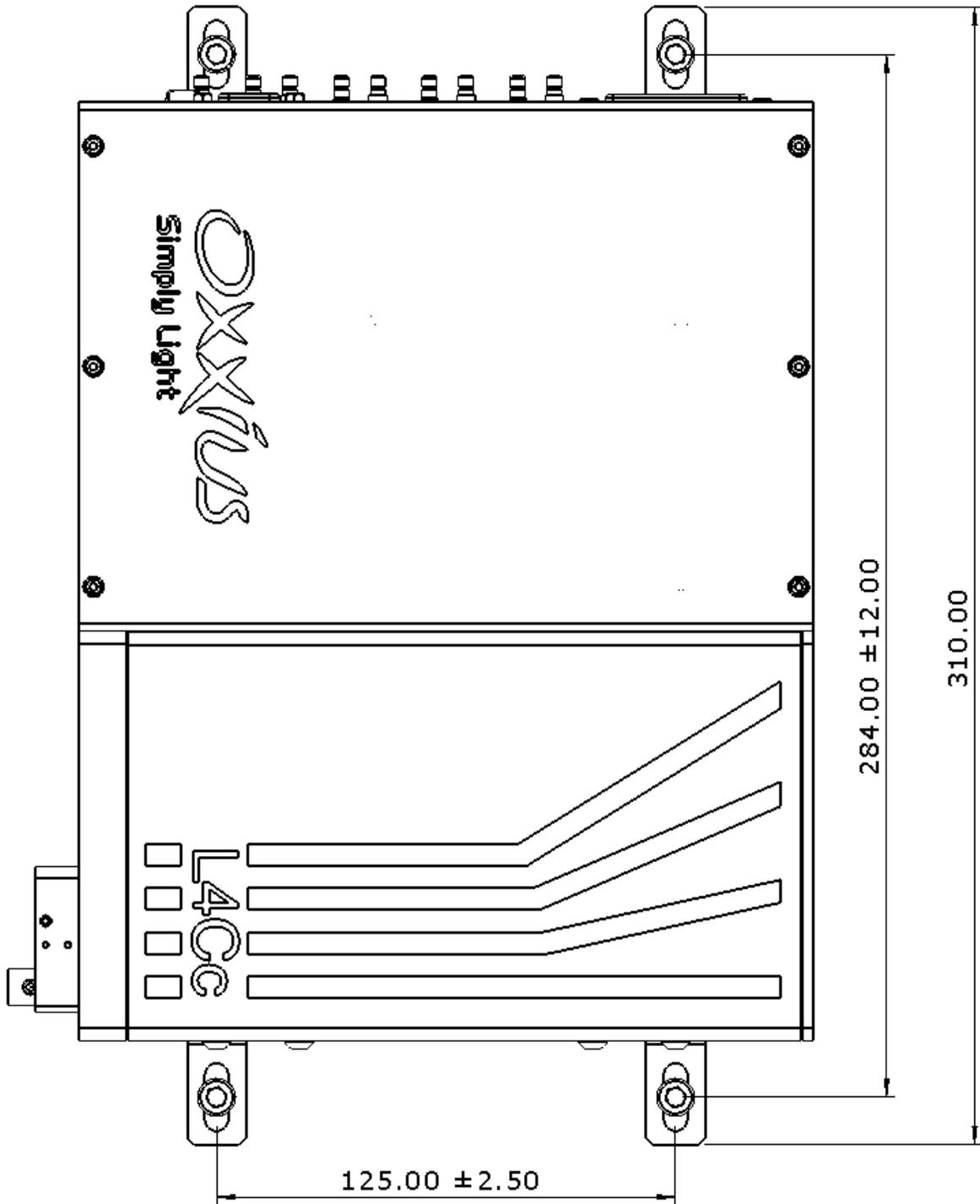
### L6CC LASER HEAD





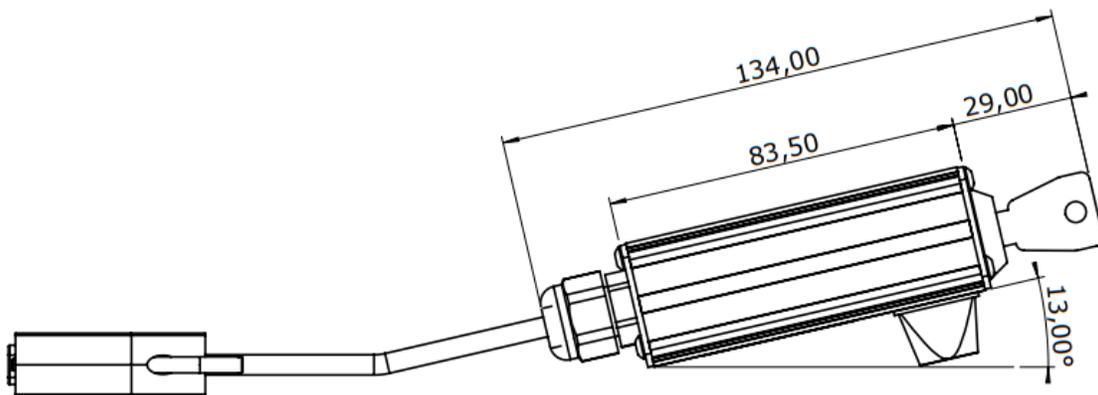
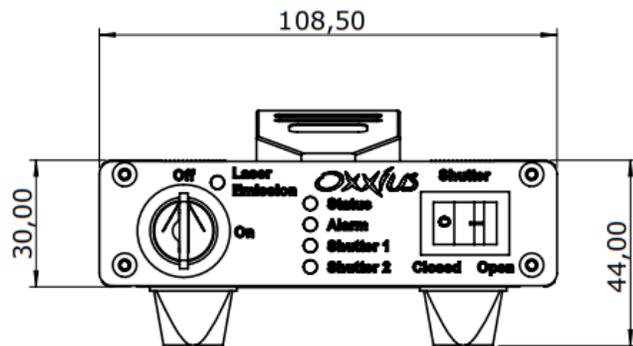
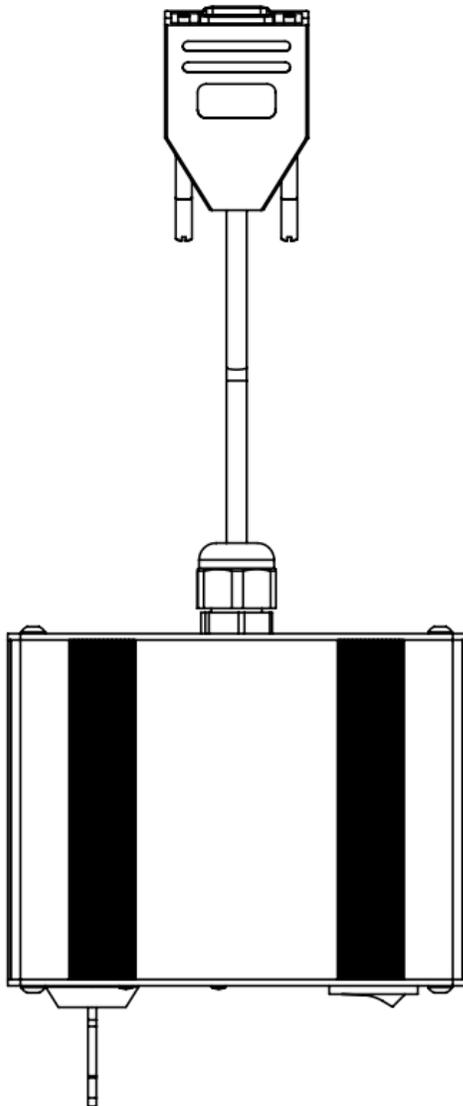
L4CC LASER HEAD





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# REMOTE CONTROL



## 8-6 Software commands and queries

### COMMANDS FOR THE COMBINER

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

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

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

#### Communication and identification:

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

Assigns a gateway IP address (for a static IP assignment)	EGA	“EGA 192.168.1.1” Assigns the gateway IP address to 192.168.1.1
Retrieves the assigned gateway IP address	?EGA	“192.168.1.1”
Assigns the subnet mask of the combiner (for a static IP assignment)	EMA	“EMA 255.255.255.0” Assigns the subnet mask to 255.255.255.0
Retrieves the assigned subnet mask	?EMA	“255.255.255.0”
Retrieves the MAC address of the combiner	?EMAC	“00:11:22:33:44:55”
Sets the TCP socket number. The combiner needs to be restarted after this variable has been modified.	ESO	“ESO 22300” Assigns the communication socket port to 22300.
Retrieves the communication socket port	?ESO	“22300” is the default value.
Sets the Ethernet communication speed	ESP	“ESP 0” : Auto-negotiation “ESP 1” : 10Base-T, full duplex “ESP 2” : 100Base-TX, full duplex
Retrieves the Ethernet speed	?ESP	“0”: Auto-negotiation
Retrieves the serial number of the combiner unit	HID?	“L4CC-XXXXX” on a L4Cc combiner, “L6CC-XXXXX” on a L6Cc combiner
Retrieves the model of the source on slot n (where n is a number from 1 to 6)	INF? n	“LCX-561-100” for a LCX LaserBoxx emitting 100mW at 561nm
Retrieves the firmware version of the combiner	?SV	“1.0.17”

Configuration and status:

Purpose	Query	Syntax and examples
Sets the regulation loop to “automatic constant current”	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

<p>Selects the analog modulation, and the mode of operation of the AOM</p>	<p>AM</p>	<p>AM 0 (AM,&lt;space&gt;,0): The analog modulation functions are disabled. The AOM is driven exclusively from software commands. Use the command “P” to set the output power.</p> <p>AM 1 (AM,&lt;space&gt;,1): The analog modulation functions are enabled on all LBX units. The AOM is driven by the analog modulation signal, but its maximum value is set using the command “P” below:</p> <p>When a voltage of 0V is applied, the output power is nil,</p> <p>When a voltage of 5V is applied, the output power equal the value set using the command “P”</p> <p>In this mode of operation, the modulation function between the input voltage and the output power is linearized.</p> <p>AM 2 (AM,&lt;space&gt;,2): The analog modulation functions are enabled on all LBX units. The AOM is driven exclusively by the analog modulation signal, its maximum value being the power delivered by the laser source linked to that AOM. In this mode of operation, the modulation function between the input voltage and the output power is not linearized (direct access).</p>
<p>Set the “autostart” function on all sources</p>	<p>AS</p>	<p>“AS 0” Configure all the sources not to emit on start-up, once the emission key is turned. Software commands will have to be sent to launch the emission</p> <p>“AS 1” Configure all the sources to emit on start-up, once the emission key is turned (provided that the conditions are met for emission)</p>
<p>Retrieves the status of the interlock circuit</p>	<p>?INT</p>	<p>“0” Interlock open, laser emission is not possible</p> <p>“1” Interlock closed, laser emission is possible</p>
<p>Retrieves the status of actuated key master control</p>	<p>KEY?</p>	<p>“0” the key is off, laser emission is not possible</p> <p>“1” the key is on, laser emission is possible</p>
<p>Sends the command “CMD” to the laser source on slot n (where n is a number from</p>	<p>Ln CMD</p>	<p>L1 AM 1 (L1,&lt;space&gt;,AM,&lt;space&gt;,1): enables the analog modulation on laser source number 1</p>

1 to 6). Refer to the specific commands for LBX and LCX in the following tables.		L3 INF? (L3,<space>,INF?): Get the model name of source number 3
Retrieves the status of the combiner	?ST	<p>“Lasers off” when the actuated key master control is off</p> <p>“Lasers on” when the actuated key master control is on and all the sources in use are emitting</p> <p>“Starting-up” when at least on laser sources in use is in “starting-up” status</p> <p>“Alarm” when at least one of the sources is in “alarm” status</p> <p>“Stand-by” when all laser sources are in “stand-by” status</p> <p>“Blanking” when the blanking function is activated</p>
Sets the bias voltage v on the AOM n (where n equals 1 or 2, and v is between 0 and 50). This value determines the extinction contrast of the AOM. We recommend a value of 20 for v.	TA n v	TA 1 20 (TA,<space>,1,<space>,20): sets the bias voltage to 20 on the AOM 1.
Retrieves the value of the bias voltage on AOM n (where n equals 1 or 2).	?TA n	“20”

Power and operational settings:

Purpose	Query	Syntax and examples
Sets the position of the flip mirror number p (where p is a number from 1 to 5). Each flip mirror can be set to either “0” or “1” positions	FMn	FM1 1 (FM1,<space>,1) toggle the flip mirror number 1 to its position “1”
Sets the position of the fast mirror number p (where p is a number from 1 to 2). Each flip mirror can be set to either “0” or “1” positions	GAn	GA1 1 (GA1,<space>,1) toggle the fast mirror number 1 to its position “1”
Sets the transmission ration of the “M-Dual” module	IPA	IPA 40 (IPA,<space>,40) sets a transmission ratio of 40% on channel 1

Sets the power set point on source number n (where n is a number from 1 to 6). On sources linked to a modulator (AOM, MPA), the set point of that modulator will be affected. The argument is an absolute optical power.	PLn	PL1 10.1 (PL1,<space>,10.1) sets the power of laser source L1 at 10.1mW
Retrieves the power set point on source number n (where n is a number from 1 to 6). On sources linked to a modulator (AOM, MPA), the set point of that modulator will be returned.	?PLn	"40.0" for a set point of 40.0 mW
Sets the power set point on source number n (where n is a number from 1 to 6). On sources linked to a modulator (AOM, MPA), sets the set point of that modulator. The argument is a percentage of the nominal power.	PPLn	PPL2 25.2 (PL2,<space>,25.2) sets the power of laser source L3 at 25.2% of its nominal power
Retrieves the power set point on source number n (where n is a number from 1 to 6), as a percentage of the nominal power. On sources linked to a modulator (AOM, MPA), the set point of that modulator will be returned.	?PPLn	"21.0" for a set point of 21.0 %
Open or close shutter on channel n (where n is a number from 1 to 4)	SHn	SH1 1 (SH1,<space>,1): opens the shutter on channel 1 SH1 0 (SH1,<space>,0): closes the shutter on channel 1

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## SENDING COMMANDS TO THE 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 to be addressed (L1 to L6).

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## COMMAND AND QUERIES FOR THE LCX LASERBOXX

Purpose	Query (and aliases)	Result and syntax
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		<p>“1” Emission is off</p> <p>“2” Emission is on at low power</p>
Retrieves the laser’s measured output power (in milliwatts)	<p>?P</p> <p>IP?</p>	<p>“53.6”</p> <p>“53.6 mW”</p>
Queries the state of the laser module (see section “Troubleshooting” for more information concerning the laser status)	<p>?STA</p> <p>DL?</p>	<p>?STA returns a number corresponding to one of the following status:</p> <p>“1” : Warm-up phase</p> <p>“2” : Warm-up phase completed, emission OFF</p> <p>“3” : Emission ON</p> <p>“5” : Alarm present</p> <p>“6” : Sleep mode</p> <p>“7” : Searching for SLM point</p> <p>“DL?” returns one of the following text messages:</p> <p>“Laser off”</p> <p>“Setting temperature”</p> <p>“Waiting for stabilization”</p> <p>“Starting up”</p> <p>“Laser on”</p> <p>“Laser alarm”</p>
Retrieves the status of the temperature regulation loop	<p>?T</p> <p>T?</p>	<p>“0” Temperature regulation loop is deactivated and the emission is off</p> <p>“1” Temperature regulation loop is activated, the emission is on</p>



Retrieves the monitored current of the laser diode	?C	"550.4" for 550.4 mA
Retrieves the status for digital high-speed modulation	?CW	"1" when engaged "0" when disabled
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 emission status	?L	"0" Emission is off "1" Emission is on
Retrieves the measured optical power	?P	"53.6" for 53.6 mW
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" : Warm-up phase completed, emission OFF

		<p>“3” : Emission ON</p> <p>“4” : Internal error raised</p> <p>“5” : Alarm present</p> <p>“6” : Sleep mode (see also the query “?T”)</p>
Retrieves the status of the temperature regulation loop	?T ?SS	<p>“0” Temperature regulation loop is deactivated, unit is in “sleep” mode</p> <p>“1” Temperature regulation loop is activated</p>

Purpose	Command (and aliases)	Syntax and examples
Sets the regulation loop (see also “APC”)	ACC ANA	<p>ACC 1 (ACC,&lt;space&gt;,1): set the ACC mode</p> <p>ACC 0 (ACC,&lt;space&gt;,0): set the APC mode</p>
Sets the analog modulation	AM EXT	<p>AM 1 (AM,&lt;space&gt;,1): enables the analog modulation</p> <p>AM 0 (AM,&lt;space&gt;,0): disables the analog modulation</p>
Sets the regulation loop (see also “ACC”)	APC	<p>APC 1 (APC,&lt;space&gt;,1): set the APC mode</p> <p>APC 0 (APC,&lt;space&gt;,0): set the ACC mode</p>
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%.
<p>Sets the laser diode current, but does not record this value in memory, thus sparing stress on the internal EEPROM.</p> <p>Prefer this command to “C” if you need to change the current at high frequency (ten times per second or higher).</p>	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	<p>CW 1 (CW,&lt;space&gt;,1): disables the digital modulation</p> <p>CW 0 (CW,&lt;space&gt;,0): enables the digital modulation</p>

<p>Sets the laser power, then saves this value as the new default.</p>	<p>P</p>	<p>P 20 (P,&lt;space&gt;,20) sets the optical power at 20mW. Values allowed between 0 and the maximum power (see the query ?MAXLP).</p>
<p>Sets the laser power, but does not record this value in memory, thus sparing stress on the internal EEPROM.</p> <p>Prefer this command to “P” if you need to change the power at high frequency (ten times per second or higher).</p>	<p>PM</p>	<p>PM 20 (PM,&lt;space&gt;,20) sets the optical power at 20mW. Values allowed between 0 and the maximum power (see the query ?MAXLP).</p>
<p>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.</p>	<p>T</p>	<p>T 0 (T,&lt;space&gt;,0): switches the emission off, and sets the operating status to “sleep” mode (see “STA”).</p> <p>T 1 (T,&lt;space&gt;,1): switches the emission back on. The unit is no longer in “sleep” mode.</p>

