rgb lasersystems

λbeam
User Manual

User Manual
For the Lambda beam with PowerController Laser
Version: 2.4.2
Date: April 8, 2021

Contents

1   Laser Safety Precautions

CAUTION: This device emits visible and invisible **LASER** radiation. Avoid exposure to the beam!

Lasers emit visible and invisible radiation that may cause damages to material and person, mainly by thermal effect. Radiation entering the human eye can damage the retina, which leads to partial or total loss of vision. The damage can occur without particular perception or sensation of pain.

Please consider all protection and safety regulations while handling laser systems. Always use laser protection glasses for the specified wavelength range.

Never direct the laser towards people. Keep the laser beam away from reflective surfaces in order to avoid uncontrolled reflections. Do not mount the laser at eye level.

It is your responsibility to guarantee the laser safety as required by law. Please pay attention to safety regulations DIN EN 61010-1, DIN EN 60825-1:2003-10 and DIN EN 60950 when operating the laser.

The Lambda beam series is specified by the United States National Center of Device and Radiological Health (CDRH)) as a class 3b laser product. Visible and invisible laser radiation is emitted.

Modifications that my affect any aspect of the product's performance or intended functions will require re-certification and re-identification of the product in accordance with the provisions of 21CFR 1040.10 and 1040.11.

Lambda beam laser modules are marked with a warning label as show on the right.

2 Introduction

2.1 Product Overview

The Lambda beam series offers high performance, modulatable laser modules in a small design. The high quality product „Made in Germany"guarantees universal capabilities in almost all fields of applications, with optical output powers up to 1000 mW. High durability, excellent beam quality and various options for system integration (for example into the Qioptiq rail system FLS 40) guarantee highest flexibility in industrial, scientific and medical applications.

Laser Head Features

- Small design
- Optical output powers up to 1000 mW
- Active Temperature Stabilization
- IP67 protected housing, optionally vacuum sealed
- Optional fiber coupler
- Horizontal, vertical and diagonal mounting options
- Produced in clean-room atmosphere
- Adjustable temperature
- Professional housing

Laser Controller Features

- Compact design
- Microprocessor-controlled laser driver
- Digital control via Universal Serial Bus (USB)
- Modulation input analog or digital 0 V to 5 V direct current (DC)
- Interlock input, key switch and mode switch

2.2   Package Contents

Laser head

In order to provide the best beam quality only high quality optical components are used within the laser head. A thermoelectric cooler is integrated for stabilizing the temperature.

Laser controller

The laser controller includes three status indicators, a USB interface, a modulation mode switch and a key switch with a 5 s delay. The back side holds connectors for the laser head (D-Subminiature 9 (DSUB-9)), modulation input (BNC), interlock and power supply.

AC adapter

The alternating current (AC) adapter provides a regulated power supply from any AC outlet (100 V to 240 V). Only use the AC adapter included with your laser, otherwise damage to the laser system may occur.

Cable

The Lambda beam system includes a 0.8 m DSUB-9 cable to connect the laser head to the controller as well as a standard 1.5 m Micro USB cable to connect the controller to a computer.

Software

The CD-ROM includes the Windows application software Ltune for configuring and controlling the laser system as well as this manual as a Portable Document Format (PDF) file.

3 Installation and Operation

3.1 Precautions

- **Take care of all laser safety instructions** as described in chapter 1. Always wear laser protection glasses for the specified wavelength range.
- Consider regulations for electrostatic discharge (ESD).
- Do not open the laser head. Opening the case voids the warranty and may cause uncontrolled laser radiation.
- Always mount the laser module securely and pay attention to sufficient heat dissipation.
- **Never disconnect the laser head from the controller** while connected to the power supply. This can damage the laser.
- **Do not reflect the laser beam back into the laser head.** The laser diode could be damaged if more than 2 % of the emitted power is reflected back into it. Carefully check all mirroring surfaces of your optical setup for possible back reflections. If required, use a suitable optical insulator.
- Do not exceed the environment conditions specified in chapter 5.

3.2 Device Setup

1. Make sure the key switch is in the OFF position.
2. Connect the Lambda beam laser controller with the laser head using the accompanying cable.
3. If you have several laser modules, please note that the controllers are not interchangeable. Make sure the serial numbers on the laser head and the laser controller match each other.
4. Connect the AC adapter to the laser controller.
5. Turn on the supply voltage VCC.
6. After a quick self-test the green POWER LED should be lit continuously. The status indicators are further described in the following section.

Connector and Controls

The PowerController laser driver has the following connectors and controls:
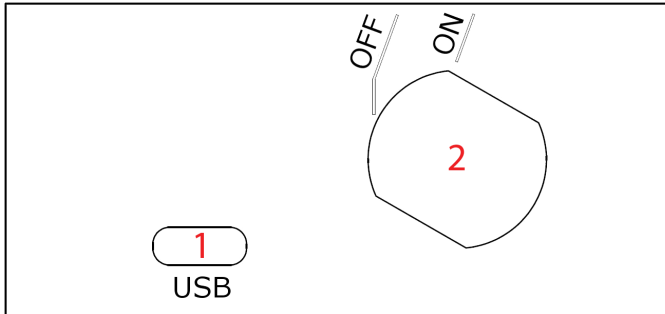
(a) controller front side
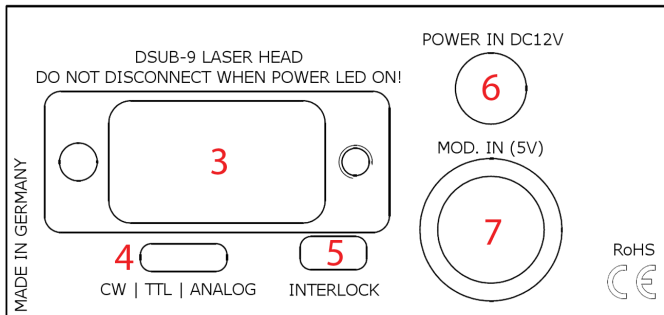
(b) controller back side

1   Micro USB connector
2   Key switch
3   Laser head connector (DSUB-9)
4   Modulation mode switch (CW, TTL, Analog)
5   Interlock connector
6   Power supply input (DC 12 V)
7   Modulation input (Bayonet Neill-Concelman (BNC))

Status Indicators

The laser module includes two light emitting diodes (LEDs) to indicate the laser status:

LED	Status	Description
POWER	On	Key switch off, interlock open or switched off via USB
	Off	Power supply not connected
KEYLOCK	On	Key switch off, interlock open or switched off via USB
	Off	Key switch on and interlock closed (and switched on via USB if connected to computer)
	Flashing	Error
EMISSION	On	Laser active, emission possible (depending on selected output power)
	Off	Laser inactive
	Flashing	5 second delay before activating laser

3.3 Laser operation

In order to turn the laser on without using a computer or remote control, please:

1. Connect the system as described in the previous section.

2. Select the modulation mode using the switch (continuous wave (CW) / transistor-transistor logic (TTL) / ANALOG) on the back side of the controller. Changing the modulation mode is only possible while the key switch is in the OFF position.

3. For TTL or ANALOG modulation mode, please apply a voltage to the modulation input (BNC connector). Note that even with an input voltage of $0\,V$, a small amount of laser radiation can be emitted.

4. Close the interlock and turn the key switch to the ON position. The laser will start with a $5\,s$ delay (as required by CDRH regulation). Once the laser is active, the EMISSION indicator is lit.

For safety reasons, the key lock is activated when you connect the laser to power, even if the key switch is in the ON position. To start the laser, turn the key switch off and on again.

The Lambda beam series can also be controlled via USB as described in chapter 4.

Note for lasers at 473 nm, 532 nm and 561 nm: it is recommended to initially oper-
ate the laser at full maximum output power for 5 min. Afterwards the output power can
be adjusted to any value. At low output powers these lasers often exhibit multi-mode
emission.

3.4 Operation modes

You can select the operation mode using Ltune or your own custom software. In stand-
alone operation, the laser system is always in Combined Modulation Mode. The technical
specifications for the modulation inputs can be found in chapter 5.

Constant Power Mode

The Lambda beam laser systems can be driven in CW mode without an external control
voltage. In this case, the laser emission is constant at the value which is defined by the
Ltune Software.

Analog Modulation Mode

In this mode the optical output power can be controlled by an external voltage at the
analog modulation input connector. The output power is modulated proportional to this
signal.

Digital Modulation Mode

Here, the digital modulation input is used to switch the laser off and on between 0 %
and 100 % maximum power. The nominal TTL input levels for the low-speed modulation
input are 0 V (laser off) and 5 V (laser on)[1].

3.5 Disconnecting the system

Always disconnect the power supply before removing the controller from the laser head
in order to prevent damage to the laser!
To disconnect the laser system, please proceed in this order:

1. Turn the key switch to the OFF position.

2. Disconnect the power supply and the modulation input connector (if used) from
   the controller.

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[1]However, all signals below 0.8 V are considered as off and above 2 V as on.

3. Finally disconnect the laser head from the controller.

3.6 Troubleshooting

If the device is detected by Ltune, but there is no laser emission:

Please make sure that these conditions are met:

- The green LED is lit continuously (if not, please check the bottom of the Ltune window for error messages).
- The interlock connector is closed
- The key switch is set to the ON position
- Either Constant Power Mode is selected or a proper signal is connected to the modulation inputs
- If connected to a computer: The power on/off button in Ltune is turned on and an output power larger than zero is selected

If the yellow LED is flashing, please run Ltune and check the bottom of the window for error messages.

If the device is not detected when Ltune is started

First of all, please disconnect the laser from the computer, restart the computer, connect the laser again and start the Ltune software.

   If the laser is still not found: The Ltune software communicates with the laser using a "virtual serial port". If the driver is installed correctly, it should show up in the Windows Device Manager. You can open the device manager by clicking Start -> Control Panel (-> Performance and Maintenance) -> System -> Hardware -> Device Manager.

   In the device manager, please open the "Ports (COM & LPT)" subtree. One of the COM ports listed there should belong to your laser. If you right-click on the correct item, choose "Properties" and then the "Driver" tab page, it should read: "Driver Provider: FTDI" and "Driver Version: 2.8.14.0" (or later). If this is the case, please start Ltune and try to select this COM port manually by unchecking "Auto-scan all serial ports" in "Device setup".

   If your laser is not listed in the device manager or marked with an exclamation or question mark, please try the following:

1. Disconnect your laser from the computer and from power supply.

2. Download http://www.ftdichip.com/Resources/Utilities/FTClean.zip and run this tool to remove the FTDI driver from your computer.

3. Reinstall Ltune from the CD.

4. Reconnect the laser to the computer.

5. Start Ltune.

4 Computer Control

The Lambda beam uses a USB interface for remote control. The laser can be controlled with

- The Windows application software Ltune (included),
- the cable remote control RC-1 (available separately) or
- Custom user software via serial communication.

4.1 Ltune Laser Control Software

The Lambda beam laser can be configured and controlled using the Ltune software for Windows. The software features:

- Modulation mode selection
- Output power adjustment
- Display of the laser status, configuration and operating hours
- Temperature display and adjustment

To install the software, simply run the setup file from the CD-ROM included in the package. The setup package then installs the application software and the device driver. For the operating system to properly recognize the de software first before attaching the device.

The software is tested with 32 and 64 bit versions of Windows 10, 8, 7, Vista and XP. It requires the Microsoft .NET framework version 3.5 or 4.0, which is already installed on most PCs. If this framework is not installed, the setup package asks you to install it first. You can find the setup file for the .NET framework on the CD or download it from Microsoft's website. Please note that you need at least version 3.5 of the .NET framework.

After the software is installed, please connect your Lambda beam laser to a USB 2.0 port on the computer. You can use the provided USB cable or almost any other Micro-USB cable.

If not already installed wait until the laser driver is completely installed. The laser should be detected automatically. If not you can click on device setup to start a new search.
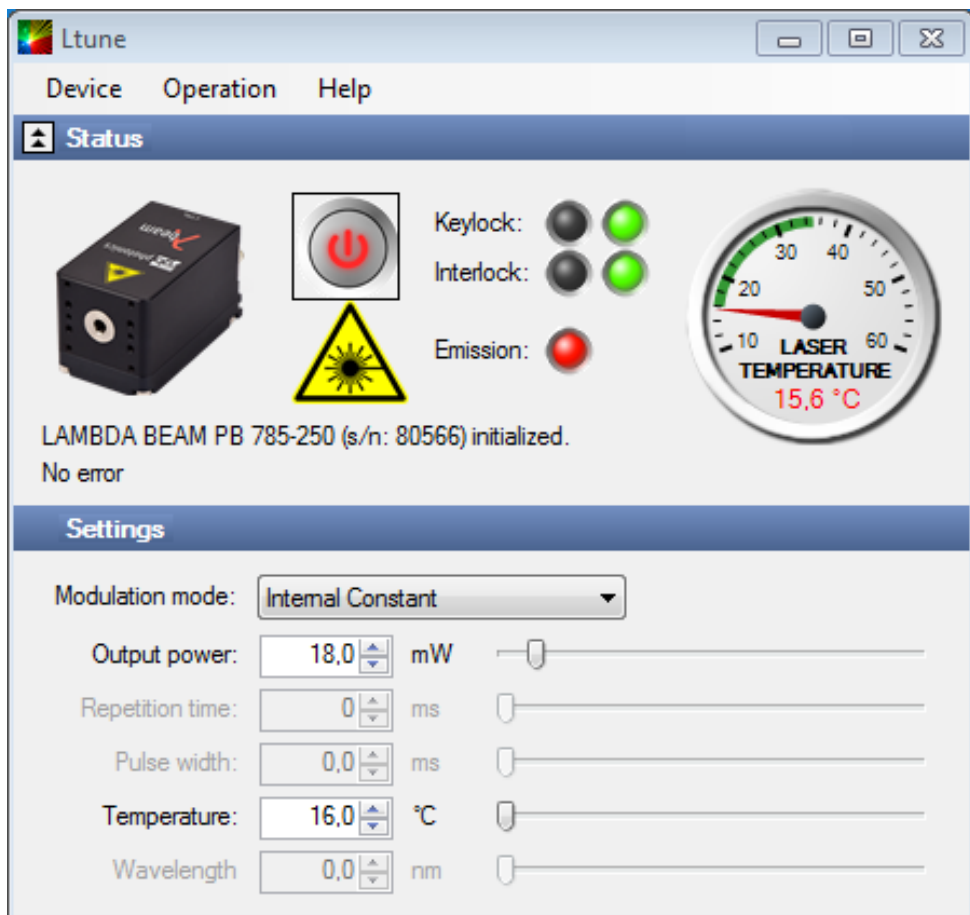
Figure 4.1: Ltunes GUI

Please note that you can change the user interface to a more compact view by clicking the small button next to "Device Proporties"

The sliders for "Repetition time" and "Pulse width" are for future enhancements.

The "Temperature" slider can be used to shift the working temperature of the laser. This can be used to shift the wavelength in a certain amount but also has effects on the output power.

4.2   Serial Communication

Overview

When the laser controller is connected to a PC and the device driver installed, it shows up as a virtual communication port/serial port (COM) port and can be accessed from almost any programming language. A detailed description of the commands and queries is given in the following section.

The command settings are not stored when the system is powered down.

Communication protocol

The commands and queries have the following syntax:

Commands: command=
A command changes an actual setting. The syntax is the command, followed by an equal sign and the parameter value. The parameter value is the value to be set. Commands have no return value.

Queries: query?
A query returns information about the device or the value of a setting. The syntax is the query, followed by a question mark. Queries have no parameter value. A query delivers a return value.

Return Code

A return code gives information about the processing of a command or query. There is always a space character between the return code and the result. The return codes are listet in table 4.1.

Table 4.1: Return Codes

Code	Name	Description
0	COMMAND_SUCCESS	Command successful
1	COMMAND_INVALID	Command invalid
2	PARAMETER_ERROR	Wrong numbers of parameters
3	VALUE_INVALID	Parameter value is out of range
4	CODE_INVALID	Unlocking code is wrong
5	DEVICE_LOCKED	Device is locked for this command
6	FUNCTION_NOT_SUPPORTED	This function is not supported
7	COM_TIME_OUT	Timeout while reading command (60 s)
8	VALUE_NOT_AVAILABLE	This value is currently not available

All commands and queries and all responses from the device are followed by the line termination string "\r \n" (carriage return & line feed). All instructions have to be written in capital letters.

Initializing the serial communication

The Lambda beam uses the communication settings displayed in table 4.2.

Table 4.2: Lambda beam communication settings

Baud rate	57600
Parity	None
Data bits	8
Stop bits	1

To initialize the controller, send "INIT". The controller responds with the return code 0 (Command successful).

Closing the communication

Send "BYE" to close the connection to the laser controller.

Turning the laser on and off

This command is used to set the and read the "*Laser Enable*" request. The laser can only be activated if the key switch is in the ON position and the interlock is closed.

Table 4.3: Laser Enable commands

Command/ Query	Parameter value	Return code	Return value
0=	0: Delete Enable Request 1: Set Enable Request	COMMAND_SUCCESS PARAMETER_ERROR	-
0?	-	COMMAND_SUCCESS	0: Enable Request not set 1: Enable Request set

Temperature settings[2]

The Lambda beam monitors the operating temperature. If it exceeds the permitted temperature range, the laser is turned off to prevent damage to the module. The commands for temperature settings are listed in table 4.4

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[2]Not all laser systems support this function

Table 4.4: commands for temperature settings

Command/ Query	Parameter value	Return code	Return value
T?	-	COMMAND_SUCCESS VALUE_NOT_AVAILABLE	Current temperature in °C
TD?	-	COMMAND_SUCCESS	Default temperature in °C
T0=	Temperature offset in °C (vallue between LTN and LTP)	COMMAND_SUCCESS VALUE_INVALID FUNCTION_NOT_SUPPORTED	-
T0?	-	COMMAND_SUCCESS	Temperature offset in °C
LTN?	-	COMMAND_SUCCESS	Lowest operating temperature in °C
LTP?	-	COMMAND_SUCCESS	Highest operating temperature in °C

The command T0= expects a temperature offset for the default temperature (TD?) to be decreased or increased. The temperature can be adjusted with a resolution of $0.1\,°C$.

The highest and lowest possible temperature value can be queried with LTP? and LTN?, respectively.

Selection of modulation mode

The following commands are used to change the mode of modulation. The mode selection via USB takes priority over the manual switch on the laser controller. The actual position of the manual switch can be determined with the SP? query.

Table 4.5: commands for selection of modulation mode

Command/ Query	Parameter value	Return code	Return value
M=	A = external analog T = external TTL C = internal CW M = combined analog & TTL	COMMAND_SUCCESS VALUE_INVALID FUNCTION_NOT_SUPPORTED	-
M	-	COMMAND_SUCCESS	A = external analog T = external TTL C = internal CW M = combined analog & TTL

CW mode

The Lambda beam series can be operated in CW mode at constant power between $0\,\%$ and $100\,\%$ of the maximum output power. There is no need to supply an external control voltage.

Table 4.6: CW mode commands

Command/ Query	Parameter value	Return code	Return value
P?	-	COMMAND_SUCCESS	Output power in mW
P=	Output power in mW (value between 0 and LP)	COMMAND_SUCCESS VALUE_INVALID	-
LP?	-	COMMAND_SUCCESS	Maximum output power in mW

TTL modulation

In the TTL modulate mode the output power can be switched between two levels by applying a TTL compatible (0 V and 5 V) external control voltage. The lower level is set by the P0= command and the higher level by P=. If a level larger than the maximum output power is specified for P= or a level larger than the P= value is specified for P0=, the value is decreased to the maximum value.

Command/ Query	Parameter value	Return code	Return value
P0?	-	COMMAND_SUCCESS	Lower,Output level in mW
P0=	Lower,Output level in mW (value between 0 and P)	COMMAND_SUCCESS, VALUE_INVALID	-

Status and device information

The query S? gets the actual status of the laser system including information about the Enable Request, the key switch, the interlock, active errors and the temperature control.

The query R? returns the operation hours of the laser system. The operation time is the accumulated time during which the laser was active (red LED on).

Table 4.7: Status and device information commands

Query	Parameter value	Return code	Returnvalue
S?	-	COMMAND_SUCCESS	Current device status (see table below)
R?	-	COMMAND_SUCCESS	Total operating hours [hhhh:mm]
DM?	-	COMMAND_SUCCESS	Manufacturer
DT?	-	COMMAND_SUCCESS	Device name
DS?	-	COMMAND_SUCCESS	Serial number
D0?	-	COMMAND_SUCCESS	Software version
DW?	-	COMMAND_SUCCESS	Emission wavelength in nm
DF?	-	COMMAND_SUCCESS	Available features: T = Temperature adjustable H = High speed TTL integrated D = Drive mode changeable (ACC/APC) C = Temperature is controlled M = External analog and digital modulation A = Modulation inputs can be combined R = Round beam L = Wavelock E = ECDL laser W = Water-cooled B = Multi-mode beam S = Customized
DC?	-	COMMAND_SUCCESS	ACC = active current control (ACC) APC = active Power control (APC)

The result of the status request *S?* is a bit-wise combination of the values listed in table 4.8

Table 4.8: status request commands

Code	Mnemonic	Description
0x01	LASER_ON	Laser system in active, radiation can be emitted
0x02		(reserved)
0x04	INTERLOCK_OPEN	The interlock is open
0x08	ERROR	Error is active (error can be read with E? query)
0x10	TEMPERATURE_OK	Temperature of laser head is ok

Error status of the laser system

The query *E?* reads the actual active errors of the laser system.

Table 4.9: Error status of the laser system

Query	Parameter value	Return code	Return value
E?	-	COMMAND_SUCCESS	Error code (see table below)

Possible error codes are shown in table 4.10

Table 4.10: error codes

Code	Mnemonic	Description
0x01	LASER_HEAD_OVERTEMP	Temperature of laser head is too high
0x02	LASER_HEAD_UNDERTEMP	Temperature of laser head is too low
0x04	TEMP_SENSOR_OPEN	Temperature-sensor connection is broken
0x08	TEMP_SENSOR_SHORTENED	Temperature sensor cable is shortened
0x40	LASER_OVERCURRENT	Current for laser head is too high
0x80	FATAL_INTERNAL_ERROR	Internal error (laser system cannot be activated)

5 Specifications

5.1 General Specifications

Noise:	<2 % RMS
Power stability:	<1 % (10 h)
Warm-up time:	ready for use after 5 s,
	calibrated operation after 5 min
Drive mode:	473 nm, 532 nm and 561 nm: APC
	others: ACC
Modulation modes:	Constant power, analog and digital external modulation
Modulation frequency:	standard version: 500 kHz
	473 nm, 532 nm and 561 nm: 15 kHz[3]
Control mode:	Power, temperature and modulation controllable via USB
Temperature control:	active TEC
TEC accuracy:	<10 mK
glsCDRH Classification	Class 3b
Weight:	94.4 g (laser head)
ESD protection:	Level 4
Operating temperature:	0 °C to 45 °C (non-condensing)
Storage temperature:	−25 °C to 70 °C

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[3]An optional acousto-optical modulator (AOM) may be used for faster modulation.

5.2   Beam Specifications

Beam diameter:	473 nm, 532 nm and 561 nm: 1.2 mm circular
	others: 1.1 mm × 2.2 mm to 1.2 mm × 4.3 mm
Divergence:	<0.9 mrad
Spatial beam mode:	TEM_{00}
Polarization:	>100/1 linear
Polarization angle:	horizontal ±5° (other on request)
Beam alignment:	<5 mrad and <0.1 mm (compared to base mount)
Pointing stability (10 h):	5 µrad/K

5.3   Electrical Specifications

Power Supply and Control

Power supply:	12 V DC, supplied via AC adapter 100 V to 240 V AC
Power consumption:	up to ≤2 A (at 12 V, depending on laser output power)

Power Supply and Control

Connector type:	BNC
Analog / digital input:	0 V to 5 V
Digital input threshold:	<0.8 V: low, >2V: high
Input polarity:	active high
Input impedance:	10kΩ

5.4   Mechanical specifications

Lambda beam laser head

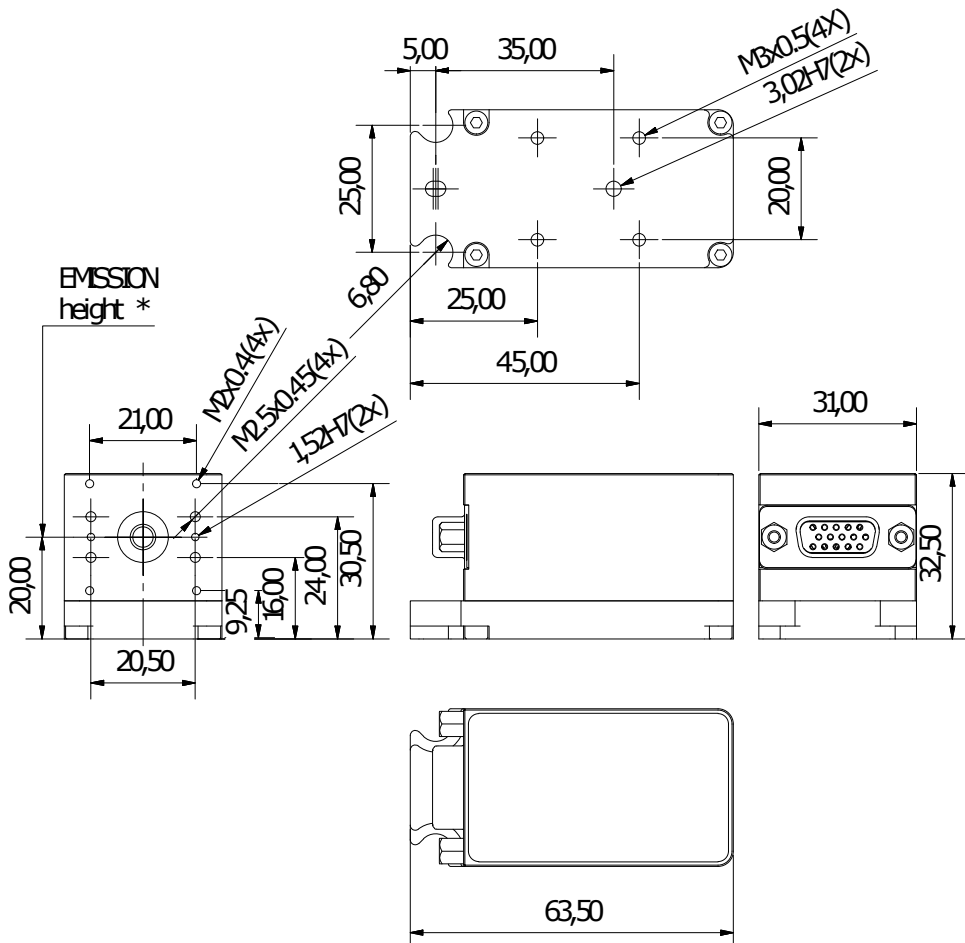|		
Length:	63.5 mm	(2.5 in)
Width:	31 mm	(1.22 in)
Height:	32.5 mm	(1.28 in)

Figure 5.1: LambdaBeam technical drawing

All dimensions in mm.

3D computer-aided design (CAD) files are available for download on www.rgb-photonics. com.

PowerController laser controller

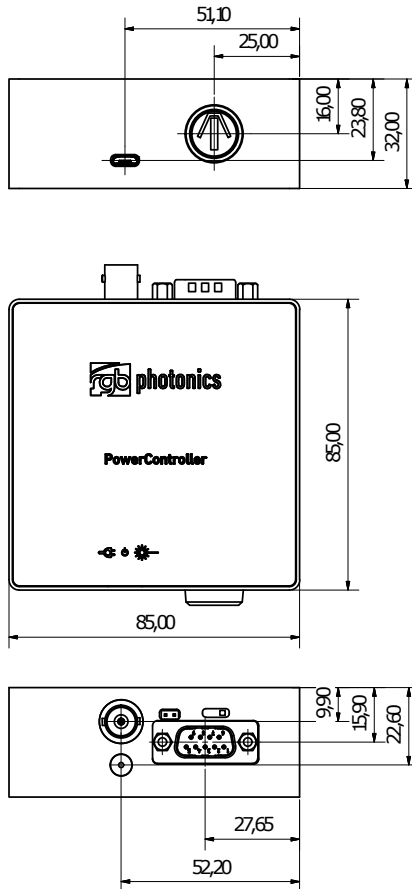|		
Length:	39 mm	(2.5 in)
Width:	31 mm	(1.22 in)
Height:	32.5 mm	(1.28 in)

Figure 5.2: PowerController laser controller technical drawing

All dimensions in mm.
3D CAD files are available for download on www.rgb-photonics.com.

6 Optional system configurations

Fiber coupler

Each Lambda beam laser system can be equipped with a fiber coupler.

Water cooling system

For operation in extreme conditions, there is an optional water cooling system for the bottom plate. This ensures an optimal heat dissipation.

Wavelock

The Wavelock option provides an exceptionally stable single mode emission. Available for wavelengths of 405 nm, 640 nm, 660 nm, 785 nm and 808 nm.

7 Certifications and Compliance

CE Declaration of Conformity

The manufacturer

    RGB Lasersystems GmbH
    Donaupark 13
    93309 Kelheim

declares that the following product

    Lambda beam   Version 1.0

complies with the following normative documents

    EN6100-6-4: 2007 + A1:2011
    EN6100-6-2: 2005

and therefore with the following EG requirements

    Electromagnetic compability (2014/30/EU)

This declaration applies to all models of the above named product version, in case it will be unsed in the configuration of the tesst assembly.

Kelheim , November 19th, 2020   Stefan Englbrecht

FCC Compilance

This declaration applies to the following product:

        Lambda beam   Version 1.0

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Kelheim , November 14th, 2020   Stefan Englbrecht

RoHS Declaration of Conformity

The manufacturer

    RGB Lasersystems GmbH
    Donaupark 13
    93309 Kelheim

declares that the following product

    Lambda beam   Version 1.0

contains no toxic substances which are specified in the

    RoHS Directive 2011/65/EU.

The conformity to RoHS Directive 2011/65/EU is condirmed

This declaration applies to all models of the above named product version, in case it will be unsed in the configuration of the tesst assembly.

Kelheim , October 12th, 2020   Stefan Englbrecht

WEEE Directive

Please respect the Waste Electrical and Electronic Equipment (WEEE) directive 2012/19/EU and do not throw you RGB Laser-systems GmbH product into waste disposal but recycle it.

Acronyms

AC   alternating current. 4, 5
ACC   active current control. 16, 19
AOM   acousto-optical modulator. 19
APC   active Power control. 16, 19

BNC   Bayonet Neill-Concelman. 6, 7, 20

CAD   computer-aided design. 20, 22
CDRH   Center of Device and Radiological Health. 1, 7
CE   Conformité Européenne. 25
COM   communication port/serial port. 12
CW   continuous wave. 6, 7, 8, 15

DC   direct current. 3, 6
DSUB-9 D-Subminiature 9. 4, 6

ESD   electrostatic discharge. 5, 19

FCC   Federal Communications Commission. 26

LED   light emitting diode. 5, 6, 9

PDF   Portable Document Format. 4

RMS   root mean square. 19
RoHS   Restriction of the use of certain hazardous substances. 27

TEC   thermo electric cooler. 19
TEM   transverse electromagnetic mode. 20
TTL   transistor-transistor logic. 6, 7, 8, 15, 16

USB   Universal Serial Bus. 3, 4, 6, 7, 11, 15, 19

WEEE   Waste Electrical and Electronic Equipment. 27