integrated optics ®

MatchBox series

Continuous Wave laser

User's Manual

Version 2.5 October. 2020

INTRODUCTION

As the title hints, MatchBox® products are ultra-compact, single-unit laser sources with overall dimensions comparable to a regular matchbox (30x50x18 mm^3), connector pins not included.

The MatchBox® series include a range of continuous wave laser sources, featuring wide range of wavelength, output power, output type and line-width options.

The series is composed of solid state (DPSS) lasers, passive Q-Switch short-pulse lasers, multi-wavelength lasers based on classical dichroic combining, as well as direct laser diode (LD) lasers. Despite the different technical implementation, physical and electrical properties, usability and connectivity are almost identical throughout the series, representing our commitment to perfect user experience and faster time to market for our customers.

Please take your time to read this instruction manual which provides essential information about the usage of the continuous wave single-wavelength lasers. We have also included various hints and tips that will help you to get the most out of a certain laser source.

CONTENTS

1. SAFETY INFORMATION

1.1: Labels

Along the text you will find icons designed to draw your attention to different bits of safety or otherwise important information:

This icon is used to draw your attention to important information, related to the usage of a laser.

This symbol is a warning sign. It marks safety precautions related to optical laser radiation and alerts the operator to the danger of exposure to hazardous visible or invisible laser radiation.

This symbol is a warning sign. It marks safety precautions related to electrical safety and alerts the operator about the presence of dangerous voltage, which might appear on certain conditions. Electric shocks caused by such voltage may constitute risks to the operator and the equipment used.

Figure 1-1. Labels on a side of the laser indicates product safety information. MatchBox lasers belong to the class 3B or class 4.

Figure 1-2. Serial number is marked on the back of the laser body, right above the pin connection.

1.2: Electrical safety

Do not disassemble the enclosure. All units are designed to be operated as assembled. Warranty will be voided if the enclosure is opened.

Electric shocks from an unsuitable or poorly grounded power supply, can cause extreme pain, severe burns, cardiac arrest and in some cases can be even lethal, that is why the operator should always obey the safety measures given below.

The laser body of MatchBox is connected to the ground, this means that all internal electronics share the same ground of the laser body.

It is recommended to make sure that the power supply used with MatchBox laser pin connection, is well grounded and that there are no grounding interruptions with other devices. Otherwise it can be dangerous for an operator and it can cause malfunction of the laser.

1.3: Optical Safety

Light, emitted from a laser source, features hazardous properties, as compared to conventional light sources, such as: luminescent bulbs, light

emitting diodes and etc. It is important for users or other persons approaching to laser systems, to know the dangers involved. Only users, who are familiar with laser safety should use laser systems, this way the risks of laser radiation related accidents would be minimized.

MatchBox lasers are Class 3B laser products with rare exceptions of Class 4. Different models are arranged to emit up to 500 mW of visible or invisible (infrared) radiation. Several models emit continuous wave (further shortened to CW) laser radiation up to 1W of optical power.

The radiation is hazardous if the eye is exposed directly to the beam or to it's specular reflection. The risk of permanent eye damage or even blindness increases due to longer exposure time.

Diffuse reflections as those from paper or other matte surfaces are typically not harmful if observed at a distance of 1 m (3 ft) or larger.

The use of eye protection when operating a MatchBox laser is necessary if at any circumstances the laser beam could be exposed to an eye directly or through a specular reflection.

Eye protection in the form of spectacles or goggles is preferred to be with appropriate wavelength filtering. For example, spectacles absorbing waves of spectral region from 180 to 532 nm are suitable to work with e.g. 405 nm, 457 nm, 473 nm, 488 nm, 491 nm, 515 nm and 532 nm MatchBox lasers. However, these spectacles shouldn't be used to filter 561 nm, 593 nm waves or radiation in the red and infrared regions.

Protective eyewear provides another significant advantage - when working in dark rooms, laser radiation could haze user's eyes even if it is observed from diffuse reflections. Properly chosen eyewear definitely reduce or even eliminate such haze and extend productive hours.

The beam emitted from Class 3B and Class 4 lasers can easily damage photosensitive surfaces like those found in photodiodes, CCD cameras or

photomultipliers. It is important to make sure that an unattenuated beam does not strike any of aforementioned devices directly. Calculation of allowed fluency is necessary before using such devices with our lasers.

In addition to laser safety from the laser source alone, given safety precautions must be followed:

- Experimental setup must ALWAYS be horizontal and below eye level;
- To avoid accidental exposure, never bend over or look down. If something falls off of experimental setup, user must first turn off the laser or close the mechanical shutter and only then pick up the fallen parts;
- Use protective shields or filters to get rid of unnecessary reflections and scattering;
- User must never wear any kind of jewellery or watches while using the laser system to avoid any laser beam reflections from those surfaces;
- The laser system must be used in a closed room, because high power and collimated laser beam can damage biological tissues even at long distances;
- Extreme precautions must be taken while using volatile substances in laser operational area;
- High level of ambient light in laser operating room should be maintained whenever it is possible, in order to keep the pupil of the eye as small as possible and to prevent the risk of eye damage;
- Warning signs must be posted near the entrance to the laser operation area and inside of it;
- Use of laser must be limited to users, who are completely familiar with the rules above.

1.4: Laser Safety and Classification

The European requirements for Electromagnetic Compatibility (EMC) are specified in the EMC Directive (published in 2004/108/EC).

Conformance (EMC) is achieved through compliance with the harmonized standards EN55011:2009 for emission and EN61000-6-1:2007 for immunity.

The laser meets the emission requirements for Class 3B or Class 4 as specified in EN55011:2009.

Compliance of lasers within the MatchBox series with the (EMC) requirements is certified by the CE mark.

MatchBox lasers are OEM dedicated lasers and usually come without necessary safety means. OEM type products are designed for installation into Class 1 enclosures. However, by adding accessories like beam shutter and key-switch, CDRH compliance is reached.

The CDRH Accession Number for the MatchBox series lasers and wavelength combiners is: 1810832-000.

The MatchBox CW laser alone has a simplified physical interface with 5 pins. These pins have power supply, communication bus (UART) and programmable pin for modulation or fan control (predefined for different laser types) inputs/outputs. This interface is sufficient and convenient for OEM laser integration.

However, for quick laser installation into scientific setups a Break-out-Box comes handy to provide interlock, USB or RS232 control, modulation and fan power supply connector, complying the CDRH requirements.

2. DESCRIPTION AND SPECIFICATIONS

2.1: Part Numbers

The part number is composed for the MatchBox series CW lasers as follows:

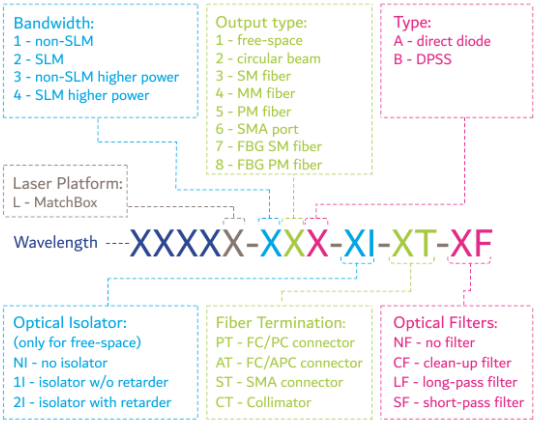

Figure 2-1. Understanding part numbers of the MatchBox CW lasers.

The part number of MatchBox lasers is composed of five sections:

- First section defines wavelength and platform;
- The second is for bandwidth, output type and over all type (direct diode or DPSS)
- The third is for optical isolator option;

- The fourth is for fiber termination;
- The last one is for optical filters installed inside the laser enclosure.

2.2: Description of Series

The MatchBox laser system contains laser source with integrated power electronics. The system can be mounted on a heatsink accessory and a Break-out-Box can be used for converting UART communication to either USB or RS232.

The MatchBox laser system provides power, consistency and great performance in one of the smallest packages at one of the most attractive price levels available in the market!

2.3: Thermal Management

The MatchBox series includes DPSS (Diode pump solid state) and direct diode lasers.

Depending on model, one or two thermo-electric coolers (TEC) are equipped inside the enclosure for thermal management of a pump laser diode and associated optics. Thermal stabilization of all critical components is very important for low-noise and efficient operation of the complete laser.

Depending on laser configuration, cooling of 5 to 25 W (5 to 10 W for most diode lasers and 15 to 25 W for DPSS) may be required in a form of TEC-cooled, conduction-cooled (AM-H8/AM-H3) or water-cooled (AM-H4) heatsink, attachable to the bottom side of the laser.

Also, depending on a laser model, a suitable heatsink must have low thermal resistance. For DPSS lasers, thermal resistance of <0.5 °C/W is recommended, while for diode lasers <1 °C/W is sufficient. <0.5 °C/W requirement is usually met by a larger passive copper heatsink or an actively cooled aluminium heatsink.

In case of specific applications, such as holography, interferometry and quantum cryptography, where narrow-linewidth lasers are being used in varying environment temperature, the internal TEC of the laser might not provide sufficient thermal stability to maintain high level of coherence and central wavelength stability. For these applications Integrated Optics, UAB released a number of TEC based coolers and adapters (AM-H9, AM-H10, AM-H11), which provide the extra stability needed. Furthermore, these heatsinks provide higher thermal handling capacity and/or extend operational temperature range for continuous-wave lasers.

Additionally, Integrated Optics, UAB offers adapter plates, which help to accommodate the MatchBox laser in place of previously installed laser of other brands. However, adapter plates need to be attached to heatsinks, having sufficiently low thermal resistance.

For efficient cooling, make sure that there are no other heat radiating devices, such as heat exchangers, heaters or computers in the proximity of the laser. Also, make sure that the laser is not covered with or obstructed by any obstacles, which could prevent air circulation around the laser.

All MatchBox lasers are equipped with internal thermal protection feature. If the internal temperature reaches 45 °C, the laser shuts down. If the laser starts to blink, turn it off and ensure better heat dissipation by decreasing the heatsink temperature and increasing the heat dissipation capabilities thereof.

2.4: Power Supply

The MatchBox series include a variety of lasers featuring different power ratings, thus requiring different power supply parameters. Power supply requirements are provided below.

Table 2-1. Power supply requirements regarding laser type.

Type	Part No.	MAX Current at 45 °C	Typical Current at 25 °C
DPSS	XXXXL-XXB	4 A	1-2 A
LP Diode	XXXXL-1XA and XXXXL-2XA	0.6A	0.2-0.4 A
HP Diode	XXXXL-3XA and XXXXL-4XA	1 A	0.4-0.5 A

Voltage of 5 V is needed to be supplied for this type of MatchBox series lasers. Lasers of the same model could require different current. For instance, low-power laser 405L-21A needs maximum current of 0.6 Amps and typical of 0.3 Amps, whereas it is estimated that low-power laser 785L-21A needs maximum current of 0.3 Amps and typical of 0.2 Amps.

To power MatchBox CW lasers with power delivery (PD) type power supplies, Integrated Optics, UAB recommend using a Break-out-Box, further BoB. The BoB triggers the power supply to run at 9 V and converts it to 5 V internally.

For direct diode lasers the optimal power supply that is 18W PD type USB power supply (AM-P7), while for DPSS lasers it is recommended to use 25 W, but optimally 45W to 60W PD type (depending on other accessories used) power supply (AM-P8).

To understand, the specifics of power supply requirements for your MatchBox laser, better, power supply requirements regarding laser type during start-up are depicted below.

Table 2-2. Power supply requirements regarding laser type during start-up.

Type	Part No.	MAX Current at 45 °C	Typical Current at 25 °C
DPSS	XXXXL-XXB	4.0 A	2-3 A
LP Diode	XXXXL-1XA and XXXXL-2XA	1.8 A	1-1.2 A
HP Diode	XXXXL-3XA and XXXXL-4XA	2.2 A	0.8-1.2 A

The values in the table are not absolute for all lasers and can vary from laser to laser.

2.5: Cables

The MatchBox laser features an OEM design, where integrators implement their own physical interface to connect directly to the pins of the laser. This is the reason why it is sold without any cables in its standard configuration. However, standard cables are handy for end-user setups, and therefore MatchBox accessories come with compatible cables: power supplies are shipped with USB-C to USB-C type cables for power delivery and Break-out-Boxes are shipped with USB-A to USB-micro cables for data communication.

Please contact Integrated Optics, UAB for a customized physical interface for data and power.

2.6: Power and Signal Connections

The MatchBox laser alone has a simplified physical interface with 5 pins with 2.54 mm spacing (Figure 2-2). These pins are 0.7 mm diameter and have power supply, communication bus (UART) and programmable pin for modulation/fan (predefined for different laser types) inputs/outputs. This interface is sufficient and convenient for OEM laser integration.

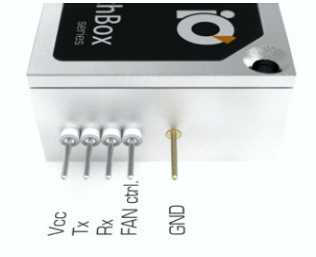

Figure 2-2. Pinout on the back side of the laser.

Viewing left-to-right, the pins are dedicated for: first pin is for VCC, next two are UART bus interface pins Tx and Rx, then follows a multifunctional programmable pin for TTL modulation or fan speed control. An empty slot is used as a key, ensuring that the female pinhead connector will not be polarizing in a wrong orientation or position. The fifth pin works as a ground. The ground pin is soldered into the enclosure of the laser, thus complete laser body is grounded.

2.7: Specifications

The MatchBox series includes a variety of lasers featuring different wavelength and power ratings. The actual specifications of a laser are provided in a test report accompanying a laser, which is sold to the customer. General specifications for all laser models can be found at www.integratedoptics.com , you can scan the QR code below for a quick access to our website:

2.8: Mechanical Design

The laser sources within the MatchBox series employ a single-box design, which means that all optics, power electronics and thermal management components are arranged inside a single enclosure.

The overall dimensions of the laser are 30 x 50 x 18 mm^3 (Width x Depth x Height), not taking into account the connecting pins, which are used for connecting the laser to a power source and control interface. The pins extend approx. 10 mm from the back of the laser. Different output options, such as free-space output with or without a mechanical shutter,

permanently fixed fibers, have different arrangements on the front facet of the laser.

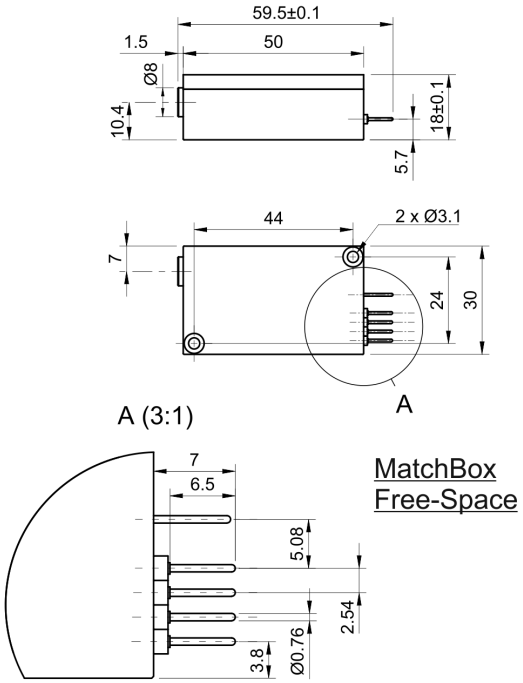

Figure 2-3. Top and side view drawing of the MatchBox free-space laser.

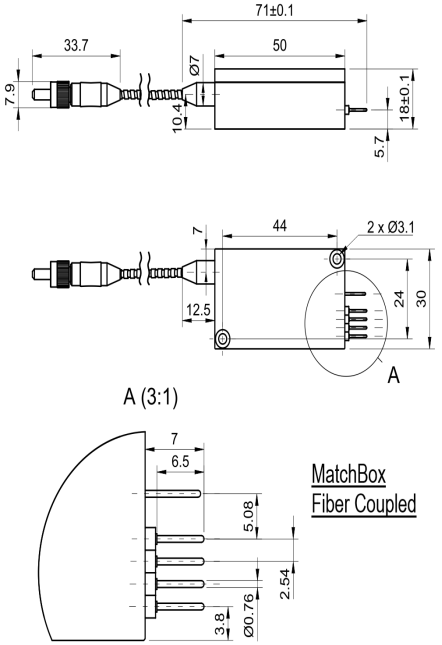

Figure 2-4. Top and side view drawing of the fiber coupled MatchBox laser.

2.9: Laser Output Options

MatchBox laser sources are offered in two main configurations regarding to the type of the output.

Free-space output is commonly used in compact (portable) laser setups, where working area (an object to be irradiated) is relatively close to the laser source and the beam could be delivered directly or using just a few mirrors.

Furthermore, the free-space output versions are provided with a PTFE safety cap (not shown in pictures), which might be necessary for a scientific open-frame setup. The cap must be attached to the output window, whenever the laser is not operating or when it could be shut for a short period of time, in case minor adjustments need to be made without stopping the laser, thus stable operation is not lost. The cap helps to keep the output window clean during maintenance of the setup.

In all other cases, it is advisable to trigger the interlock function found on all attachable control interfaces of the MatchBox laser. If triggered, it disconnects the power supply of the laser.

Figure 2-5. Free-space output version of the MatchBox laser.

Permanent fiber pigtailed output has few modifications, though it looks essentially similar. The difference is in the fiber type, which is represented by the indicating colour: multi-mode (orange), single-mode (yellow) or

single-mode polarization maintaining (blue) fiber, could be arranged with this output type.

Fiber with metal protection bend radius is 30 mm and fiber without metal protection bend radius is 20mm.

Lasers with non-detachable fibers feature lower output power, 2-3 times worse output power stability, but significantly improved beam shape and homogeneity, as compared to free-space versions.

As standard, fiber pigtailed lasers do not have auto-start enabled. If one enables the auto-start function, please make sure the metal cap is removed from fiber tip before operating the laser. If the cap is not removed, the metal will heat up and damage the fiber tip. This would not be a warranty case.

Figure 2-6. PM fiber, fiber-coupled MatchBox laser.

Lastly, Integrated Optics, UAB offers MatchBox laser sources with a **SMA port**, shown in Figure 2-7. Such lasers are supplied with a metal safety cap (not shown in picture). The cap must be attached to the SMA port, whenever the laser is not in operation or it could be shut for a short period

of time, in case minor adjustments need to be made without stopping the laser, thus stable operation is not lost.

This output option is designed for custom multi-mode fiber installations. Fiber can be supplied optionally upon clients request.

Figure 2-7. SMA port output version of the MatchBox laser

2.10: Operating Environment

MatchBox lasers are designed to be operated in non-condensing environment, in temperature range between 20 and 29 °C. Whether the customer needs to operate the laser at higher temperature, such option has to be provided by Integrated Optics, UAB during assembly of the laser. The temperature range can also be extended by attaching the laser to a cold plate, which has surface temperature in the aforementioned range and good thermal conductivity parameters.

Dusty environment might cause collection of debris on an output of the laser. Therefore special maintenance, such as cleaning of the exterior of the output window or the fiber tip must be performed from time to time in order to keep the laser power within the desired power range and extend the lifetime of the laser.

3. INSTALLATION

3.1: Preliminary Checks

Every MatchBox unit is packed in an antistatic foam package, which is arranged to protect electronics inside the laser from charge accumulation. The same foam is also used for absorbing mechanical shocks well during transportation. Further, the foam is packed into a carton box.

Figure 3-1. The package of a MatchBox CW laser.

Make sure that shipping boxes do not have any signs of damage. In case of inspected damage, do not accept the package. Such case scenario should be immediately reported to the shipping carrier, to Integrated Optics, UAB administration or to an authorized MatchBox distributor.

During unpacking, keep the box in a horizontal position. In order to see the laser, carefully remove the upper part of the foam inlay, which contains accessories and cables.

After unpacking, save the laser package boxes for potential later shipments.

Table 3-1. Contents of a typical package.

Item	Quantity
Laser Source	1 unit
Thermal Paste (1 gram)	1 unit
Countersunk Screws of M2.5x25 mm	2 units

If there is an extra screw, it is used for mounting the Break-out-Box to a heatsink or an adapter.

Power supplies and bigger accessories, such as heatsink, Break-out-Box, Break-out-Box with RS232, key-switch, accessory bundles or external control interfaces may be included in the same box or packed separately.

3.2: Heatsink Requirements

To ensure satisfying operation and for the warranty to be valid, the MatchBox laser must be attached to a heatsink, providing a required thermal resistance. Various types of MatchBox lasers have different thermal resistance requirements, to find out more, see “Thermal Management” on page 12.

Integrated Optics, UAB recommends to use a thermal paste between a MatchBox continuous-wave laser and a heatsink to provide proper thermal contact.

The mounting surface of a heat sink should be flat within <0.05 mm over the mounting surface.

Table 3-2. Heatsink requirements regarding laser type.

Type	Part No.	Optimum Heatsink Temp	Thermal Resistance
DPSS	XXXXL-XXB	15-30 °C	0.5 °C/W
LP Diode up to 200 mW output power	XXXXL-1XA and XXXXL-2XA	15-30 °C	1 °C/W
HP Diode up to 500 mW output power	XXXXL-3XA and XXXXL-4XA	15-30 °C	0.5 °C/W

For assistance in thermal management and system integration, please contact Integrated Optics, UAB technical support.

3.3: Heatsink Installation

The CW MatchBox configurations include DPSS and direct diode lasers, whereas the higher power DPSS lasers tend to generate more excessive heat than diode lasers.

Furthermore, all MatchBox lasers are equipped with an internal TEC (Peltier) thermal management element, which, when operated, generates even more heat to stabilize the optical components inside the laser, thus it is required to attach the laser enclosure to an external heatsink. Optimal enclosure's temperature for most effective and stable laser operation is 25-28 °C.

In case laser installation does not meet heatsinking requirements, internal thermal protection stops the laser operation whenever the internal (laser diode) temperature reaches around 45°C.

To find out more about Integrated Optics, UAB heatsinks and heatsinking requirements, see "Thermal Management" on page 12.

In order to mount a laser on a heatsink appropriately, please follow these steps:

1. Secure a heatsink to a desired location. Ensure that proper air flow is granted and room temperature is not over 30 °C.

2. Apply a thin layer of thermal paste to the interface between a laser and a heatsink. Spread the paste evenly and remove the surplus.

3. Mount a MatchBox laser head to a heatsink with M2.5 screws (provided in the package).

For the best performance, screws for fixing the laser to a mounting surface should be screwed with tightening torque of 0.25 - 0.35 N·m.

3.4: Starting the laser

Starting a MatchBox CW laser is quite simple:

1. The laser has to be mounted and secured on a heatsink;

2. A Break-out-Box or any other UART has to be connected to the laser pins. However, if no communication with laser is required, UART is not necessary and the laser can be operated by supplying power to its' VCC and GND pins;

3. 5 V at 1.5 A (4-5 A for DPSS lasers) has to be supplied directly to the laser pins, or 9-12 V at 3 A with power delivery type power supply, has to be supplied to the Break-out-Box;

4. Once the laser is powered up, it is ready to be connected to the software and operated.

No user adjustments are possible inside the laser. Never open a laser module. Any attempt to open a laser enclosure will damage it and render the warranty void.

Maintenance of the product is done exclusively by Integrated Optics, UAB personnel at the factory.

To control a continuous-wave laser through Integrated Optics, UAB software, firstly it has to be installed.

Follow these steps to install Integrated Optics, UAB software:

1. Download the MatchBox control software at the "Downloads" section on our website (more in depth explanations are shown on our Youtube page).

2. When the download is finished, extract .zip file to a desired directory.

3. After the .zip file is extracted, the CP210xUSB to UART Bridge Driver has to be installed. Depending on the operational system of a computer, click on either CP210xVCPInstaller_x64 or CP210xVCPInstaller_x86.

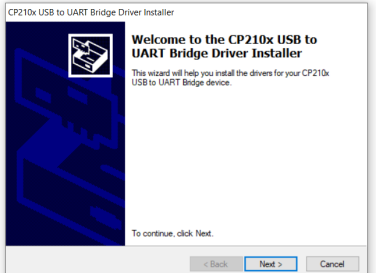

Figure 3-2. Initial installation window.

4. While installing the driver a user will be asked to read and accept the license agreement to proceed.

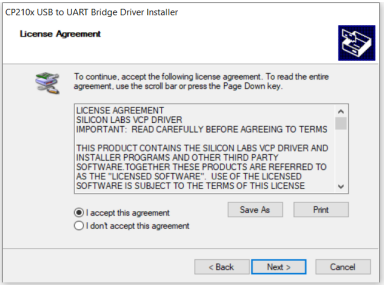

Figure 3-3. License agreement window.

5. After the agreement is accepted, the driver will automatically install and a user is informed about the successful installation.

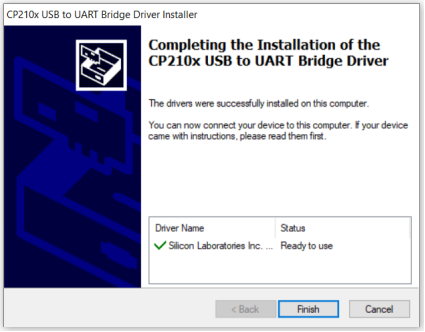

Figure 3-4. Installation complete window.

6. When drivers are installed successfully, the MatchBox-Controller file can be opened. It is a portable application and it does not need to be installed.

See section “Laser Control Software” on page 33 to learn about the use of the control software.

4. OPERATION

4.1: Operating Fiber Coupled Laser

Fiber coupled diode or DPSS laser is a compact and robust unit for alignment-free operation throughout the lifetime of the laser.

Proprietary fiber coupling technology ensures good power stability and excellent fiber-coupling efficiency.

FC/PC connector is provided as a standard for all non-SLM lasers, the same configurations of SLM fiber-coupled lasers come with FC/APC, in order to minimize impact from back-reflections. In any case, the pigtail length is approximately 1 m. Other connectors and fiber lengths are available on request.

Fiber with metal protection bend radius is 30 mm and fiber without metal protection bend radius is 20mm.

Figure 4-1. Exemplary Fiber-Coupled MatchBox Laser with MM Fiber.

The fiber cap has to be removed before turning the laser on. Starting the laser with a safety-cap attached might damage the laser and render the warranty void.

Fiber coupled lasers must be turned on via MatchBox laser control software. The autostart function shall be only enabled after careful consideration of laser safety and potential contamination of the fiber tip.

4.2: Operating Free-space Output Laser

Free-space output MatchBox lasers series deliver superior performance regarding power stability, signal to noise ratio, beam properties, polarization contrast and many more. Plug and play operation allows the customer to use the laser as soon as possible, saving hours of precious time.

Scientific open-frame setups might require full CDRH compliance. The PTFE cap (provided with each free-space laser) can be used as a shutter, i.e. attached to the output window or a mechanical shutter assembly can be purchased from Integrated Optics, UAB. Using these options a laser is not in operation or it could be shut for a short period of time, in case minor adjustments need to be made without stopping the laser, thus stable operation is not lost.

In all other cases, it is advisable to trigger the interlock function found on all attachable control interfaces of the MatchBox laser.

Full CDRH compliance is reached only with additional accessories. Please contact your sales or technical support for recommendations.

Free-space lasers start instantaneously when power is applied, i.e the auto-start function is enabled by default at the factory.

Figure 4-2. Exemplary Free-space Output of MatchBox laser.

4.3: UART bus

UART (Universal Asynchronous Receiver/Transmitter) is a commonly used communication device in computer based systems. Integrated Optics, UAB offers a few UART communication options: it can be converted to USB and RS232 by using a Break-out-Box with USB control interface (AM-C8) or RS232 control interface (AM-C3).

4.4: Laser Control Software

The control software incorporates many useful parameter settings and readings. It also displays operational hours and times the laser has been started. To install the MatchBox software see chapter “Starting the laser” on page 27.

To connect a MatchBox CW laser to the software, the user must connect the UART or a Break-out-box (AM-C8/AM-C3) to the laser, connect the power supply, power up a laser and plug the communication cable to UART and a computer. Once this cable is connected to both devices, it is

advised to check in ‘Device manager’ (in Windows operating system) if a COM port is created. Once the COM port is created open Integrated Optics, UAB laser control software and choose a required serial port. If no ports appear, refresh the software window by clicking the ‘refresh’ button at the bottom of the page. Once the serial port appears, the laser is ready to connect to the software.

Figure 4-3. Laser connection window

When a laser is connected to the software, all information that is saved inside a laser and all control options will be read and displayed by MatchBox software.

Information about laser firmware version, serial number, model, operating duration and times the laser was started will be provided on the right side of the application window in the section ‘more...’

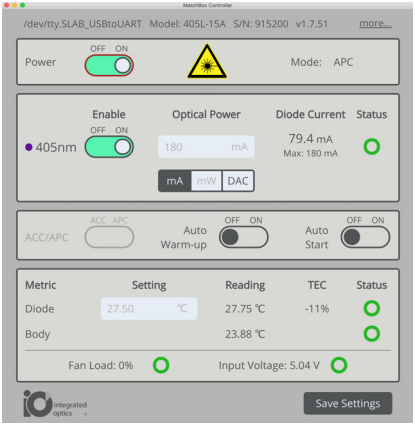

Figure 4-4. The main software window for CW lasers.

The software window is shown in Figure 4-4. The window is divided in four segments. Each segment represents different control fields of the MatchBox laser:

Right above the first segment a port number, an item name, a serial number and a hardware version can be seen. **The first segment** is used to turn on the power of the laser. Once the power is enabled, a laser will start warming up. A warning sign can be seen in this segment too. It indicates weather the laser power is on or off. Next parameter seen in this column is operating mode of the laser. There are three types of operating modes:

if laser beam is turned off, but power is on, the laser is in warming mode - Wrm;

if laser is in ACC mode, it means that laser is in automatic current control mode. It keeps the laser diode current constant and output power can only be changed by changing mA value;

if laser is in APC mode, it means that laser is operating in automatic power control mode. It keeps the laser output power constant. Output power can only be changed by changing mW and DAC values.

The second section of the software window is used for laser power control. You can enable or disable laser radiation, change the units of optical power setting. This column also shows the current of the laser diode - its maximum value and the actual current. In the status bar if the circle is green, the laser is emitting light, if it is grey, laser radiation is turned off.

The third section is for controlling operation modes of the laser - ACC/ APC, auto-Warm-up, auto-start. However, changing ACC to APC operation modes requires access level 2.

The last section is for observing temperature of the laser body and the laser diode, cooler status, fan load and laser input voltage.

Any warning signs seen in the main window display provide explanations if clicked on them.

Grey-like parameter settings are unavailable to the user.

If laser is connected to the computer, but no devices are shown, please check if USB port is connected correctly. After checking the connection press ‘refresh’ button, until the device is shown.

Whether some parameters are changed, they are not saved automatically. This is done intentionally for several reasons. If the new

laser parameters make the laser operate undesirably, the user can always simply disconnect the laser from USB and power supply and connect it again - the old settings will be restored and displayed on the screen.

Another reason not to write new parameters in the memory is limited write cycles of the EPROM. Especially if integrators are making their own control software, having, for example a slider for power setting, one stroke of such slider might result in hundreds of values saved in the EPROM, reducing its' cycle capacity.

In order to save newly set parameters in the laser memory, user must press 'Save settings' at the bottom of the main software window.

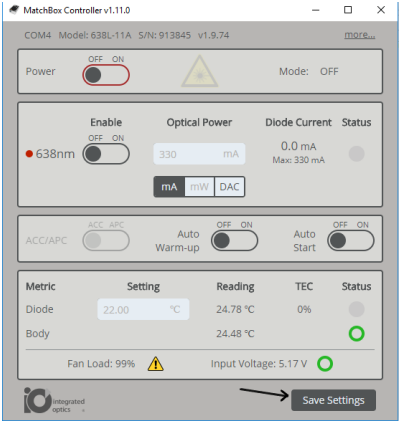

Figure 4-5. In order to save newly set parameters, press 'Save settings'.

Next, we will briefly describe particular lines of the software window. These lines are accessed through ‘more...’ section in the top right corner of the main software window.

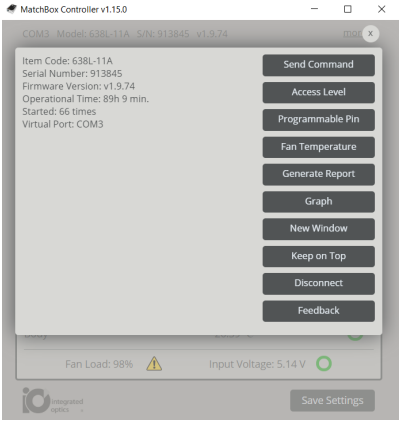

Figure 4-6. ‘more...’ section view

‘more...’ section provides detailed information about a laser: item code, serial number, firmware version, operational time (laser working time), started time (how many times turned on), and virtual port. Also this section provides other laser control options.

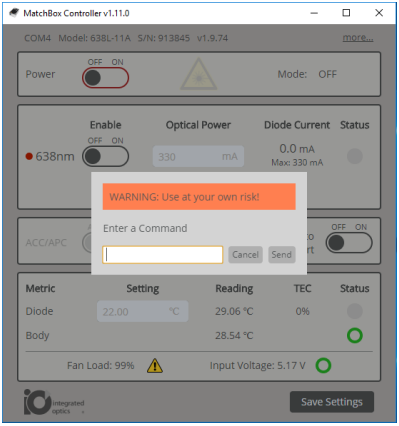

Figure 4-7. 'Send Command' section view

'Send command' section is used for sending commands directly to the laser. See which commands can be sent in paragraph "Communication Command Table" on page 46

Entering commands with higher access levels might cause undesirable laser function.

'Access level' function is used as a protection that allows different type of users to operate the laser safely without a risk to misconfigurate it.

By default access level for all lasers used without control software is 0. However, if laser is connected to the control software, the access level automatically changes to level 1.

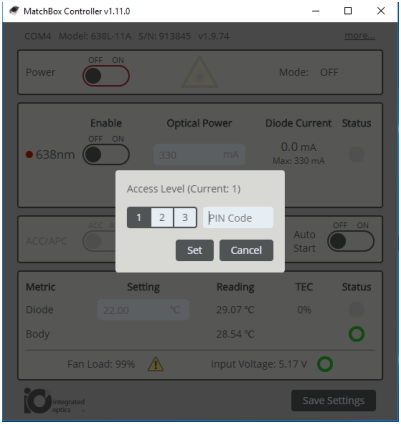

Figure 4-8. 'Access level' section view.

If laser is operated without control software, access level can be changed to Level 1 with a command 'c u 1 1234'.

For access level 2 and level 3 code please contact your distributor or Integrated Optics, UAB technical support.

If access level is changed to level 2 or 3, after the software re-load or laser turn off, access level restores back to level 1 or 0 (depending on whether laser is used with control software or without).

If access level is not sufficient to execute a command, the laser will return <ERR 1>.

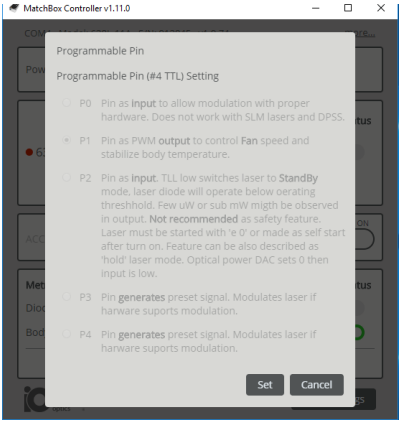

Figure 4-9. 'Programmable pin' section view

'Programmable pin' section is used to define programmable pin configuration. To program this pin access level 2 or 3 is required.

'P0' setting is for direct diode laser TTL modulation (electronics version 1.3v);

'P1' setting is for fan control. Programmable pin controls fan speed according to built in transistor which provides 0-5 V PWM signal depending on laser body temperature;

'P2' setting is reserved for future development;

'P3' setting is for using programmable pin as interlock. Once interlock is triggered, the laser should be re-started. If interlock is restored, the laser doesn't turn on automatically;

'P4' is for DPSS type continuous wave laser TTL modulation (electronics version 11.4.XX). Modulation speed is up to 500 Hz.

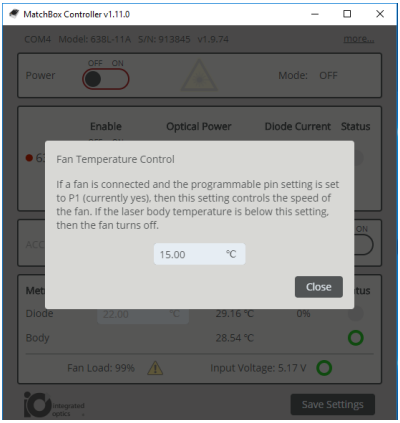

Figure 4-10. 'Fan Temperature' section view

'Fan temperature control' section is used for controlling fan rotation speed. Fan speed can be set to maintain the laser body temperature in the range from 15 deg.C to max 35 degrees. Controlling fan speed helps to stabilize laser body temperature and prevents it from heating up.

If the temperature in the environment is too hot, e.g. 30 deg. Celsius or higher, or the surface area of the heatsink is too small to radiate enough heat, the fan speed control might not be enough and at some point the temperature of the laser body will keep rising until the laser shuts down at the pre-programmed temperature level.

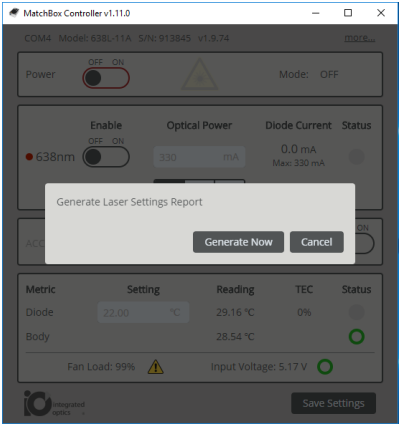

Figure 4-11. 'Generate Report' section view.

'**Generate report**' section provides user the ability to generate a report about the laser. This report generates information about what settings were set, what are laser readings, like, temperature, diode current and other parameters. This is a very helpful tool, which should be provided to Integrated Optics, UAB technical support, if any issues occur.

Laser will start emitting light as soon as the 'Enable' button is ON. Please make sure that there is no risk of getting the laser to radiate to an eye or skin of a person, as outlined in the chapter "SAFETY INFORMATION" on page 5.

Before starting the laser, make sure that the cap is taken off of the output window or a fiber connector.

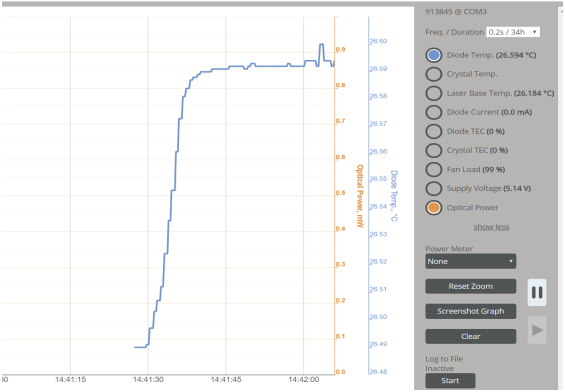

Figure 4-12. 'Graph' section view.

'Graph' section is a very handy tool to check how laser behaves in longer periods of time. It can be used to identify many issues regarding laser operation instabilities.

This section can track:

1) diode temperature;

2) laser base temperature;

3) diode current;

4) diode TEC load;

5) fan load;

6) supply voltage;

7) optical power, if Thorlabs, Inc. PM100, PM100USB or PM100D power meter is connected.

It is recommended, if possible, to generate this graph for 30 minutes before contacting Integrated Optics, UAB technical support about laser operation issues.

More than one laser can be connected to a computer simultaneously. All connected lasers can be controlled with multiple program windows – one for each laser, but these lasers must be connected to different COM ports. Once connected, lasers are detected automatically. If a newly connected laser is not found, try to check if laser USB port is connected properly and press the 'Refresh' button.

A user can also observe a percentage of TEC capacity, which is being used. If TEC value is near 100% for more than 10 seconds, it means that the laser does not get enough heat dissipation and it heats too much. In such case, the laser will turn off automatically if internal laser diode and laser body temperature reaches 45 deg. Celsius.

'New window', enables controlling a few MatchBox lasers using the same computer. However, each laser has to be connected to different COM ports. Controlling multiple lasers with only one software window is unavailable.

'Keep on top', keeps the MatchBox control software on top of other programs windows.

'Disconnect', disconnects the laser from control software. The software window changes to initial connection window, displaying MatchBox lasers that are connected to computers' COM ports.

'Feedback', directs user to a short survey, regarding laser operation and user experience. The survey is sent directly to Integrated Optics, UAB.

Default laser parameters will be displayed, once the laser is connected to the computer and power is supplied. In order to save customized parameters, click 'Save Settings' at the bottom of the main window.

4.5: Changing Output Power

In order to change the optical power of a laser, DAC (digital-analogue converter) value should be entered. The DAC value is related to the internal optical feedback loop and represents a value of optical signal, which must be detected by the internal photodiode, and the values are from 0 to 8191. However each laser has a pre-set power limit and in most cases maximum optical power value will be lower than 8191 DAC value.

Other options of changing the laser power are setting the laser output power in mA (in ACC operation mode) or in mW (in APC operation mode). However, changing output power in mW is only possible if the laser power is calibrated and calibration values are saved in the internal micro-controller.

Calibration process can be either done in the factory or user can request instructions from the manufacturer, describing how to do the calibration in a specific setup. For calibration instructions, please contact our technical support.

Calibration is also possible for fiber coupled lasers, as well as for a complete turnkey system, e.g. a microscope setup.

4.6: Communication Command Table

The following commands are used with MatchBox series lasers at serial communication rate of 115200 bps. The '␣' sign means space.

Table 4-1. Communication commands of MatchBox lasers.

Command	Function	Argument Example	Returned Value	Access Level[a]
e␣	start/stop laser	0 or 1	<ACK> or <ERR>	0

Table 4-1. Communication commands of MatchBox lasers.

Command	Function	Argument Example	Returned Value	Access Level[a]
c␣1␣	set crystal temperature to 25.5 °C	2550	<ACK> or <ERR>	3
c␣2␣	set laser diode temperature to 25.5 °C	2550	<ACK> or <ERR>	3
c␣3␣	set laser diode current to 180 mA	180	<ACK> or <ERR>	3
c␣4␣	set 100 mW optical power	100	<ACK> or <ERR>	1
c␣6␣	set feedback DAC value (max 8191)	1100	<ACK> or <ERR>	1
c␣f␣	set fan temperature to 32°C	3200	<ACK> or <ERR>	1
c␣a␣	enable/disable autostart after power on	1 or 0	<ACK> or <ERR>	1
c␣u␣	Change user access level to 1 “c u 1 1234”	0..3␣ code[b]	<ACK> or <ERR>	0
NM?	Returns laser name - the product code.	-	<405L-21A>	0
ID?	return product ID. 6 digit value is returned with random delay up to 1000ms.	-	<915627>	0

Table 4-1. Communication commands of MatchBox lasers.

Command	Function	Argument Example	Returned Value	Access Level[a]
r␣s	receive settings. Returned values are: crystal set temp, laser diode set temperature, laser diode set current, feedback DAC set value, optical power set value, laser diode current limit (mA), autostart mode, access level, fan set temp.	-	#Settings: 1800 2350 90 850 nan 170 Autostart: OFF 3 3200	0
r␣r	receive readings. Returned values are: laser diode temperature, crystal temperature (if there is no crystal, the value is negative), laser base temperature, laser diode current, crystal TEC load, laser diode TEC load, system status, fan load, input voltage	-	#Readings: 27.386 -27.086 24.978 0.0mA 0% 0% OFF 0% 5.25V	0
r␣m	receive operating mode (APC/ACC)	-	APC	0
r␣l	receive access level	-	Access level: 0	0

Table 4-1. Communication commands of MatchBox lasers.

Command	Function	Argument Example	Returned Value	Access Level[a]
r␣i	Receive laser information. Returned values are: firmware version, serial number, product code, operating time, the number of times the laser diode was turned on.	-	Firmware for MatchBox2 v1.7.648 Laser S/N: 915322 Laser model: 405L-21A 266h 15 min. 58 times	0
r␣t	receive operating hours. Returns information about operating hours and how many times the laser diode has been turned on.	-	266h 15 min. 58 times	0
f␣s	save changes	-	<ACK> or <ERR>	1

a. To execute the commands, access level must be equal to the values given in the table or higher.

b. To change access level, command argument code can be provided by sales person on separate request.

The list below explains error codes for MatchBox lasers:

- 0 - error name not assigned yet
- 1 - command forbidden for current access level
- 2 - laser already on or making ramp-up

- 3 - laser busy, task is not complete please wait for 1 s and try again
- 4 - arguments out of range
- 5 - unknown command
- 6 - laser must be enabled to execute this command

4.7: Communication with Multiple Lasers in a Bus

There are several ways, how integrators can connect and control multiple lasers in a single communication bus. Our engineers have tested and recommend connecting diagram as depicted in Figure 4-13.

This communication diagram is based on simultaneous communication from the system UART controller to all connected lasers and individual response from a particular laser. Random response timing is used only for laser initialization with 'ID?' command.

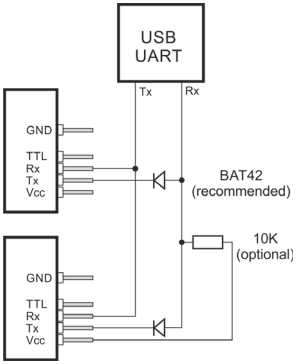

Figure 4-13. Suggested communication diagram for multiple lasers in a single bus.

One example of such communication is shown in Figure 4-14, where the system UART enquires all lasers in the bus to send their IDs. All lasers respond randomly.

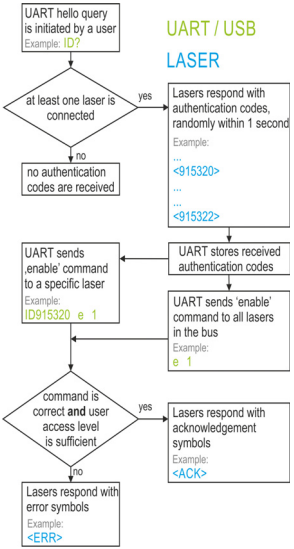

Figure 4-14. ID request sent from the system UART to a bus with multiple lasers.

All communication from the laser side features commands with '<' '>' beginning and end symbols.

A new laser can be connected while others are operating. ID request is repeated in order to collect IDs once again.

Controlling multiple lasers in one window with Integrated Optics, UAB software isn't possible. It is only an example for integrators.

4.8: TTL Modulation

TTL stands for transistor-transistor-logic. In the context of laser modules, TTL modulation means a convenient and standardized method for lasers' modulation. The voltage tolerance for TTL inputs of all MatchBox lasers is +5 VDC (+ 3.3 VDC compatible).

Programmable pin configuration and modulation speed differ between DPSS and direct diode lasers:

- for DPSS type lasers, to allow TTL modulation, programmable pin has to be set to 'P4' and modulation speed in both APC and ACC operation modes is up to 500 Hz (electronics version: 11.4.XX).

- for direct diode lasers, programmable pin has to be set to 'P0' and modulation speed in ACC operation mode can reach up to 10 MHz, in APC operation mode only up to 1 kHz (electronics version: 1.3).

To use TTL modulation, modulation inputs should be connected to 'TTL' and 'GND' pins.

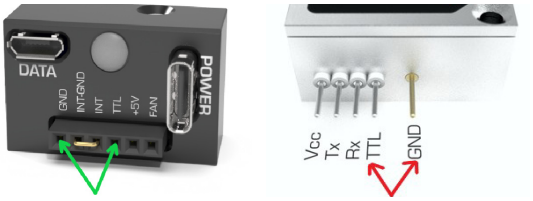

Figure 4-15. Respective pins for TTL modulation in Break-out-Box (left) and the laser module (right).

To find out how laser operation is affected by different TTL modulation pin states, check the table below.

Table 4-2. Laser control via TTL input truth table

TTL input	Laser output
Open	Y
Low (0 V)	N
High (+ 3.3 VDC and above)	Y

Note: In all cases laser is either ON, using GUI or is autostart enabled.

Laser control via TTL input truth table explanations:

- when TTL input is **open** and laser beam is enabled through software, laser is emitting light;

- when TTL input is **low**, the laser is not emitting light even if the laser beam is enabled through software, instead laser is put to warm-up mode;

- when TTL input is **high** and laser beam is enabled trough software, laser is emitting light.

If a laser is turned off by TTL modulation, but the modulation signal is somehow disconnected, the laser will start to emit light at the set output power, causing potential harm to a user or burning facets that the beam is pointed to.

TTL modulation is not available for narrow spectrum, single longitudinal mode (SLM) lasers.

4.9: Attaching Control Interfaces

The pins of the laser can be attached to control interfaces, which are designed as accessories of the MatchBox series. On the other hand, in OEM arrangements, the pins can be connected to a custom electronics within an instrument or portable laser equipment, which is arranged to work as a control interface for the laser.

Orientation of the pinhead has to be taken into account, when connecting a control interface to the laser. To find out more about laser pinout, see “Power and Signal Connections” on page 16.

All pins of the laser must connect to correct pins in the control interface. Wrong connection of the pinhead might lead to permanent damage of the laser electronics and the warranty will be void.

Do not solder or bend the pins of the laser. These actions might make service impossible and thus void the warranty.

5. ACCESSORIES

Integrated Optics, UAB offers a variety of accessories for heat management, power supplying and mounting.

As our company strives for perfection and diversity, our engineers and researchers work hard everyday to make improvements of our products, especial in new products newly created equipment. Henceforth, accessories in MatchBox user manual are described in general, without going into specifications of each product.

For additional detailed information please visit our website at www.integratedoptics.com.

6. TROUBLESHOOTING Q&A

Whether there are any technical issues concerning our products or any general questions, we are always willing to answer it as fast as possible via email or phone. In order to save both our and our clients time, we have provided a list of frequently asked questions.

6.1: Frequently Asked Questions

Q: What type of power supply should I use?
A: If power is being applied directly to the laser pins 5 V at 4-5 A for DPSS lasers, and 5 V at 1.5 A for diode lasers.
If a laser is being powered through a Break-out-box, we recommend using 18 W PD type power supply for low power direct diode lasers, 45-60 W PD type power supply for higher power direct diode or DPSS lasers.
We highly recommend to use the same power supply as we offer on our website. Otherwise we can not ensure that the laser would work the same as it was tested during production.
Note: Some lasers can draw more current at the moment of turn on, compared to specified.

Q: Power has dropped drastically. What happened?
A: There might be several reasons:
a) the laser is overheating,
b) the power supply is not sufficient,
c) the laser diode or pump diode has failed.
Please check if heat dissipation is sufficient. Launch the laser control software, check whether the TEC is operating at 100% capacity.
What is the voltage between Vcc and GND pins? It should not be less than 4.0 V and not exceed 5.5 V. In case the voltage is different, wires might be too long or too thin or other components are involved that might cause voltage drop/increase.

Q: How should I cool the MatchBox series laser?

A: Low power, broad spectrum diode lasers typically require 7.5 W heat dissipation, so such laser could be cooled when attached to any optical table or cooling device. Higher power diode, narrow spectrum diode or DPSS lasers typically require 10-25 W heat dissipation so such lasers should be cooled using air-forced (AM-H3), TEC based (AM-H9-AM-H10/ AM-H11) heatsinks or water-cooled adapter plates.

Q: How to be sure that laser gets enough cooling?

A: During production, our lasers are tested on water-cooled adapter plates, that can keep 25 °C temperature. Aluminium breadboards could be used to dissipate low amount of heat, but that would not be enough for stable laser operation.

Keep in mind that steel has very poor thermal conductivity, therefore conventional optical tables and breadboards are not suitable for heatsinking DPSS lasers.

User's should always use thermal paste when mounting the laser.

Body temperature of the laser should not exceed about 40 °C, and the TEC load should not exceed 80%, with rare exceptions.

Q: What accessories are needed in order to use MatchBox laser?

A: The MatchBox series is designed for OEM applications. Integrators can install the laser without any other accessories, just by providing 5 V at 1.5-2 A and UART control signals to the Vcc and GND pins on the back of the laser. However for quick setup, a Break-out-Box and a power supply are necessary. Power supply and the Break-out-Box should be ordered separately as they are not included in the package.

Also, for stable laser operation it is always advised to use heatsinks. Contact our sales support for suitable heatsinking recommendations.

Q: What is a Breakout-Box?

A: Break-out-box is a small printed circuit board attachable directly to a laser pins. This electronics board features a USB-C power socket, pins for interlock, TTL and fan control. Furthermore it incorporates a UART-to-

USB converter chip (SiLabs) and a micro USB socket for data communication. Also, it converts PD type (Power Delivery) power supply input to a suitable and stable voltage and current output for a laser.

Q: I changed the laser power in the control software, but after restart of the system the new power setting was not saved?
A: New parameters are not saved in the micro-controller of the laser unless 'Save settings' at the bottom of the main software window is activated. This is done to save EPROM write resource.

Q: What fiber core diameter do you use?
A: We use fibers from many different vendors. Whether you need to know the actual fiber details, please contact our technical support.

Q: When do I have to use FC/PC and FC/APC fiber connector?
A: We recommend to use FC/APC for SLM lasers - this is to avoid back-reflections from a polished fiber tip to the laser cavity. In all other cases both FC/PC or FC/APC connectors can be used, depending on users preference.

Q: Should I ensure grounding for the laser?
A: The GND pin of the laser should be connected to the GND of a power supply.

Q: Can I modulate the laser with PWM square wave?
A: In general, yes. However, the bandwidth of PWM depends on the laser type and pinout configuration. For example, by default, DPSS lasers are configured for fan control instead of TTL modulation. It can still be PWM controlled by sending commands over UART interface with up to 1 kHz bandwidth. Direct diode lasers are typically configured for fast (up to 10 MHz in ACC mode) modulation instead of fan control, thus PWM with a bandwidth of up to 10 MHz is possible.

Q: Do I get a replacement if the laser is broken?
A: Lasers within warranty period are repaired or replaced free-of-charge.

Warranty becomes obsolete in cases indicated in “WARRANTY” on page 67.

Q: I have ordered an SLM laser, but can observe more than one longitudinal mode. How can I solve this problem?
A: It is possible that laser is working at non-optimal temperature point. First step is to make sure that the laser gets enough heat dissipation. Second step is to adjust laser diode (or cavity) temperature using the laser control software. For this access level 3 is needed. Please contact Integrated Optics, UAB for further instructions.

Q: How hard should I tighten the screws of the laser?
A: Recommended Tightening torque is 0.25 - 0.35 N·m.

Q: Laser is working, but it's body is very hot.
A: First of all it means that the laser diode should be fine, but it could be that heat dissipation is not sufficient, if so TEC load will be about 100%. You should also check how much Amperes does the laser consume - it should be no more than 1.5 A for diode lasers and typically no more than 4-5 A for DPSS lasers (exceptions may apply).

Q: Laser emits no light at all. Power is 0mW.
A: Firstly, internal cold plate of the laser could be more than 45 °C temperature. Also, It could be that the internal laser diode has died.

If the laser is fiber-coupled, another option is that the fiber is damaged inside the jacket. You should check for any damages on the fiber itself or its connector.

Recommendations: Before turning the laser on, proper cooling of the laser should be ensured. Laser should be mounted using thermal paste and the screws that were provided with the laser. Please, make sure that thermal paste is put evenly and covers whole bottom of the laser. If laser is fiber coupled, the fiber should be carefully straightened up first.

Q: Is there a recommended way to improve the diode laser's longevity?
A: Cold start is one of the factors reducing the lifetime of laser diodes, especially pump laser diodes in DPSS lasers. 'Warm-up' is the best mode for stand-by operation to improve the longevity of the laser diode or the pump diode.

Q: How to send laser to a warm-up state?
A: There are two ways to send laser to warm-up state, or in general to control laser: using our software. There is simply a button, that says 'Auto Warm-up' or sending commands via terminal, the command is: 'e 2'.

Q: What command must be sent to read MatchBox CW laser input voltage?
A: To read the input voltage "r_r" command must be used. The information it returns is explained in page 46.

Q: Is AM-H8 cooler suitable with DPSS lasers?
A: Unfortunately DPSS lasers require a better cooling system. The most suitable coolers in this case would be TEC-based heatsinks - AM-H9, AM-H10, or AM-H11.

Q: Turned on laser voltages are below the nominal 4.8V to 5.3V mentioned in laser specifications, is there something wrong with the laser?
A: If the laser works, the voltage isn't below 3.5V which is the minimum voltage for the internal microprocessor to operate, doesn't overheat and cools it self, then the voltage drop can be not taken into consideration.

Q: Our laser has a Firmware version of 1.76483. Is there a later version of the firmware and can it be upgraded?
A: Updating firmware is highly not recommended, because if in any case power source would disconnect or get damaged while updating, laser would be instantly damaged and would have to be sent to Integrated Optics, UAB for repair. So, laser firmware can only be updated in

particular situations after consulting with the support team at Integrated Optics, UAB.

Q: After a while, laser power dropped by a few mW, why is that?
A: There could be a few reasons why the laser power might drop by few mW:
1. The laser is getting some back-reflections and these are having impact on the internal photodiode response. The photodiode 'sees' more light and triggers the driving electronics to reduce LD current.
2. Environmental temperature changed significantly and the internal photodiode isn't perfectly thermally stabilized and it's temperature has changed as did the quantum efficiency of the laser.
3. The wavelength of the laser diode drifted. If it is on the slope of efficiency of the photodiode, then wavelength change of hundreds of pico-meters can change the response of the photodiode. Please, adjust the DAC value to restore the power level. If the power of the laser was calibrated, you might want to recalibrate it.
4. The power sensor of the power measurement degraded.
5. The power sensor got saturated. Please, check the parameters of the power sensor.
In cases 1 to 3 it should be visible in the software window that the LD current decreased upon decrease of the laser power.

Q: Is there a way to change the polarization direction of MatchBox lasers?
A: You can change the polarization direction by turning the laser body by a desired angle or using optical devices like: quartz polarization rotator, waveplate/2. We should note that different types of MatchBox lasers have different polarization direction, but two of the same type lasers of MatchBox'es must have the same polarization!

7. GLOSSARY

°C	Degrees Celsius
µm	Micrometer = 10^{-6} m
A/Amps	Amperes
AC	Alternating Current
ACC	Automatic Current Control
APC	Automatic power control
BoB	Break-out-Box
bps	Bytes Per Second
CCD	Charge-coupled device
CDRH	Centre for Devices and Radiological Health
cm	Centimetre
CW	Continuous Wave
DAC	Digital-to-Analog Converter
DC	Direct Current
DPSS	Diode-Pumped Solid-State
EMC	Electromagnetic Compatibility
EPROM	Erasable Programmable Read-Only Memory

kHz	Kilohertz = 10^3 Hz
LD	Laser Diode
MHz	Megahertz = 10^6 Hz
MM	Multi-Mode
mrad	Milli-radian = 10^{-3} radians
mW	Milliwatt = 10^{-3} Watts
nm	Nanometre = 10^{-9} meter
N·m	Newton metre
NTC	Negative Temperature Coefficient
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PM	Polarization maintaining
PVC	Polyvinyl Chloride
PWM	Pulse Width Modulation
RMS	Root Mean Square

RoHS	Restriction of Hazardous Substances
RS232	Standard for serial communication transmission of data
Rx	Receive
SLM	Single-Longitudinal-Mode
TEC	Thermo-Electric Cooler
TTL	Transistor-Transistor Logic
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
Vcc	Voltage at the Common Collector
VBG	Volume Bragg Grating

8. WARRANTY

Integrated Optics, UAB warrants the MatchBox laser to the original purchaser (the Buyer) only, that the laser system, that is the subject of this sale, (a) conforms to specifications provided before a certain laser has been shipped to the buyer and (b) is free from defects in materials and workmanship.

The MatchBox lasers are warranted to conform to Integrated Optics, UAB published specifications and to be free from defects in materials and workmanship for a period of:

- 14 months or 10000 hrs, whichever occurs first;
- Operational time calculation is based on an internal EPROM counter.

The Buyer is responsible for providing the appropriate utilities and an operating environment as outlined in the product literature. Damage to the laser system caused by failure of the buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Integrated Optics, UAB of any claims made under warranty. In no event will Integrated Optics, UAB be responsible for warranty claims made later than seven (7) days after the expiration of warranty.

8.1: Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from:

- Components and accessories manufactured by companies, other than Integrated Optics, UAB, which have separate warranties,
- Improper or inadequate maintenance by the buyer,
- Buyer-supplied interfacing,
- Operation outside the environmental specifications of the product,
- Unauthorized modification or misuse,
- Improper site preparation and maintenance, or
- Opening the laser housing.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. Integrated Optics, UAB SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Kalvariju str. 125B
08221 Vilnius, Lithuania
Tel: +370 5 2196393
info@integratedoptics.com

www.integratedoptics.com