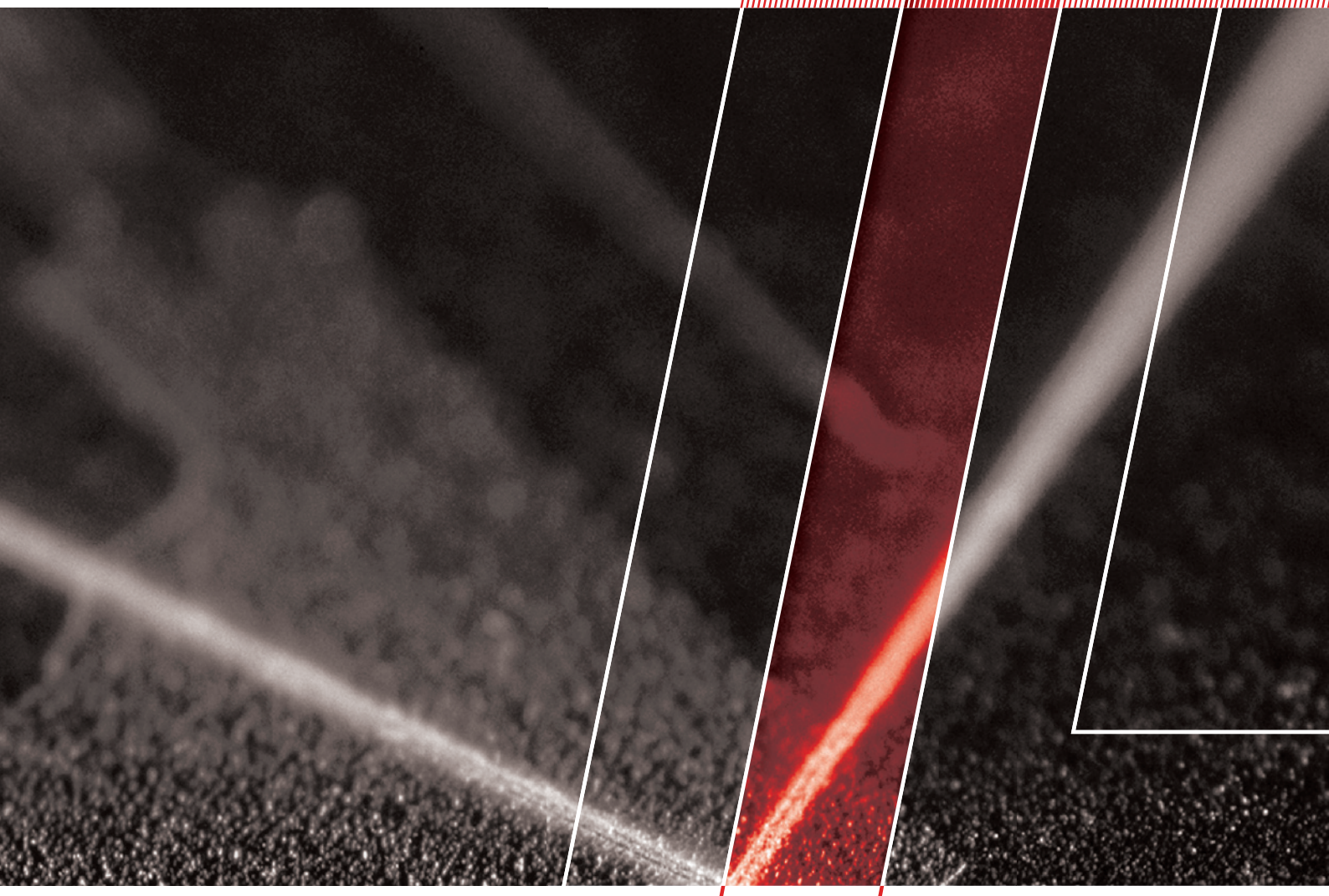
blizz*

High Power DPSS Lasers

User and Installation Manual



Think of LASER as a tool

INNOLAS PHOTONICS

Revision History

1.0	First release

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Preface

Audience

This manual should be read by all personnel who install or operate the blizz laser.

> **Important!**
> Read this manual carefully before operating the laser for the first time. Pay special attention to the Safety chapter.

The blizz laser is designed and sold for use in Original Equipment Manufacturer (OEM) systems and is not to be used as a stand-alone laser. The OEM is responsible for compliance with all applicable safety regulations.

Other publications

- *EN60825–1 Radiation Safety of Laser Products, Equipment Classification, Requirements and User's Guide*

  http://www.cenelec.org
- *IEC 60204–1 Safety of Machinery, Electrical Equipment of Machines*
- *IEC 61010–1 Safety Requirements for Electrical Equipment for Measurements, Control and Laboratory Use*
- *Laser Safety Guide*

  Laser Institute of America, 13501 Ingenuity Drive, Suite 128, Orlando, Florida 32826, USA

  http://www.laserinstitute.org
- *ANSI Z136.1–2000 — Safe Use of Lasers*, American National Standards Institute

  http://www.ansi.org/

  http://www.z136.org/

How to use this manual

The manual contains information required for safe operation, installation and routine maintenance of the equipment.

U.S. Export Control Laws Compliance

Lasers from InnoLas Photonics GmbH are made in Germany. Nevertheless many of our lasers contain sub-components that are originating from the U.S. and need to comply with U.S. export control laws.

Export and re-export of lasers manufactured by InnoLas Photonics GmbH are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components might be regulated by the State Department under the International Traffic in Arms Regulations (ITAR).

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or reexport of certain articles. When there is uncertainty

about the obligations imposed by U.S. law, clarification should be obtained from an appropriate U.S. Government agency.

1. Safety

Only authorised personnel, familiar with the potential dangers presented by laser equipment during operation or installation, are allowed to work with the laser system. It is of utmost importance that personnel working with the system read, understand and observe the information and instructions in this manual.

> **⚠ WARNING**
> **Risk of exposure to laser radiation**
> Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The blizz is a Class IV laser intended to be used as part of an integrated laser-based processing system.

Safe use of this equipment is reinforced by safety labels fixed to the equipment in a visible manner. The type of safety labels used and their location is detailed in section 1.4.

The use of controls, replacement parts, adjustments, or procedures other than those specified within this manual may result in exposure to any of these hazards.

- Laser hazards
- Electrical hazards
- Environmental hazards
- Mechanical hazards.

The degree of seriousness of the hazard is indicated by the use of the following signal words:

DANGER

Indicates an imminent hazard which, if not avoided, is extremely likely to result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It is also used to alert the user against unsafe working practices and potential damage to the equipment.

1.1. Qualification and training of personnel

Personnel who install and/or operate the laser must be adequately qualified for the work concerned and should have read this manual. The user must clearly specify the sphere of responsibility, competence and certification for personnel concerned.

1.2. Electrical

DANGER
Risk of electrocution
Switch off and disconnect the equipment from the mains electrical supply before removing covers. Only trained and authorised personnel should remove covers from the power supply.

Before working on the system:

- Remove the key from the key switch on the power supply.
- Turn off the mains electrical supply and, if possible, disconnect the equipment from the supply.
- Restrict access to the area to trained people who are aware of the hazards.
- Refer to the system manual and circuit diagrams for wiring connections and polarities. Never guess or use trial and error techniques.
- Fit only InnoLas Photonics approved parts.
- Do not operate the equipment with safety panels removed or with interlock switches overridden (unless a key operated override facility has been included).
- Never attempt to work on electrical circuits when alone; always have a colleague nearby.
- Observe the requirement of the electrical safety codes for the establishment where the laser is installed.
- External equipment connected to the system must comply with EN61010–1 and appropriate local standards.
-  This symbol is intended to alert the operator of the danger of electrostatic discharge (ESD) susceptibility.

1.3. Laser radiation

WARNING
Risk of exposure to laser radiation
Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

During installation or in a maintenance situation, the operating area of the laser system must be clearly marked to warn unauthorised personnel not to enter the area. All entrances and exits must be marked with appropriate warning signs.

OEM system integrators are obliged to provide training to their customers and to make them familiar with the potential dangers of Class IV laser in general and the blizz laser in particular.

When working on the system during installation or in a maintenance situation, observe the following rules:

- Avoid eye or skin contact to direct or scattered radiation.
- Always wear protective eye wear matched to the emission wavelength and output power of the laser. Instruct all personnel in the vicinity to wear identical protective eye wear.
- Never look into the laser beam!
- Make sure there are no reflective materials in the beam path that could deflect the beam toward the operator or another person in the vicinity.
- Use only non-flammable, absorbing or non-reflective materials as beam dumps.
- Never operate the laser in the vicinity of explosive liquids or gases.
- Be aware that laser processing certain materials (e.g. plastics) may create poisonous fumes and by-products.

1.4. Location of safety labels

The labels shown on the following drawing are fitted to the equipment in the locations specified and must not be removed or defaced. Immediately replace any missing labels. Replacement labels can be obtained from InnoLas Photonics.

Labels on the side of the laser head are repeated on both side faces.

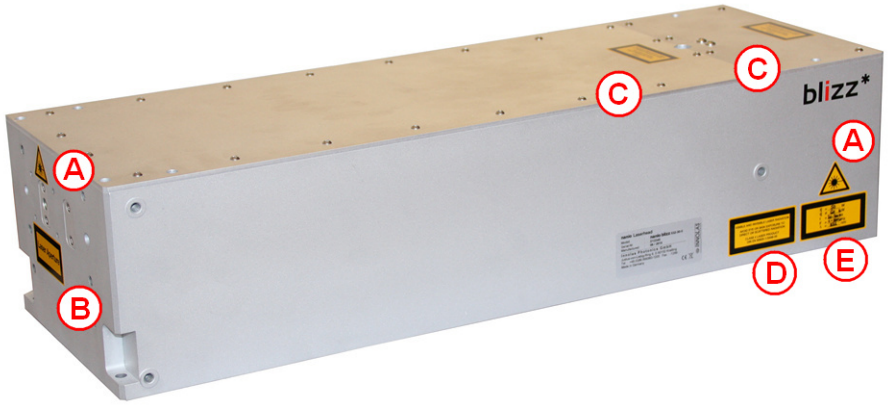


Figure 1 - Safety label locations

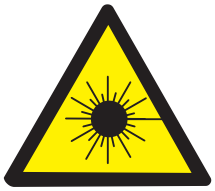


Figure 2 - Label A

Figure 3 - Label B

Figure 4 - Label C

Figure 5 - Label D

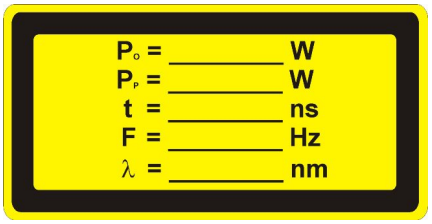


Figure 6 - Label E

The following information appears on Label E, depending on the laser type:

P_o	40 W
P_p	50 kW
t	10–100 ns
F	Single shot to 300 kHz
λ	532 nm

Figure 7 - Type label

Figure 8 - Mains cord connection point

1.5. Hazardous materials

The laser head contains indium used as a heat conductor in the diode module and all crystal mounts. Indium is toxic. Do not open the laser head or crystal assemblies.

1.6. Decommissioning and disposal

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

Dispose of the system according to appropriate local regulations, paying particular attention to disposal of indium components in the laser head.

2. General description

2.1. Intended use

The blizz is a diode-pumped solid-state laser system designed for OEM applications as part of an integrated laser-based materials processing system. It offers a choice of output wavelengths and powers with repetition rates up to 300 kHz and excellent beam quality and stability.

2.2. Laser head

Figure 9 - Laser head

The laser head consists of a sealed resonator module and an electronics compartment. All electrical connections are on the end face of the laser head. Laser output is emitted from the front face of the resonator module. The laser head is mounted using the bottom surface. A three-point fixing is provided with precise and repeatable location assured by means of precision reference holes and slots for dowel pins.

The complete assembly is sealed to prevent the ingress of dust and humidity.

> **Important!**
> Never open the laser cavity. No user serviceable parts inside.

The laser head contains the following key components:

- A laser diode
- Control electronics
- Laser crystal and resonator mirrors
- Intra-cavity acousto-optic Q-switch

In addition, it can be fitted with harmonic generation and separation modules and an external acousto-optic modulator.

All connectors can be supplied in either inline, 45° or 90° configurations.

2.3. PCB stack power supply

The power supply is common to all blizz lasers. This provides maximum flexibility and minimises spare part holdings. The power supply requirement is 48 Vdc. PCB stack

modules are designed to be integrated within the customer's equipment and the customer is responsible for electrical supply, control signals and safety circuits. The PCB stack modules, provided by InnoLas Photonics, are:

- PCB stack to laser head power cable (5–pin)
- PCB stack to laser head signal cable (25–pin)
- PCB stack consisting of two circuit boards
- PCB stack interconnection cable
- RF driver
- RF driver to PCB stack RF cable
- RF driver to PCB stack signal cable

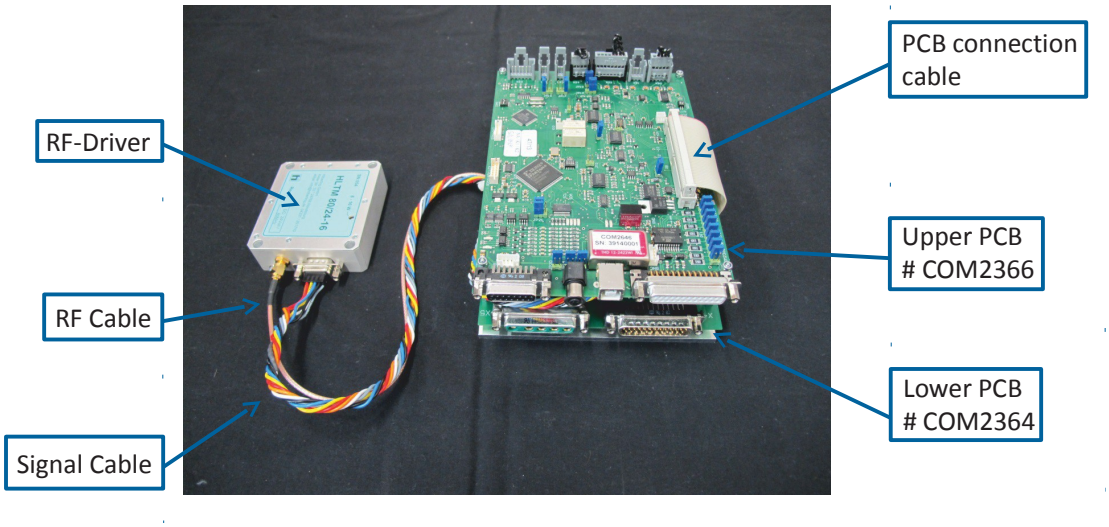


Figure 10 - PCB stack assembly

The customer is responsible for provision of:

- 48 Vdc power supply with 12 A minimum current
- Power supply to PCB stack cable with 6.3 mm blade terminals
- Scan controller
- Scan controller to PCB stack cable with 25–pin sub-D female connector
- PC with RS232 or USB interface
- PC to PCB stack RS232 cable with 5–pin JST B5B-PH-S male connector. Not required for USB control.
- Emission warning lamp
- Interlock switches
- Remote start push button
- Cooling fan for PCB stack and Q-switch driver
- Key switch (optional)
- System status LEDs (optional)
- Customer equipment to PCB stack cable for emission warning lamp, interlocks, remote start push button, key switch, etc. with 15–pin sub-D female connector

Figure 11 shows the system modules and interconnects.

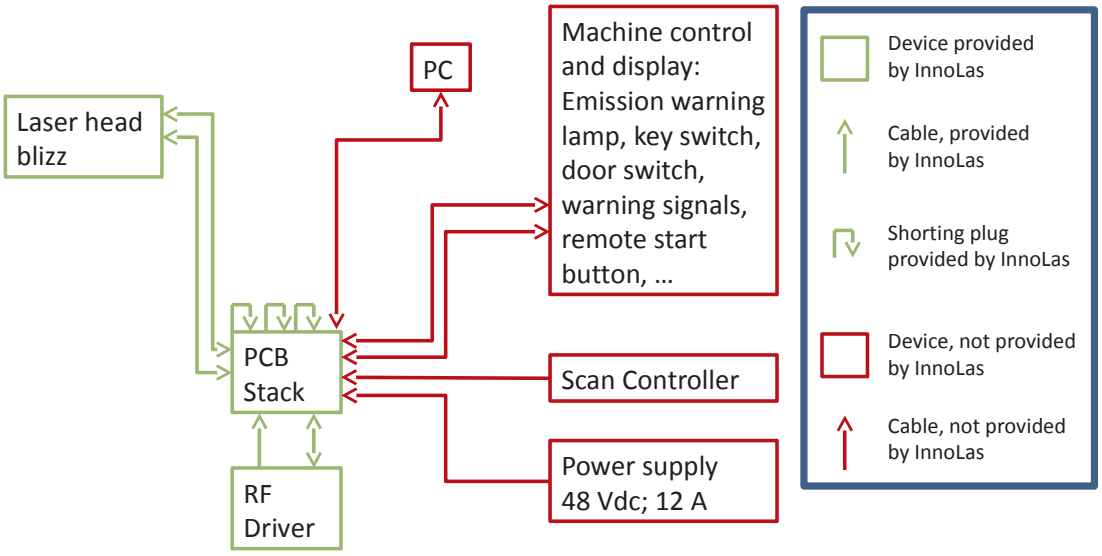


Figure 11 - PCB stack system overview

2.4. Power supply — 19–inch rack option

Figure 12 - Power supply — 19–inch rack option

The power supply is common to all blizz lasers. This provides maximum flexibility and minimises spare part holdings. The power supply is designed to fit into a 19–inch rack and is 1RU high. The standard mains supply is 115–230 VAC ± 10%, 50–60 Hz, single phase.

2.5. Thermal management

When installing the blizz laser head, the heat produced in the laser head must be properly removed using a water chiller. The heat load to be dissipated from the laser head is 300 W max. at a cooling water temperature of 20°C.

The conditions which generate the most heat in the blizz laser head are the following:

- Diodes ON
- Gate or Trigger OFF

With insufficient cooling (high water temperature, low flow or pressure) these conditions can cause an over-temperature failure of the laser. Proper heat removal from the head ensures that the heat is efficiently dissipated, serving the following purposes:

1. **Avoid over temperature faults**

   If the head temperature reaches 40°C a "Laser Head Base Temp Warning" will be shown but the laser continues to operate. Once the base plate temperature exceeds 45°C the blizz will automatically shut down. Proper cooling of the laser head will ensure that over-temperature faults do not occur.

2. **Consistent pointing angle**

   The pointing angle of the blizz changes with a change in laser head base temperature. Maximizing the base temperature stability will minimize temperature induced pointing angle drift.

3. **Enhanced power stability**

   Excessive changes in the laser head base temperature will induce thermal stress and affect the efficiency of the SHG crystal, reducing the power stability of the laser.

As soon as the head temperature exceeds approximately 45°C, a Warning Code "Laser Head Base Temp Warning" is issued, but the laser will continue to operate normally. However, once the maximum operating limit of 50°C is exceeded, the laser will perform an emergency shut-off, whereby the laser is immediately placed into Sleep mode. At the same time, a temperature error signal is emitted. Sleep mode can be exited by restarting the laser after the laser head temperature has dropped below 50°C (typical) again.

2.5.1. Water Cooling

Using a closed loop water chiller will provide the most stable temperature control for all blizz lasers. The blizz laser will operate safely over a wide range of operating temperatures, but for maximum output power, maximum power stability and minimum pointing angle drift, the temperature of the laser head should be set to 20°C and vary no more than ±1°C. The chiller should be set to a flow rate greater than or equal to 3 l/min. The input and output connectors are male and female to avoid accidental reversal of the coolant flow.

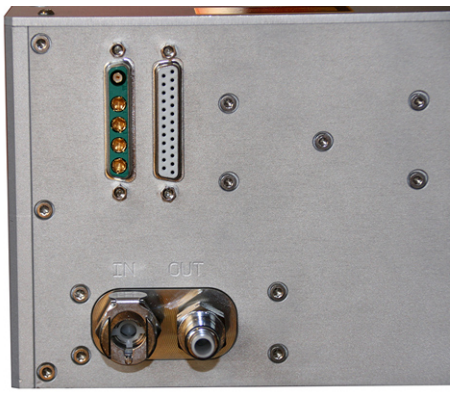


Figure 13 - Head connectors

2.5.2. Chiller

InnoLas Photonics can provide a closed loop water chiller to be used with the blizz laser. This chiller can be ordered directly from InnoLas Photonics. For chiller types and part numbers please contact InnoLas Photonics.

For the use of a second party chiller the following specifications must be met:

Cooling water specifications	
Temperature	20°C ± 1°C
Flow rate	3-6 l/min (min. 1 l/min)
Pressure drop	3 bar (max. 6 bar)
Particle size	<20 µm
Water quality	Distilled water
Chiller water circuit component materials	Stainless steel or plastics only. *No nonferrous metals!*
Water connector specifications	
Connectors used at laser head	Colder Products (CPC) LC series
Water inlet on laser head	CPC part number LCD10004BSPT
Water outlet on laser head	CPC part number LCD24004BSPT
Recommended hose connector for inlet	CPC part number LCD22006; or similar
Recommended hose connector for outlet	CPC part number LCD17006; or similar

2.6. Beam delivery options

- Beam expander
- Scan head mounting option
- Variable attenuator

2.7. Specifications

2.7.1. Electrical supply — laser

Maximum power consumption	500 W
Maximum current demand	12 A

Supply voltage	Single phase, 115–230 VAC ± 10%
Supply frequency	50/60 Hz

2.7.2. Dimensions — laser head

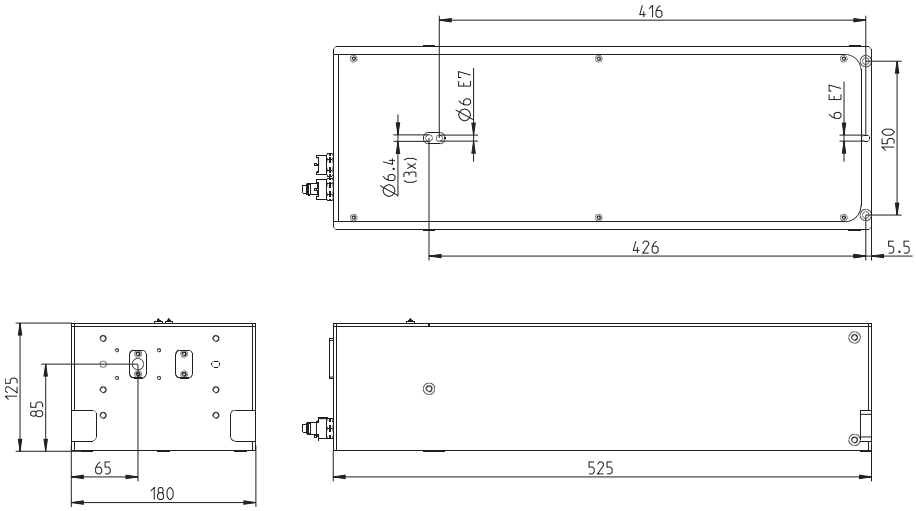
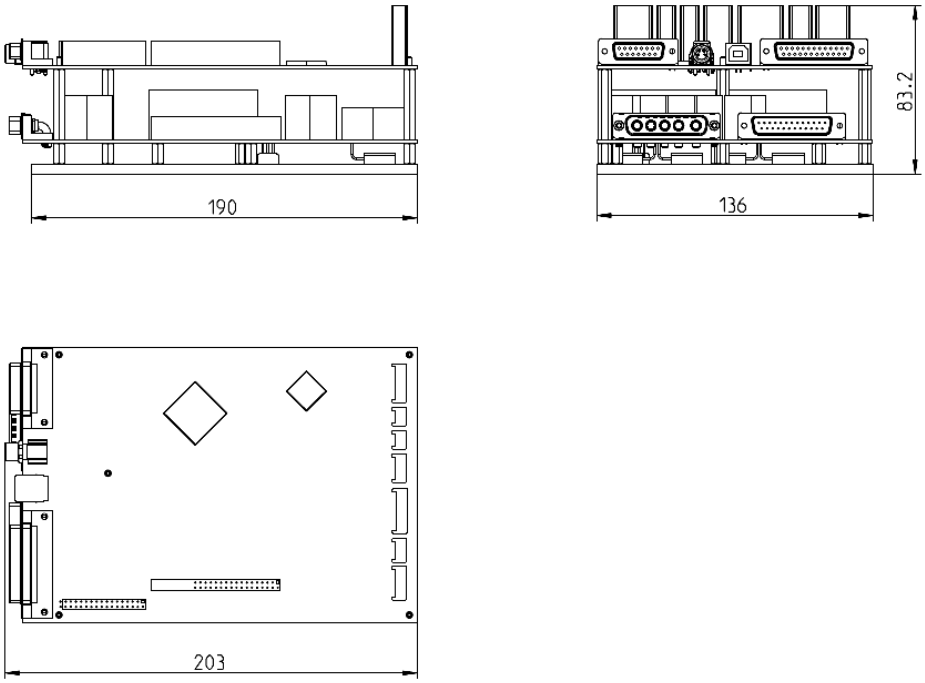


Figure 14 - blizz head

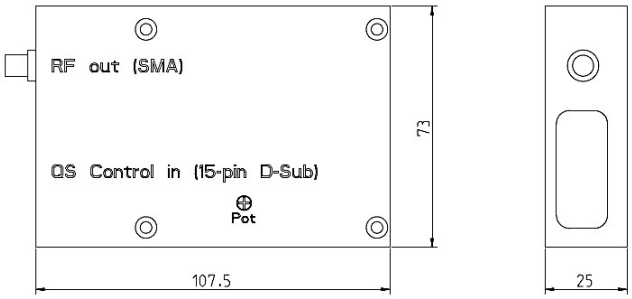
Note: *3D step files are available on request.*

2.7.3. Dimensions — PCB stack power supply

PCB stack



RF driver



2.7.4. Dimensions — 19–inch rack power supply option

19–inch rack mount — 1RU

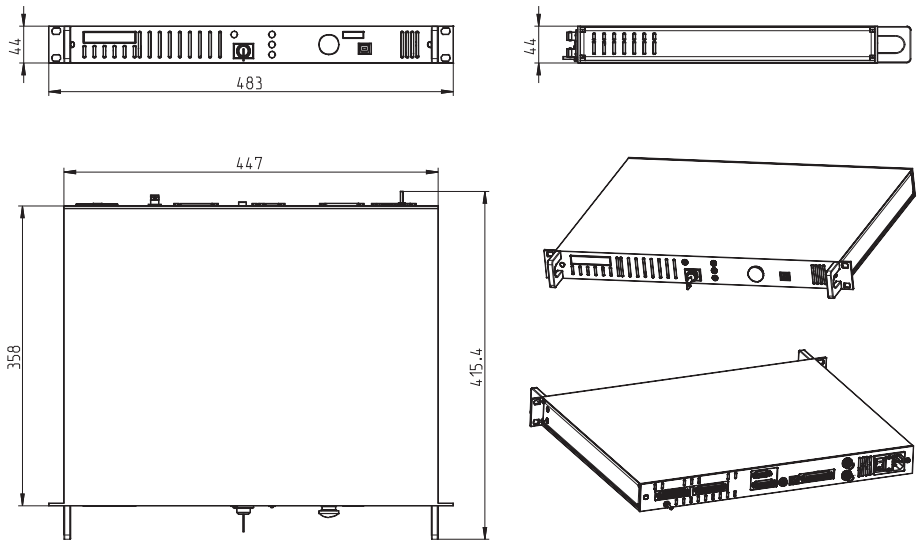


Figure 15 - Power supply

2.7.5. Interconnection cables

The umbilical cable linking laser head and power supply has a standard length of 3 m but can be supplied in lengths from 1 m to 10 m on request.

2.7.6. Nominal weights

Laser head	≤20 kg depending on model
PCB stack power supply	≤1.5 kg
Power supply unit (19–inch rack option)	≤6 kg

2.7.7. Customer connections

Customer connections for control and safety circuits are available on the rear of the 19–inch rack power supply or directly on the PCBs of the PCB stack power supply. Interfacing details are given in the Interfacing chapters (Chapter 10 and Chapter 11).

2.7.8. Performance

Refer to the product data sheet and final test protocol.

2.7.9. Environmental

Ambient temperature range

Working	15–35°C, non-condensing
Transport and storage	Above 2°C

Relative humidity and conductive dust

The blizz must not be installed in an environment with conductive dust or condensation.

Altitude range

0–3300 m

Shock, vibration and acceleration

The blizz is robust in normal operation but may be damaged by dropping or when subject to severe vibration and shocks, such as those encountered during transport over rough or uneven floors.

2.7.10. Design lifetime of the equipment

The blizz system is designed for a maximum use of ten years from initial date of shipment. After this period it should be decommissioned or returned to InnoLas Photonics for refurbishment.

3. Operation

3.1. Direct start up using the 19–inch power supply (option)

1. Turn on the main switch on the power supply back panel. The white Power status lamp illuminates.
2. Ensure that the Emergency Stop (System Off) button on the power supply front panel is in the active position (turn it clockwise to release).
3. Insert the key in the key switch and turn the key switch clockwise to position 1. The white Warmup/Ready status lamp flashes to indicate that the system is warming up. The white laser emission warning indicator lamps on the front of the power supply and on the top of the laser head illuminate.

   Note: *The key can only be inserted or removed when the switch is in position 0.*

   When the white Warmup/Ready lamp illuminates continuously, the system is ready for use but the diode power supply is not enabled.

   Note: *The warm up may take up to 15 minutes.*

   Important!

   When wearing personal eye protection, remember that the emission warning and status lamp colour depends on the filter glass used in the eye protection.

4. Turn the key switch to position 2. The diode power supply starts if the interlock circuits are enabled.

3.2. Direct shut down

1. Turn the key switch counter-clockwise to position 1. The diode power supply shuts down.
2. Turn the key switch to position 0. The Warmup/Ready lamp and the emission warning indicator lamps on the laser head and power supply go out.
3. Switch off the main switch. The Power lamp goes out.

3.3. Remote start up

This assumes that:

- The laser power supply main switch is on
- The key switch is in position 2
- No Emergency Stop has been activated

1. Turn on the AC mains power to power supply. The Power status lamp illuminates.
2. Wait for five seconds to allow the system to initialise.
3. Send a system reset signal (from the interlock connector or the RS232 interface).
4. Apply a system enable signal (from the customer interface or the RS232 interface). The Warmup/Ready status lamp flashes to indicate that the system is warming up. The laser emission warning indicator lamps on the front of the power supply and on the top of the laser head diode module illuminate.

When the system is warmed up, the Warmup/Ready lamp illuminates and the diode power supply starts if the interlock circuits are enabled.

Important!

When wearing personal eye protection, remember that the emission warning and status lamp colour depends on the filter glass used in the eye protection.

3.4. Remote shut down

1. Deactivate the system enable signal (from the customer interface or the RS232 interface). The diode power supply shuts down. The Warmup/Ready lamp and the emission warning indicator lamps on the laser head and power supply go out.
2. Turn off the AC mains power to the power supply. The Power status lamp goes out.

3.5. Emergency shut down

In an emergency either:

Press the Emergency Stop (System Off) button on the power supply front panel fully in until it locks.

or

Activate any external Emergency Stop device fitted to the complete system.

3.6. Restart after an emergency shut down

1. Release all Emergency Stop (System Off) devices that have been activated and locked in the off position.
2. Apply a system reset signal (from the interlock connector or the RS232 interface) or turn the key switch to position 0.
3. Perform a normal direct or remote start up procedure.

3.7. Constant pulse energy mode (CPEM)

Constant pulse energy mode (CPEM) improves the pulse-to-pulse stability of the laser output by maintaining a certain level of output in the laser crystal between pulses. In this mode, even the first pulse in a sequence has the same energy as the following pulses.

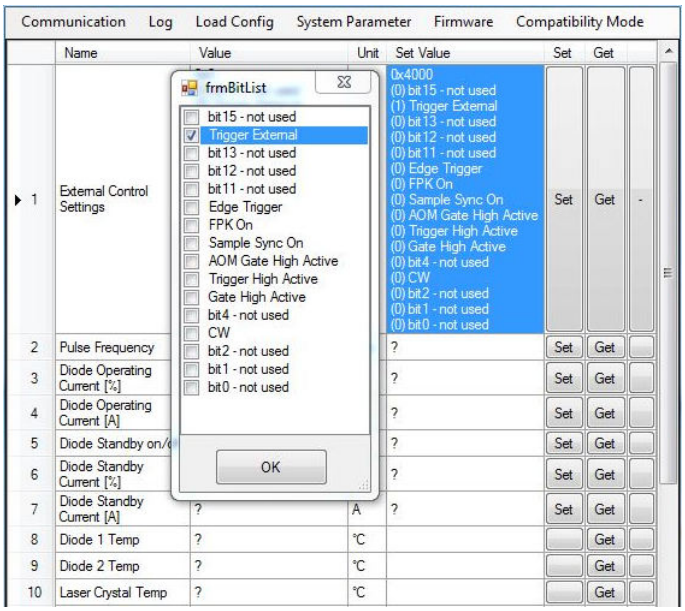
Requirements for CPEM operation are:

- blizz laser head optimised for CPEM operation

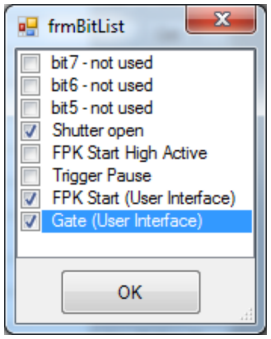
  Note: *The InnolasLaserController main screen setting* ***Pulse width limit enable*** *shows whether the laser is already prepared for CPEM or not. If the* ***Pulse width limit enable*** *setting is activated (value=1) the laser cannot operate in CPEM Mode. Please contact InnoLas Photonics for possible solutions.*
- PC with “InnolasLaserControl” software installed
- a suitable trigger source

3.7.1. CPEM setup

1. CPEM requires an external trigger signal. To select external trigger:
   a. From the InnolasLaserController main screen, select **External Control Settings** and click **Set**. The frmBitList displays.



   b. Check **Trigger External** and **FPK On**. Ensure that **Edge Trigger** and **Trigger High Active** are *unchecked*. Click **OK** to save the configuration.
   c. Select **FPK Trigger Source** and click **Set**. The frmBitList displays.



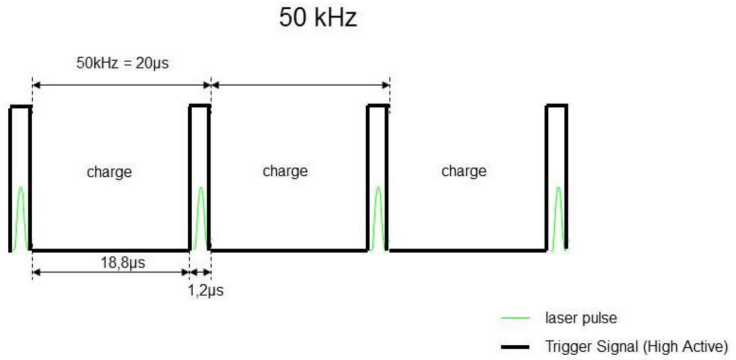
   d. Uncheck **Trigger Pause** and click **OK** to save the configuration.

> **Important!**
> After making these configuration changes, the laser must be triggered from the external interface connector. See the interfacing chapters, Chapter 10 and Chapter 11.

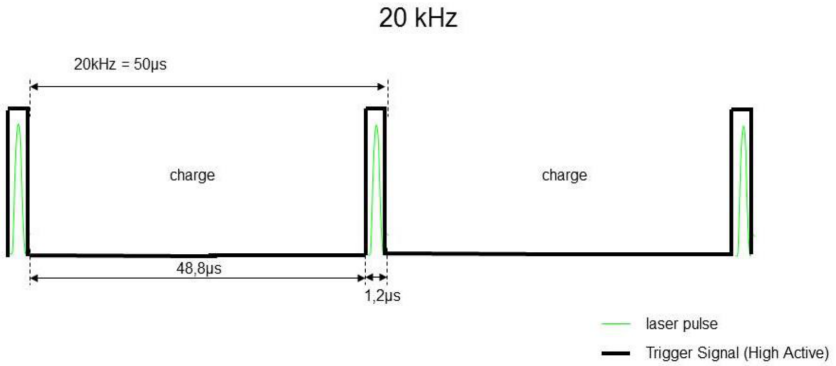
3.7.2. CPEM functionality

When the laser is triggered internally, the trigger signal pulse width is always 1.2 µs. Changing the repetition rate only affects the pause time between laser pulses. For

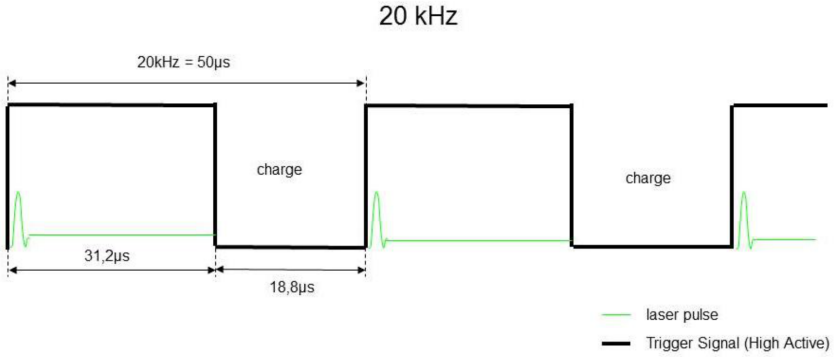
example; at a repetition rate of 50 kHz, the trigger pulse width and the Q-switch open time are both 1.2 µs with a pause of 18.8 µs between pulses.



Changing the repetition rate to 20 kHz only affects the pulse-to-pulse period, not the pulse width which remains constant at 1.2 µs, and so the pause time is now 48.8 µs.

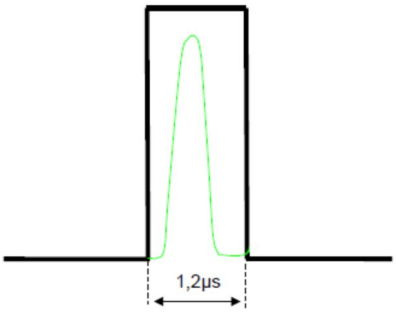


The different pause times result in a different amount of optical charge present in the laser crystal at the time of the next pulse and so the pulse energy is different, even if the diode current is constant. To maintain a constant pulse energy when the repetition rate changes the trigger pulse width must be varied to keep the Q-switch off time constant at all repetition rates. This gives a constant optical charging period and results in constant pulse energy each time the Q-switch opens.



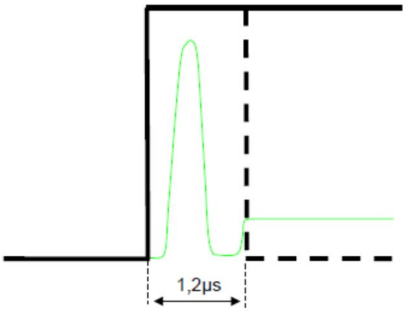
3.7.3. CPEM in detail

Normal mode (internal trigger)



- The trigger pulse width is 1.2 µs.
- The trigger signal is high (Q-switch open) for 1.2 µs.
- The trigger signal is low immediately after laser pulse emission (Q-switch closed).

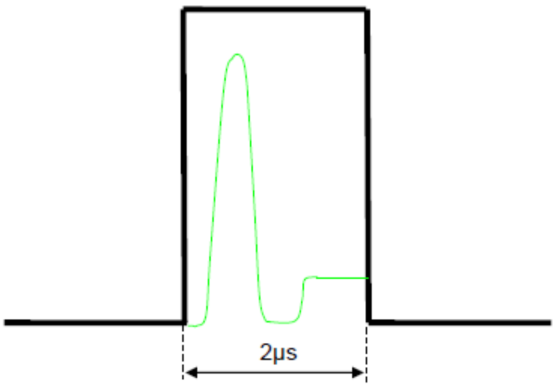
Effect of keeping the trigger signal high



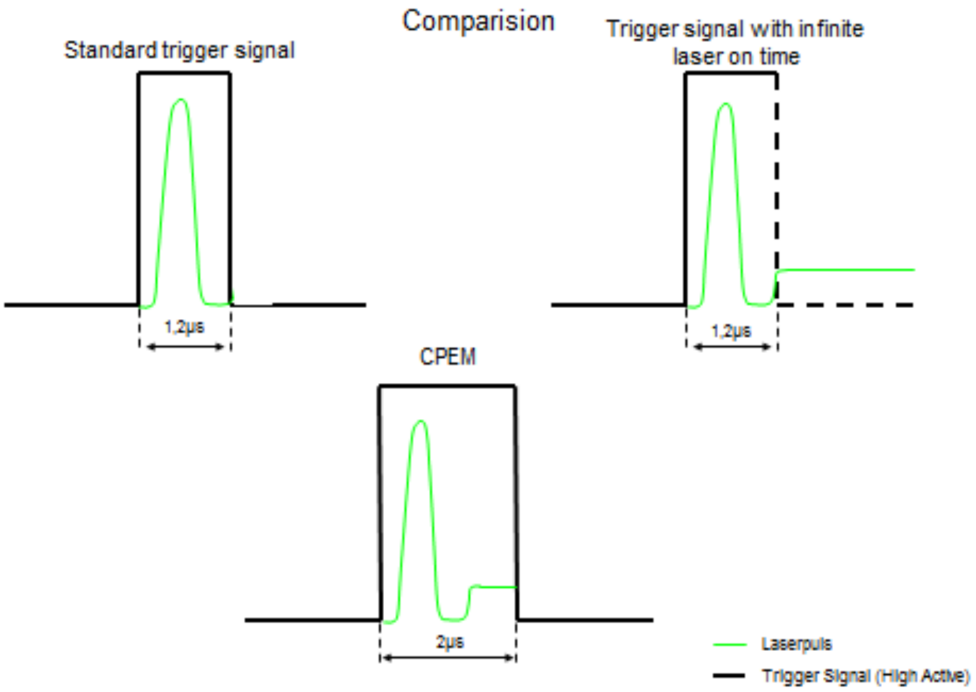
- The trigger signal remains high after emission of a laser pulse resulting in Constant Wave (CW) laser emission after the pulse.
- The trigger pulse width is theoretically infinite.
- With the infinitely long laser pulse time, the Q-switch remains open and the laser crystal charges to CW level within 3 µs.

  Note: *It is important to deactivate the Edge Trigger function, otherwise the power supply modifies the external trigger to a maximum pulse width of 1.2 µs (as shown by the dotted line). In this case, the laser output cannot reach a stable CW state.*

Constant Pulse Energy Mode



- The Q-switch open time is increased so that the laser output reaches stable CW level after every laser pulse.
- The result is that optical charging in the laser crystal always starts at the same stable level.
- Every laser pulse has the same pulse energy, even the first pulse.



3.7.4. CW suppression for CPEM operation

Important!

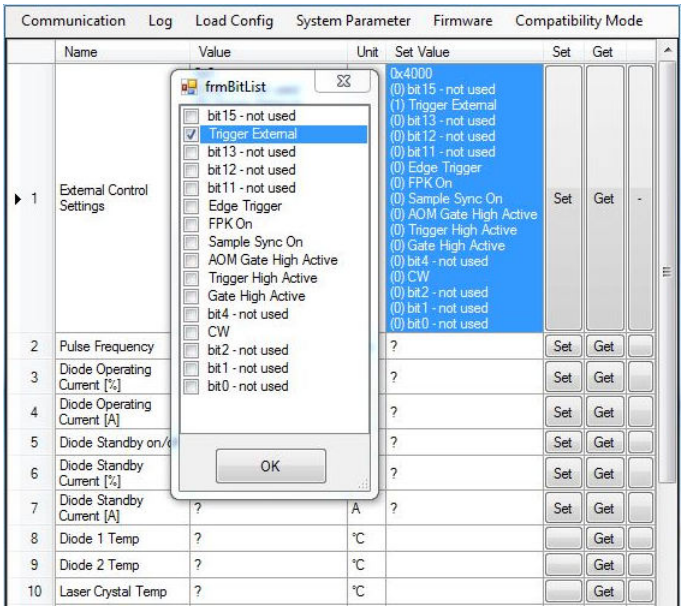
FPK functionality needs to be turned *off* for CPEM CW suppression.

Important!

Take note that incorrect analog signal timing will damage the internal laser optics.

Software configuration

1. From the InnolasLaserController main screen, select **External Control Settings** and click **Set**. The frmBitList displays.



2. Check **Trigger External**. Ensure that **Edge Trigger**, **FPK On** and **Trigger High Active** are *unchecked*. Click **OK** to save the configuration.

External signal connections (19–inch rack option)

Connect external trigger signal to BNC connector X108. Connect analog signal to BNC connector X109

1 Laser head power (X102)
2 Laserhead control (X115)
3 RS232 sub-D control signals (X105)
4 Interlocks (X101)
5 Optional fan control (X104)
6 USB control signals (X107)
7 User interface (X112)
8 External trigger (X108)
9 RF level (X109)
10 AC mains in (X100)

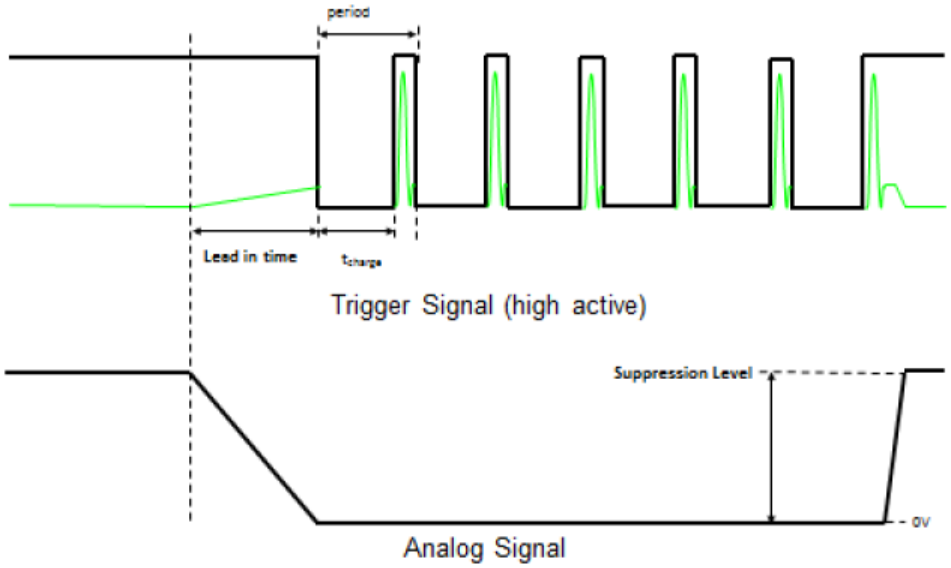
Figure 16 - Power supply connections

CW suppression operation

The analog suppression signal is used to suppress CW laser output, when the laser is not triggered, by reducing the RF-level.

- 10 V = maximum suppression
- 0 V = no suppression

The maximum analog suppression signal (10 V) must always be applied when the laser is not triggered. Before triggering the laser a lead in sequence is required. When the laser is triggered the analog signal must be 0 V.



- **Lead-in time**

  The lead in sequence is a ramp on the analog signal starting from the chosen suppression level (for example 10 V) down to 0 V. The typical lead in time is 200 µs.
- **Marking**

  After the lead in sequence is finished the laser is triggered normally in CPEM mode.
- **End of marking**

  The analog suppression signal must be set back to the chosen suppression level again (for example 10 V) 2 µs after the last pulse.
- **Timing optimisation**

  Use the minimum suppression level needed to suppress the CW leakage. As little as 5 V might be sufficient. Suppression levels <10 V allow lead in times <200 us.

Important!

Take note that an incorrect suppression signal timing can damage the laser internal optics. e.g.: If the signal is switched off rapidly (without ramp), a high energy first pulse will be output resulting in damage to the internal laser optics.

4. Software

Access to the RS232 commands is limited by access code. After startup, the access level is always set to level 0, operator access. This access level has been preset and can only be exceeded by using a password.

Access levels are:

- Level 0 — Operator
- Level 1 — Customer service or maintenance
- Level 2 — InnoLas Photonics certified service personnel
- Levels 3 and higher are for factory use only.

4.1. Default software installation

1. Insert the InnolasLaserControl software CD-ROM in the CD drive or your PC. Check that the Microsoft™ .NET 2.0 or higher and the Windows™ Installer are already installed on the PC. If not, install them from the CD-ROM before installing the InnolasLaserControl software.
2. Install the InnolasLaserControl software from the CD-ROM.

   Note: *On Windows 7 and later operating systems make sure not to use the default installation folder* ***Program Files****. Windows 7 and later blocks programs from writing files into this folder so log files (needed for troubleshooting) cannot be created.*
3. Remove the CD-ROM and then launch the software.

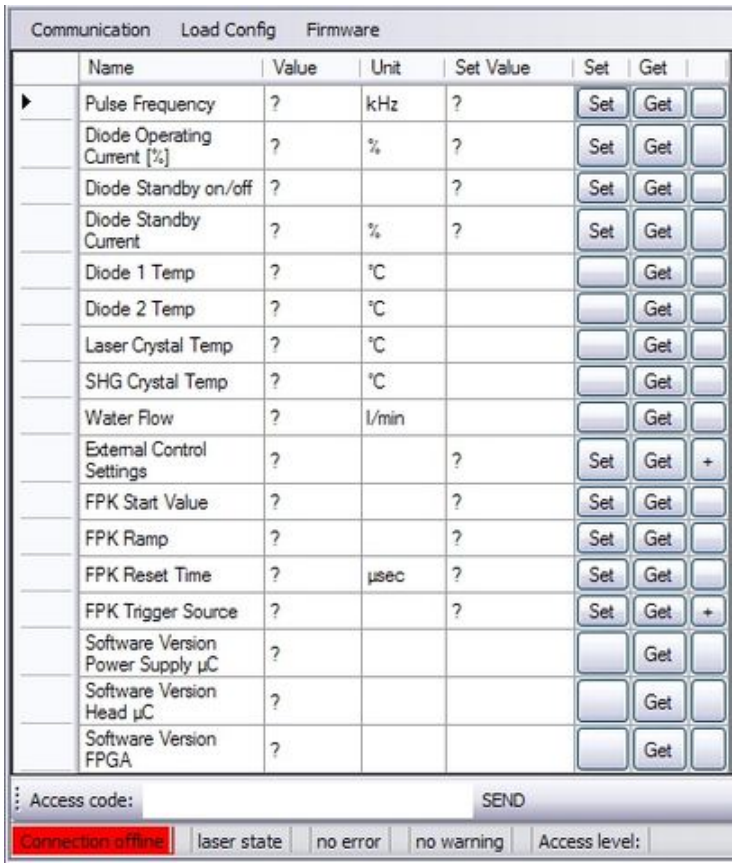


Figure 17 - blizz controller offline

4. Select **Communications > Serial Communication** and then select the appropriate COM port setting at the bottom-left of the Serial Communication dialog box.

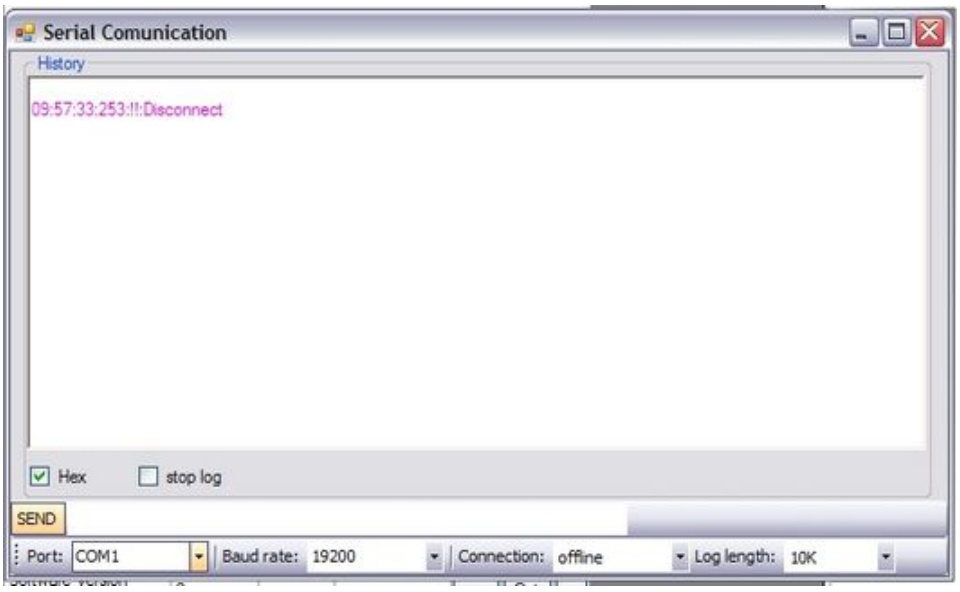


Figure 18 - COM port setting

5. Establish a connection to the blizz and verify that the connection is set to **Online**.

4.2. Default software

Click **Communication** to establish a link between your PC and the blizz, the following screen displays.

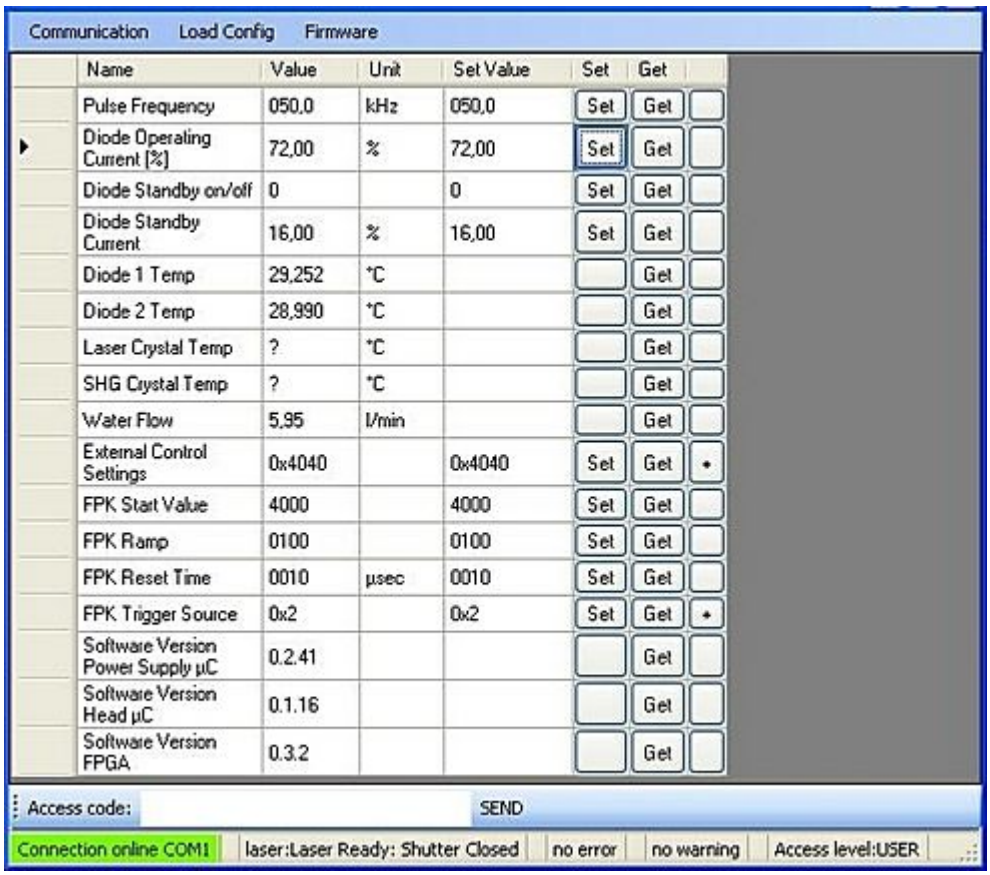


Figure 19 - blizz controller online

- **Connection online**

  Confirms that the communication link between your PC and the blizz is active.
- **Laser state**

  Displays the current laser state. See Appendix E for a list of state codes.
- **No error and No warning**

  Both show that there is no current error or warning active. Otherwise, the error or warning code displays.

  See Appendix C for a list of error codes and Appendix D for a list of warning codes.

To enter or view laser parameters:

- Click **Get** to view the active parameter.
- To change a parameter, enter the new value in the **Set Value** box and click **Set**. The new value is sent to the laser.

4.3. RS232 port configuration

- Data bits — 8
- Stop bits — 1
- Parity bits — None
- Baud rate — 19200

4.4. RS232 protocol

- Any query is answered using the same message ID

- Any executable command will be answered by an acknowledge using the same message ID
- A faulty, non-executable or non-authorised command will be answered by a warning command ***not executable*** using the same message ID. The warning will be followed by a laser generated command using a new message ID indicating the cause of the warning.
- The laser will automatically send any warning, error or change in state (e.g. shutter open/close, warmup , ready…) on the RS232 Interface.

  This makes available the necessary information for the laser without polling.

  The sending of laser generated commands can be deactivated.

Name	Size	Description
Startbyte	2 byte	Value is 0xFF00; for synchronising to the start of a message in case of interrupted or faulty connection.
Length of command	1 byte	In bytes counting as follows: • without startbyte • without length of command • including command type • including message ID • including opcode • including parameters • including checksum • including endbyte (carriage return)
Message ID	2 byte	For enumeration of commands and queries to avoid mixing up responses. PC originated commands or queries may use the numbers 0… 0x7FFF. Laser originated commands will use the numbers 0x8000… 0xFFFF. The laser will respond to a PC command or query using the same message ID that was sent by the PC.
Command type	1 byte	0x47 query (get) 0x57 command (set) 0x74 response query 0x75 Acknowledge of command 0x76 Warning, command not executable 0x77 Laser generated message
Opcode	2 byte	See opcode list for details
Parameter	0…245 byte	See opcode list for details
Checksum	1 byte	Addition mod 256 (including startbyte, excluding checksum, excluding endbyte [carriage return])
Endbyte (carriage return)	1 byte	Send 0x0D

4.5. RS232 basic control commands

Important!

Contact InnoLas Photonics for custom features and advanced controls.

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
0x0026	Laser Crystal Temp	Measured temperature of laser crystal	get	2	unsigned integer	0.002°C	1	na
0x0036	SHG Crystal Temp	Measured temperature of SHG crystal	get	2	unsigned integer	0.002°C	0	na
0x0056	Diode 1 Temp	Measured temperature of diode 1	get	2	unsigned integer	0.002°C	0	na
0x0066	Diode 2 Temp	Measured temperature of diode 2	get	2	unsigned integer	0.002°C	0	na
0x0070	Diode Operating Current [%]	Set diode current in %	set + get	2	unsigned integer	0.01%	0	0
0x0071	Diode Standby Current	Standby current in %	set + get	2	unsigned integer	0.01%	0	0
0x0072	Diode Standby on/off	Send 0 for normal operation Send 1 to set diodes to standby	set + get	1	unsigned integer	na	0	0
0x0081	Pulse Frequency	Pulse repetition frequency	set +get	2	unsigned integer	0.1 kHz	0	0
0x0088	Software Version FPGA	Version of FPGA firmware	get	2	unsigned integer	na	0	na
0x0092	External Control Settings	FPGA pulse mode • Bit 15 = not used • Bit 14 = trigger external • Bit 13 = not used • Bit 12 = not used • Bit 11 = not used • Bit 1 0= not used • Bit 9 = FPK on • Bit 8 = Sample sync on • Bit 7 = AOM gate high active • Bit 6 = Trigger high active • Bit 5 = Gate high active • Bit 4 = Edge triggered • Bit 3 = CW • Bit 2 = not used • Bit 1 = not used • Bit 0 = not used	set + get	1	bit	na	0	3: all 0: &0xc3ed
0x0093	FPK Start Value	FPK start value	set + get	2	unsigned integer	1	0	0
0x0094	FPK Ramp	FPK ramp	set + get	2	unsigned integer	1	0	0
0x0095	FPK Reset Time	FPK reset time	set + get	2	unsigned integer	1	0	0

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
0x0096	FPK Trigger Source	FPK trigger source • Bit 7 = not used • Bit 6 = not used • Bit 5 = not used • Bit 4 = not used • Bit 3 = not used • Bit 2= Trigger pause • Bit 1 = FPK Start (User interface) • Bit 0 = Gate (User interface)	set + get	1	bit	na	0	0
0x00A2	Software Version Power Supply µC	Hardware, software, bugfix	get	3	unsigned integer	na	0	na
0x00A3	Software Version Head µC	Hardware, software, bugfix	get	2	unsigned integer	na	0	na

4.6. RS232 Events

Event Code (decimal)	Event Code (hex)	Message ID	Name
Byte 1 + 2	Byte 1 + 2	Byte 3 + 4	
16	0010	xxxx	Command not available
18	0012	xxxx	OpCode unknown
20	0014	xxxx	Value out of range
22	0016	xxxx	Access level violation

4.7. ILC event logging

The Innolas Laser Control (ILC) software provides two different functions in order to collect data from the laser system.

- **Requirements**
  - PC with “InnolasLaserControl” software installed
  - blizz laser system
- **General logging**

  The general logging function logs all the status, warning and error conditions which occur while the laser system is running. This log function is automatically activated, if the software Innolas Laser Control is started. If you want to access the logged files you will find them in the same directory where you have installed the “InnolasLaserController” Software. The following path is an example which shows where the “InnolasLaserController” is usually installed.

  Note: *On Windows 7 and later operating systems make sure not to use the default installation folder* ***Program Files****. Windows 7 and later blocks programs from writing files into this folder so log files (needed for troubleshooting) cannot be created.*

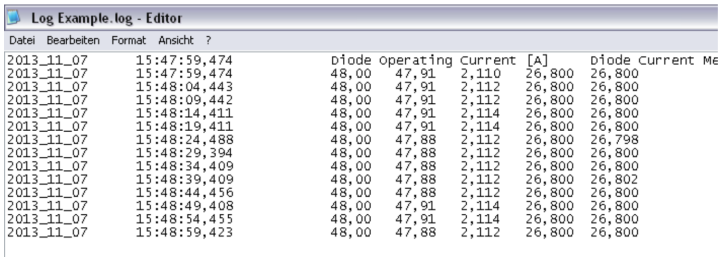
  C:\Programs\InnolasLaserControllerV1040\nnnn where *nnnn* is the name of the log file.

The format for log file names is: **NANIO_yyyy_mm_dd.log** where *yyyy* = year, *mm* = month and *dd* = day.

- **Detailed logging**

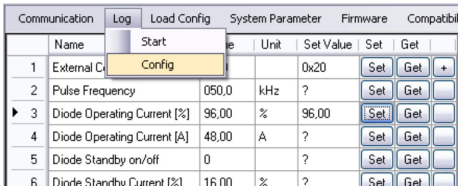
  The detailed logging function gives you the possibility to log specific parameters in detail (e.g. diode current + diode temperature etc.).

  The log file is stored in the root directory of the control software: **C:\Programs\InnolasLaserControllerV1040\nnnn** where *nnnn* is the name of the log file.



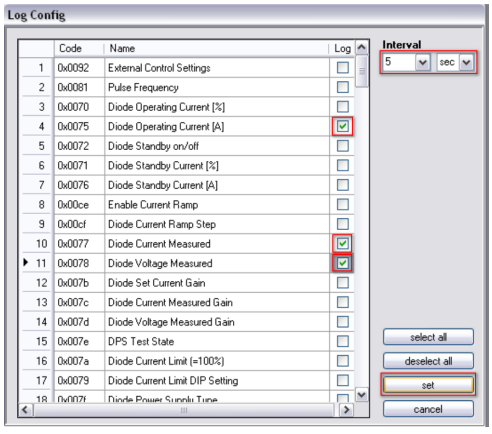
1. Preparation
   a. Load ***full.xml** list
   b. Set the access level code to Service User – 232131 and click **SEND**.

2. Configure logging parameters
   a. From the tag bar, select **Log > Config**.

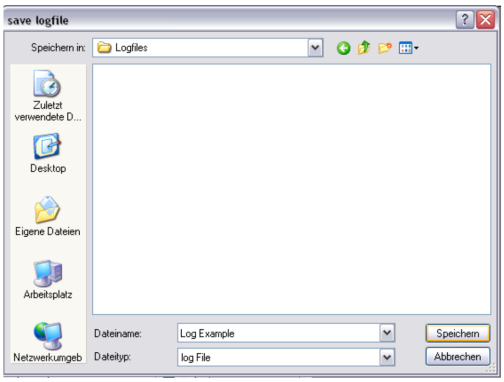


   b. Choose the parameters you want to log and select a suitable logging interval. You can log all available parameters.

   ***Note:** It is recommended to log only useful parameters to keep the log file more specific and legible.*



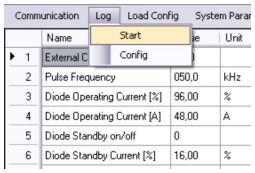
c. Click **Set** to save the configuration. The Save logfile window displays.



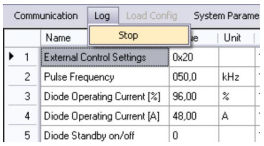
d. Enter a suitable name for the log file (e.g. **LogExample.log**) and click **Save**.

3. Starting and stopping logging.

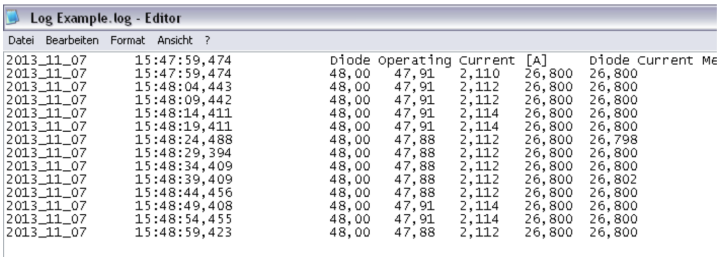
a. To start logging, select **Log > Start** from the tab bar.



b. To stop logging, select **Log > Stop** from the tab bar.



4. The log is saved as a tab delimited text file which can be imported into a spreadsheet or database for easy and detailed analysis.



4.8. Gate

Requirements are:

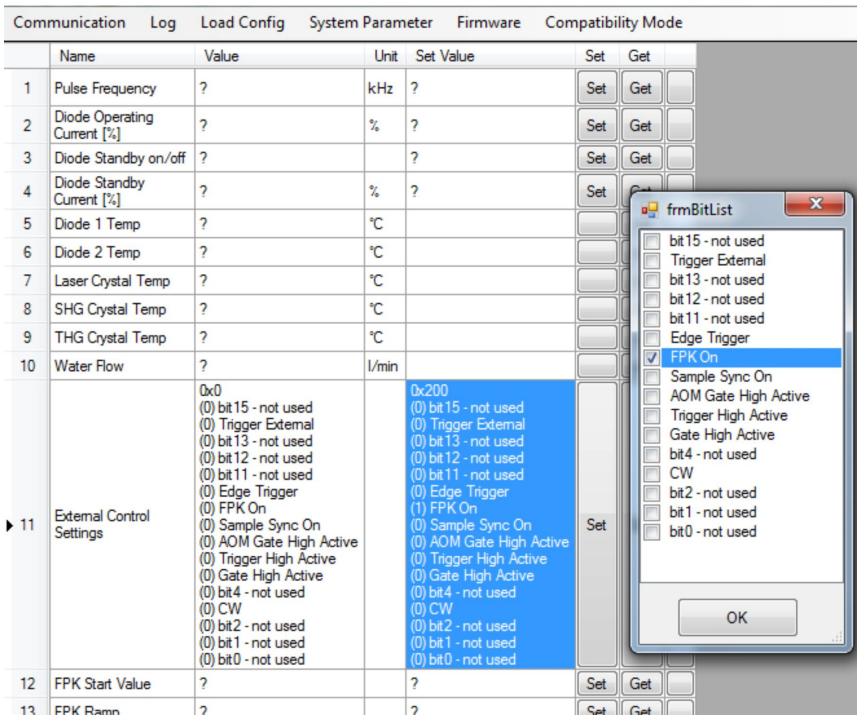
- blizz laser head optimised for CPEM operation

  Note: *The InnolasLaserController main screen setting* ***Pulse width limit enable*** *shows whether the laser is already prepared for CPEM or not. If the* ***Pulse width limit enable*** *setting is activated (value=1) the laser cannot operate in CPEM Mode. Please contact InnoLas Photonics for possible solutions.*
- PC with “InnolasLaserControl” software installed
- internal trigger

- a suitable gate signal, either high active or low active depending on the external signal source

4.8.1. Setup for gate operation

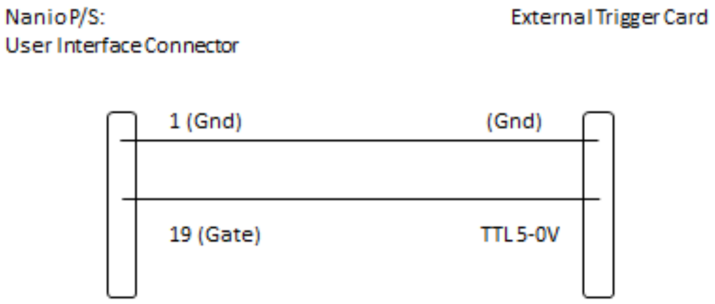
1. Gate operation requires an internal trigger signal. To select external trigger:
   a. From the InnolasLaserController main screen, select **External Control Settings** and click anywhere in the **Set value** field. The frmBitList displays.



	Name	Value	Unit	Set Value	Set	Get
1	Pulse Frequency	?	kHz	?	Set	Get
2	Diode Operating Current [%]	?	%	?	Set	Get
3	Diode Standby on/off	?		?	Set	Get
4	Diode Standby Current [%]	?	%	?	Set	
5	Diode 1 Temp	?	°C			
6	Diode 2 Temp	?	°C			
7	Laser Crystal Temp	?	°C			
8	SHG Crystal Temp	?	°C			
9	THG Crystal Temp	?	°C			
10	Water Flow	?	l/min			
11	External Control Settings	0x0 (0) bit15 - not used (0) Trigger External (0) bit13 - not used (0) bit12 - not used (0) bit11 - not used (0) Edge Trigger (0) FPK On (0) Sample Sync On (0) AOM Gate High Active (0) Trigger High Active (0) Gate High Active (0) bit4 - not used (0) CW (0) bit2 - not used (0) bit1 - not used (0) bit0 - not used		0x200 (0) bit15 - not used (0) Trigger External (0) bit13 - not used (0) bit12 - not used (0) bit11 - not used (0) Edge Trigger (1) FPK On (0) Sample Sync On (0) AOM Gate High Active (0) Trigger High Active (0) Gate High Active (0) bit4 - not used (0) CW (0) bit2 - not used (0) bit1 - not used (0) bit0 - not used	Set	
12	FPK Start Value	?		?	Set	Get
13	FPK Ramp	?		?	Set	Get

   b. Check **FPK On**. Click **OK** to save the configuration.

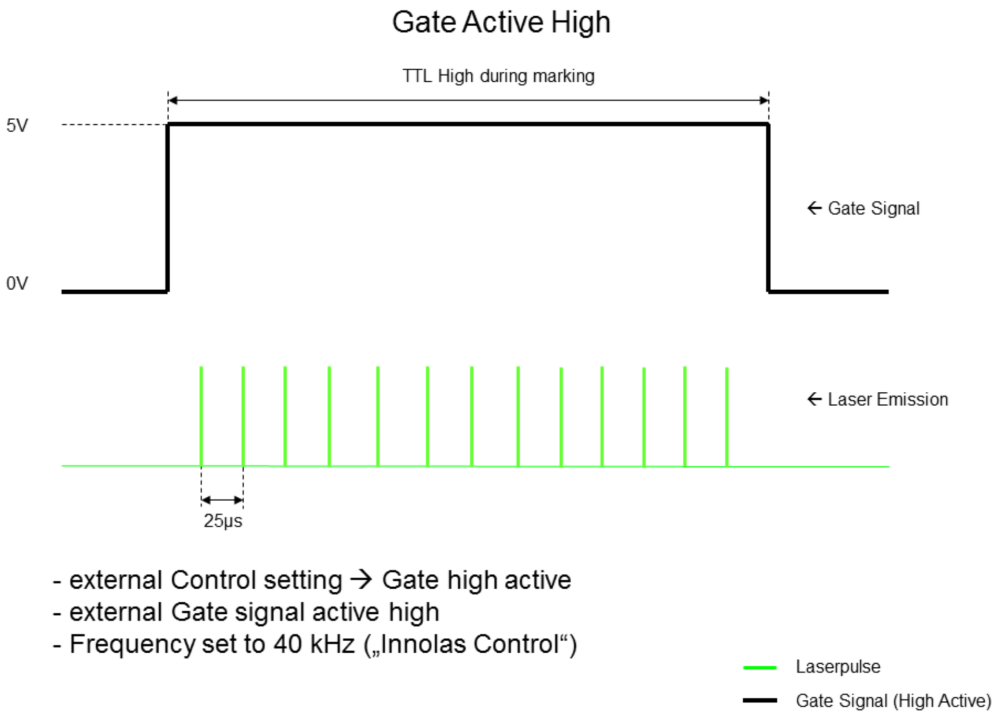
4.8.2. External gate signal connection



Signal name	Pin N°	Function	Type	Range	Comment	Max. current (I_{max})
Ground	1	Signal ground				
Gate	19	Enable for pulsed or CW output Rising edge can start FPK Sequence. Internal pulse generator is synchronised to rising or falling edge of gate	TTL in	TTL	State triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	5 mA

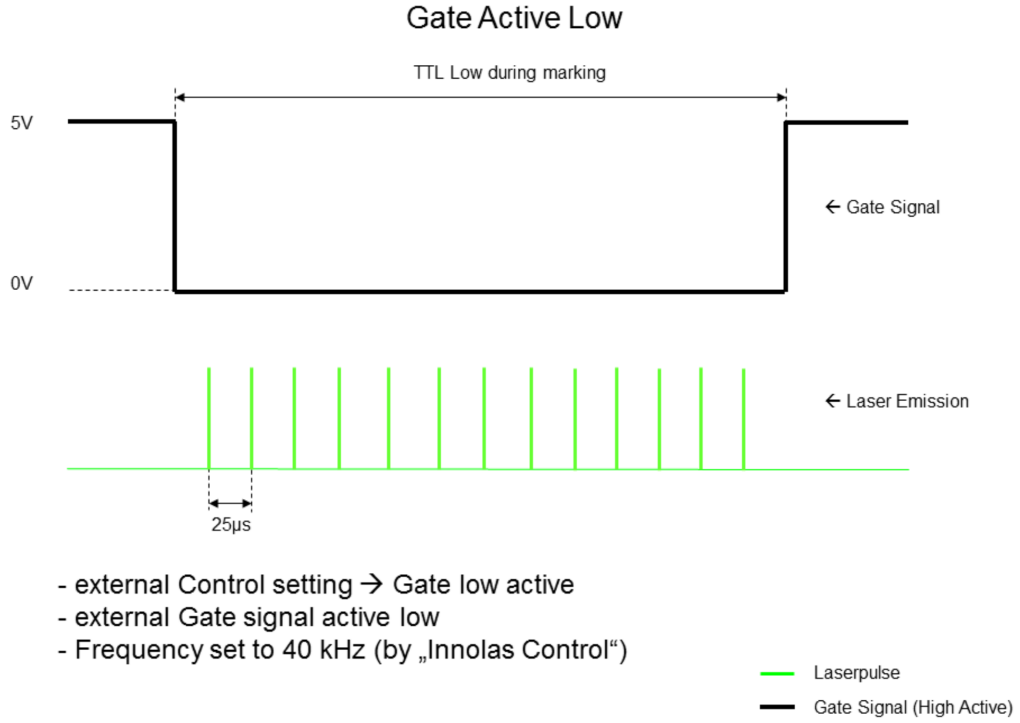
4.8.3. Gate active high signal

1. From the InnolasLaserController main screen, select **External Control Settings** and click **Set**.
2. In the frmBitList window, check **Gate high active**. Click **OK** to save the configuration.



4.8.4. Gate active low signal

1. From the InnolasLaserController main screen, select **External Control Settings** and click **Set**.
2. In the frmBitList window, uncheck **Gate high active**. Click **OK** to save the configuration.


Gate Active Low
TTL Low during marking
5V
0V
← Gate Signal
← Laser Emission
25µs
- external Control setting → Gate low active
- external Gate signal active low
- Frequency set to 40 kHz (by „Innolas Control“)
Laserpulse
Gate Signal (High Active)

5. Routine maintenance

DANGER
Risk of electrocution
Switch off the system and disconnect it from the AC mains supply before carrying out any maintenance.

Important!
After performing maintenance, always run a complete check on the system before putting it into production.

5.1. Safety compliance checks

Frequency: Weekly

1. Check all emission warning lamps function and ensure that they are clearly visible.
2. Check that all safety labels are present.
3. Check the correct functioning of Emergency Stop and external interlocks.

5.2. PCB stack power supply and 19–inch rack option

DANGER
Risk of electrocution
Switch off and disconnect the equipment from the mains electrical supply before removing covers. Only trained and authorised personnel should remove covers from the power supply.

DANGER
Risk of electrocution
Electrical connections must only be made by trained and authorised personnel.

DANGER
Risk of electrocution and damage to equipment
If the insulation around the AC mains supply terminals is damaged do not connect the power supply. Replace it with an undamaged power supply.

DANGER
Risk of electrocution
Before switching on the AC power, verify the quality of the ground connection according to the appropriate standards.

There are no user serviceable parts inside the power supply.

In case of a fault, replace the complete power supply or call InnoLas Photonics customer support for instructions.

The power supply may be returned to InnoLas Photonics customer service for factory repair.

5.3. Laser head

There are no user serviceable parts inside the laser head. Maintenance and service must only be performed by trained and certified personnel.

The laser head may be returned to InnoLas Photonics customer service for factory repair.

CAUTION
Risk of optical damage
Do not open the laser head. Only to be opened by trained and qualified service personnel.

CAUTION
Risk of optical damage
Do not touch the beam output window or place it under mechanical stress.

Contact InnoLas Photonics for maintenance/troubleshooting training and certification.

5.4. Temperature Optimization

Diode and crystal temperatures can be adjusted to optimize the laser output power. This is can be done by selecting the diode, THG or SHG temperature settings in the ILC software. For a detailed tutorial please contact InnoLas Photonics at service@innolas-photonics.com or +49 89 899 360-1234.

For diode, SHG and THG temperature, increase or decrease the set temperature level in 0.1°C degree increments. Wait a few minutes for the actual temperature to stabilize. If the new setting results in a power increase, continue adjusting the temperature in the same degree increments until maximum power is achieved. If the new setting results in a power decrease, adjust the temperature in the opposite direction until maximum power is achieved. It is sometimes helpful to make a bigger change, perhaps 1°C, and note the temperature at which a peak occurs. Then return to that temperature and make the smaller incremental changes.

6. Troubleshooting

6.1. Error messages

Code	Error Message	Description	Action
2000	Emergency Stop Loop 1 Open	The interlock circuits for the external emergency stop device are not closed.	Check the emergency stop circuit 1 at interlock connector HAN14, pin 1-8
2001	Emergency Stop Loop 2 Open	The interlock circuits for the external emergency stop device are not closed.	Check the emergency stoop circuit 2 at interlock connector HAN14, pin 2-9
4005	Diode 1 Temp Error	Diode 1 outside the limit settings.	Check ambient temperature.
4007	Laser Crystal Temp Error	Laser crystal temperature outside the limit settings.	Check ambient temperature.
4008	SHG Temp Error	SHG crystal temperature outside the limit settings.	Check ambient temperature.
4009	THG Temp Error	THG crystal temperature outside the limit settings.	Check ambient temperature.
4011	Laser Head Base Temp Error	Laser head base temperature outside the limit setting.	Check ambient temperature.
5005	Diode Overvoltage Error	The diode voltage outside the limit setting.	Check cable connections at the diode module after pump diode replacement. ***Note:*** *When changing from very short (e.g. 3m) to long (>10m) umbilical lengths, the error limit settings need to be adapted.*
5006	Diode Undervoltage Error	The diode voltage outside the limit setting.	Check cable connections at the diode module after pump diode replacement. ***Note:*** *When changing from very long (>10m) to short (e.g. 3m) umbilical lengths, the error limit settings need to be adapted.*

6.2. Warning messages

Code	Warning message	Description	Action
4000	Diode 1 Low Temperature	Diode 1 outside the low limit setting.	Check ambient temperature.
4001	Diode 1 High Temperature	Diode 1 outside the high limit setting.	Check ambient temperature.
4004	Laser Crystal Low Temperature	Laser crystal temperature outside the low limit setting.	Check ambient temperature.
4005	Laser Crystal High Temperature	Laser crystal temperature outside the high limit setting.	Check ambient temperature.

Code	Warning message	Description	Action
4006	SHG Low Temperature	SHG crystal temperature outside the low limit setting.	Check ambient temperature.
4007	SHG High Temperature	SHG crystal temperature outside the high limit setting.	Check ambient temperature.
4008	THG Low Temperature	THG crystal temperature outside the low limit setting.	Check ambient temperature.
4009	THG High Temperature	THG crystal temperature outside the high limit setting.	Check ambient temperature.

Due to our policy of continuous product and software improvement, please contact InnoLas Photonics for updated troubleshooting details.

7. Installation — PCB stack power supply

Important!

If you have any questions or problems during the integration contact InnoLas Photonics support.

7.1. Unpacking

1. Transport the equipment carefully. Do not subject it to excessive shock or vibration. (See 9.1.)
2. Carefully unpack all the packages and check the components against the packing list supplied. Check that the Shockwatch and Tiltwatch sensors have not been activated. *Notify any shortages or damage to the shipping company and to InnoLas Photonics immediately.*

   (See Appendix F.)
3. Remove the packaging from the laser head and power supply. Keep the packing materials for use when transporting the system to the final destination.

7.2. Positioning and mechanical mounting

Important!

The blizz system must not be installed in an environment with conductive dust or condensation.

Important!

Ensure that all parts of the system are securely fixed to withstand vibrations.

Important!

Position all components so that the safety and type labels are clearly visible.

⚠ WARNING

Risk of injury or damage to equipment

The laser head is heavy. Transport it using the handles provided and fasten it in position firmly using appropriate bolts and dowels.

The support framework must be sufficient to provide a solid and safe fixing.

7.2.1. Laser head

The laser head is mounted from the bottom face. A three-point fixing is provided in each case together with a precision hole and slot to locate on dowel pins on the system support framework. This assures accurate and stable beam pointing.

1. Locate the laser head onto two dowel pins that are securely fixed to the system support framework, then firmly fix the head in position using three bolts.
2. Remove the protection plate or tape from the beam output window.

> **⚠ CAUTION**
> **Risk of optical damage**
> Do not touch the beam output window or place it under mechanical stress.

7.2.2. PCB stack

Mount the PCB stack on a heat sink capable of dissipating at least 60 W while maintaining the lower PCB heat sink plate below 50°C. Provide space around the stack for forced cooling by means of a 24 Vdc ventilation fan (customer supplied). Allow sufficient access for connecting cables to the upper and lower PCB.

- **Upper PCB**
  COM2366
- **Lower PCB (with heat sink)**
  COM 2364

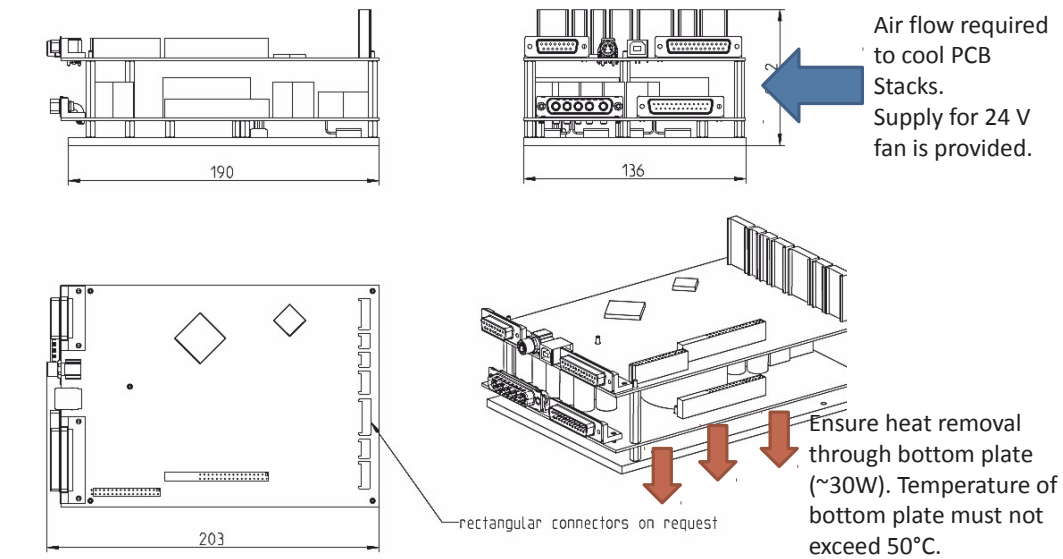
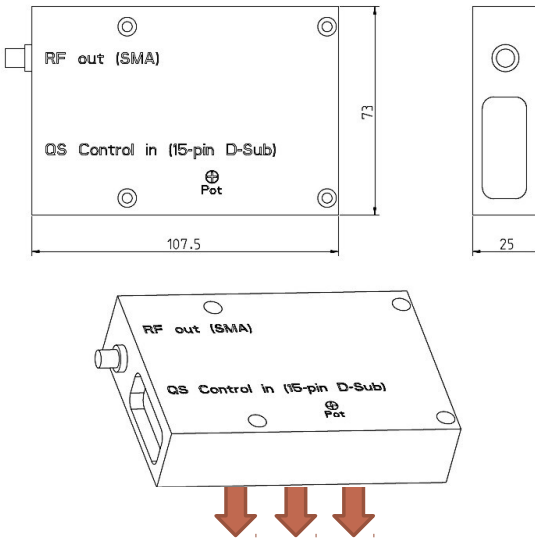


Figure 20 - PCB stack dimensions

7.2.3. RF driver

Mount the PCB stack on a heat sink capable of dissipating at least 25 W while maintaining the RF driver heat sink plate below 50°C. Allow sufficient access for connecting cables.



Ensure heat removal through bottom plate (~15W).
Temperature of bottom plate must not exceed 50°C.

Figure 21 - RF driver dimensions

7.3. Electrical connections

Important!

While connecting the laser diode cables, make sure to avoid ESD damage by connecting to ground via a wrist-band or other appropriate equipment.

Important!

Work on the electrical system must only be carried out by trained and authorised personnel. The valid VDE guidelines must be observed.

The site mains supply voltage *must* match the voltage stated on the device label.

Important!

External equipment connected to the system must comply with EN61010–1 and appropriate local standards.

Important!

Use only cables complying with EN61010–1 and EN60204–1.

DANGER
Risk of electrocution
Switch off and disconnect the equipment from the mains electrical supply before exposing electrical terminals. Only trained and authorised personnel should remove covers from the power supply.

DANGER
Risk of electrocution
Electrical connections must only be made by trained and authorised personnel.

1. Connect the interconnection cables supplied by InnoLas Photonics between laser head, PCB stack and RF driver.
2. Connect an external 24 Vdc supply and a good ground to the PCB stack.
   Connect interlock, signal and control cables between the machine and PDB stack.

7.4. External beam delivery components

External OEM beam delivery components must not degrade the beam from the laser head and must fully comply with the requirements of EN60825.

7.5. Initial operation

WARNING
Hazardous laser radiation
Always wear protective eye wear matched to the emission wavelength and output power of the laser. Instruct all personnel in the vicinity to wear identical protective eye wear.

1. Place a suitable beam block or power monitoring device in the beam path. Do not place it close to optical surfaces to avoid risk of contamination by evaporated material.
2. Turn on the customer supplied 48 Vdc supply to the PCB stack
3. Ensure that the customer supplied Emergency Stop is in the active position.
4. Ensure that all external interlock circuits are enabled.
5. Turn the customer supplied key switch to position 1. When fitted, the Warmup/Ready status lamp flashes to indicate that the system is warming up and the laser emission warning indicator illuminates.
   When the Warmup/Ready lamp illuminates continuously, the system is ready for use but the diode power supply is switched off.
   Note: *The warm up may take up to 15 minutes.*
6. Turn the customer supplied key switch to position 2. The shutter opens if the external safety and interlock circuits are enabled.
7. Transmit a set of process parameters to the blizz

- Check that the blizz emits a beam.
- Open an external emergency stop interlock. Check that the blizz powers off.

8. Power up the system again and carry out beam delivery alignment, as required.

8. Installation — 19–inch rack option

Important!

If you have any questions or problems during the integration contact InnoLas Photonics support.

8.1. Unpacking

1. Transport the equipment carefully. Do not subject it to excessive shock or vibration. (See 9.1.)
2. Carefully unpack all the packages and check the components against the packing list supplied. Check that the Shockwatch and Tiltwatch sensors have not been activated. *Notify any shortages or damage to the shipping company and to InnoLas Photonics immediately.*

   (See Appendix F.)
3. Remove the packaging from the laser head and power supply. Keep the packing materials for use when transporting the system to the final destination.

8.2. Positioning and mechanical mounting

Important!

The blizz system must not be installed in an environment with conductive dust or condensation.

Important!

Ensure that all parts of the system are securely fixed to withstand vibrations.

Important!

Position all components so that the safety and type labels are clearly visible.

⚠ WARNING

Risk of injury or damage to equipment

The laser head is heavy. Transport it using the handles provided and fasten it in position firmly using appropriate bolts and dowels.

The support framework must be sufficient to provide a solid and safe fixing.

8.2.1. Laser head

The laser head is mounted from the bottom face. A three-point fixing is provided in each case together with a precision hole and slot to locate on dowel pins on the system support framework. This assures accurate and stable beam pointing.

1. Locate the laser head onto two dowel pins that are securely fixed to the system support framework, then firmly fix the head in position using three bolts.
2. Remove the protection tape from the beam output window.

⚠ CAUTION
Risk of optical damage
Do not touch the beam output window or place it under mechanical stress.

8.2.2. Power supply

The power supply is designed to fit into a 19–inch rack. Ensure that the rack is fitted with rails sufficient to support the weight of the power supply.

Never rely on the front plate fixing holes to support the full weight of the unit.

Position the power supply so that the emission warning lamp and other status lamps are visible during operation.

8.3. Electrical connections

Important!


While connecting the laser diode cables, make sure to avoid ESD damage by connecting to ground via a wrist-band or other appropriate equipment.

Important!

Work on the electrical system must only be carried out by trained and authorised personnel. The valid VDE guidelines must be observed.

The site mains supply voltage *must* match the voltage stated on the device label.

Important!

External equipment connected to the system must comply with EN61010–1 and appropriate local standards.

Important!

Use only cables complying with EN61010–1 and EN60204–1.

DANGER
Risk of electrocution

Switch off and disconnect the equipment from the mains electrical supply before exposing electrical terminals. Only trained and authorised personnel should remove covers from the power supply.

DANGER
Risk of electrocution

Electrical connections must only be made by trained and authorised personnel.

1. Connect the power supply to the laser head using the special D-connectors.
2. Connect the mains supply and a good ground. Fit a circuit breaker with 16 A capacity.

DANGER
Risk of electrocution and damage to equipment

If the insulation around the AC mains supply terminals is damaged do not connect the power supply. Replace it with an undamaged power supply.

DANGER
Risk of electrocution

Before switching on the AC power, verify the quality of the ground connection according to the appropriate standards.

8.4. Safety and interlock connections

Interlock and system reset connections are made using a 15-pin sub-D connector.

8.4.1. Emergency Stop interlock

The blizz Emergency Stop circuit must be connected to the system Emergency Stop. See section 11.1.1.

8.4.2. Diode Power Supply (DPS) interlock

The DPS interlock is an interlock circuit that does not shut down the laser completely, but only shuts down the diode power supply. This interlock allows laser emission to be switched off and on without restarting the complete system. The functionality of this DPS interlock can be used as a classical machine loading door interlock and brings the basic functionality of a classical shutter interlock to the laser. See section 11.1.2.

Even though this functionality is ensured by a dual circuit electronics design it is not fail-safe as required by some laser safety standards. If your local laser safety standards require a fail-safe and supervised laser shutter the DPS interlock must not be used for

this purpose and an external laser safety shutter must be implemented according to the valid safety standards.

8.4.3. External laser emission warning lamp

At least one external laser emission warning lamp must be provided in a clearly visible location on the laser safety enclosure. This must comply with EN60825.

8.5. Control connections

1. Connect either the USB or RS232 connector on the power supply to an external controller or to a PC.
2. Connect the 25–pin user interface connector to an external controller.

8.6. External beam delivery components

External OEM beam delivery components must not degrade the beam from the laser head and must fully comply with the requirements of EN60825.

8.7. Initial operation

⚠ WARNING
Hazardous laser radiation
Always wear protective eye wear matched to the emission wavelength and output power of the laser. Instruct all personnel in the vicinity to wear identical protective eye wear.

1. Place a suitable beam block or power monitoring device in the beam path. Do not place it close to optical surfaces to avoid risk of contamination by evaporated material.
2. Turn on the main switch on the power supply back panel. The Power status lamp illuminates.
3. Ensure that the Emergency Stop (System Off) button on the power supply front panel is in the active position. (Turn it clockwise to release.)
4. Ensure that all external interlock circuits are enabled.
5. Insert the key in the key switch and turn the key switch clockwise to position 1. The Warmup/Ready status lamp flashes to indicate that the system is warming up. The laser emission warning indicator lamps on the front of the power supply and on the top of the laser head diode module illuminate.

   Note: *The key can only be inserted or removed when the switch is in position 0.*

   When the Warmup/Ready lamp illuminates continuously, the system is ready for use but the diode power supply is switched off.

   Note: *The warm up may take up to 15 minutes.*
6. Turn the key switch to position 2. The shutter opens if the external safety and interlock circuits are enabled.
7. Transmit a set of process parameters to the blizz
   - Check that the blizz emits a beam.

- Open an external emergency stop interlock. Check that the blizz powers off.

8. Power up the system again and carry out beam delivery alignment, as required.

9. Transport and recommissioning

9.1. Transport

- Fit the protection plate over the beam output window.
- Store and transport in a clean, dry environment away from dust, moisture, etc.
- Do not subject the system to excessive shock or vibration. (See 2.7.9)
- Transport in a horizontal position.

9.2. Recommissioning

Follow the procedures and checks used for the initial installation.

Important!
The complete system must be checked by a qualified specialist before restarting.

Important!
Remember to remove the cover plate from the output window before starting the system.

DANGER
Risk of electrocution
Switch off and disconnect the equipment from the mains electrical supply before removing covers. Only trained and authorised personnel should remove covers from the power supply.

DANGER
Risk of electrocution
Electrical connections must only be made by trained and authorised personnel.

DANGER
Risk of electrocution and damage to equipment
If the insulation around the AC mains supply terminals is damaged do not connect the power supply. Replace it with an undamaged power supply.

DANGER
Risk of electrocution

Before switching on the AC power, verify the quality of the ground connection according to the appropriate standards.

WARNING
Hazardous laser radiation

Always wear protective eye wear matched to the emission wavelength and output power of the laser. Instruct all personnel in the vicinity to wear identical protective eye wear.

10. Interfacing — PCB stack power supply

Note: *D-connector locking screws have #4–40UNC threads.*

10.1. Lower PCB — COM 2364

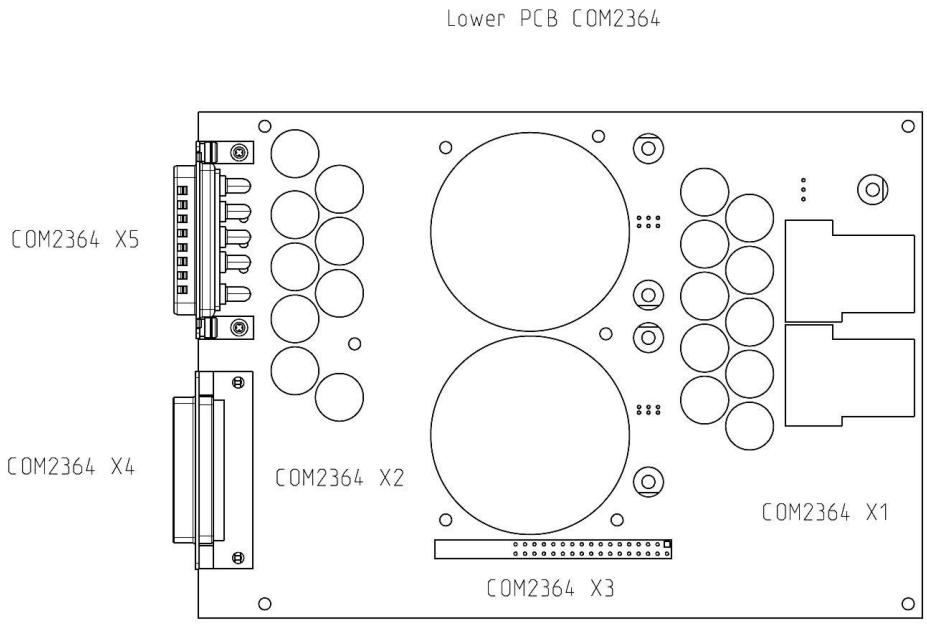


Figure 22 - COM 2364

Connector	Pin	Function
X1 — 6.3 mm blade	X1.1	+48 Vdc
	X1.2	+48 Vdc
	X1.3	N/A
	X1.4	Ground
	X1.5	Ground

10.2. Upper PCB — COM 2366

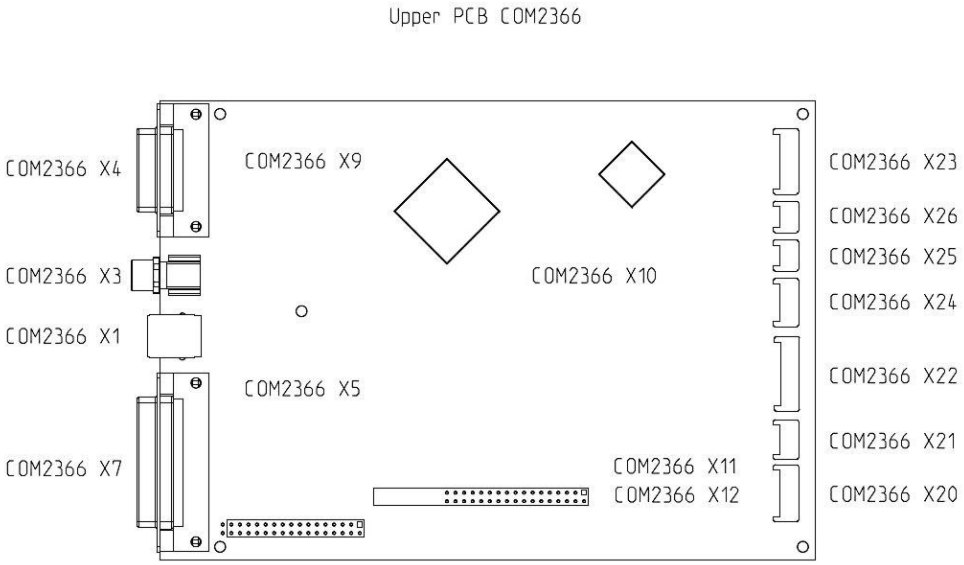


Figure 23 - COM 2366

10.2.1. Customer external connections — required

Important!

From August 2015, connector X4 has additional functionality on pins 1, 2, 3 and 15. (See the pin allocation table). This feature provides a diode power supply interlock that stops and starts the power supply without switching off the complete system. The effect is equivalent to a classical laser shutter interlock. If this functionality is not required, link pins 1 and 2, 3 and 15 using the dummy connector provided.

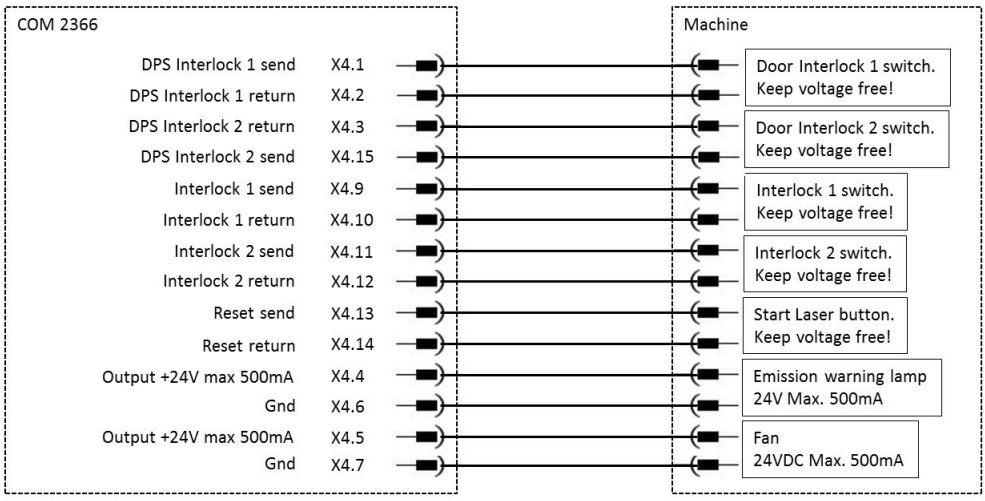


Figure 24 - Connectors X4, X7 and X9

Connector	Pin	Function
X4 — 15–pin, D-sub, female	X4.1	Diode power supply interlock 1.1, voltage free Link to pin X4.2 if this functionality is not required
	X4.2	Diode power supply interlock 1.2, voltage free
	X4.3	Diode power supply interlock 2.1, voltage free Link to pin X4.15 if this functionality is not required
	X4.4	PCB stack cooling fan or LED, jumper configurable, 24 Vdc, max. 500 mA
	X4.5	PCB stack cooling fan or LED, jumper configurable, 24 Vdc, max. 500 mA
	X4.6	Fan/LED, ground
	X4.7	Fan/LED, ground
	X4.8	Ground
	X4.9	Emergency stop 1.1, voltage free
	X4.10	Emergency stop 1.2, voltage free
	X4.11	Emergency stop 2.1, voltage free
	X4.12	Emergency stop 2.2, voltage free
	X4.13	Reset/laser start 1.1, voltage free
	X4.14	Reset/laser start 1.2, voltage free
	X4.15	Diode power supply interlock 2.2, voltage free
X7 — 25–pin, D-sub, female	X7.1	Ground
	X7.6	Analog in, 0–10 Vdc, >1 mA
	X7.7	Trigger in, TTL, 10 mA
	X7.19	Gate in, TTL, 10 mA
	X7.12	Link to pin X7.25
	X7.25	Link to pin X7.12
X9 — 5–pin, JST B5B-PH-K-S, male ***Note:*** *Adapter JST B5B-PH-K-S to 9-pin D-Sub available from InnoLas Photonics on request.*	X9.1	N/A
	X9.2	RS232 RX
	X9.3	RS232 TX
	X9.4	N/A
	X9.5	Ground

10.2.2. Customer external connections — optional

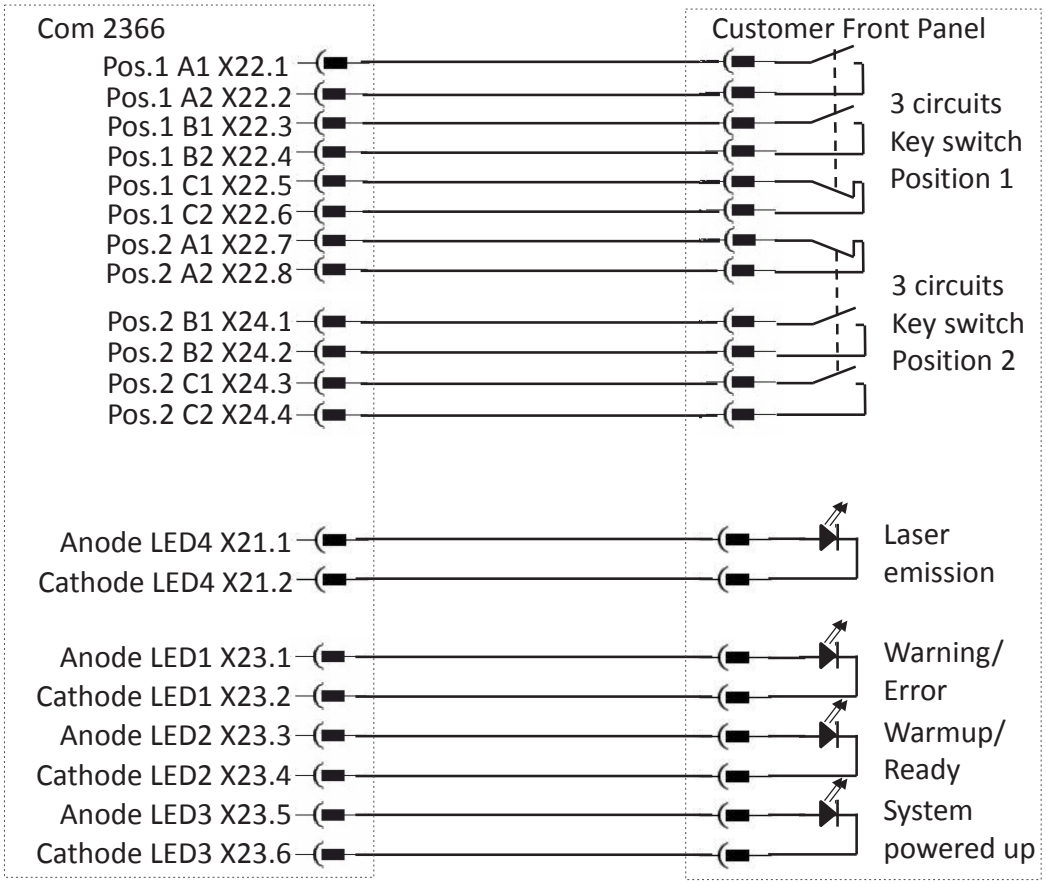


Figure 25 - Connectors X21, X22, X23 and X24

Connector	Pin	Function
X22 — 8–pin, Stocko MKS, male	X22.1	Key switch, circuit A, switch position 1, NO
	X22.2	Key switch, circuit A, switch position 1, NO
	X22.3	Key switch, circuit B, switch position 1, NO
	X22.4	Key switch, circuit B, switch position 1, NO
	X22.5	Key switch, circuit C, switch position 1, NC
	X22.6	Key switch, circuit C, switch position 1, NC
	X22.7	Key switch, circuit A, switch position 2, NC
	X22.8	Key switch, circuit A, switch position 2, NC
X24 — 4–pin, Stocko MKS, male	X24.1	Key switch, circuit B, switch position 2, NO
	X24.2	Key switch, circuit B, switch position 2, NO
	X24.3	Key switch, circuit C, switch position 2, NO
	X24.4	Key switch, circuit C, switch position 2, NO
X21 — 3–pin, Stocko, male	X21.1	Laser emission LED4 anode
	X21.2	Laser emission LED4 cathode
	X21.3	N/A
X23 — 6–pin, Stocko, male	X23.1	Warning/error LED1 anode

Connector	Pin	Function
	X23.2	Warning/error LED1 cathode
	X23.3	Warmup/ready LED2 anode
	X23.4	Warmup/ready LED2 cathode
	X23.5	System powered up LED3 anode
	X23.6	System powered up LED3 cathode

11. Interfacing — 19–inch rack option

All external customer connections are located on the rear panel of the power supply.

Note: *D-connector locking screws have #4–40UNC threads.*

1 Laser head power (X102)
2 Laser head control (X115)
3 RS232 sub-D control signals (X105)
4 Interlocks (X101)
5 Optional fan control (X104)
6 USB control signals (X107)
7 User interface (X112)
8 External trigger (X108)
9 RF Level (X109); software configurable analog input, identical to X112.6
10 AC mains in (X100)

Figure 26 - Power supply connections

11.1. Interlocks

Interlock and system reset connections are made using a 15-pin sub-D connector.

11.1.1. Emergency Stop interlock

Signal name	Pin number	Function
User_NA1.1	9	Emergency stop loop 1, send. Keep voltage free!
User_NA1.2	10	Emergency stop loop 1, return. Keep voltage free!
User_NA2.1	11	Emergency stop loop 2, send. Keep voltage free!
User_NA2.2	12	Emergency stop loop 2, return. Keep voltage free!

11.1.2. Diode Power Supply (DPS) Interlock

Signal name	Pin number	Function
DPS_IL1.1	1	DPS Interlock stop loop 1, send. Keep voltage free!
DPS_IL1.2	2	DPS Interlock stop loop 1, return. Keep voltage free!
DPS_IL2.1	3	DPS Interlock stop loop 2, send. Keep voltage free!
DPS_IL2.2	15	DPS Interlock stop loop 2, return. Keep voltage free!

11.1.3. System reset

Signal name	Pin number	Function
User_SystemReset 1.1	13	Reset emergency stop send (can be also done by turning the keyswitch to position 0 or by RS232 command)
User_SystemReset 1.2	14	Reset emergency stop return (can be also done by turning the keyswitch to position 0 or by RS232 command)

Signal name	Pin number	Function
24 Vdc Out (External fan or chiller start)	4 & 5	Switched DC output for heatsink fans or chiller remote start
GND (External fan or chiller start)	6 & 7	GND for 24 Vdc for heatsink fans or chiller remote start

11.2. Q-switch and AOM control inputs

Q-switch control inputs are made using BNC connectors.

Trigger

Used to trigger the intra-cavity Q-switch.
Voltage: TTL
State or edge triggered
Switchable between high or low active
Pullup or pulldown to stop emission in case the cable is disconnected

RF level

An analog voltage used to control the RF level in the intra-cavity Q-switch.
Voltage: 0–10 V
0 V = 0% RF
10 V = 100% RF
(not linear)

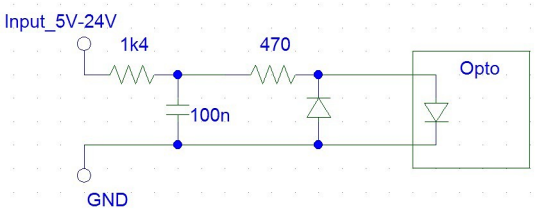
11.3. User interface

User interface connections are made using a 25–pin D-connector.

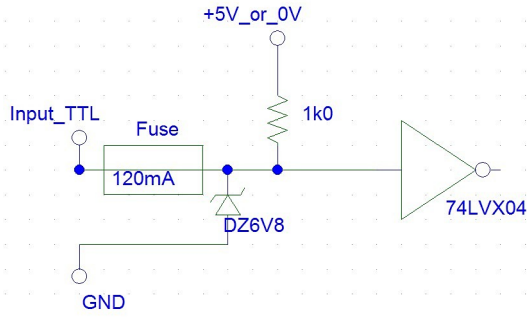
Important!
24 V output signal levels are standard but may be globally reconfigured to 5 V TTL levels, if required.

11.3.1. Input and output configurations

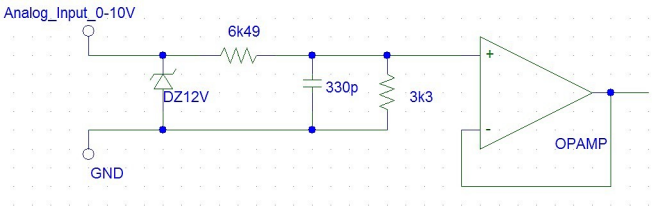
Input 5–24 V



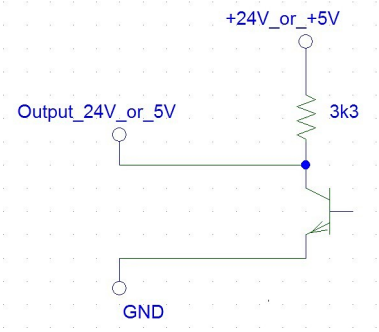
Input 5 V TTL



Input analog



Output 5–24 V



11.3.2. Signal list

Signal name	Pin N°	Function	Type	Range	Comment	Max. current (I_{max})
Ground	1	Signal ground				
FPK Start	2	Initiates an FPK sequence	TTL in	TTL	Rising or falling edge trigger; software configurable	5 mA
Emergency Stop status	3	Indicates if the Emergency Stop circuits are open or closed	TTL / 24 V out	TTL or 24 V	High = closed	8 mA @ 24 V or 1.5 mA @ 5 V
Changes Complete	5	Confirms that changes are active after a change of parameter set	TTL / 24 V out	TTL or 24 V	High = changes complete	8 mA @ 24 V or 1.5 mA @ 5 V

Signal name	Pin N°	Function	Type	Range	Comment	Max. current (I_{max})
RF Modulation, software configurable analog input, identical to BNC X109	6	Software configurable analog input. Default setting: RF level control Q-switch. Other settings: diode current, crystal charge time.	Analog in	0-10V or 0-5V, software configurable	0V = 100% 10V=100% or 5V=100% (RF level not linear)	1 mA
Trigger	7	External trigger for the intra-cavity Q-switch	TTL in	TTL	State or edge triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	5 mA
Laser Ready	8	Indicates the laser is ready to lase	TTL / 24 V out	TTL or 24 V	High = ready	8 mA @ 24 V or 1.5 mA @ 5 V
Not used	9					
Ground	10	Signal ground				
System Enable	12	Softstart and softstop System starts if Pin12 is high and RS232 system enable=1 (RS232 default is system enable=1)	5–24 V digital in	5–24 V	High = system on Low = system off	12 mA @ 24 V or 2 mA @ 5 V
Ground	13	Signal ground				
Diodes Powered	14	Warning signal that the diodes are powered and laser emission is possible.	TTL / 24 V out	TTL or 24 V	High = diodes are powered	8 mA @ 24 V or 1.5 mA @ 5 V
Warning	15	Indicates there is a system warning	TTL / 24 V out	TTL or 24 V	High = warning	8 mA @ 24 V or 1.5 mA @ 5 V
Error	16	Indicates there is an error (Error always leads to emergency stop)	TTL / 24 V out	TTL or 24 V	High = error	8 mA @ 24 V or 1.5 mA @ 5 V
Not used	17					
Not used	18					
Gate	19	Enable for pulsed or CW output Rising edge can start FPK Sequence. Internal pulse generator is synchronised to rising or falling edge of gate	TTL in	TTL	State triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	5 mA

Signal name	Pin N°	Function	Type	Range	Comment	Max. current (I_{max})
Set Parameter Strobe	20	Strobe clocks pins 21 to 24 with micro-controller and activates the transmitted parameter set	5–24 V digital in	5–24 V	Positive edge	12 mA @ 24 V or 2 mA @ 5 V
Parameter Set – bit 0	21	Bit 0 of the parameter set	5–24 V digital in	5–24 V	High = 1 NC or low = 0	12 mA @ 24 V or 2 mA @ 5 V
Parameter Set – bit 1	22	Bit 1 of the parameter set	5–24 V digital in	5–24 V	High = 1 NC or low = 0	12 mA @ 24 V or 2 mA @ 5 V
Parameter Set – bit 2	23	Bit 2 of the parameter set	5–24 V digital in	5–24 V	High = 1 NC or low = 0	12 mA @ 24 V or 2 mA @ 5 V
Parameter Set – bit 3	24	Bit 3 of the parameter set	5–24 V digital in	5–24 V	High = 1 NC or low = 0	12 mA @ 24 V or 2 mA @ 5 V
24 V Supply	25	24 V supply for external components and/or system enable and shutter control	24 V	24 V ±10%	Fused @ 200 mA	100 mA

12. Parts list

Appendix A. RS232 communication overview

Requirements

- Laptop or desktop PC with RS232 interface
- RS232 serial cable, USB cable or fibre optic cable

Port configuration

- Data bits — 8
- Stop bits — 1
- Parity bits — None
- Baud rate — 19200

Protocol

For details, see section 4.4

Command examples

- **Check diode temperature**

FF 00 07 01 10 47 00 56 B4 0D

Startbyte:	Length of command:	Message ID:	Command Type:	Opcode	Checksum	Endbyte:
Values is always FF00	7 byte	Hex 01 10 Dec 272	47 = get	0056 = Diode Temp		Value is always 0D

This is a "get" query sent from the PC to the blizz laser. The command uses the message ID **0110**. The opcode is diode temp.

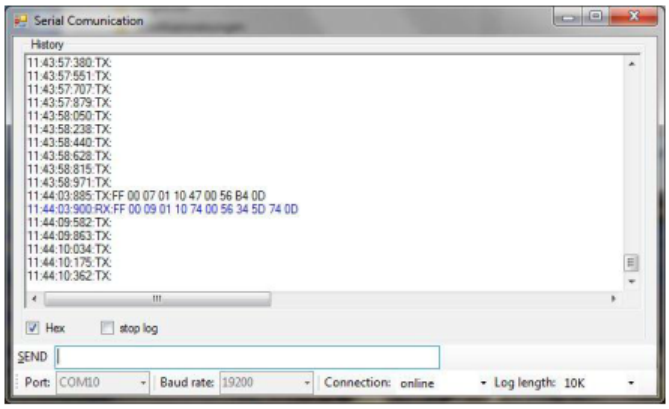
So, this command is asking for the actual diode temperature. The expected return command from blizz laser will also have the message ID **0110**.

FF 00 09 01 10 74 00 56 34 5D 74 0D

Startbyte:	Length of command:	Message ID	Command Type:	Opcode	Parameter	Checksum	Endbyte:
Values is always FF00	9 byte	Hex 01 10 Dec 272	74 = response query	0056 = Diode Temp	Hex345D Dec13405 Scaling 0,002°C => Temp 26,8°C		Value is always 0D

This shows the response sent from the laser to the PC. The command uses the message ID **0110**, so that confirms it is the response to the original query. It is type “response query”. The opcode is diode temp + parameter. So, this response gives the actual diode temperature.

The query and response appear in the log results, as follows:



- **Change diode current**

FF 00 09 00 96 57 00 70 1F 40 C4 0D

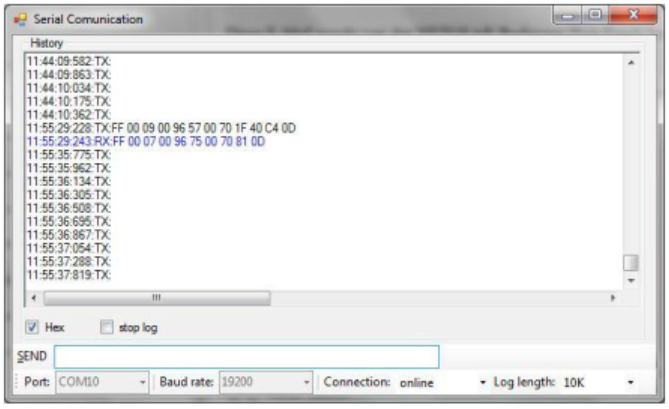
Startbyte:	Length of command:	Message ID:	Command Type:	Opcode:	Parameter Hex:	Checksum	Endbyte:
Values is always FF00	8 byte	Hex 00 96 Dec 150	57 = set	0070 = Diode Operating Current	1F40 Dec: 8000 Scaling 0,01% => Diode Current 80%		Value is always 0D

This is a "set" command sent from the PC to the laser. The command uses the message ID **0096**. The opcode is diode operating current.

So, this command is changing the diode current to Hex 50 (Dec 80%). To realize a more detailed resolution the Parameter can be also more than 2 bit. The laser automatically answers with an acknowledge (0x75).

FF 00 07 00 96 75 00 70 81 0D

The set command and acknowledge appear in the log results, as follows:



- **Check diode current**

FF 00 07 00 99 47 00 70 56 0D

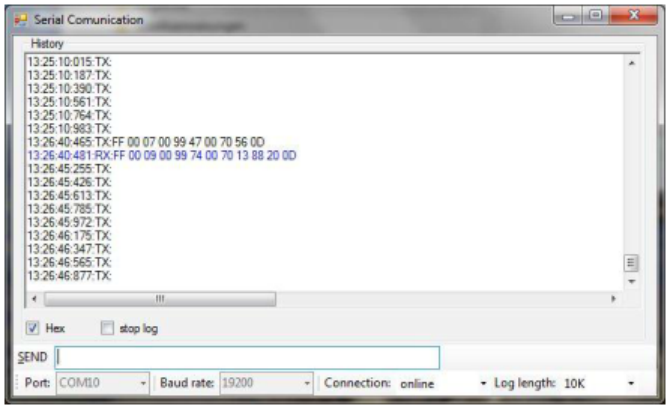
Startbyte:	Length of command:	Message ID:	Command Type:	Opcode:	Parameter	Checksum	Endbyte:
Values is always FF00	7 byte	Hex 00 99 Dec 153	47 = get	0070 = Diode Operating Current	n/a		Value is always 0D

This is a "get" query sent from the PC to the laser. The command uses the message ID **0099**. The opcode is diode operating current.

So, this command is asking for the actual diode current. The expected return command from the laser will also have the message ID **0099**

FF 00 09 00 99 74 00 70 13 88 20 0D

The laser is operating at 50% diode current. The query and response appear in the log results, as follows:



- **Change frequency**

FF 00 09 00 97 57 00 81 01 C2 3A 0D

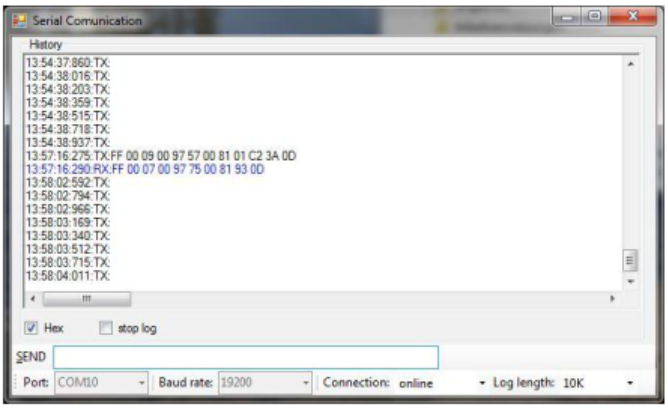
Startbyte:	Length of command:	Message ID:	Command Type:	Opcode	Parameter:	Checksum:	Endbyte:
Values is always FF00	8 byte	Hex 0097 Dec 151	57 = set	0081 = pulse frequency	Hex 2D Dec 45 Scaling 0,1kHz => frequency 45kHz		Value is always 0D

This is a "set" command sent from the PC to the laser. The command uses the message ID **0097**. The opcode is pulse frequency.

So, this command is changing the repetition rate (pulse frequency) to Hex 2D (Dec 45) which is 45 kHz. To realize a more detailed resolution the Parameter can be also more than 2 bit. The laser automatically answers with an Acknowledge (0x75).

FF 00 07 00 97 75 00 81 93 0D

The set command and acknowledge appear in the log results, as follows:



- **Check frequency**

FF 00 07 00 98 47 00 81 66 0D

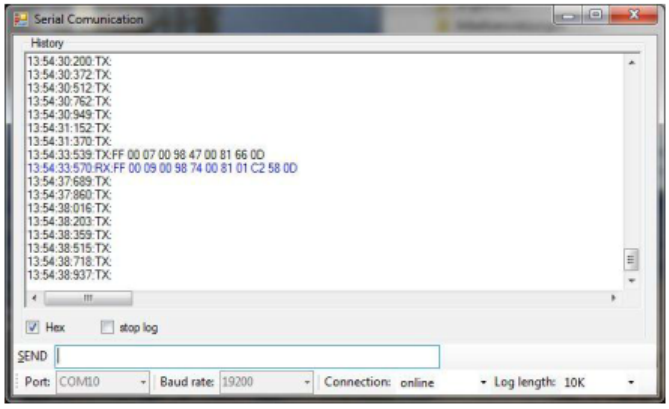
Startbyte:	Length of command:	Message ID:	Command Type:	Opcode	Parameter:	Checksum:	Endbyte:
Values is always FF00	7 byte	Hex 0098 Dec 152	47 = get	0081 = pulse frequency	n/a		Value is always 0D

This is a "get" query sent from the PC to the laser. The command uses the message ID **0098**. The opcode is pulse frequency.

So, this command is asking for the actual repetition rate (pulse frequency). The expected return command from the laser will also have the message ID **0098**

FF 00 09 00 98 74 00 81 01 C2 58 0D

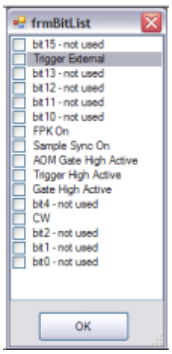
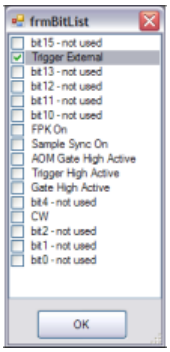
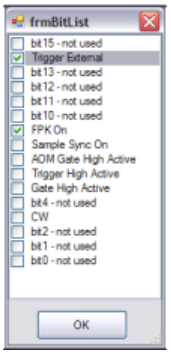
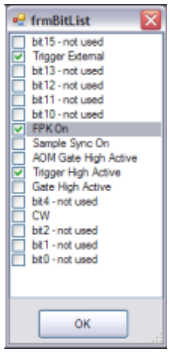
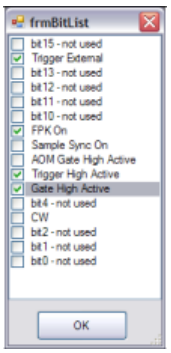
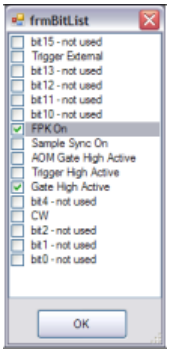
The laser is operating at 50% diode current. The query and response appear in the log results, as follows:



- **Change external control settings**

  Changing/checking the external control settings could make sense at the first start up of the system to ensure correct interface communication.

The following are examples of possible Hex codes for different external control settings:

0x0		0x4000	
0x4200		0x4240	
0x4260		0x220	

How to determine the "length of command"

The length is counted starting after the start byte “FF00” excl. the length byte of command length. Every single bit is counted, including the end byte.

For example, query: FF 00 07 01 10 47 00 56 B4 0D
1 2 3 4 5 6 7

There are 7 bytes so length of command = **07**

For example, response: FF 00 09 01 10 74 00 56 32 00 15 0D
1 2 3 4 5 6 7 8 9

There are 9 bytes so length of command = **09**

How to perform a checksum calculation (Modulo 256)

We calculate the cross foot of the command. Every single byte, independent from the classification will be added. Beginning with the start byte but excluding the end byte (e.g. the parameter 32 00 which is defined as one argument will also be added separately like 32 + 00). The last two digits represent the checksum.

For example: FF 00 09 01 10 74 00 56 32 00 15 0D

Sum = FF + 00 + 09 + 01 + 10 +74 + 00 + 56 + 32 + 00 = 2**15** so the checksum is **15**

How to use status codes

The laser status codes show the actual operation status of the system. (e.g. laser off, warm up, laser ready/shutter open, laser ready/shutter closed).

Implementing the laser status codes always gives the operator the right status and helps them to operate the laser correctly.

Monitoring the laser status code is also helpful for failure analysis and troubleshooting.

How to use warning codes

Warning messages does not shut down the laser. The system will always continue, there are no restrictions.

Example 1: a temperature warning may occur during warm up. The laser is already warming up, the temp. is beginning to stabilize. During this warm up run the temperature (diodes, crystals) are in the ramp up phase and not stabilized yet.

Example 2: A low water warning indicates that the water level of the tank should be corrected by topping up with water.

In general it is useful to take notice of warning messages to prevent the system from a sudden stop. Every warning message gives you the chance to correct the issue before the system stops due to an error.

Monitoring warning messages is also helpful for failure analysis and troubleshooting.

How to use error codes

Error messages always shut down the laser. If an error message is detected by RS232 the laser has already shut down. Error Messages can be used to display the actual situation (Emergency Stop Error), so that the customer can correct the error (eg. close emergency stop circuit).

Monitoring error messages is also helpful for failure analysis and troubleshooting.

Opcodes

For details of opcodes, see section 4.5, RS232 basic control commands

How to handle temperature scaling

Example 1: Diode 1 temp. response = FF 00 09 00 C9 74 00 56 **3B 60** 36 0D

Parameter = **3B60** (Hex) = 15200 (Dec) x 0.002°C (Scaling) = 30.40°C

Example 2: Diode 2 temp. response = FF 00 09 01 7C 74 00 66 **30 D4** 63 0D

Parameter = **3B60** (Hex) = 12500 (Dec) x 0.002°C (Scaling) = 25.00°C

Example 3: SHG crystal temp. response = FF 00 09 01 FF 74 00 36 **72 44** 68 0D

Parameter = **7244** (Hex) = 29252 (Dec) x 0.002°C = 58.50°C

Example 4: Laser crystal temp. response = FF 00 09 03 DE 74 00 26 **30 DF** 92 0D

Parameter = **30DF** (Hex) = 12551 (Dec) x 0.002°C (Scaling) = 25.02°C

How to handle error and warning messages

Warning and error messages are “Laser generated Messages”. Therefore they will always have the opcode **0x77**.

The shutter position is combined with the status code. There are different status messages like “Laser ready: Shutter disabled”,” Laser ready: Shutter enabled”.So a shutter position change will also be indicated by a “Laser generated Message” using Opcode **0x77**.

In the following simplified example, using the Innolas Laser Control software, the screen is reduced to display only Diode operating current.

This gives a simple log entry:

```
17:01:34:625:TX:FF 00 07 0C 37 47 00 70 00 0D
17:01:34:656:RX:FF 00 09 0C 37 74 00 70 07 D0 06 0D
```

The main communication is querying diode current status by using opcode **0070**. The response value is **07D0** which is equivalent to 2000 (Dec) = 20,00 A.

In a scenario where the Emergency Stop is activated, a laser generated message is sent using opcode 77.

FF 00 09 00 04 77 10 00 **07 D0** 6A 0D

07D0 (Hex) = 2000 (Dec) = Emergency Stop Loop 1 Open

FF 00 09 00 05 77 10 00 **07 D1** 6C 0D

07D1 (Hex) = 2001 (Dec) = Emergency Stop Loop 2 Open

Note: *The two bytes before 10 00 or 10 10 can be ignored.*

The Shutter status changes work in the same way. Analyse the strings for “laser generated code” “77” extract parameter like “07 D0” or Status like “00 04 00 00” to see actual error/warning message or laser status.

Important!

The Laser status shutter open or closed is not monitored by the interlock circuit. So if, for example, the shutter interlock circuit is opened the shutter laser status reported by RS232 is still Shutter opened. To get a monitored status of shutter position you must use user interface I/O signal (pin-17, Shutter position status).

Appendix B. RS232 event codes

Event Code (decimal)	Event Code (hex)	Message ID	Name
Byte 1 + 2	Byte 1 + 2	Byte 3 + 4	
16	0010	xxxx	Command not available
18	0012	xxxx	OpCode unknown
20	0014	xxxx	Value out of range
22	0016	xxxx	Access level violation

Appendix C. RS232 error codes

Error code (decimal)	Error code (hex)	Name	Description
2000	07D0	Emergency stop loop 1	Emergency stop loop 1 is open
2001	07D1	Emergency stop loop 2	Emergency stop loop 2 is open
2002	07D2	Emergency stop relay 1	Emergency stop relay 1 released
2003	07D3	Emergency stop relay 2	Emergency stop relay 2 released
4005	0FA5	Temperature error laser crystal	Laser crystal temperature out of range
4006	0FA6	Temperature error laser crystal	Laser crystal temperature out of range
4007	0FA7	Temperature error laser crystal	Laser crystal temperature out of range
4008	0FA8	Temperature error laser crystal	Laser crystal temperature out of range
4009	0FA9	Temperature error laser crystal	Laser crystal temperature out of range
5004	138C	QSD failure	Hardware failure
5005	138D	Overvoltage at diodes	Hardware failure
5006	138E	Undervoltage at diodes	Hardware failure

Due to our policy of continuous product and software improvement, please contact InnoLas Photonics customer support for updated error code details.

Appendix D. RS232 warning codes

Warning code (decimal)	Warning code (hex)	Name	Description
4000	0FA0	Diode 1 low temperature	Device not at set temperature, e.g. during warm up.
4001	0FA0	Diode 1 high temperature	Device not at set temperature, e.g. during warm up.
4004	0FA4	Laser crystal low temperature	Device not at set temperature, e.g. during warm up.
4005	0FA5	Laser crystal high temperature	Device not at set temperature, e.g. during warm up.
4006	0FA6	SHG low temperature	Device not at set temperature, e.g. during warm up.
4007	0FA7	SHG high temperature	Device not at set temperature, e.g. during warm up.
4008	0FA8	THG low temperature	Device not at set temperature, e.g. during warm up.
4009	0FA9	THG high temperature	Device not at set temperature, e.g. during warm up.

Due to our policy of continuous product and software improvement, please contact InnoLas Photonics customer support for updated warning code details.

Appendix E. Laser state codes

Main state (hex)	Sub state (hex)	Description
0	0	Start initialising
0	1	Initialisation running
0	2	Initialisation complete
4	0	Emergency stop
6	0	System off
10	0	Warmup initialising
10	1	Warmup starting chiller
10	2	Warmup flow check OK
10	3	Warmup temperature check OK
10	4	Warmup chiller check OK
10	10	Warmup starting head power supply
10	11	Warmup DPS relay OK: Wait for CAN bus
10	12	Warmup head TECs temp reached
10	13	Warmup head TECs temp stabilisation
10	14	Warmup DPS feedback test
10	16	Warmup write head
10	17	Warmup CAN bus OK; Wait for DPS
10	18	Warmup start TECs
10	19	Warmup TECs ramp up
20	0	Standby 2
30	0	Standby 1
30	1	Standby 1; Shutter disabled
30	2	Standby 1; Shutter enabled
40	0	Laser ready
40	1	Laser ready; Shutter disabled
40	2	Laser ready; Shutter enabled
50	0	Shutdown initialising
50	1	Shutdown DPS off
50	2	Shutdown TECs off
50	3	Shutdown chiller off
50	4	Shutdown flow off
51	0	Shut down system
51	1	Shutdown start relay off
51	2	Shutdown DPS off
51	3	Shutdown chiller off

Main state (hex)	Sub state (hex)	Description
51	4	Shutdown system off

Appendix F. Packing list

Packing List

Customer: xy
Serial No.: Q5235

Quantities	Description	Type
1	Laser Head	532-30-V
1	Power Supply Unit	COM2360
0	Chiller	
	Accessories	
2	Keys	
1	Cable Diode Supply (*)	Length: 3m
1	Cable Signals Laser head (*)	Length: 3m
0	Water Hose (*)	
1	Power Cable Supply	
0	Power Cable Chiller	
0	Control Cable Chiller Power Supply (RS232)	
1	Control Cable PC Power Supply (RS232)	
0	Control Cable PC Power Supply (USB)	
1	Dummy Connector User Interface	
1	Dummy Connector Interlock	
0	Floating Bearing	
2	Handles	
0	Water Bottle	
1	Strain-relief on Power Supply & Chiller	
0	Water Connectors	
0	Replacement Filter for Chiller	
	Documentation	
1	User Manual	
1	Software & Manual USB Drive	
1	Final Test Protocol	
	Additional	

Shockwatch 1 Nr.:
Shockwatch 2 Nr.:
Tiltwatch 1 Nr.:
Tiltwatch 2 Nr.:

Date Name

(*) length of the cables and water hose are noted in the "Produktionsplan Nanio.xlsx"

Appendix G. Your notes

CE

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