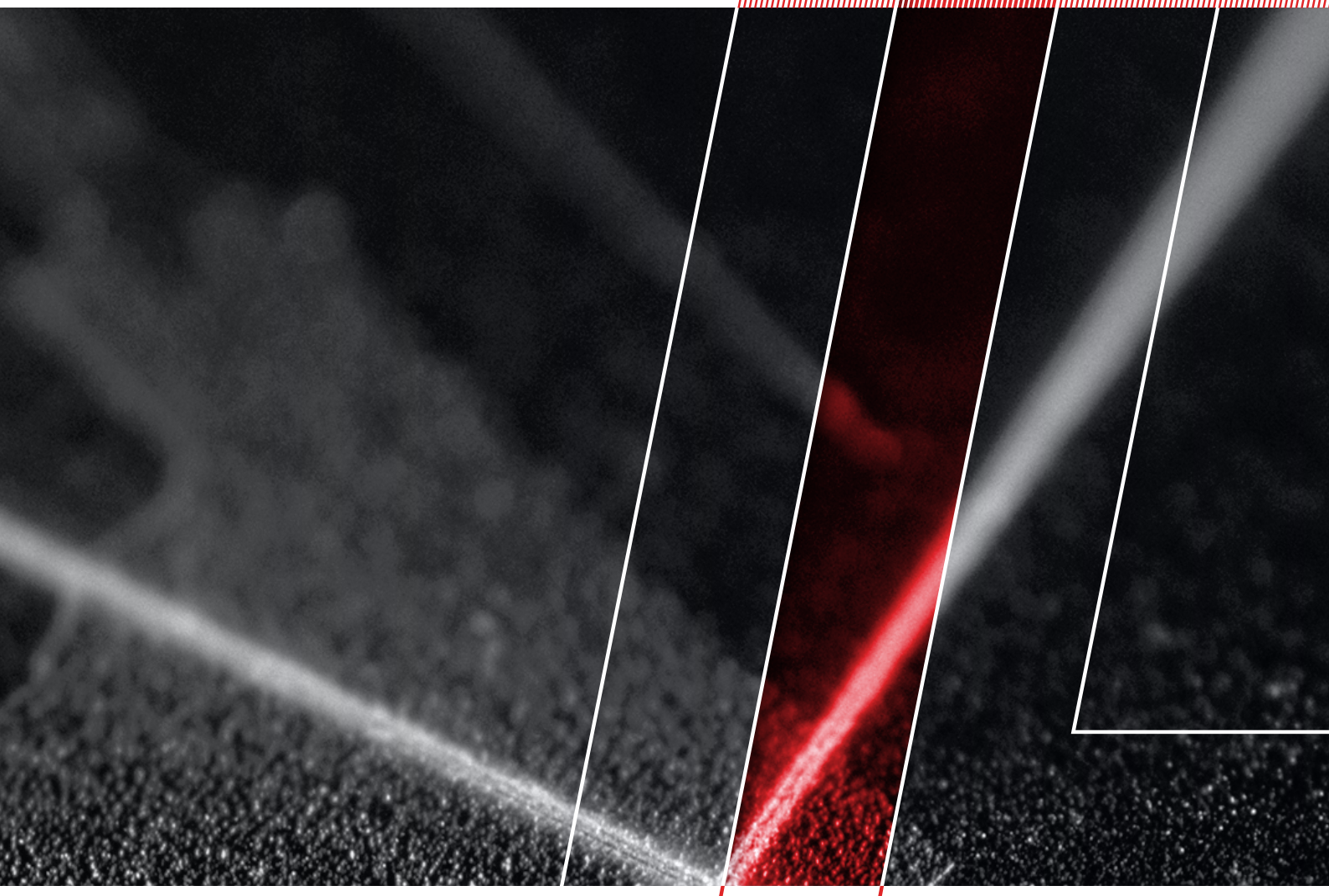
nanio series*

Industrial DPSS Lasers

User and Installation **Manual**



Think of **LASER** *as a tool*

INNOLAS LASER

Revision History

1.0	First release
2.0	201004 — Control and interface updates
2.1	201407 — Add US export compliance

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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 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/
- *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.

U.S. Export Control Laws Compliance

Lasers from InnoLas Laser 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 Laser 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 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 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 or chiller.

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 Laser 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 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 Laser.

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

Figure 1 - Safety label locations

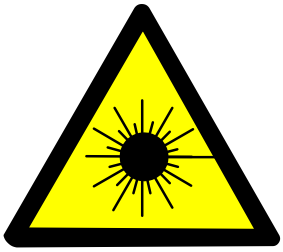


Figure 2 - Label A

Figure 3 - Label B

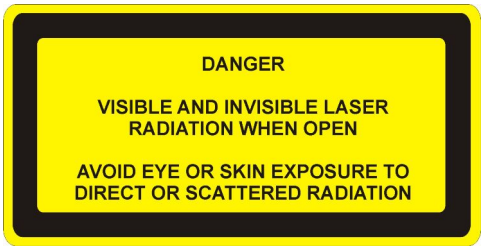


Figure 4 - Label C

Figure 5 - Label D

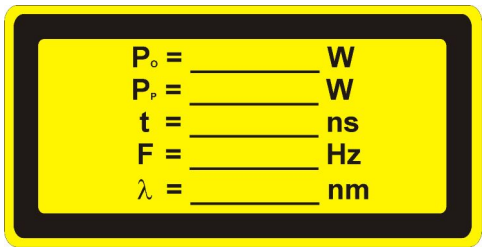


Figure 6 - Label E

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

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

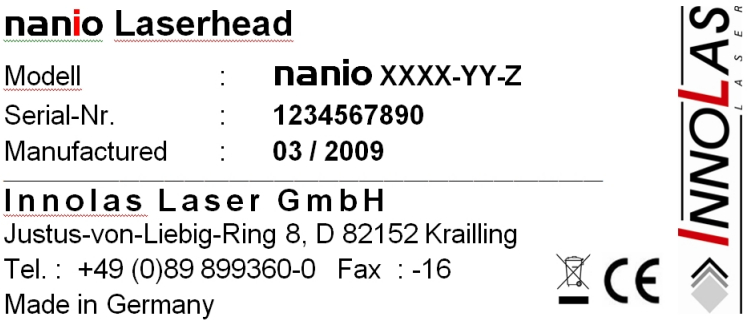


Figure 7 - Type label

Figure 8 - Mains cord connection point

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 or 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 hoses 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

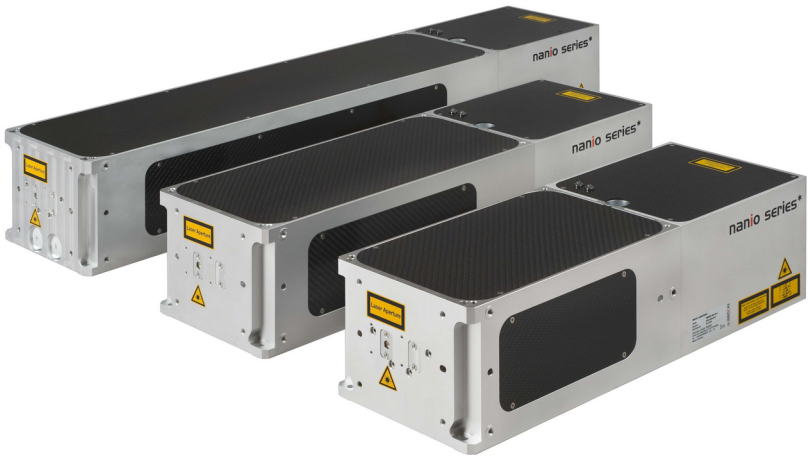


Figure 9 - Laser head

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. 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 acousto-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 acousto-optic modulator.

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

2.3. Power supply

Figure 10 - 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. All 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. The standard mains supply is 115–230 VAC ± 10%, 50–60 Hz, single phase.

2.4. Chiller options

2.4.1. Water/air — standard

Figure 11 - Water/air chiller

The water/air chiller is designed to fit into a 19–inch rack and is available in medium power (5RU high) or high power (6RU high) versions.

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

The standard mains supply for the chiller is 230 VAC ± 10%, 50–60 Hz, single phase. 200 VAC and 115 VAC versions are available on request.

2.4.2. Other options

- Water/water
- Compressor/water
- Dual circuit
- Quad circuit

2.5. Beam delivery options

- Beam expander
- Scan head mounting option

2.6. Specifications

2.6.1. Electrical supply — laser

Maximum power consumption	600 VA
Maximum current demand	6 A
Supply voltage	Single phase, 115–230 VAC ± 10%
Supply frequency	50/60 Hz

2.6.2. Electrical supply — standard chiller

Maximum power consumption	1.0 kVA
Maximum current demand	9 A
Supply voltage	Single phase 230 VAC ± 10%
Supply frequency	50/60 Hz

2.6.3. Dimensions — laser heads

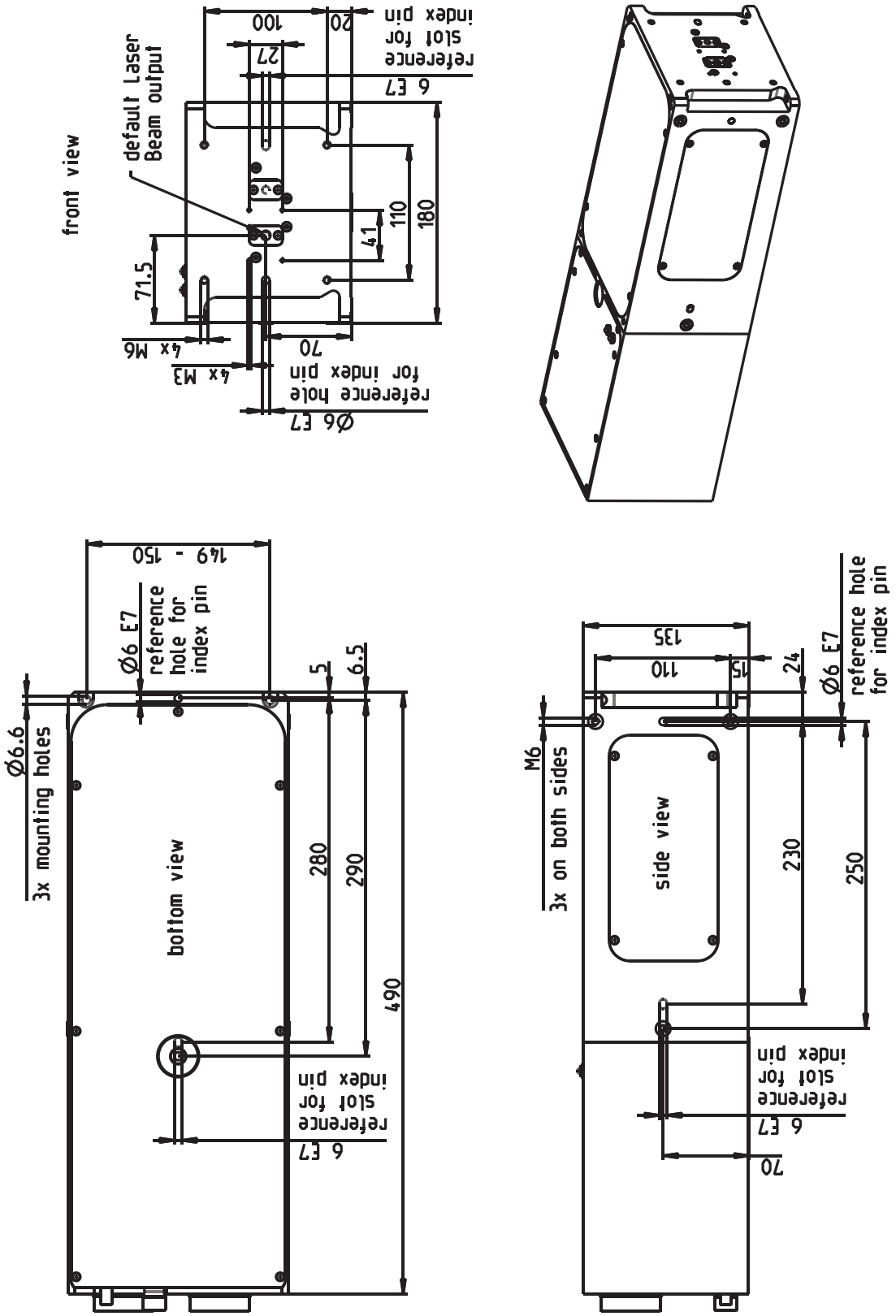


Figure 12 - 490 mm head

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

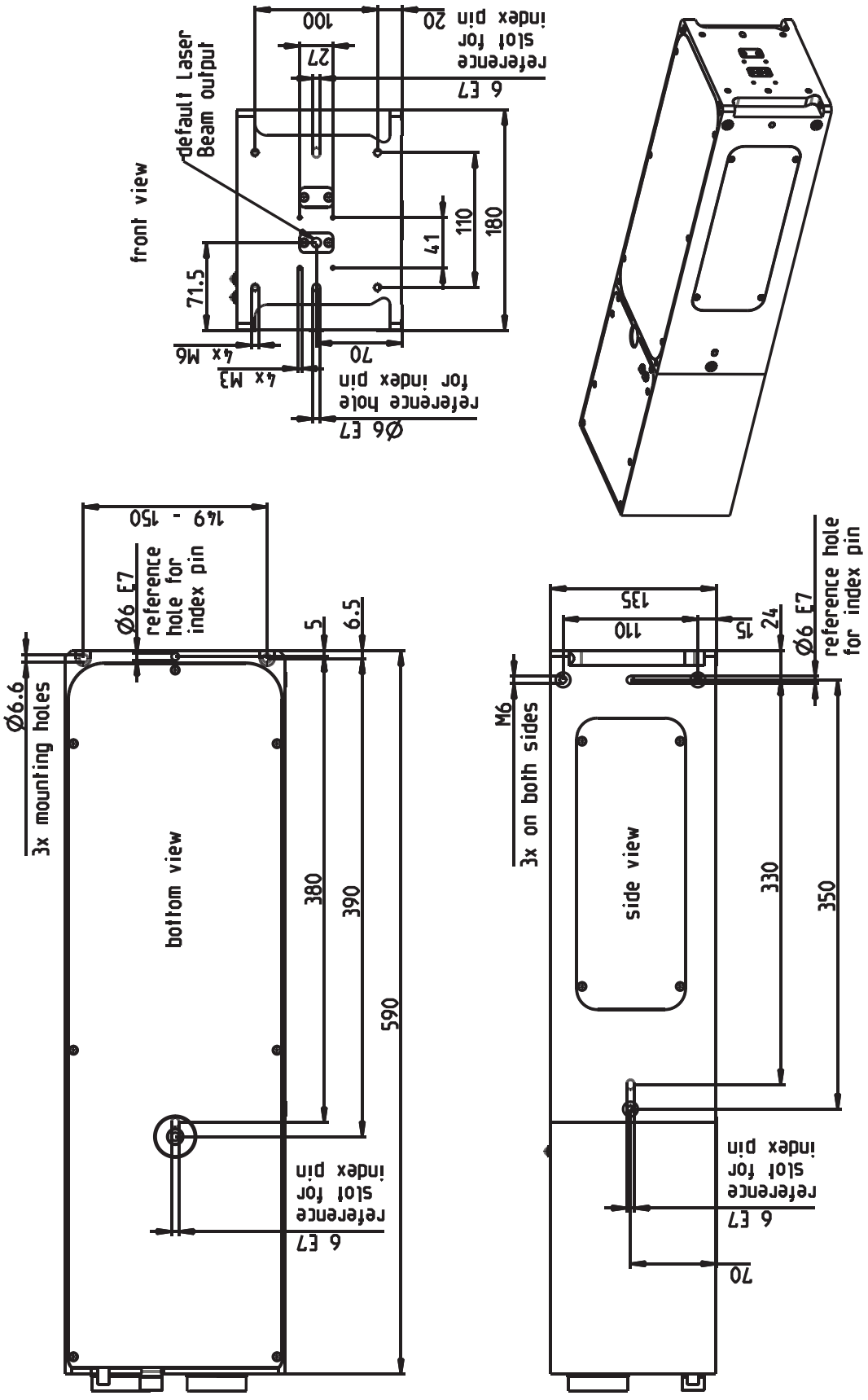


Figure 13 - 590 mm head

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

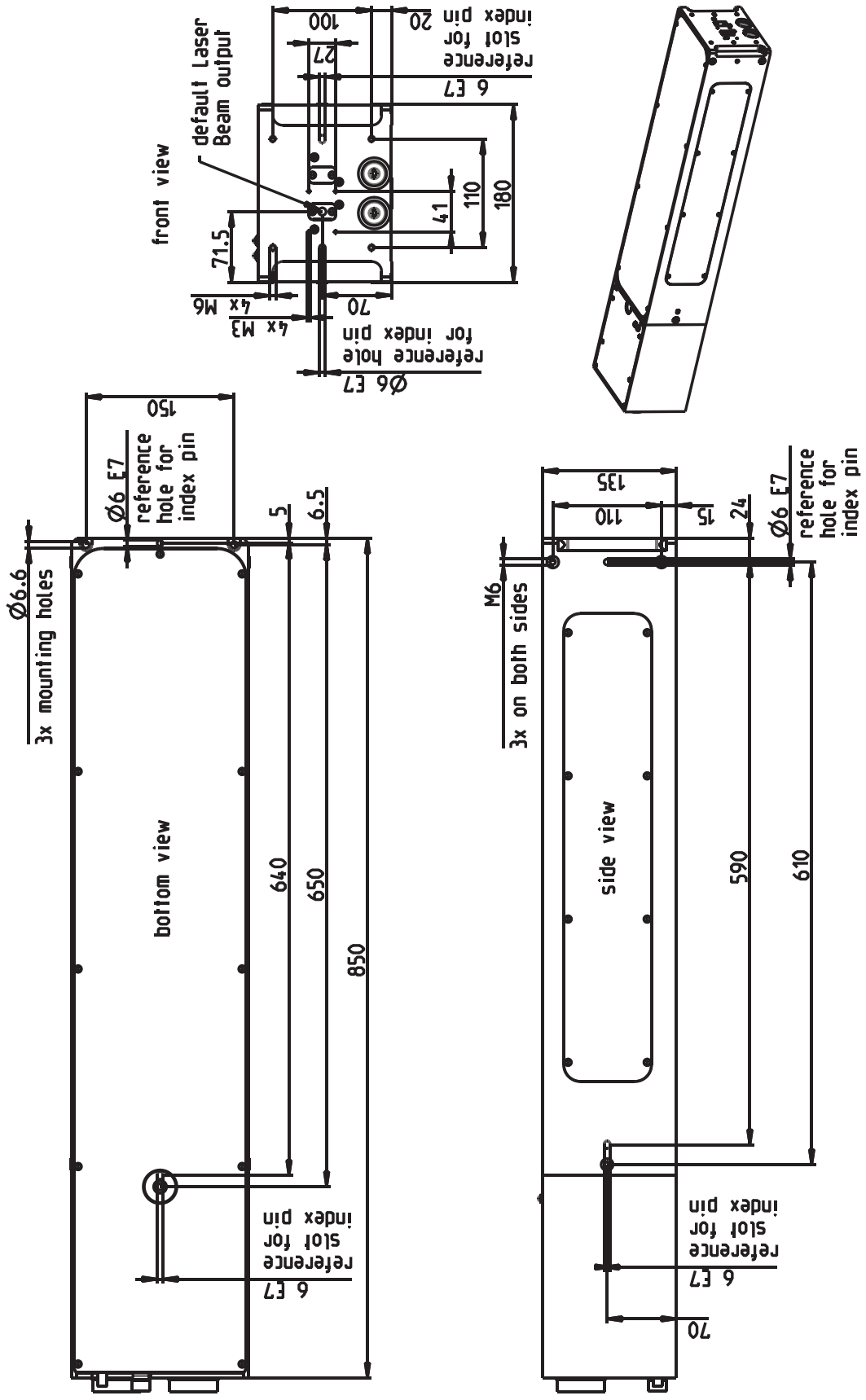


Figure 14 - 850 mm head

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

2.6.4. Dimensions — standard chiller

19–inch rack mount — 5RU (6RU for high power option)

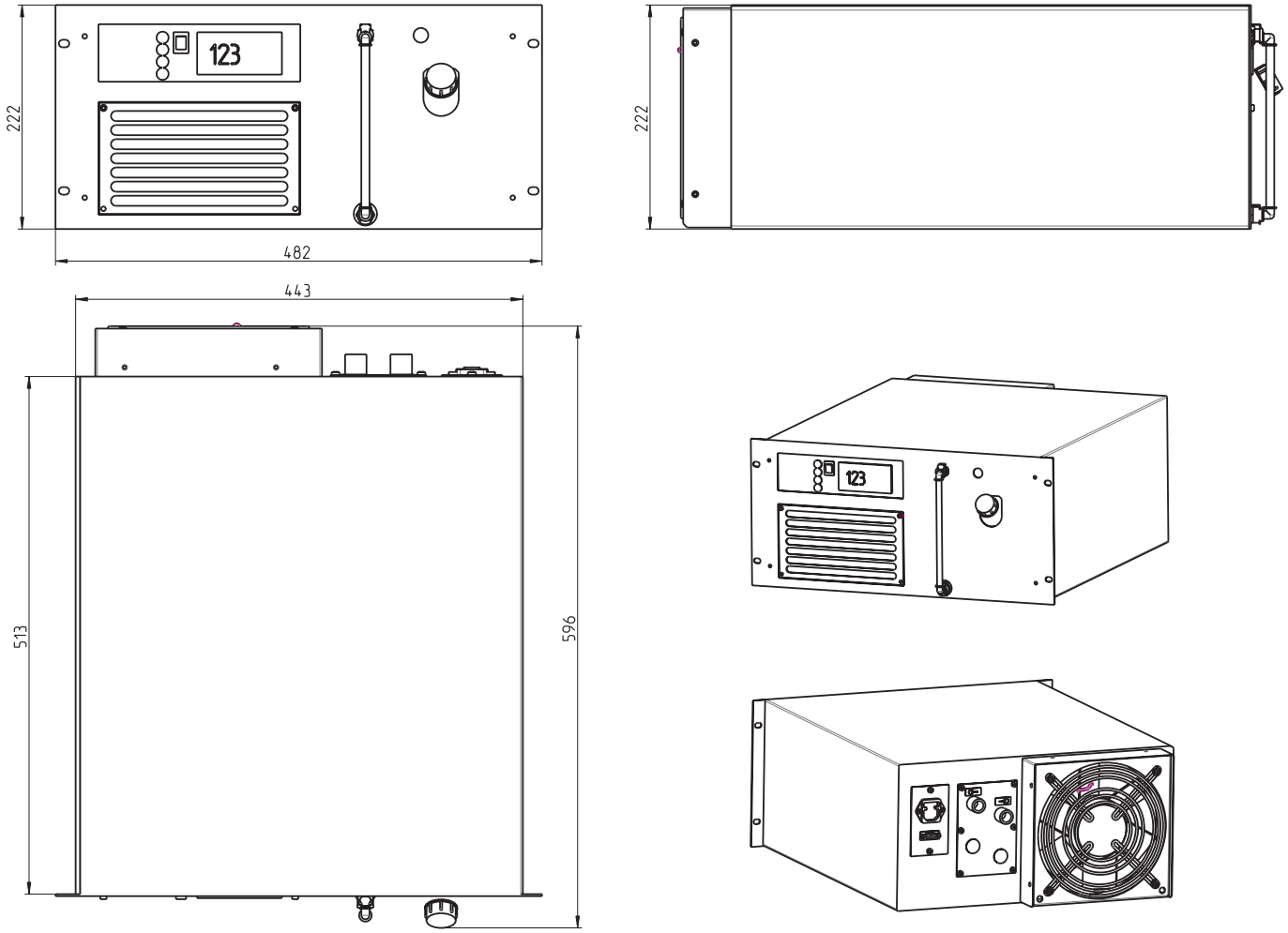


Figure 15 - Chiller 5RU

2.6.5. Dimensions — power supply

19–inch rack mount — 2RU

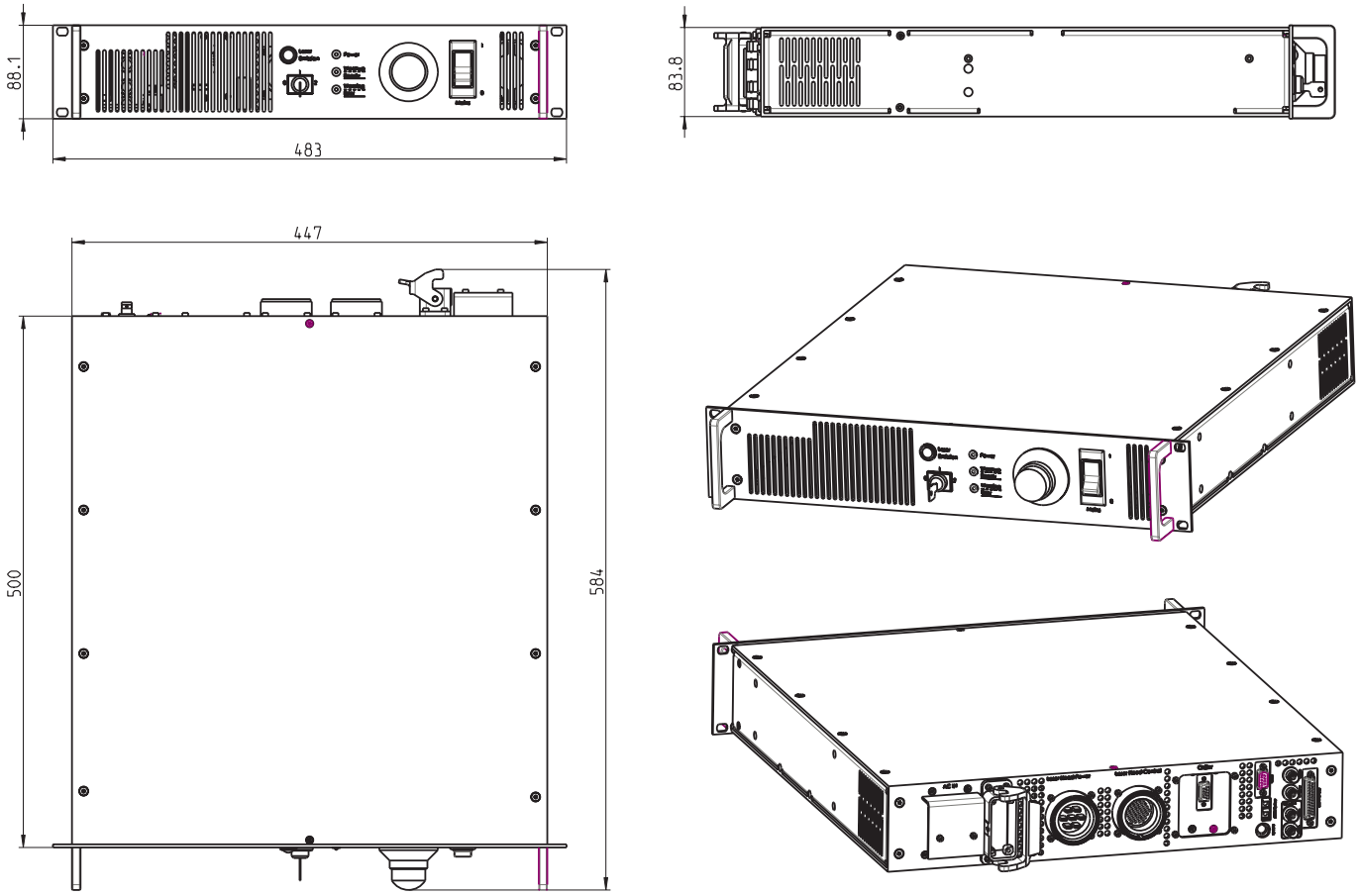


Figure 16 - Power supply

2.6.6. Interconnection cables and hoses

Umbilical cables and cooling water hoses 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.

2.6.7. Nominal weights

Laser head	17–23 kg depending on length and configuration
Power supply unit	12 kg
Water/air chiller	medium power 35 kg; high power 40 kg
Other chiller options	Depends on model — see chiller manual for details.

2.6.8. 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).

2.6.9. Performance

Refer to the product data sheet and final test protocol.

2.6.10. Environmental

Ambient temperature range

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

Relative humidity and conductive dust

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

Altitude range

0–3300 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.

2.6.11. 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 Laser 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/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 closed.

   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 opens if the external safety and interlock circuits are enabled.

3.2. Direct shut down

1. Turn the key switch counter-clockwise 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
- The water/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 opens if the external safety and 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 shutter closes. 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 position 0.
3. Perform a normal direct or remote start up procedure.

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 certified service personnel
- Levels 3 and higher are for factory use only.

4.1. Default software installation

1. Insert the nanio control 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 nanio control software.
2. Install the nanio control software from the CD-ROM.
3. Remove the CD-ROM and then launch the nanio control software.

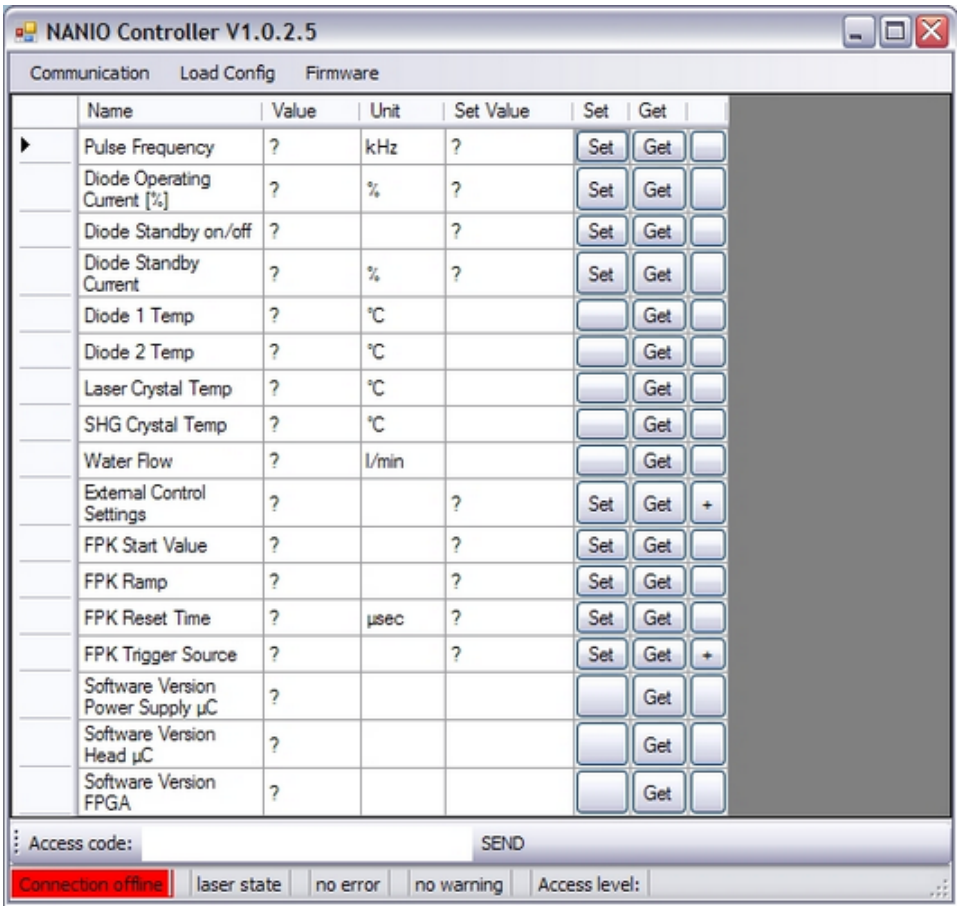


Figure 17 - Nanio controller offline

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

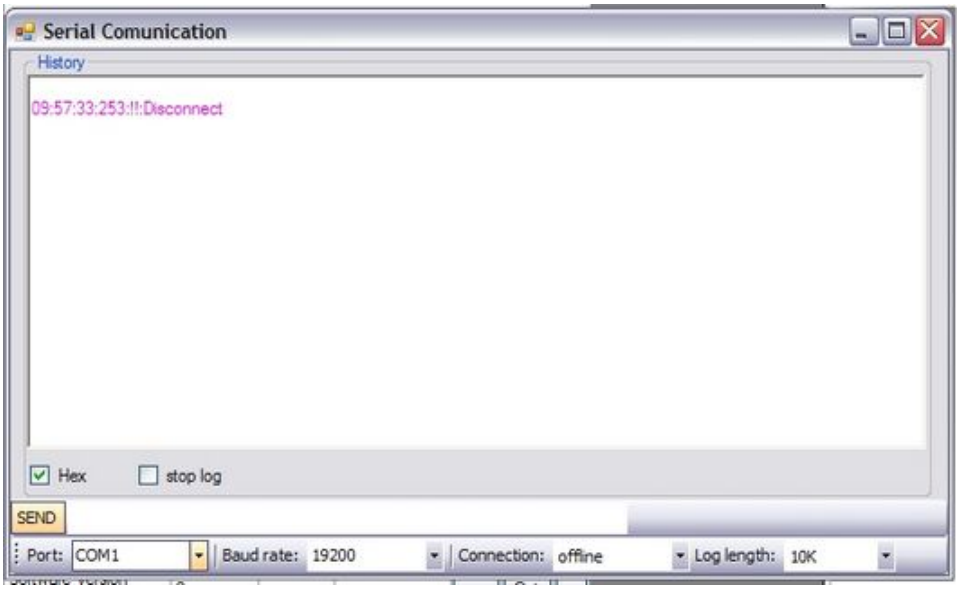


Figure 18 - COM port setting

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

4.2. Default software

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

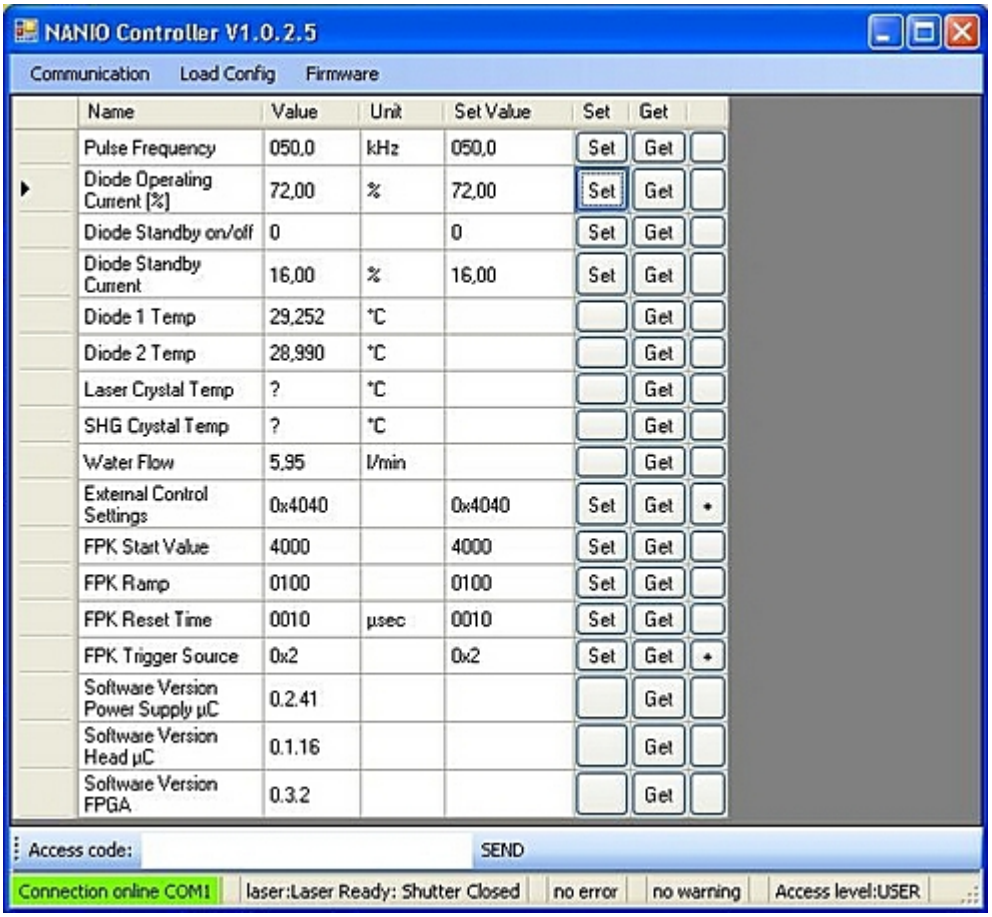


Figure 19 - Nanio controller online

- **Connection online**

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

  Displays the current laser state. See Appendix D 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 B for a list of error codes and Appendix C 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)

Name	Size	Description
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 Laser for custom features and advanced controls.

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
0x001A	Water Flow	Water flow into laser head	get	2	unsigned integer	0.01 l/min	0	na
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	0.01°C	0	na
0x0056	Diode 1 Temp	Measured temperature of diode 1	get	2	unsigned integer	0.01°C	0	na
0x0066	Diode 2 Temp	Measured temperature of diode 2	get	2	unsigned integer	0.01°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

Op code	Name	Description	Type	Param. length (Byte)	Format	Scaling	Access level	
							Get	Set
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
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

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. Chiller

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.

5.2.1. 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.
4. Check the filter cartridge and water flow.

5.2.2. Filter cartridge replacement

Frequency: 6 monthly or as required

Note: *The filter cartridge is a consumable part. For stable laser operation a preventive exchange every 6 months is recommended.*

1. See the chiller manual for the replacement procedure

5.2.3. Water pump replacement

Frequency: 2 yearly or as required

Note: *The water pump is a consumable part. For stable laser operation a preventive exchange every 2 years is recommended.*

1. Contact InnoLas Laser customer service.

5.3. Power supply

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 or 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 Laser customer support for instructions.

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

5.4. 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 Laser 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.

For optimum performance, the following parts should be regularly replaced by trained and certified personnel:

- **Pump diode**

  2 yearly or as required.

Contact InnoLas Laser for maintenance/troubleshooting training and certification.

6. Troubleshooting

6.1. Error messages

Code	Error Message	Description	Action
1000	Flow Error	The water flow inside the cooling system dropped below 1 l/min	• Check if the water filter inside the cooling system needs replacement. • Check that the laser head connectors are properly fitted. • Check that hoses are not kinked or trapped. • Further causes of the error can be due to a damaged pump that must be replaced.
1002	Low Water Error	The water level inside the cooling system is too low. Error state float switch released. Low water error could also indicate loss of power to the chiller unit.	Check water level. Check all water connections for leaks. Refill cooling water. Check the chiller power connection.
1003	Water Temperature Error	The water temperature is not between 15 and 30°C	Check that the ambient temperature is between 15°C and 40°C.
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 water temperature and water flow.
4006	Diode 2 Temp Error	Diode 2 outside the limit settings.	Check water temperature and water flow.
4007	Laser Crystal Temp Error	Laser crystal temperature outside the limit settings.	Check water temperature and water flow.
4008	SHG Temp Error	SHG crystal temperature outside the limit settings.	Check water temperature and water flow.
4009	THG Temp Error	THG crystal temperature outside the limit settings.	Check water temperature and water flow.
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
1002	Low Water Warning	The water level inside the cooling system is low. Warning state float switch released.	Check water level. Check all water connections for leaks. Refill cooling water.
4000	Diode 1 Low Temperature	Diode 1 outside the low limit setting.	Check cooling water temperature.
4001	Diode 1 High Temperature	Diode 1 outside the high limit setting.	Check cooling water temperature.
4002	Diode 2 Low Temperature	Diode 2 outside the low limit setting.	Check cooling water temperature.
4003	Diode 2 High Temperature	Diode 2 outside the high limit setting.	Check cooling water temperature.
4004	Laser Crystal Low Temperature	Laser crystal temperature outside the low limit setting.	Check cooling water temperature.
4005	Laser Crystal High Temperature	Laser crystal temperature outside the high limit setting.	Check cooling water temperature.
4006	SHG Low Temperature	SHG crystal temperature outside the low limit setting.	Check cooling water temperature.
4007	SHG High Temperature	SHG crystal temperature outside the high limit setting.	Check cooling water temperature.
4008	THG Low Temperature	THG crystal temperature outside the low limit setting.	Check cooling water temperature.
4009	THG High Temperature	THG crystal temperature outside the high limit setting.	Check cooling water temperature.
5000	Head Emission Lamp 1 Defective	Head emission warning lamp 1 defective	Call InnoLas Laser customer support for replacement.
5001	Head Emission Lamp 2 Defective	Head emission warning lamp 2 defective	Call InnoLas Laser customer support for replacement.

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

7. Installation

Important!

If you have any questions or problems during the integration contact InnoLas Laser 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 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 Laser immediately.*

   (See Appendix E.)
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 safety and type labels are 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!

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

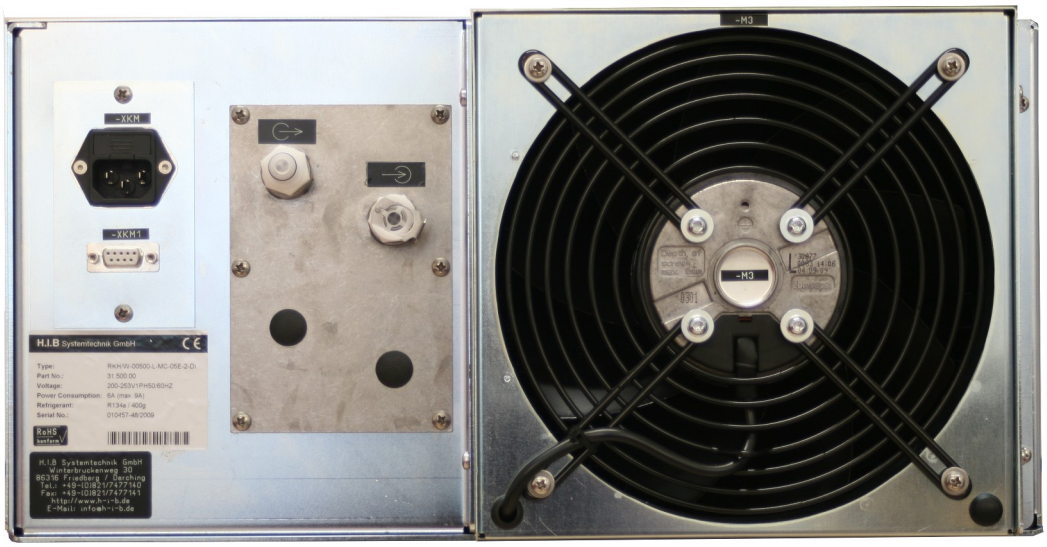


Figure 20 -

Connect the control cable from connector -XKM1 on the chiller to the power supply.

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

Connect the power cable from connector -XKM on the chiller to the AC mains supply.

Note: *The connectors on these control cables are mechanically reversed and cannot be accidentally interchanged.*

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 hose connectors onto the laser head and chiller. The connectors are mechanically reversed to avoid confusion.

   The blue hose is flow and the red hose 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 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 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. 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 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 hoses 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 closed.

   Note: *The warm up may take up to 15 minutes.*
8. Turn the key switch to position 2. The shutter opens if the external safety and interlock circuits are 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 recommissioning

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 2.6.10)
- 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.

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 or 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.

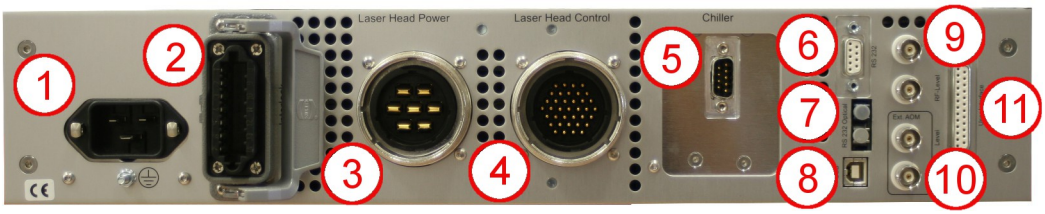
DANGER
Risk of electrocution
Switch off and disconnect the system from the AC mains supply before draining or filling the coolant tank.

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

9. Interfacing

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

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



1 AC mains in
2 Harting HAN10 interlock connector with 14–pin insert. See Chapter 10 for connector details.
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 USB connector
9 BNC Q-switch control connectors
10 Optional external AOM connector
11 User interface connector

Figure 21 - Power supply connections

9.1. Interlocks

Interlock and system reset connections are made using a Harting HAN10 connector with 14–pin insert.

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)
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 (Max. 48 VAC or 0.5 A DC)
Emission lamp contact 2	13	Voltage-free relay contact (Max. 48 VAC or 0.5 A DC)

9.3. 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)

Gate (optional)

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

Level (optional)

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

9.4. User interface

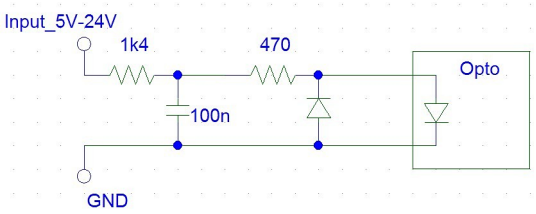
User interface connections are made using a 25–pin D-connector.

Important!

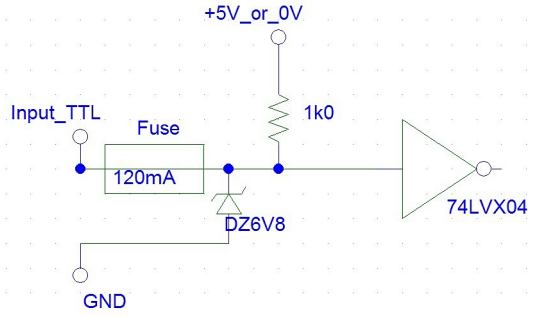
24 V output signal levels are standard but may be globally reconfigured to 5 V TTL levels, if required.

9.4.1. Input and output configurations

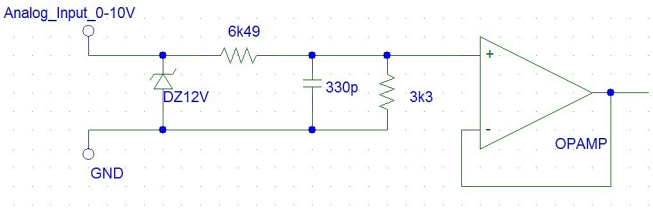
Input 5–24 V



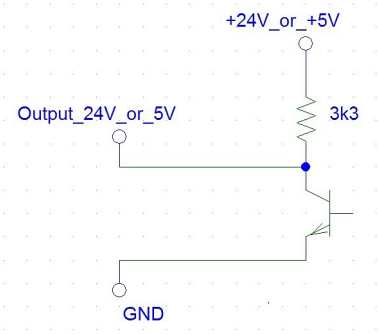
Input 5 V TTL



Input analog



Output 5–24 V



9.4.2. 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
Shutter Interlock status	4	Indicates if the Shutter interlock 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
RF Modulation	6	Represents the RF power that is applied to the intra-cavity Q-switch during the RF-off time	Analog in	0–10 V	0 V = 0% RF 10 V = 100% RF (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

Signal name	Pin N°	Function	Type	Range	Comment	Max. current (I_{max})
External AOM Gate (optional)	9	External AOM gate signal	TTL in	TTL	State triggered Switchable between high or low active Pullup or pulldown to stop emission in case cable is disconnected	5 mA
Ground	10	Signal ground				
External AOM Modulation (optional)	11	RF power at external AOM for modulation of the laser power	Analog in	0–10 V	0 V = 0% RF 10 V = 100% RF (not linear)	1 mA
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
Shutter Position status	17	Indicates shutter position (High=open)	TTL / 24 V out	TTL or 24 V	High = open	8 mA @ 24 V or 1.5 mA @ 5 V
Shutter Control	18	Control for process shutter (safety function) Shutter opens only if: • Pin18 is high • Keyswitch is in position 2 • Shutter interlock is closed • RS232 shutter control=open (RS232 shutter control default = open)	5–24 V digital in	5–24 V	High = open Low or NC = closed	12 mA @ 24 V or 2 mA @ 5 V

Signal name	Pin N°	Function	Type	Range	Comment	Max. current (I_{max})
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
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

10. Parts list

- Filter cartridge, 20 μm — Part number 21073
- Harting HAN10 connector components — Harting part numbers:
  - Insert Plug: # 09 20 014 2811 (screw type); # 09 20 014 2810 (solder type) STAF14, 14-pin
  - Hood: # 09 30 010 1440, Size 10A, low, straight, PG13.5

Appendix A. 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 B. RS232 error codes

Error code (decimal)	Error code (hex)	Name	Description
1000	03E8	Flow error off	Water flow is too low
1002	03EA	Low water error	Water level in the reservoir is critically low
1003	03EB	Temperature error chiller	Cooling water is out of environmental specs
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
5008	1390	AOM HF off	Hardware failure

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

Appendix C. RS232 warning codes

Warning code (decimal)	Warning code (hex)	Name	Description
1002	03EA	Low water warning	Low water level in chiller
4000	0FA0	Doide 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.
4002	0FA2	Diode 2 low temperature	Device not at set temperature, e.g. during warm up.
4003	0FA3	Diode 2 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.
5000	1388	Head emission lamp 1 defective	
5001	1389	Head emission lamp 2 defective	

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

Appendix D. 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 E. Packing list

Packing List

Customer: _____
Serial Nr.: _____

Quantities	Description	Type
_____	Laser Head	_____
_____	Power Supply Unit	_____
_____	Chiller	_____

Accesoirs

_____ Keys
_____ Cable Diode Supply (*)
_____ Cable Signals Laser head (*)
_____ Water hose (*)
_____ Power Cable Supply
_____ Power Cable Chiller
_____ Control Cable Chiller Power Supply (RS232)
_____ Control Cable PC Power Supply (RS232)
_____ Dummy Connector User Interface
_____ Dummy Connector Interlock
_____ Floating bearing
_____ Handles
_____ Water bottle
_____ Strain-relief on Power Supply & Chiller

Documentation

_____ User Manual
_____ Software & Manual CD
_____ 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 F. Your notes