INNOLAS LASER

nanio Industrial DPSS Laser

User and Installation Manual

nanio series*

Innolas Laser GmbH
Justus-von-Liebig-Ring 8
D-82152 Krailling
Germany

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Customer Support Contact Addresses

InnoLas Laser GmbH
Justus-von-Liebig Ring 8
D-82152 Krailling
Germany
Tel: +49 89 899 36 0 - 0
Fax: +49 89 899 36 0 - 16
E-mail: info@innolas-laser.com

InnoLas (UK) Ltd.
67 Somers Road
Rugby
Warwickshire CV22 7DG
United Kingdom
Tel: +44 1788 550 777
Fax: +44 1788 550 888
E-mail: innolasuk@aol.com

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Preface

Audience

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

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

The nanio laser is designed and sold for use in 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/
- *H.I.B. Systemtechnik GmbH Industrial Cooling Systems, Operating Instructions Withdrawable Units (19 inch)*

How to Use this Manual

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

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 nanio 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

1.2. Electrical

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 or water to air chiller.

DANGER
Risk of electrocution

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

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 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.

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 nanio 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 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.

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

Figure 1 - Safety label locations

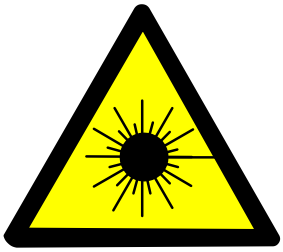


Figure 2 - Label A

Figure 3 - Label B

Figure 4 - Label C

Figure 5 - Label D

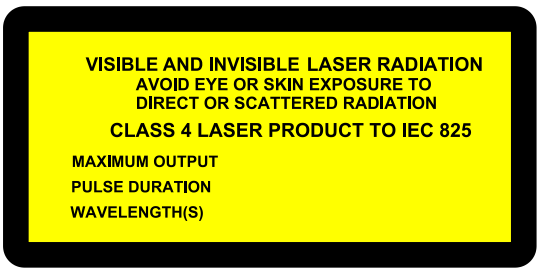


Figure 6 - Label E

The following information appears on Label E:

P_o	40 W
P_p	100 kW
t	20–500 ns
F	Single shot to 500 kHz
λ	1064/532/355 nm

DONT FORGET THE TYPE LABEL!!

1.5. Refrigerant medium

The water/air chiller contains a refrigerant medium. Avoid direct contact with the refrigerant.

DANGER
Risk of explosion

Do not use a water/air chiller in an explosive atmosphere or for cooling flammable of explosive substances.

WARNING
Risk of lung damage

Never smoke in the vicinity of a water/air chiller. If refrigerant escapes it decomposes to form cauterising acids that can severely damage your lungs.

If the refrigerant has to be drained or replaced, the procedure must be performed by a specialised and trained person. Discarded refrigerant must be disposed of in accordance with ISO/DIS 11650 or an equivalent local rules and regulations.

1.6. 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 diode modules or crystal assemblies.

1.7. Decommissioning and disposal

If the laser will be definitively taken out of service and decommissioned, disconnect and remove all signal and power cables, disconnect the external cooling water pipes and drain the chiller.

Dispose of a water/air chiller in accordance with EN 378–4.

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 nanio 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 500 kHz and excellent beam quality and stability.

The laser fails safe with no beam output and therefore must not be used where the beam is part of a safety system; for example, as a light barrier.

2.2. Laser Head

Figure 7 - Laser head

The laser head consists of a diode module and a resonator module. The resonator module is supplied in several lengths depending on the output specification. All electrical and cooling connections are on the end face of the diode module. Laser ouptut is emitted from the end face of the resonator module and can be configured so that the beam axis is to the left or right of the centre line. The laser head can be mounted using the bottom surface (preferred) or either side face. In each case, 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 and is fitted with a desiccant cartridge. It is temperature stabilised by means of stainless steel cooling pipes embedded under the base of the resonator module and into a Peltier cooler in the diode module.

Important!

Never open the laser head unless. No user serviceable parts inside.

The laser head contains the following key components:

- One or two laser diode modules with collimating optics
- Control electronics

- Laser crystal and resonator mirrors
- Intra-cavity accousto-optic Q-switch

  Note: *The Q-switch driver can be mounted on the left or right-hand side of the resonator module, depending on the mounting method chosen for the laser head.*
- Intra-cavity safety shutter with dual-redundant closure detector

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

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

2.3. Power Supply

Figure 8 - Power supply

The power supply is common to all nanio lasers. This provides maximum flexibility and minimises spare part holdings. An output is provided for the chiller. Water/water chillers are both powered and controlled from the power supply. Water/air chillers use an independent mains electrical connection but are controlled from the power supply. The power supply is designed to fit into a 19–inch rack and is 2RU high.

2.4. Chiller options

2.4.1. Water/air

Figure 9 - Water/air chiller

The water/air chiller is recommended for low average power or low duty cycle applications. It is designed to fit into a 19–inch rack and is available in low power (5RU high) or medium power (6RU high) versions.

Water/air chillers require an unrestricted flow of air at less than 40°C.

2.4.2. Water/water

Figure 10 - Water/water chiller

Water/water chillers are available in standard and clean-room versions. They are designed for high average power or high duty cycle applications. Both versions fit into a 19–inch rack and are 4RU high. External water pipe connections are xx flow and xx return.

Water/water chillers require an external water supply with minimum flow rate of 8 l/min and pressure differential of 100 kPa

2.5. Beam Delivery Options

- Beam expander
- Scan head mounting option

2.6. Specifications

2.6.1. Electrical supply

Maximum power consumption	1.5 kVA
Maximum current demand	16 A
Supply voltage	Single phase 115–230 VAC ± 10%
Supply frequency	50/60 Hz

2.6.2. Dimensions

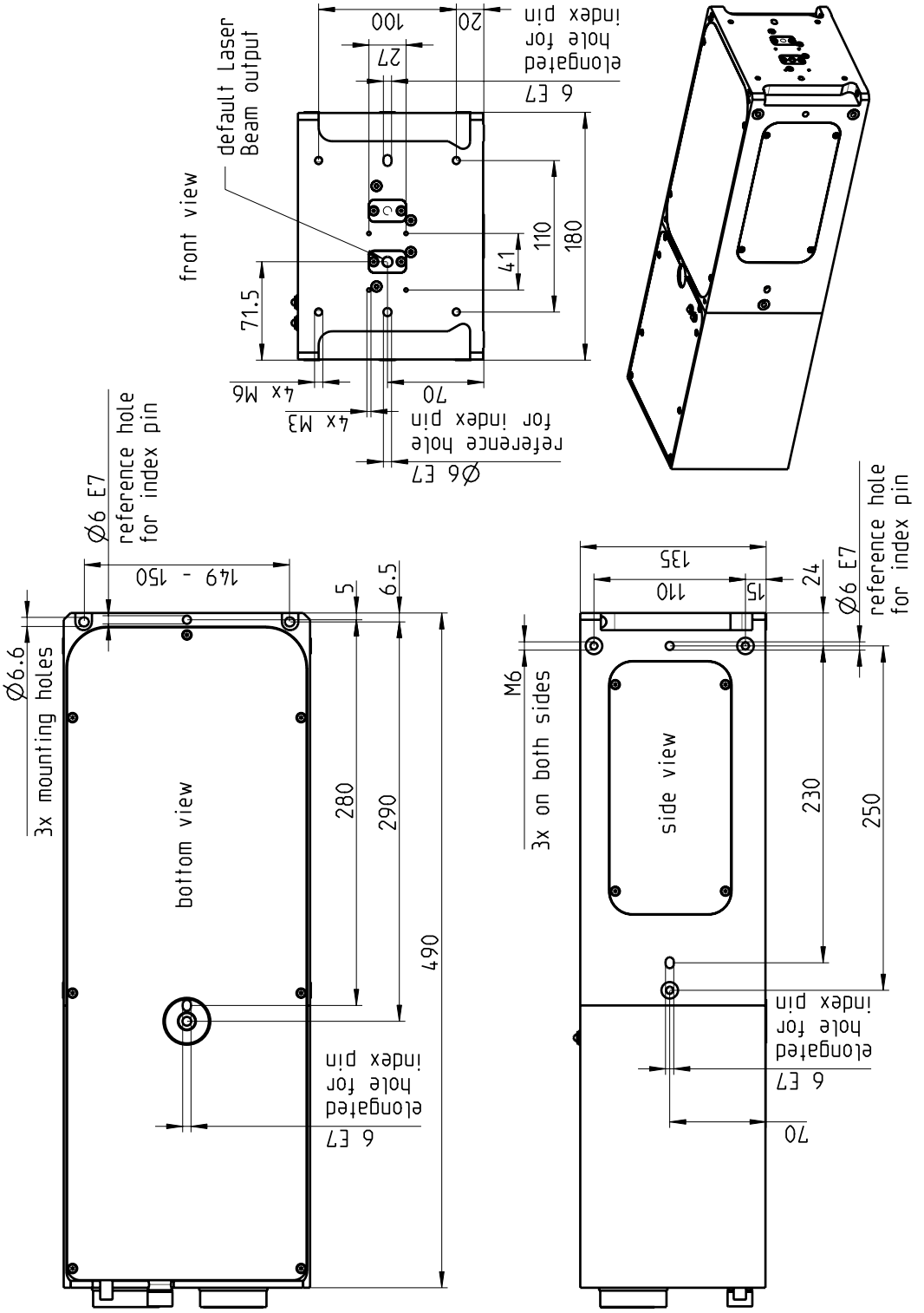


Figure 11 - 490 mm head

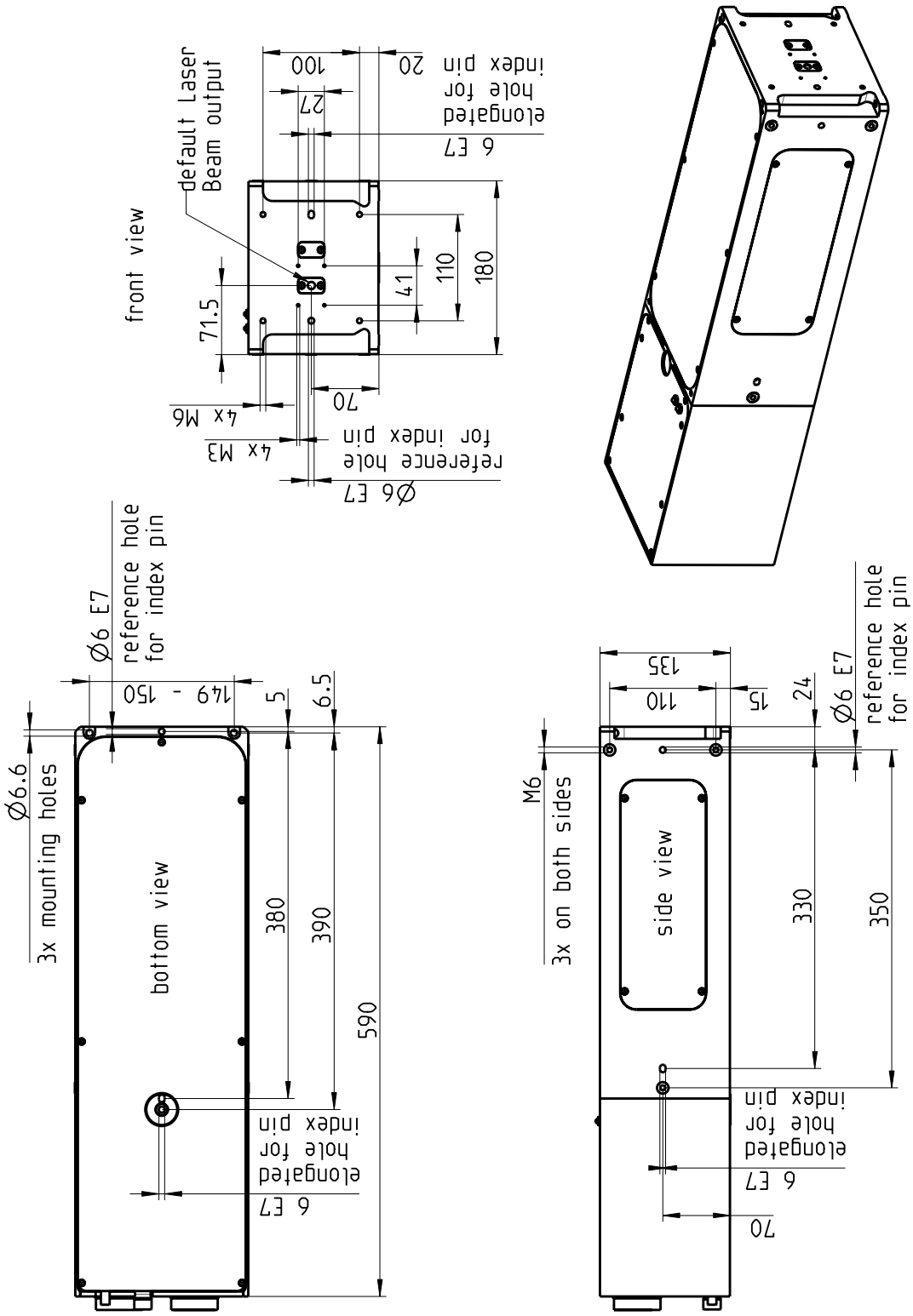


Figure 12 - 590 mm head

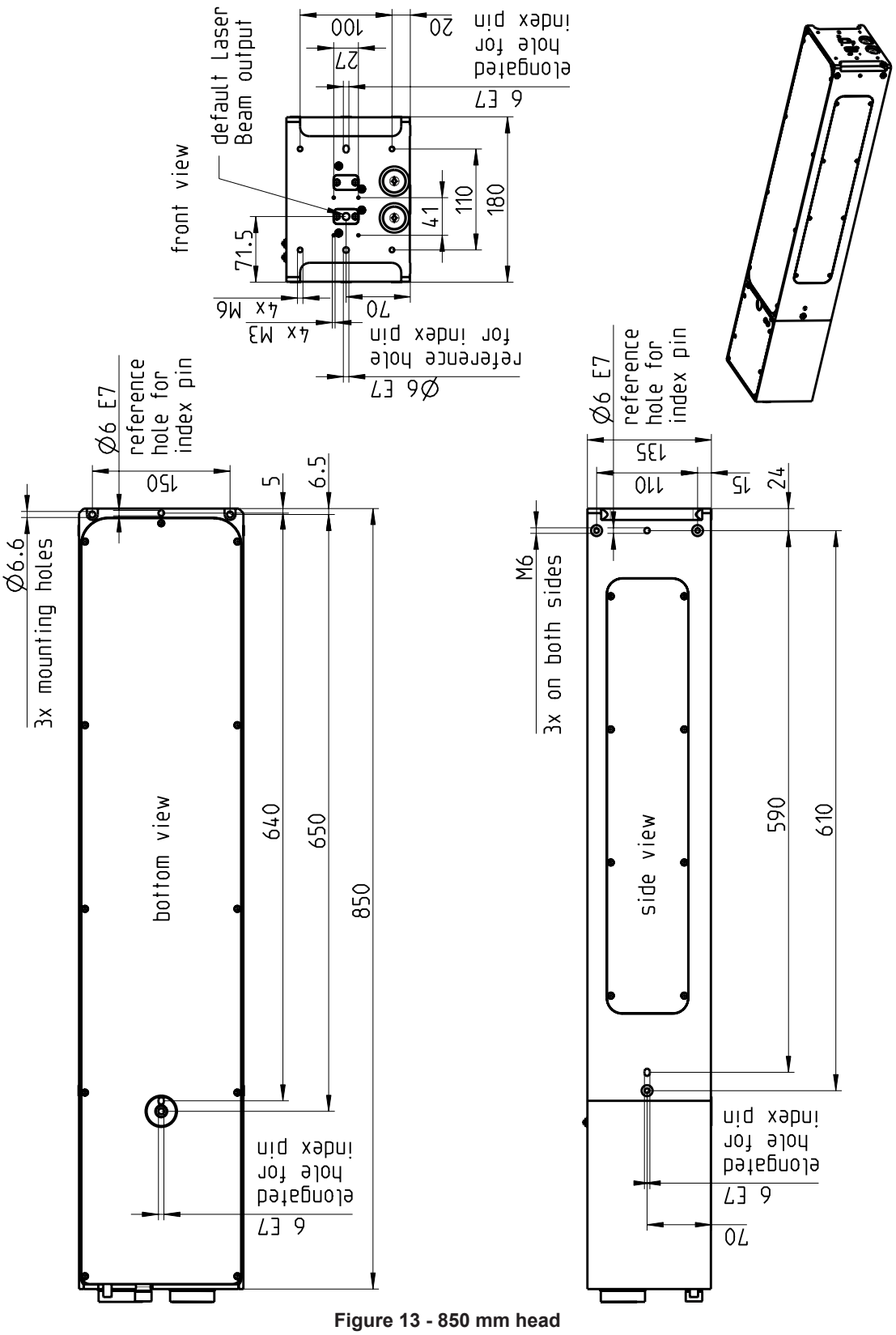


Figure 13 - 850 mm head

Umbilical cables and cooling water pipes linking laser head, power supply and chiller have a standard length of 3 m but can be supplied in lengths from 1 m to 20 m on request.

2.6.3. Nominal weights

Laser head	17–23 kg depending on length and configuration
Power supply unit	12 kg
Water/air chiller	low power 35 kg; medium power 40 kg
Water/water chiller	20 kg

2.6.4. Customer connections

Customer connections for control and safety circuits are available on the rear of the power supply. Interfacing details are given in the Interfacing chapter (Chapter 9).

2.6.5. Performance

Refer to the product data sheet.

2.6.6. Environmental

Ambient temperature range

Working	15–40°C, non-condensing
Transport and storage	Greater than 2°C

Relative humidity and conductive dust

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

Altitude range

0–3000 m

Shock, vibration and acceleration

The nanio 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.

2.6.7. Design lifetime of the equipment

The nanio 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 for refurbishment.

3. Operation

3.1. Direct start up

1. Check that the chiller coolant is above the minimum level.

> **Important!**
>
> If the coolant level is below minimum, top up the coolant before starting the system.

2. *If a water to air chiller is fitted,* turn on the green main switch on the chiller front panel. The switch illuminates indicating that the chiller is in standby mode.
3. Turn on the main switch on the power supply front panel. The white Power status lamp illuminates.
4. Ensure that the Emergency Stop (System Off) button on the power supply front panel is in the active position. (Turn it clockwise to release.)
5. 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 diode module illuminate. The chiller starts to run.

   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 shutter is disabled.

   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.

6. Turn the key switch to position 2. The shutter is enabled.

3.2. Direct shut down

1. Turn the key switch anticlockwise to position 1. The shutter closes.
2. Turn the key switch to position 0. After a few seconds the chiller switches off. 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

- *If fitted*, the water to air chiller main switch is on

1. Turn on the AC mains power to power supply and chiller. The Power status lamp and chiller main switch lamps illuminate.
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. The chiller starts to run.

   When the system is warmed up, the Warmup/Ready lamp illuminates and the shutter is 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 shutter is disabled. After a few seconds the chiller switches off. 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 and the chiller. The Power status lamp and chiller main switch lamps go 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 the 0 position.
3. Perform a normal direct or remote start up procedure.

4. Software

4.1. Default software

For details, contact InnoLas.

4.2. RS232 control protocols

Table 1 - nanio RS232 control protocols

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
0x0015	TEMP_WATER_SET	Temperature set point for cooling water	set + get	2	unsigned integer	0.01°C	0	1
0x0016	TEMP_WATER_ MEASURED	Measured temperature of cooling water	get	2	unsigned integer	0.01°C	0	na
0x001A	WATER_FLOW	Water flow into laser head	get	2	unsigned integer	0.01 l/min	0	na
0x0010	TEC_ON_OFF	Enable/disable tecs • Bit 0 = Xtal • Bit 1 = SHG • Bit 2 = THG • Bit 4 = Diode1 • Bit 5 = Diode2 • Bit 6 = na • Bit 7 = na	set + get	1	bit	na	1	3
0x0025	TEMP_XTAL_SET	Temperature set point for laser crystal	set + get	2	unsigned integer	0.01°C	1	3
0x0026	TEMP_XTAL_ MEASURED	Measured temperature of laser crystal	get	2	unsigned integer	0.01°C	1	na
0x0035	TEMP_SHG_SET	Temperature set point for SHG crystal	set + get	2	unsigned integer	0.01°C	1	3
0x0036	TEMP_SHG_ MEASURED	Measured temperature of SHG crystal	get	2	unsigned integer	0.01°C	1	na
0x0045	TEMP_THG_SET	Temperature set point for THG crystal	set + get	2	unsigned integer	0.01°C	1	3
0x0046	TEMP_THG_ MEASURED	Measured temperature of THG crystal	get	2	unsigned integer	0.01°C	1	na
0x0055	TEMP_DIODE_1_ SET	Temperature set point for DIODE 1 crystal	set + get	2	unsigned integer	0.01°C	1	3
0x0056	TEMP_DIODE_1_ MEASURED	Measured temperature of DIODE 1 crystal	get	2	unsigned integer	0,01°C	1	na
0x0065	TEMP_DIODE_2_ SET	Temperature set point for DIODE 2 crystal	set + get	2	unsigned integer	0,01°C	1	3
0x0066	TEMP_DIODE_2_ MEASURED	Measured temperature of DIODE 2 crystal	get	2	unsigned integer	0,01°C	1	na

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
0x0071	DIODE_CURRENT_STANDBY_1	Standby current in %	set + get	2	unsigned integer	0.01 A	0	2
0x0072	STATE_STANDBY	• Send 0 for normal operation • Send 1 for setting Diodes to standby • Send 3 for shutting down diodes and TECs but operate chiller	set + get	1	unsigned integer	na	0	0
0x0081	PRF	Pulse repetition frequency 0.1 to 500 kHz	set + get	2	unsigned integer	0.1 kHz	0	0
0x0082	TRIGGER_PULSE WIDTH	Width of RF off	set + get	2	unsigned integer	0.1 µs	0	0
0x0088	FPGA_VERSION	Version of FPGA firmware	get	2	unsigned integer	na	0	na
0x0089	FPGA_TRIGGER_DELAY	Only in pulse mode; sample sync delay between sample and trigger	set + get	2	unsigned integer	0.1 µs	0	0
0x0092	PULSMODE	FPGA Pulsmode • Bit 0 = Trigger internal (0)/ external (1) • Bit 1 = Trigger low active (0)/ high active (1) • Bit 2 = Gate low active (0)/ high active (1) • Bit 4 = Sample sync off (0) /on (1) • Bit 5 = na • Bit 6 = na • Bit 7 = na	set + get	1	bit	na	0	0
0x00A2	VERSION_MAIN	Firmware version of main controller	get	3	unsigned integer	na	0	na
0x1000	SET_ERROR	Laser reports an error. Refer to error code list for details.	event	2	unsigned integer	na	na	na
0x1001	CLEAR_ERROR	Laser clears an error. Refer to error code list for details.	event	2	unsigned integer	na	na	na
0x1002	SET_WARNING	Laser reports a warning. Refer to warning code list for details.	event	2	unsigned integer	na	na	na
0x1003	CLEAR_WARNING	Laser clears a warning. Refer to warning code list for details.	event	2	unsigned integer	na	na	na
0x1005	EVENT	Laser reports an event. Refer to the event code list for details.	event	2	unsigned integer	na	na	na

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
0x1010	SET_STATUS	Laser reports a change of status. Refer to status code list for details.	event	2	unsigned integer	na	na	na
0x1020	ERROR_ ACKNOWLEDGE	Send this command to continue after an error has occurred.	set	0	na	na	0	na
0x1030	REQUEST_ERROR_ LIST	Send this command to get the actual errors. System will respond with an acknowledge followed by one 0x1000 command per error.	set	0	na	na	0	na
0x00A4	GET_STATE	Send this command to get the current system state.	set	0	na	na	0	na

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 are clearly visible.
2. Check that all safety labels are present.
3. Check the correct functioning of Emergency Stop and external interlocks.

5.2. Chiller

5.2.1. General checks

Frequency: Monthly

1. Check that the pump is running quietly.
2. Check for water leaks.
3. Monitor the water level and top up if required via the filler tube or level sight tube, depending on the chiller model.

5.2.2. Water/water

Frequency: 6–monthly or as required

Tools required for this procedure

None

Materials required for this procedure

- Filter/deioniser cartridge

DANGER
Risk of electrocution
Switch off and disconnect the system from the AC mains supply before draining/filling the coolant tank or changing the filter/deioniser cartridge.

1. Switch off and disconnect the system from the AC mains supply.

2. Unscrew the four thumbscrews (A) to release the filter/deioniser unit.

3. Withdraw the filter/deioniser unit until the three quick-release connectors are accessible then disconnect the pipes from the unit.

4. Completely remove the unit from the chiller.

5. Locate a replacement unit in the chiller and connect the three pipes.
6. Fully insert the unit into the chiller until it engages with the four fixing studs.
7. Fit the four thumbscrews and tighten them firmly by hand. The chiller is now ready for use.

5.2.3. Water/air

Refer to the manufacturer's user manual.

> **⚠ DANGER**
> **Risk of electrocution**
> Switch off and disconnect the system from the AC mains supply before draining/filling the coolant tank or performing maintenance on the chiller.

5.3. Power supply

> **⚠ 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 or water to air chiller.

> **⚠ 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 service for instructions.

5.4. Laser head

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

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.

6. Troubleshooting

List of error & warning codes here.

1. **The laser will not power up**
   List of things to check.

7. Installation

Important!

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

7.1. Unpacking

1. Transport the equipment carefully. Do not subject it to excessive shock or vibration. (See 8.1).
2. Carefully unpack all the packages and check the components against the parts list supplied. *Notify any shortages or damage to the shipping company and to InnoLas immediately.*
3. Remove the packaging from the laser head, power supply and chiller. Keep the packing materials for use when transporting the system to the final destination.

7.2. Positioning and mechanical mounting

Important!

The nanio 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 type label is clearly visible.

⚠ DANGER

Risk of electrocution or damage to equipment

Position electrical equipment in such a way that no water can leak into it.

Do not position the chiller or laser head above the power supply or any other electrical equipment in case of water leakage.

⚠ 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 can be mounted from the bottom (recommended) or from either side 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. For bottom mounting, the bolts are screwed into the support framework and a spring compression device allows for expansion of the head or support whilst maintaining accurate location. For side fixing, the bolts are screwed through the support into threaded holes (M6) in the head.
2. Remove the protection plate from the beam output window. Keep the plate to be used for later transportation.

⚠ CAUTION
Risk of optical damage

Do not touch the beam output window or place it under mechanical stress.

7.2.2. 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.

7.2.3. Chiller

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

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

Position the chiller so that there is clear access to the filler and drain.

7.3. Electrical connections

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 or water to air chiller.

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 round, 7-pin and 37–pin AMP connectors. Tighten the locking rings until they click.
2. Connect the chiller.
   a. **Water to water**

      Connect the chiller to the power supply connector.
   b. **Water to air**

      Connect the control cable from connector -XKM1 on the chiller to the power supply. Connect the power cable from connector -XKM on the chiller to the AC mains supply. Fit a circuit breaker with 6 A capacity.
3. 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.

7.4. Coolant connections

⚠ DANGER
Risk of electrocution

Switch off and disconnect the system from the AC mains supply before filling the coolant tank

1. Firmly push the quick-release coolant pipe connectors onto the laser head and chiller. The connectors are mechanically reversed to avoid confusion.

   The blue pipe is flow and the red pipe is return.
2. Fill the chiller coolant tank to the maximum level.

7.5. Safety and interlock connections

Interlock and system reset connections are made using a Harting HAN10 connector.

7.5.1. Emergency stop interlock

The nanio Emergency Stop circuits must be connected to the system Emergency Stop.

7.5.2. Shutter safety interlock

The customer's controller *must* close the shutter using the shutter safety interlock circuits under the following circumstances:

- abnormal operating condition
- emergency stop
- when the laser safety enclosure is opened
- when laser processing is not being performed (system standby, loading, unloading, etc.)

7.5.3. 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.

7.6. Control connections

1. Connect either the electrical or optical RS232 connector on the power supply to an external controller or to a PC.
2. Connect the sync and gating BNC connectors to an external controller.
3. Connect the 25–pin User Interface connector to an external controller.

7.7. External beam delivery components

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

7.8. Initial operation

⚠ WARNING
Hazardous laser radiation

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

1. Place a suitable beam block or energy monitoring device in the beam path. Do not place it close to optical surfaces to avoid risk of contamination by evaporated material.
2. Check that the chiller coolant is at the maximum level.

Important!

If the coolant level is below maximum, top up the coolant before starting the system.

3. *If a water to air chiller is fitted*, turn on the green main switch on the chiller front panel. The switch illuminates indicating that the chiller is in standby mode.
4. Turn on the main switch on the power supply front panel. The Power status lamp illuminates.
5. Ensure that the Emergency Stop (System Off) button on the power supply front panel is in the active position. (Turn it clockwise to release.)
6. Ensure that all external interlock circuits are enabled.
7. 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. The chiller starts to run.

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

   - Check that the chiller pump runs quietly.
   - Check that the chiller coolant level does not fall below the minimum level after air has been purged from the connecting pipes and laser head. If the level is low, switch off, disconnect the AC mains supply and top up the coolant, then restart

   When the Warmup/Ready lamp illuminates continuously, the system is ready for use but the shutter is disabled.

   Note: *The warm up may take up to 15 minutes.*
8. Turn the key switch to position 2. The shutter is enabled.
9. Transmit a set of process parameters to the nanio
   - Check that the nanio emits a beam.
   - Open an external shutter interlock. Check that the shutter closes and that no beam is emitted.
   - Open an external Emergency Stop interlock. Check that the nanio powers off.
10. Power up the system again and carry out beam delivery alignment, as required.

8. Transport and re-commissioning

8.1. Transport

- Fit the protection plate over the beam output window.
- Drain the cooling system
- Store and transport in a clean, dry environment away from dust, moisture, etc.
- Do not subject the system to excessive shock or vibration. (See 2.6.6)
- Transport in a horizontal position. Maximum tilt angle 15°.

8.2. Recommissioning

Follow the procedures and checks used for the initial installation.

Important!

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

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 or water to air chiller.

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.

DANGER

Risk of electrocution

Switch off and disconnect the system from the AC mains supply before draining or filling the coolant tank

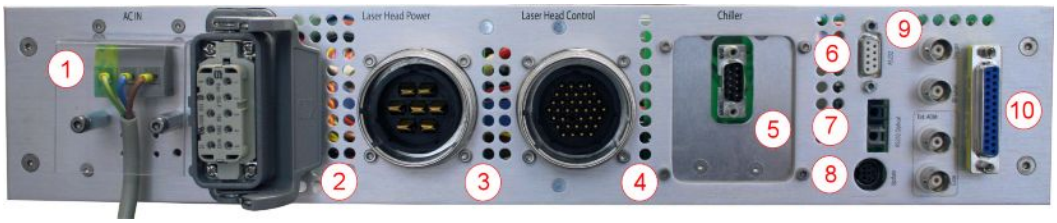
WARNING

Hazardous laser radiation

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

9. Interfacing

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



1 AC mains in
2 Harting HAN14 interlock connector
3 AMP 7–pin laser head connector
4 AMP 37–pin laser head connector
5 AMP or sub-D chiller connector
6 RS232 electrical connector
7 RS232 optical connnector
8 Firmware upgrade connector. InnoLas use only.
9 BNC Q-switch control connectors
10 User interface connector

Figure 14 - Power supply connections

9.1. Interlocks

Interlock and system reset connections are made using a Harting HAN14 connector.

9.1.1. Emergency stop

Signal name	Pin number	Function
User_NA1.1	1	Emergency stop loop 1, send. Keep voltage free!
User_NA1.2	8	Emergency stop loop 1, return. Keep voltage free!
User_NA2.1	2	Emergency stop loop 2, send. Keep voltage free!
User_NA2.2	9	Emergency stop loop 2, return. Keep voltage free!

9.1.2. Shutter

Signal name	Pin number	Function
User_Shutter IL1.1	3	Shutter interlock loop 1, send. Keep voltage free!
User_Shutter IL1.2	10	Shutter interlock loop 1, return. Keep voltage free!
User_Shutter IL2.1	4	Shutter interlock loop 2, send. Keep voltage free!
User_Shutter IL2.2	11	Shutter interlock loop 2, return. Keep voltage free!

9.1.3. System reset

Signal name	Pin number	Function
User_SystemReset 1	5	Reset Emergency Stop send (can be also done by turning the keyswitch to position 0 or by RS232 command)

Signal name	Pin number	Function
User_SystemReset 1	12	Reset Emergency Stop return (can be also done by turning the keyswitch to position 0 or by RS232 command)

9.2. Emission warning lamp

Signal name	Pin number	Function
Emission lamp contact 1	6	Voltage-free relay contact
Emission lamp contact 2	13	Voltage-free relay contact

9.3. Q-switch 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)

Gate

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

Level

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

9.4. User interface

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

Signal name	Pin N°	Function	Type	Range	Polarity	Max. current (I_{max})
User_GND	1	Signal ground				
User_FPK Start	2	Initiates a first pulse killer sequence	TTL	TTL	Rising or falling edge trigger; software configurable	
User_Status_ Emergency Stop	3	Indicates if the Emergency Stop loops are open or closed	TTL / 24V	TTL / 24V	High = closed	
User_Status_ Shutter_IL	4	Indicates if the Shutter interlock loops are open or closed	TTL / 24V	TTL / 24V	HIgh = closed	
User_Changes Complete	5	Confirms that changes are active after a change of parameter set	TTL	TTL	High = changes complete	10 mA
User_RF_ Modulation	6	Represents the RF power that is applied to the intra-cavity Q-switch during the RF-off time	Analog	0–10 V	0 V = 0% RF 10 V = 100% RF (not linear)	
User_Trigger	7	External frequency for Q-switch	TTL & OC	TTL	State or edge triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	
User_ Laser_ Ready	8	Indicates the laser is ready to lase	TTL / 24 V	TTL / 24 V	High = ready	10 mA
AOM_Gate	9	External accousto-optic modulator gate signal	TTL	TTL	State triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	
User_GND	10	Signal ground				
AOM_Analog	11	RF power at external accousto-optic modulator allows for modulation of the laser power	Analog	0–10 V	0 V = 0% RF 10 V = 100% RF (not linear)	
User_System_ Enable	12	Softstart and softstop System starts if Pin12 && RS232 system enable=1 RS232 default = system on	TTL / 24 V	TTL / 24 V	High = system on Low = system off	
User_GND	13	Signal ground				
Diodes_Powered	14	Warning signal that the diodes are powered and laser emission is possible.	24 V	24 V	High = diodes are powered	
User_Warning	15	Indicates there is a system warning	TTL / 24 V	TTL / 24 V	High = warning	

Signal name	Pin N°	Function	Type	Range	Polarity	Max. current (I_{max})
User_Error	16	Indicates there is an error (Error always leads to Emergency Stop)	TTL / 24 V	TTL / 24 V	High = error	
User_Shutter_ Position	17	Shutter position return	TTL / 24 V	TTL / 24 V	High = open	
User_Shutter_ Control	18	Control for process shutter (no safety function) Shutter opens if Pin18 & RS232 & Keyswitch & shutter IL = open RS232 default = open	TTL / 24 V	TTL / 24 V	High = open Low or NC = closed	
User_Gate	19	Rising Edge can start FPK Sequence, Internal Pulse generator is synchronized to edge on gate Enable for pulsed or CW output Rising edge can start first pulse killer sequence Internal pulse generator is synchronised to edge on gate	TTL & OC	TTL	State triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	
User_Strobe	20	Strobe clocks pins 21 to 24 with micro-controller and activates the transmitted parameter set	TTL	TTL	Positive edge	
User_PGM0	21	Bit 0 of the parameter set	TTL	TTL	High = 1 NC or low = 0	
User_PGM1	22	Bit 1 of the parameter set	TTL	TTL	High = 1 NC or low = 0	
User_PGM2	23	Bit 2 of the parameter set	TTL	TTL	High = 1 NC or low = 0	
User_PGM3	24	Bit 3 of the parameter set	TTL	TTL	High = 1 NC or low = 0	
User_24V	25	24 V supply for external components and/or system enable and shutter control	24 V	24 V ±10%		

10. Parts list

- Filter/deioniser cartridge — Part number xxxxx