



with PowerBox

User Manual

User Manual
RGB Photonics GmbH
Lambda beam with PowerBox
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Contents

1	Laser Safety Precautions.....	1
2	Introduction	2
2.1	Product Overview.....	2
2.2	Package Contents.....	3
3	Installation and Operation.....	4
3.1	Precautions.....	4
3.2	Device Setup.....	4
3.3	Stand-alone laser operation.....	5
3.4	Computer-controlled laser operation.....	6
3.5	Operation modes.....	6
3.6	Disconnecting the system.....	7
3.7	Troubleshooting.....	7
4	Computer Control.....	9
4.1	Ltune Laser Control Software.....	9
4.2	Serial Communication.....	10
5	Specifications.....	15
5.1	General Specifications.....	15
5.2	Beam Specifications.....	15
5.3	Electrical Specifications.....	16
5.4	Mechanical specifications.....	17
6	Optional system configurations.....	20
7	Certification.....	21
8	Appendix.....	22
8.1	List of abbreviations.....	22

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 for Device and Radiological Health (CDRH) as a class 3b laser product. Visible and invisible laser radiation is emitted.

Modifications that may 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 highly clean-room atmosphere
- Adjustable temperature

Laser Controller Features

- Attaches directly to laser head
- Highly compact design
- Straightforward connection via screw-type terminal block
- Digital control via USB
- Powered by 12 – 36 V DC
- Modulation input analog or digital 0 – 5 V DC
- Low speed and high speed modulation inputs
- Interlock on/off input

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 PowerBox laser controller attaches directly to the laser head through the D-SUB9 connector with a locking mechanism. The back side holds a six-pin screw terminal block, a USB port and two coaxial modulation inputs (standard version). The terminal block can be pulled out and removed from the controller.



Cable

A standard Mini USB cable is used for connecting the laser to a computer or power supply. The length of the cable is 1.5 m (5 ft).

Software

The CD-ROM includes the Windows application software Ltune for configuring and controlling the laser system as well as this manual as a 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.



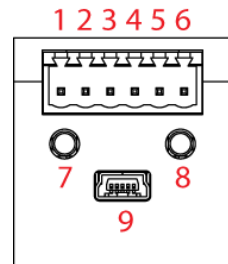
3.2 Device Setup

1. Attach the PowerBox controller to the Lambda beam laser head.
2. 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.
3. Move the locking slider on the connector to the locked position.
4. Connect the pins of the screw terminal block and the modulation inputs as required. Please see the following section for more details.
5. Turn on the supply voltage VCC.
6. After a quick self-test the green POWER LED should be lit continuously and the RDY output should be high (+ 5 V).

Connector and Pin Assignment

The connectors for the standard version are:

- | | | |
|---|-----------------|---|
| 1 | V _{CC} | Supply voltage |
| 2 | GND | Ground |
| 3 | INT | Interlock input |
| 4 | RDY | Ready output |
| 5 | TTL | Digital low-speed modulation input |
| 6 | AN | Analog low-speed modulation input |
| 7 | | Digital coaxial modulation input (MMCX) |
| 8 | | Analog coaxial modulation input (MMCX) |
| 9 | | USB connector |





The high speed modulation option does not include the coaxial modulation inputs (7 and 8) and the digital low-speed modulation input (5) on the controller. Instead, a high speed digital modulation input (MMCX) is placed directly on the back of the laser head.

All pins are low if not connected. For modulation you can choose to use the low speed terminal block input or higher speed coaxial input, depending on your bandwidth requirements. The technical specifications for the inputs can be found in chapter 5. Please note that the input levels are different for low and high speed modulation inputs. You can also use both low speed and coaxial inputs at the same time. In this case, the digital inputs are logically-OR combined and the analog inputs added.

Status Indicators

The laser controller includes two LEDs to indicate the laser status:

LED	Status	Description
POWER 	On	Power supply connected, self-test successful
	Off	Power supply not connected
	Flashing	Error
EMISSION 	On	Laser active, emission possible (actual emission depends on modulation mode and input pins)
	Off	Laser inactive
	Flashing	5 second delay before activating laser

3.3 Stand-alone laser operation

To operate the laser continuously at maximum output power, please connect the three Interlock, TTL and analog modulation inputs to + 5 V or V_{CC}. The laser starts operation

with a five second delay, as required by CDRH regulation¹. Once the laser is active, the EMISSION indicator is lit continuously. Afterwards, you can turn the laser on and off instantly by using the TTL modulation input or adjust the output power using the analog modulation input. In stand-alone operation, the laser operated in “Combined Modulation Mode”, which means that the laser emission is determined by both analog and digital modulation inputs.

3.4 Computer-controlled laser operation

The Lambda beam series can be controlled via USB. The operation is described in chapter 4.

In order to turn the laser on, please:

1. Connect the system as described in section 3.2.
2. For Digital or Analog Modulation Mode, please apply a voltage at the modulation input (BNC connector). Note that even with an input voltage of 0 V, a small amount of luminescence may be emitted. For operation in Constant Power Mode, you don't need to connect anything to the modulation inputs.
3. Connect the interlock input + 5 V or VCC.
4. Start the Ltune application software, set an output power and click on the Power On/Off button. The laser starts with a 5 second delay as described above.

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

3.5 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.

¹ Custom modification without delay is available for OEM integration.

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)².

Combined Modulation Mode³

In this mode, the laser emission is determined by both analog and digital modulation inputs. It can be turned on and off using the digital input and the output power can be adjusted using the analog input.

3.6 Disconnecting the system

Always disconnect the power supply before removing the controller from the laser head in order to prevent damage to the laser!

3.7 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 power supply)
- The interlock pin is at +5 V.
- The power on/off button in Ltune is turned on and an output power larger than zero is selected.
- Either Constant Power Mode is selected or a proper signal is connected to the modulation inputs.

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

²However, all signals below 0.8 V are considered as off and above 2.0 V as on.

³This mode cannot be selected in the current version of the Ltune software, but is fully supported by version 2, which will be made available for download on our website www.rgb-photonics.com soon. If you need this feature earlier, please ask our support team for a preview release.

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

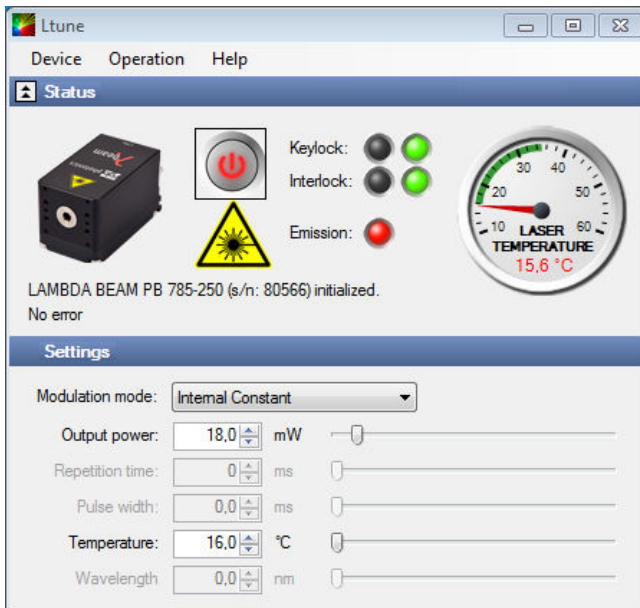
The Lambda beam series includes a USB interface for remote control. The laser can be controlled with

- The Windows application software Ltune (included) 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 device, it's best if you install the software first before attaching the device.

The software is tested with 32 and 64 bit versions of Windows 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 Mini-USB cable.

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

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 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=<parameter value>

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:

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 following 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 and read the “Laser Enable” request. The laser can only be activated if the interlock is closed.

Command/ Query	Parameter value	Return code	Return value
0= 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

(Not all laser systems support this function.)

Depending on the laser type, the temperature can be varied in a defined range. The commands and queries to access the temperature offset, actual temperature and default temperature of the laser head are:

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

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.

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

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).

Query	Parameter value	Return code	Return value
S?	-	COMMAND_SUCCESS	Current device status (see table below)
R?	-	COMMAND_SUCCESS	Total operating hours [hhhhmm]
DM?	-	COMMAND_SUCCESS	Manufacturer
DT?	-	COMMAND_SUCCESS	Device name
DS?	-	COMMAND_SUCCESS	Serial number
DO?	-	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 = Wavelength E = ECDL laser W = Water-cooled B = Multi-mode beam S = Customized
DC?	-	COMMAND_SUCCESS	ACC = Active current control APC = Active power control COMBINED = ACC and APC

The result of the status request S? is a bit-wise combination of the following values:

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.

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

Possible 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
0x10	LASER_DRIVER_OVERTEMP	Temperature of laser driver is too high
0x20	TEC_CONTROLLER_OVERTEMP	Temperature of TEC controller is too high
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 sec, calibrated operation after 5 min
Drive mode:	473, 532 and 561 nm: Active power control (APC) others: Active current control (ACC)
Modulation modes:	Constant power, analog and digital external modulation
Modulation frequency:	standard version: 1.5 MHz (with coaxial inputs) 473, 532 and 561 nm: 15 kHz ⁴ high speed mod. option: digital 50 MHz, analog 500 Hz
Control mode:	Power, temperature and modulation controllable via USB
Temperature control:	active TEC
TEC accuracy:	< 10 mK
CDRH 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

5.2 Beam Specifications

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

⁴ An optional acousto-optical modulator (AOM) may be used for faster modulation.

5.3 Electrical Specifications

Power Supply and Control

Supply voltage V_{CC} :	12 – 36 V
Supply current I_{CC} :	≤ 2 A at $V_{CC} = 12$ V
Interlock input:	0 – 5 V (< 0.8 V: low, > 2.0 V: high)
Ready output:	0 / 5 V (active high)

Absolute Maximum Ratings

The device may be damaged if these values are exceeded.

Supply voltage V_{CC} :	-40 to +40 V
Terminal block inputs:	-0.3 to $V_{CC} + 0.3$ V
Coaxial MMCX inputs:	Standard version: 0 to 2.0 V High speed modulation: 0 to 5.5 V

Low-speed Modulation Inputs

Connector type:	Screw terminal block
Analog / digital input:	0 – 5 V
Digital input threshold:	< 0.8 V: low, > 2.0 V: high
Input polarity:	active high
Modulation speed:	Standard version: 0 – 200 kHz High speed modulation: 0 – 500 Hz
Input impedance:	10 k Ω

Coaxial Modulation Inputs

Standard version

Connector type:	MMCX coaxial connector
Analog / digital input:	0 – 0.5 V
Digital input threshold:	< 0.2 V: low, > 0.3 V: high
Input polarity:	active high
Modulation speed:	0 – 1500 kHz
Input impedance:	50 Ω

High speed modulation option

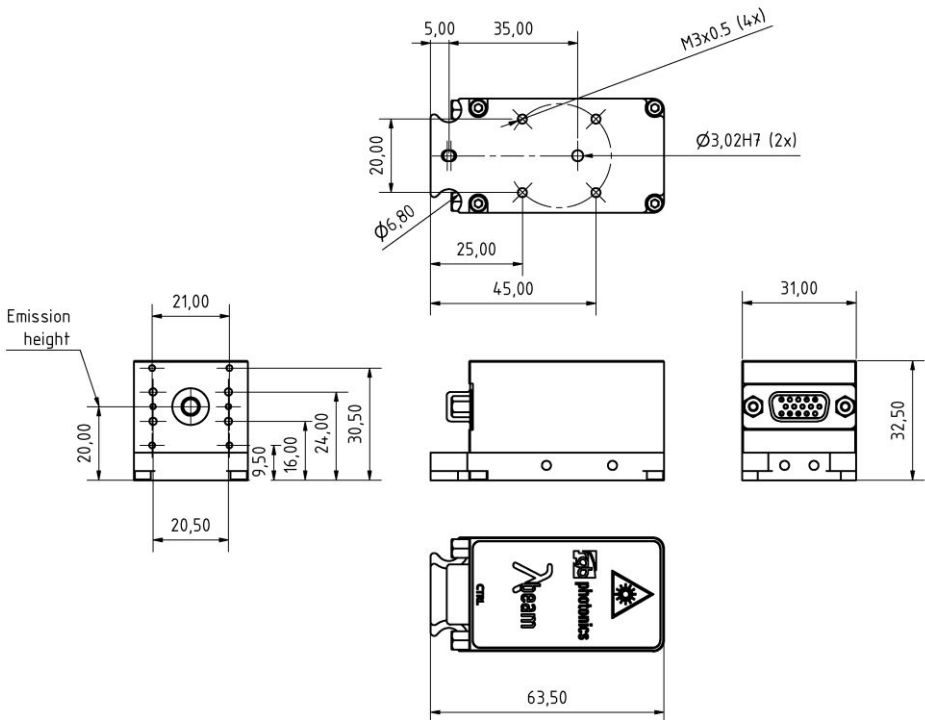
Connector type:	MMCX coaxial connector
Analog / digital input:	0 – 5.0 V
Digital input threshold:	< 0.8 V: low, > 2.0 V: high
Input polarity:	active high

Modulation speed: 0 – 200 MHz
Input impedance: 1 k Ω

5.4 Mechanical specifications

Lambda beam laser head

Length: 63.5 mm (2.5")
Width: 31.0 mm (1.22")



All dimensions in mm.

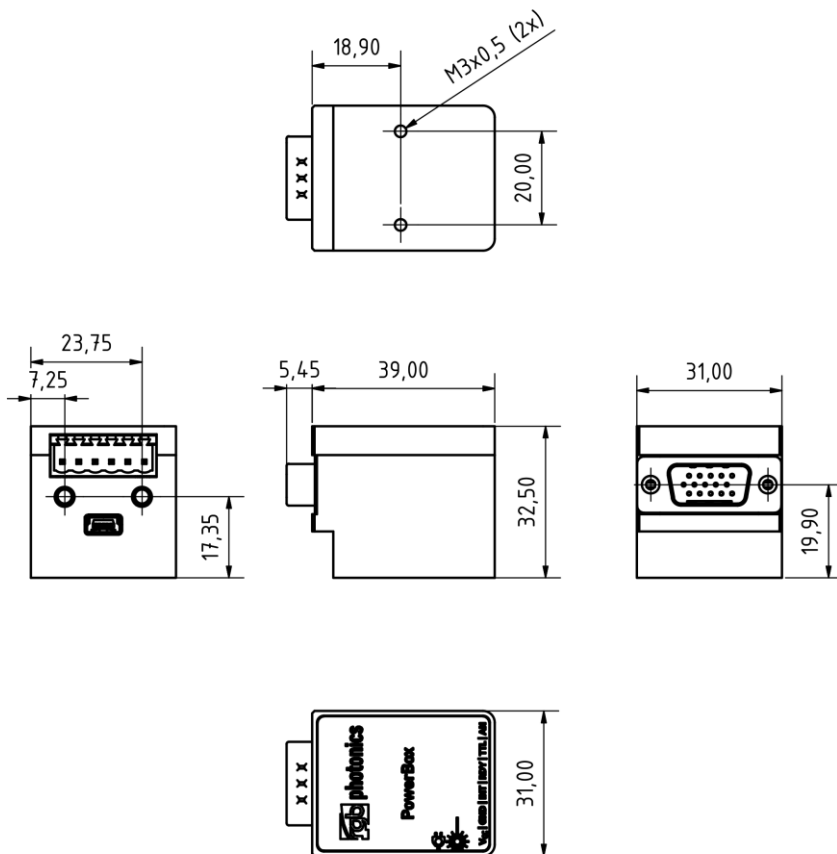
3D CAD files are available for download on www.rgb-photonics.com.

PowerBox laser controller

Length: 39.0 mm

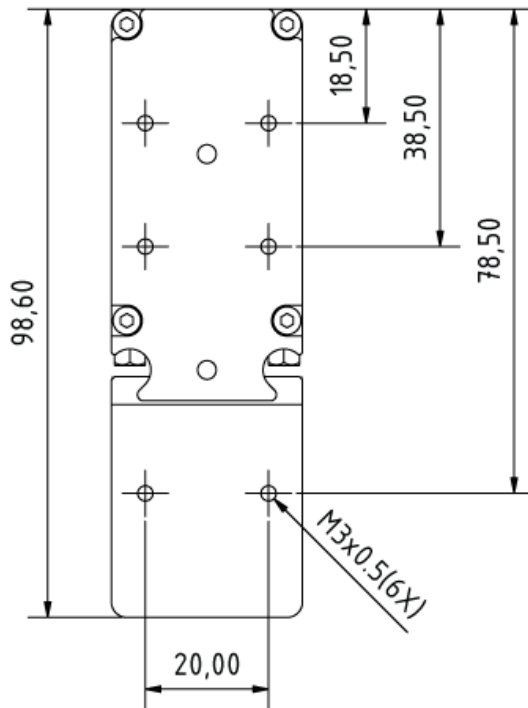
Width: 31.0 mm

Height: 32.5 mm



All dimensions in mm.

PowerBox with Lambda beam attached



All dimensions in mm.

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.

Round beam

Circular and other beam shape characteristics are available on request.⁵

Wavelock

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

⁵ Please note that the Round Beam option decreases the maximum output power by up to 30 %.

7 Certification

RoHS Declaration of Conformity

The manufacturer

RGB Photonics 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 2002/95/EG is confirmed.

This declaration applies to all models of the above named product version.

Kelheim, 06.10.2016

Mathias Reichl

8 Appendix

8.1 List of abbreviations

°C	Degrees centigrade
°F	Degrees Fahrenheit
µm	Microns
µrad	Micro radiant
AC	Alternating current
A	Ampère
BNC	BNC connector
CDRH	Center of Device and Radiological Health
CE	Conformité Européenne
CW	Continuous wave
DC	Direct current
D-SUB9	D-SUB9 connector
ESD	Electrostatic discharge
Hz	Hertz
in	inch
K	Kelvin
kHz	Kilohertz
LED	Light emitting diode
m	meters
MHz	Megahertz
mm	Millimeter
mrاد	Milliradiant
nm	Nanometer
RMS	Root mean square
RoHS	Restriction of the use of certain hazardous substances
sec	seconds
TEC	Thermo electric cooler
TEM	Transverse electromagnetic mode
TTL	Transistor-transistor logic
V	Volts
VAC	Volts, alternating current
VDC	Volts, direct current
W	Watt
WEEE	Waste Electrical and Electronic Equipment