EKSPLA

NT230 Series

Tunable Diode Pumped Laser System

Technical Description
User's Manual

NT230 Rev. 1801

2018
Lithuania

Contents

**Chapter 12 and Chapter 13 might not appear in PDF version of this manual; they may be available as separate file(s).*

List of Figures

List of Tables

Chapter 1 PREFACE

1.1. Legal Disclaimer

All original content in this Manual, including, but not limited to, texts, diagrams, schemes and datasheets, is an intellectual property of EKSPLA and is eligible for protection under copyright.

Any redistribution, retransmission or publication of any material is strictly prohibited without the express written consent of the copyright owner.

1.2. Generalized and/or Incomplete Information in the Manual

Some general information in this manual may be excessive and not related to the particular system. For example, *Safety* chapter may contain information about hazards presented by flash lamps, even if the system has diode pumping only.

EKSPLA laser systems are under constant improvement and modification; many systems are heavily customized to suit the special needs of the customer. Because of this the manual occasionally may contain information which is outdated, incomplete, or erroneous; or it may omit some information about the specific system.

Please inform the manufacturer if such errors and/or omissions were noticed.

1.3. Special Attention

Please pay special attention to Chapter 4 Safety for information about safe handling and usage of the NT230 series laser systems.

Various notes and warnings that are present in this manual should be studied and followed to ensure the safe and effective handling of the system.

1.4. Manufacturer Contacts

EKSPLA
Savanoriu Av. 237,
02300 Vilnius, Lithuania
Phone: +370 5 2649629
Fax: +370 5 2641809
E-mail: ekspla@ekspla.com
Web: http://www.ekspla.com

This page is intentionally left blank

Chapter 2 WARRANTY

This chapter contains warranty statement and service contact information.

2.1. Warranty Statement

EKSPLA warrants to the original purchaser that laser devices are free from defects in parts and workmanship. *EKSPLA* will make any necessary repairs or replacement of parts to remedy any defect according to the conditions drawn up in the contract.

The foregoing warranty does not cover equipment that is damaged by accident or improper use. *EKSPLA* does not assume any liability if adaptations are made or accessories attached to the equipment that impair or alter the normal functioning of the equipment. The limited warranty and remedy contained in this paragraph are the only warranty and remedy pertaining to the equipment. *EKSPLA* DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. *EKSPLA* is not liable for any accidental, consequential or other damages or costs, lost profits or inconvenience occasioned by loss of the use of the equipment or labor expended by persons not so authorized by EKSPLA.

WARRANTY VOID IF *EKSPLA* STICKER IS REMOVED.

2.2. Coating inhomogeneity

Small coating inhomogeneity, color change/discolor marks on optical component are signs of light-material interaction during normal routine operation and as such are not to be treated as defect, as long as specified output parameters of device are not altered.

2.3. Service Contact Information

We have a responsive Customer Service staff that will be pleased to help you. Please do not hesitate to contact them at:

Phone: +370 5 2649623

Fax: +370 5 2641809

E-mail: service@ekspla.com

This page is intentionally left blank

3.1. General Information

3.1.1. Model

NT230-100-SH-SF

3.1.2. Manufacturer

EKSPLA

3.1.3. Intended Fields of Use

Laser-induced fluorescence, flash photolysis, photobiology, remote sensing, metrology, non-linear spectroscopy, other laser spectroscopy applications.

3.1.4. Main Components of the System

Table 1 Main components of the system

Component	*Quantity*
Laser head NT230-100-SH-SF **S/N PGD202**	1
Power supply PS8000 series	1
External cooling unit	1
Control pad with cable	1
Set of cables and accessories	1
User's manual with software CD	1

3.2. Beam Characteristics

Table 2 Pump laser requirements

Parameter	***Specifications***
Wavelength, *nm*	355
Pulse duration, *ns*	3…6
Pulse energy, *mJ*	>40
Pulse energy stability, *%*	2.5
Repetition rate, *Hz*	100
Beam diameter (full width at 0.1 level), *mm*	~4
Beam divergence (full angle @1/e^2), *mrad*	<2
Beam profile	TEM_{00}
Polarization	Vertical
Jitter (with respect to internal SYNC pulse), *ns*	±0.5

Table 3 Parametric output specifications

Parameter	***Specifications***
Wavelength tuning range, *nm* Third harmonic SH/SF Signal Idler	 355 210…404.99 405…709.99 710…2600
Pulse duration, *ns*	~3
Polarization Third harmonic SH/SF Signal Idler	 Vertical Horizontal Horizontal Vertical
Output beam mode	Elliptical

3.3. Power Supply Requirements

Table 4 Power supply requirements

Parameter	***PS8001DR-48***	***HYDAC RKHW***
Supply voltage	100…240 VAC	100…240V ±10%
Frequency	47-63 Hz	50/60 Hz
Phase	1	1
Amps	10 A	7.5
Power consumption	<0.5 kW	MAX 7.5A

3.4. Liquids and Gases

Fluid/gas	*Specifications/Information*
Distilled water (water cooled systems only)	Not hazardous

3.5. Environmental Conditions

Equipment is designed to be safe under following environmental conditions according to 1.4.1.31010-1@IEC:

1. Indoor use.
2. Altitude up to 3000 m.
3. Temperature within 18…25 °C (64…77 °F).
4. Relative humidity up to 80% at temperatures below 31 °C.
5. Mains supply voltage fluctuations within ±10% from nominal.
6. Air contamination level – ISO 9 (room air) or better.
7. Pollution degree 1: no pollution or only dry non-conductive pollution.
8. For water-cooled systems with external water supply – presence of a tap water source with water temperature ≤20 °C, flow at least 8 l/min (pressure 1…8 bars).

3.6. Mechanical Dimensions

All external dimensions are given with ±3 mm tolerance.

3.6.1. Weight

~70 kg.

3.6.2. Beam Position(s)

See Figure 1.

3.6.3. Placing and Fixing

The laser is intended to be placed on a flat solid surface. Laser stands on three legs. Legs may be fixed to a surface by clamps or bolts.

3.6.4. Laser External Dimensions

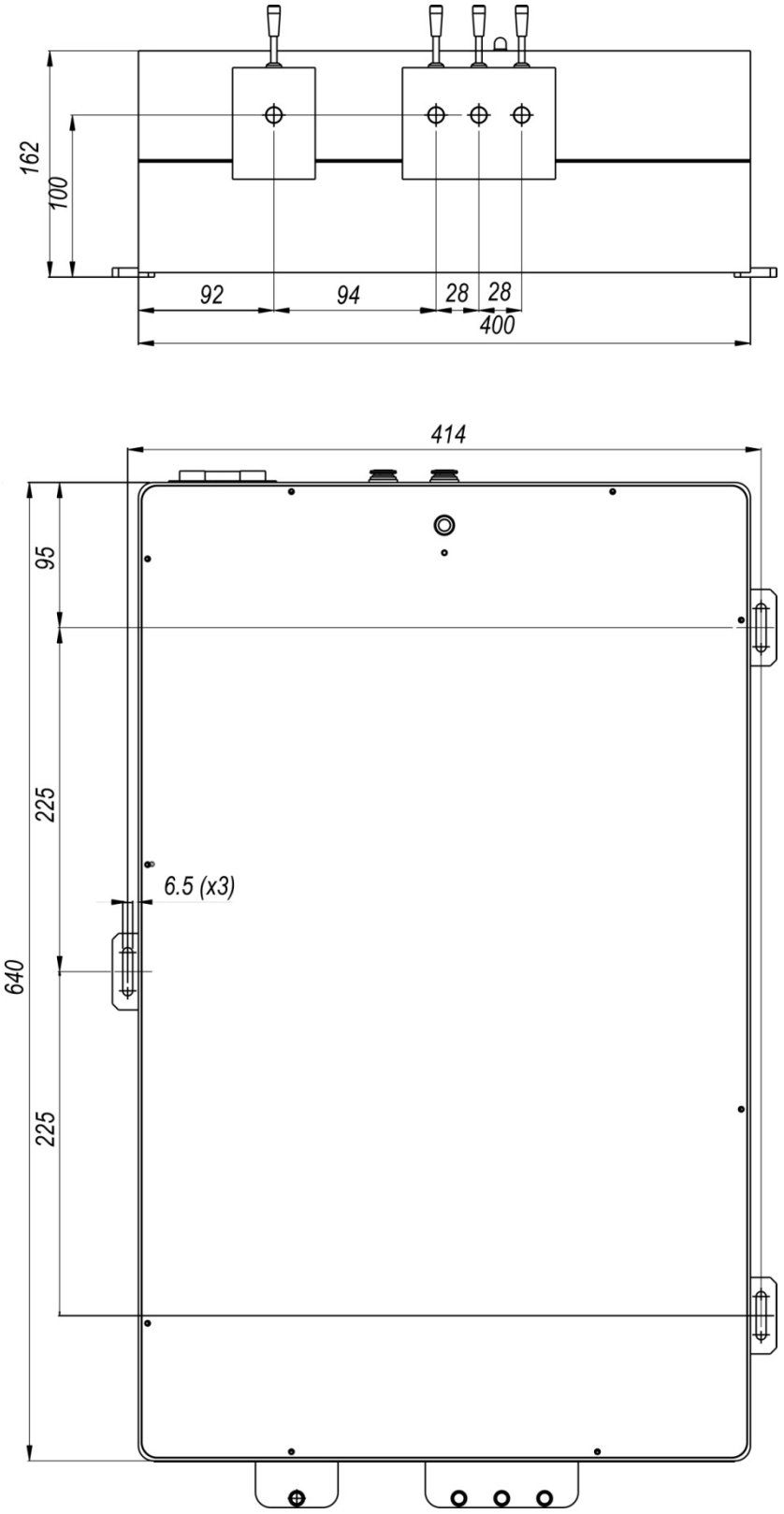


Figure 1 Outline drawing and dimensions of NT230 series laser

3.6.5. Power Supply Dimensions

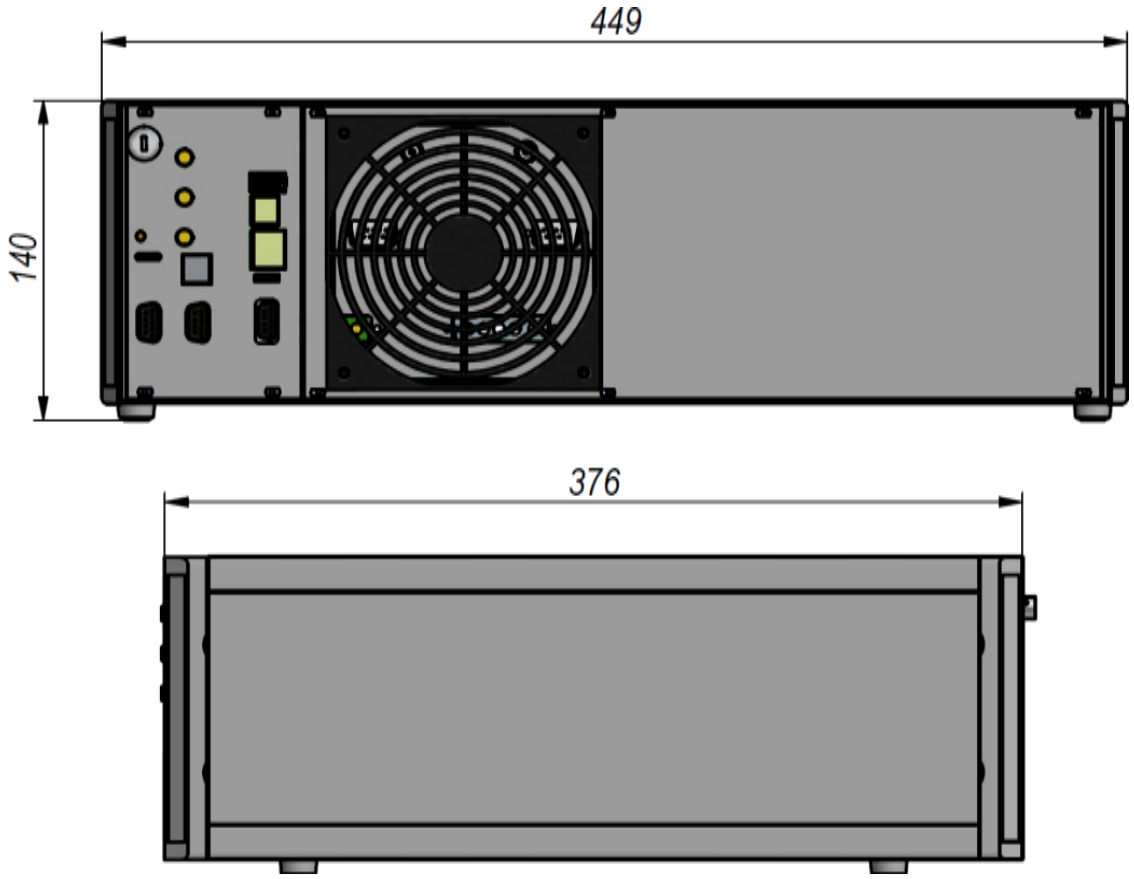


Figure 2 Outline drawing and dimensions of PS8000 series power supply

This page is intentionally left blank

This chapter provides information about safe handling and usage of the *NT230* series lasers.

> ***Caution:***
> ***Use of controls and adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.***

4.1. Safety Class

This laser is a **Class 4** laser product according to the IEC60825:2007 standard, and, by definition, relates to certain safety and fire hazards.

4.2. Safety Features and Government Requirements

The following features are incorporated into the laser to conform to several government requirements. The applicable United States Government requirements are contained in 21 CFR, chapter 1, subchapter J, administered by the Center for Devices and Radiological Health (CDRH). The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in73/23 EEC and amended in 93/68 EEC). The Low Voltage Directive requires that lasers comply with the IEC-60825-1 (Radiation Safety of Laser Products) and IEC-1010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use).

The laser head is enclosed in a protective housing that prevents human access to radiation in excess of the limits of Class I radiation as specified in 21 CFR , subchapter J, Section 1040.10(f) (1) and Table 1-A/EN60825-1, clause 4.2 except for the output beam, which is Class IV. Top cover of the housing has protection interlock. Breaking of interlock circuit stops the laser diode drivers and prevents operator from laser radiation exposure.

The appropriately labeled indicator on the laser head illuminates before laser emission can occur. Amber light is used so that it is visible when the proper type of safety glasses are used (21 CFR, subchapter J, Section 1040.10(f) (5) /EN60825-1, clause 4.6).

A beam shutter prevents contact with laser radiation without the need to switch off the laser (21 CFR, subchapter J, Section 1040.10(f) (6) /EN60825-1, clause 4.7).

The laser controls are positioned so that the operator is *not* exposed to laser emission while manipulating the controls (21 CFR, subchapter J, Section 1040.10(f) (7) /EN60825-1, clause 4.8).

4.3. Labeling

Labels attached to the equipment are listed below.

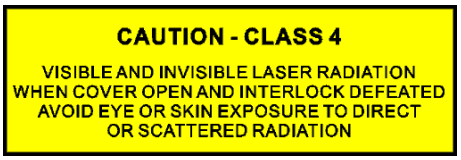
4.3.1. Laser Radiation Warnings/Identification

①

A **laser hazard** label is located on the top of laser head cover. This label is also duplicated on the output end panel of laser head frame.

Example only. Check the sticker(s) on the frame for actual values.

②



Cover interlock label is located on the top of laser head cover.

③

An **aperture** label is located above the laser apertures.

④

Laser hazard labels are located on end panel of laser head cover next to the beam output apertures.

⑤

A **product certification and identification** label is located on the end panel of laser frame.

4.3.2. Electrical Warnings

Electric shock labels are located on the covers of high voltage switches, negative feedback board and laser pump chambers.

4.3.3. Other Warnings

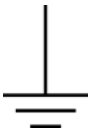
Strong magnet labels are located on the top of Faraday rotators.

Electrical hazard labels may be located on the top cover and rear of power supply unit.

4.3.4. Symbols and Other Labels Used in this Manual and on the Laser System

Hot surface labels are located on the some crystal ovens.

Risk of danger label.



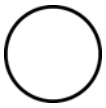
Earth (ground) terminal symbol.

Protective conductor terminal symbol.

Single-phase alternating current symbol.

Three-phase alternating current symbol.

On (Supply) symbol.



Off (Supply) symbol.

Do Not Touch label.

(Do not attempt to move or align the marked component. System is especially sensitive to its position; changing it may cause a difficult to restore loss of generation, etc.)

Adjustable knob label.

Indicates the relevant knob to be adjusted on some system parts, e.g. harmonic crystals.

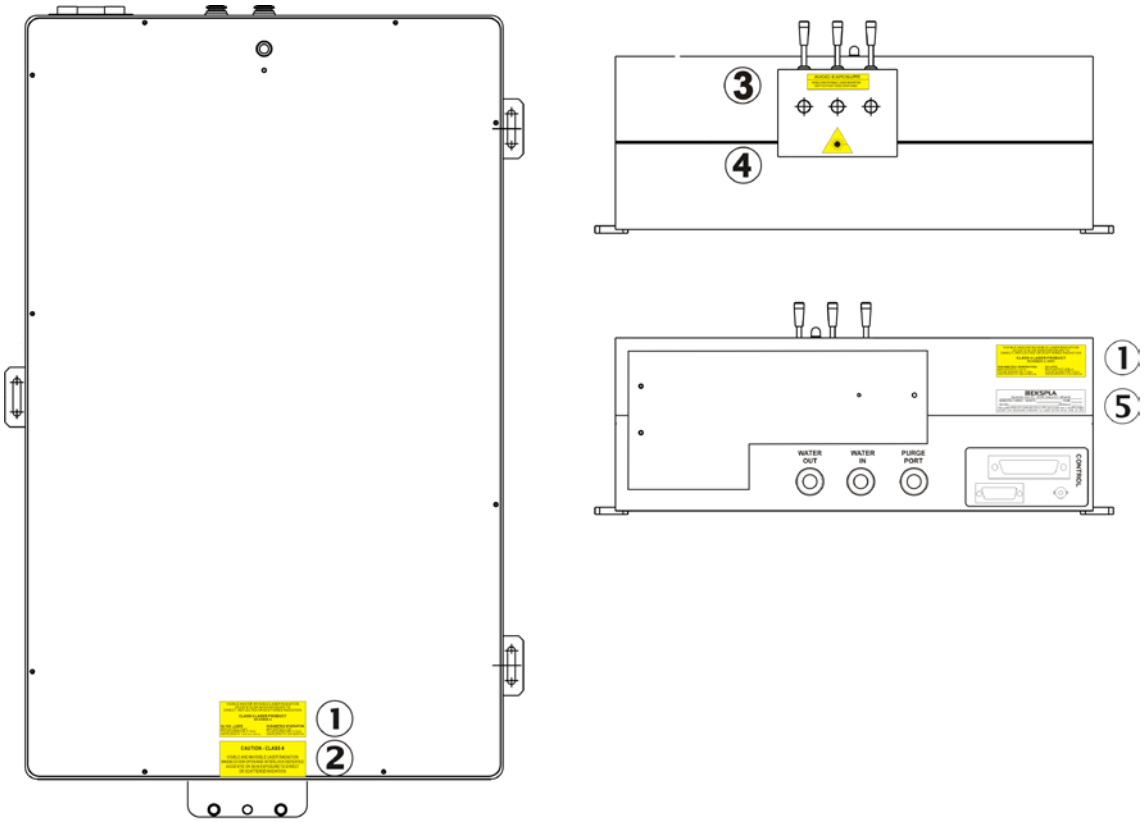


Figure 3 General warning label positions on the NT230 series laser

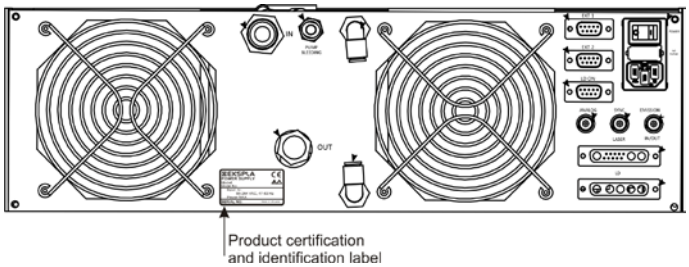


Figure 4 Warning label positions on the power supply (example)

4.3.5. Laser Radiation

This laser can emit laser radiation of different wavelengths:

Table 5 Emitted radiation

Radiation name	Wavelength(s), nm	Range	Visibility
Laser diode radiation	808	Infrared (IR)	Invisible
Fundamental	1064	IR	Invisible
2nd harmonic	532	Visible (VIS)	Visible (green)
3rd harmonic	355	Ultraviolet (UV)	Invisible
Parametric	210…2600	Various	Visible & invisible

The wavelength(s) emitted by a particular laser system are specified on the warning label. All reflections, whether specular or diffuse, from optical components such as steering mirrors and prisms, are dangerous. Human eye transmits most of the laser radiation directly to the retina, which can be severely damaged. When in doubt about the distribution of laser radiation within an external optical system, relevant detecting equipment must be used. Damage to other body parts is a function of the laser power level and exposure time.

Caution
All personnel are required to wear the proper eye protection when in the proximity of an operating laser. Be certain that the eye protection is rated for the wavelength and energy density output of the laser in operation.

Not all lasers emit visible light and extra precautions should be taken when utilizing a laser that emits invisible radiation. Invisible radiation behaves in the same manner as visible radiation when encountering reflective surfaces and great care should be taken when manipulating such laser beams, both for personnel safety and potential damage to equipment.

For increased personnel safety, access to laser areas should be restricted only to the personnel whose work requires the operation of the laser, and these personnel should be fully trained in laser safety. Warning signs should be placed at all access points to the restricted areas.

EKSPLA recommends that experiments be set up in a way where no beam path is at eye level. This reduces the potential for accidental eye damage from stray beams.

Care must be taken when using optics external to the laser system, as mirrors or lenses can reflect the beam back into the laser system and potentially damage the components of the laser. A He-Ne laser mounted collinear to the optical axis of the laser system can serve as a convenient and safe way to check the beam path for potentially harmful reflections.

Before operating a laser, read the specific warning information attached to the laser system and described in this chapter.

4.4. Pump Source Radiation

The design of the laser ensures that the operator is protected from pump source (flash lamp and/or laser diode) radiation. Specifically:

- the beam path is shrouded within the laser cavity.
- the construction of the pump chamber's protective housing restricts from getting in a direct contact with the pump source radiation. This radiation contains UV and IR components that are hazardous to the eye. Also, laser eyewear may **not** filter some hazardous wavelengths.

Caution:
Avoid looking in or around the laser apertures. It is essential to use protective goggles when handling flash lamps.

4.5. Back Reflection Safety

The back reflections from filter plates, prisms *et al* may form additional resonator with uncontrollable radiation profiles.

High energy radiation focused inside the laser resonator may cause severe damage of optical elements: both on surfaces and in bulk.

Optical parts in the laser, such as harmonic generator and output mirrors, are vulnerable to severe damage if a small percentage of the output laser beam is reflected and focused back into the laser. For instance, a common, uncoated, positive, simple lens will reflect about 4% of the beam at each surface. The first surface reflection will diverge in the backward direction, **but the second surface reflection will focus and at the focus the intensity will be very high, often enough to cause optical damage**. Even surfaces with anti-reflection coatings may back reflect focused energy enough to cause damage.

To avoid this hazard, minimize focused back reflections direct them off-axis to a harmless area or into an energy trap. Damage due to back reflections is not covered by any *EKSPLA* warranty.

4.6. Safety Interlock

The laser cover is equipped with an interlock, which prevents the laser from operating with the cover removed.

Means are provided to defeat the laser power supply interlocks for maintenance operations. Only qualified service personnel should operate the laser with the interlock defeated. There is the danger of electrical shock, skin and eye injury, which may result in permanent blindness.

4.7. External Interlock Connector

External interlock ability is provided through the COOLING INTERLOCK socket on the rear of the *PS8000 Series* power supply. A shorting plug is supplied if operation without the remote interlock is required. However, regional safety standards often require the use of a remote interlock.

4.8. Key Control

The laser cannot be operated until the key switch on power supply is in *ON* position. Removal of the key prevents operation of the laser.

Switching the key switch to *OFF* position cuts the power from all laser modules and units except crystal and laser frame heaters.

In case mains power is connected after the key switch is set to *ON* position, laser will not operate. Turn the key switch to *OFF* and again to *ON* position to get the laser to working state. The same will be needed if mains power dips for a short time.

4.9. Main Disconnect Switch

POWER switch located on the rear panel of the power supply can cut off power to the entire laser.

Main disconnect switch supplements laboratory switch or circuit-breaker but does not replace it, see regulations below.

Requirements according IEC 610010-1 (safety requirements for electrical equipment for measurement, control and laboratory use) p.6.11.2.1 (permanently connected equipment and multi-phase equipment) are following:

- a switch or circuit-breaker shall be included in the building installation;
- it shall be in close proximity to the laser and within easy reach of the operator;
- it shall be marked as the disconnecting device for the laser.

4.10. Electrical Safety

This section contains information and warnings that must be observed to keep the laser operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the safety precautions specified in this section.

4.10.1. Laser Head

- Electrical hazards

Pockels cell driver. Voltages may reach 3 kV and up, with current >2 mA. High voltages are present in the laser head when power is on and key is in ON position. Circuits with high voltage are closed by additional cover inside of the laser and are inaccessible in normal operation.

Flash lamp wiring. Voltages peaks up to 30 kV at ignition phase. Voltages, currents and stored energies may be lethal for human.

- Safety requirements

Flash lamp service procedures may be started only after the laser has been fully de-energized.

4.10.2. Power Supply

- Electrical hazards

Voltages, currents:

- Mains circuits up to 400 V AC 50/60 Hz.
- Flash lamp power supply ignition pulses up to 30 kV.
- Flash lamp power supply discharge pulse up to 2 kV and peak currents up 1000 A.
- Flash lamp power supply simmer free running voltage 1200 V DC, current >100 mA.

Stored energies. High energy capacitors are used to store energies up to 100 J at voltage 2000 kV. Storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected. Power supply needs 2 min at least to bleed charge to the safe level.

Cooling water spills on power circuits. Proximity of water and high voltage circuits create isolation breakdown risk.

- Safety requirements

Equipment is designed to be grounded through mains power ground connection and does not have a separate ground terminal. Ensure that mains power connection provides an adequate grounding.

Any interruption of the protective conductor inside or outside of the cabinet/power supply unit, or disconnection of the safety ground terminal creates a hazardous situation.

The Laser can only be placed in a complete power off state by setting laboratory switch/circuit-breaker to off position.

4.11. Safety Guide

1. Set up controlled access areas for laser operation.
2. Limit access to the laser to personnel whose presence is not necessary.
3. Never look directly into the laser beam.
4. Survey the area where the laser beam traverses and block all unnecessary specular reflections and scattering.
5. Terminate the laser beam.
6. Avoid blocking the output beams or their reflections with any part of your body.
7. Operate the laser at the lowest beam intensity possible for a given application.
8. Wear safety goggles; choose a model consistent with use conditions and visual function required.
9. Expand the laser beam whenever possible to reduce beam intensity.
10. Absorb secondary reflections with energy-absorbing filters.
11. Work in high ambient illumination when possible. This keeps the eye's pupil constricted, thus reducing the possibility of eye damage.
12. Place any external optical components with a flat or negative curved surface looking toward the laser, so that reflections are not focused back or are directed into an energy trap.
13. Double check that the laser is turned off. Use a positive check method such as an IR card or energy detector.

14. Follow the instructions in this manual.
15. Unplug the laser power cord and short internal components when working on the power supply.
16. Only attempt electrical service if you are experienced in high voltage/current circuits and understand the circuitry and related hazards.
17. Be especially careful when working with IR or UV radiation. Although you cannot see it, this radiation can focus on the retina and cause damage.
18. Never look directly into the end of a connected fiber optic cable when the laser is in operation.

This page is intentionally left blank

5.1. Main Functional Parts

The laser system is comprised of following functional parts:

- Pump laser NL230;
- Tunable parametric stage.

Optical layout of the system is presented in Figure 7.

5.2. Pump Laser NL230

The laser head contains the laser cavity and Pockels cell driver with HV power supply. The laser cavity body is machined from a single aluminium alloy piece, to ensure stable rugged operation. The body of the laser cavity is bolted to the laser head base plate and sheltered by the cover.

The laser cavity assembly includes the laser pumping chamber, cavity mirrors, Q-switch, thin-film polarizers and Q-switch electronics. The compact laser pumping head employs six water-cooled laser diode bars arranged radially around Nd:YAG laser rod. It ensures excellent gain uniformity and lasing performance.

The protective cover on the laser head is interlocked, i.e. the laser stops operating when the cover is open.

> ***Attention:***
> ***Remember that this laser is a complex product requiring a certain personnel experience to perform the service adequately, we highly recommend calling for EKSPLA assistance at laser installation (or an assistance of authorised serviceperson).***

The power supply unit contains the necessary components to power-up and cool the laser heads. It is directly connected to the mains power supply

The umbilical connecting the laser head to the power supply contains cooling water tubes, laser diode power cables, Q-switch triggering and power cables and safety interlock line.

5.2.1. Generation of Optical Pulses

The laser operates in the regime of resonator quality modulation (also referred to as resonator loss modulation). The geometry is an unstable resonator comprising of a concave rear mirror RM (99% reflection) and a convex output coupler OC – variable reflectivity mirror. Divergence of the output beam depends on the radius of curvature of the rear mirror and the thermo-induced lens in the laser rod. Thermo-induced lensing is proportional to pump power. Therefore, in order to get a near diffraction-limited output beam, the pumping level must not change from the level preset at the factory.

The Pockels cell PC together with a proprietary driver induces considerable steady losses in the resonator. While PC voltage is present, generation is not possible (Q-switch is closed). When a high voltage pulse with opposite polarity is applied to PC, losses in the resonator get minimised and laser pulse is generated (Q-switch is opened). Laser timing diagrams are presented in Figure 6.

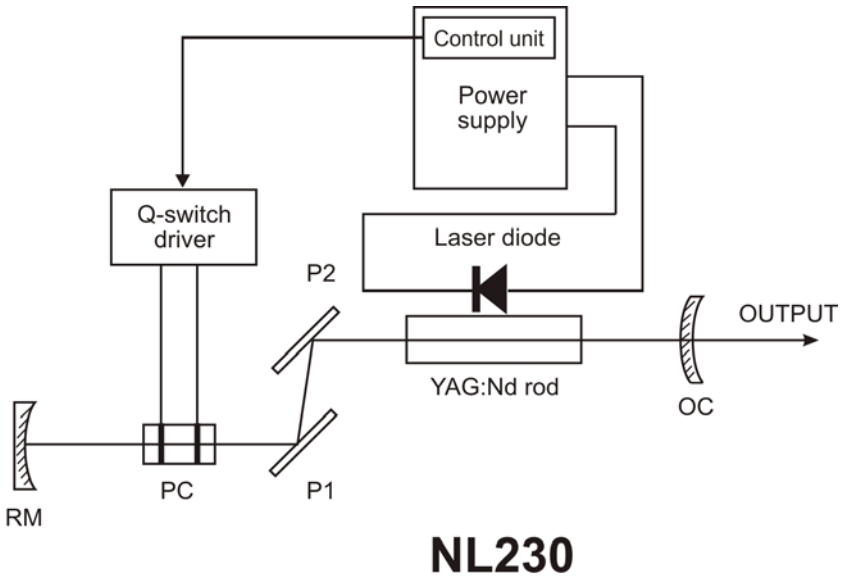


Figure 5 Optical/electrical scheme of NL230 series laser head

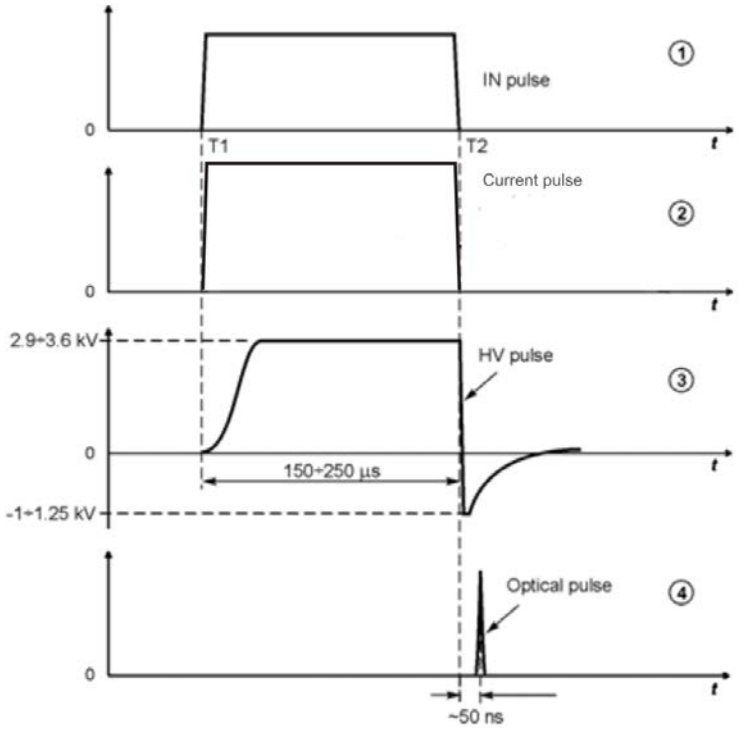


Figure 6 NL230 timing charts

The external triggering pulse applied to the input IN (chart ①) or triggering pulse generated by the internal control unit at T_1 starts the LD supply current pulse (chart ②) and closes the Q-switch (chart ③), inducing high resonator losses. The Q–switch remains closed until maximum inversion in the Nd: YAG rod is achieved. At this moment the Q–

switch opens (chart ③), losses in the resonator are minimized, and a very short and powerful optical pulse is generated (chart ④).

The delay between firing the LD pump pulse and opening the Q–switch is adjusted at the factory for each individual laser.

5.3. Tunable Parametric Stage

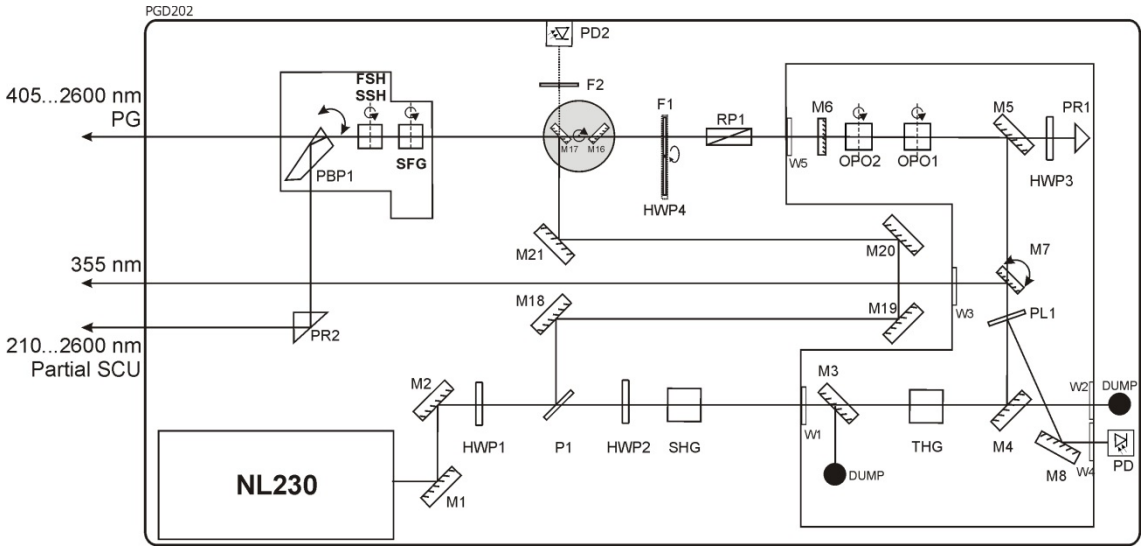


Figure 7 Optical layout of the NT230-100-SH-SF laser system

Tunable Nd:YAG Laser System comprises of the pump laser *NL230*, harmonics generators (SHG, THG), optical parametric oscillator (OPO), second harmonic generators from the OPO signal (FSH, SSH), sum frequency generator (SF) and spectra cleaning unit (SCU), all connected in a single device.

The optical layout of the *NT230* system is presented in Figure 7.

The 1064 nm radiation from the NL230 laser is directed towards the harmonic crystals SHG and THG by mirrors M1 & M2. Harmonic crystals convert the fundamental radiation to 532 and 355 nm. A motorized mirror M7 directs the 355 nm radiation to its own output. The motorized mirror M11, together with M12, direct the 532 nm to the output. Motorized mirror M13 directs the 1064 nm radiation towards an output.

The optical parametric oscillator is a solid state continuously tuneable source of visible and near IR radiation. Based on type II BBO nonlinear crystals, the *OPO* covers 405–2600 nm wavelengths with up to 15% conversion efficiency when pumped by third harmonic of a pulsed Nd:YAG laser. The pumping beam is directed by dichroic mirrors to the *OPO* cavity. The *OPO* resonator consists of mirror M6 and prism PR1. Wavelength tuning is achieved by rotation of nonlinear crystals OPO1 and OPO2. Part of 405-2600 nm wavelengths energy is emitted through the mirror M6 towards the output.

Signal and idler waves are separated by the Rochon prism RP1.

FSH, SSH and SFG are type I BBO crystals. Sum frequency generation is achieved by combining the fundamental radiation from NL230 (directed by polarizer P1) and the

output of the OPO. It covers the 300 – 404.95nm wavelength range. . FSH and SSH crystals generate the second harmonic from the OPO signal and cover the 210 – 299.95 nm wavelength range.

BBO crystals are highly hygroscopic. To prevent condensation they must constantly be maintained at an elevated temperature.

Attention:
Do not unplug the power supply from mains! Leave it connected, when your work is over and you switch off the device. The green LED on the front of power supply must remain lighting, what indicates that crystal heaters are on.

5.4. Second Harmonic and Sum Frequency Generation

FSH, SSH and SFG are type I BBO crystals. Sum frequency generation is achieved by combining the fundamental radiation from NL230 (directed by polarizer P1 and mirrors M18…M21) and the output of the OPO. It covers the 300…404.95 nm wavelength range. FSH and SSH crystals generate the second harmonic from the OPO signal and cover the 210…299.95 nm wavelength range.

BBO crystals are highly hygroscopic. To prevent condensation they must constantly be maintained at an elevated temperature.

Attention:
Do not unplug the power supply from mains! Leave it connected, when your work is over and you switch off the device. The green LED on the front of power supply must remain lighting, what indicates that crystal heaters are on.

5.5. Spectra Cleaning unit

The spectra cleaning unit (Pelin-Broca prisms PBP1) cleans the spectrum, prism PR2 directs the cleaned radiation towards a separate output. OPO signal and idler can be used in two different regimes – “Direct” and “Partial SCU” (partial cleaned spectrum, but more energy).

Chapter 6 INSTALLATION AND SET-UP

This chapter provides information about connecting and configuring the *NT230* series system.

Be aware that this laser product is complex and requires qualified personnel with experience to perform adequate product service. *EKSPLA* highly recommends contacting *EKSPLA* customer service, or a qualified service person, for assistance at laser installation. For the end user procedures in this chapter are given for reference only.

> ***You should not attempt to start up the laser prior to installation by EKSPLA authorized personnel. Damage due to usage before proper installation is not covered by the EKSPLA warranty.***

6.1. General Requirements

Laser operation is optimal in a temperature-stabilized environment. Ideally, operate the laser in an air-conditioned room, provided that the laser is placed away from air conditioning outlets.

Position the laser on a solid worktable with access to the laser from all sides. The place for power supply cabinet/unit must be provided as well within the length of connecting cables and ensuring easy access.

For air-water cooled system the cooling unit must be installed in a way that a sufficient air circulation can be maintained. Ensure that the air inlet and outlets are completely unrestricted during later operation. A restriction of the air flow will have an adverse effect on the cooling capacity of the unit.

The actual line power required is specified in the laser technical protocol and on the equipment labelling. The equipment must be operated only from the line power stated; these supply specifications cannot be ignored or changed.

6.2. Environmental Conditions

See 3.5 Environmental Conditions.

6.3. System Layout

The system consists of the laser head, connected by control cables and coolant hoses to the power supply and cooling unit (see Figure 8).

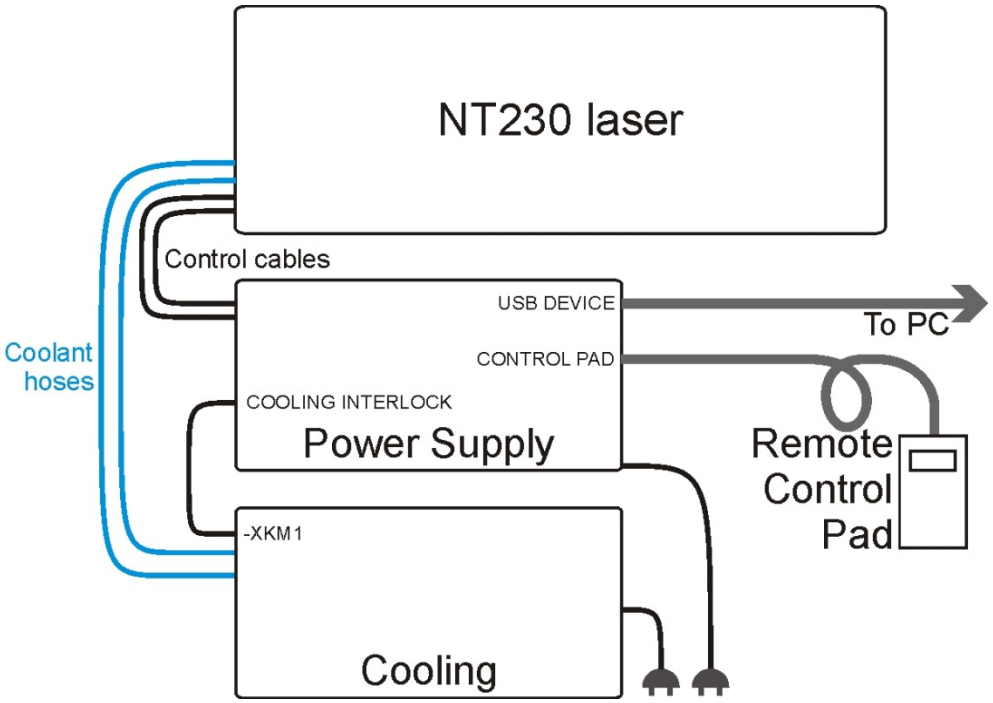


Figure 8 Layout of the system

6.4. Laser Installation Procedure

1. Inspect the shipping container for damage related to transportation. If any damage is present, inform EKSPLA and the transportation agency.
2. To avoid condensation forming after bringing the shipping container from the cold storage or transportation site, allow the box to warm up to room temperature (approx. 3…4 hours) before opening it.
3. Unpack and inspect contents for exterior damage related to transportation. If any damage is present, inform EKSPLA and the transportation agency.
4. Fix the laser to the optical table. Place the power supply and cooling unit adjacent to the laser.
5. Study the separate cooling unit manual and prepare it for operation.
6. Interconnect the laser with the power supply and cooling unit by connecting the cables as marked.
7. Interconnect the cooling unit with the PS8000 series power supply by the interlock cable.
8. Before installing the OPO part, install the NL230 laser and examine the 1064 nm pump beam for meeting the requirements.
9. Remove protective Faraday isolator covers (if any). The covers prevent steel items from being attracted by the strong magnetic field. Put the protective covers back on before transportation and servicing, cleaning.

Warning!
Do not turn on the laser until Faraday isolator covers are removed.

10. Connect mains cables.
11. Run laser according to *Routine operation*.

This page is intentionally left blank

This chapter provides information about control interfaces and electrical connections of the system.

Caution
Use of controls and adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

7.1. General Description

Laser system control is provided by using a remote control pad, from PC software, and the RS232 connection.

External synchronization control from user input signals is available using connectors on the power supply.

7.2. PS8000 Series Power Supply

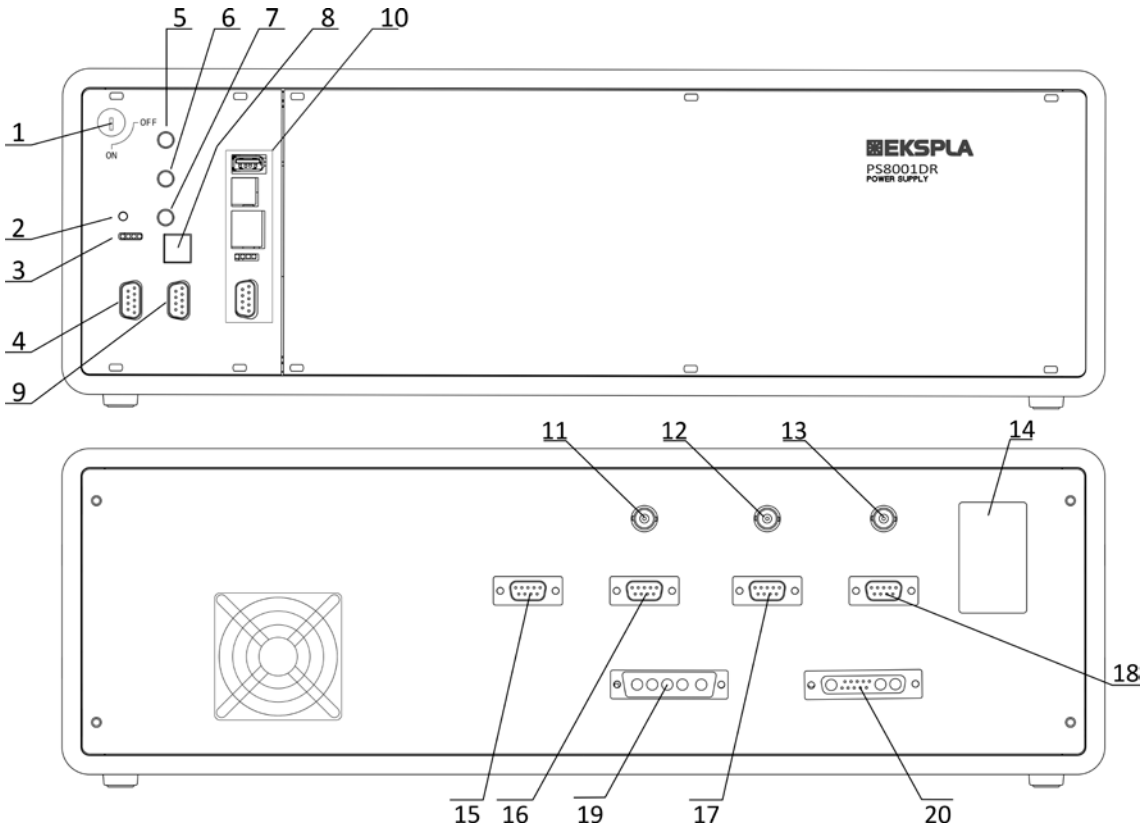


Figure 9 Front and rear panels of the power supply

7.2.1. Front Panel

Table 6 Power supply front panel connections

#	Control/connection	Description
1	Key switch	The laser cannot be operated until the key switch on control panel is in the OFF position. Removal of the key prevents operation of the laser.
2	EMISSION indicator	*Emission ready* indicator.
3	POWER, STANDBY, KEY, INTERLOCK indicators	**PWR** Red LED. Power is being supplied to laser electronics circuits. Key needs to be in ON position. **STB** Green LED. Standby power is provided. **KEY** Yellow LED. Always on. **INT** Blue LED. Always on.
4	CONTROL PAD (DB9F)	Alternative port for control pad connection.
5	SYNC OUT (SMA)	Internally generated sync pulse, adjustable in 1us steps from 50us to 20ms with respect to SYNC IN pulse. Jitter is 125ns pk-pk. SYNC IN position with respect to optical pulse depends on amplification level and is within -1000..-200us.
6	SYNC IN (SMA)	Laser diode driver synchronization input. Should be used in conjunction with **QSW IN** if low jitter is required.
7	QSW IN (SMA)	External synchronization input. Pulse is sent to q-switch driver. Should be used in conjunction with **SYNC IN**.
8	USB connector	Not used, please use USB connector shown in #10. USB device connector, laser remote control function.
9	RS232 connector (DB9M)	Alternative for laser remote control function; requires RS232 – USB adapter, can use longer cable than USB connection.
10	CONVERTER	See separate manual.

7.2.2. Rear Panel

Table 7 Power supply rear panel connections

#	Control/connection	Description
11	SYNC IN, BNC	Laser diode driver sync input.
12	ANALOG OUT, BNC	Laser diode driver current sensor output. 1V=40A
13	EMISSION socket, BNC	Emission indicator circuit.
14	POWER switch, fuse, mains socket	
15	COOLING INTERLOCK	Interlock connection for an external cooling device, such as a chiller. Interconnect the external cooling device and the power supply with the supplied cable.
16	LD ON plug, DB9M	Protection and feedback circuits for laser diode head.
17	EXT1 socket, DB9F	Not required to use.
18	EXT2 socket, DB9F	Not required to use.
19	LASER socket, D-SUB 13W3 F	DC power, safety circuits and CAN bus connection.
20	LD socket, D-SUB 5W5	Laser diode driver output.
-	GROUND connector	Located below the power socket, provides an additional ground connection.

7.3. Laser Controls

The following connections and controls are accessible on the laser:

7.3.1. Laser Head Rear Panel

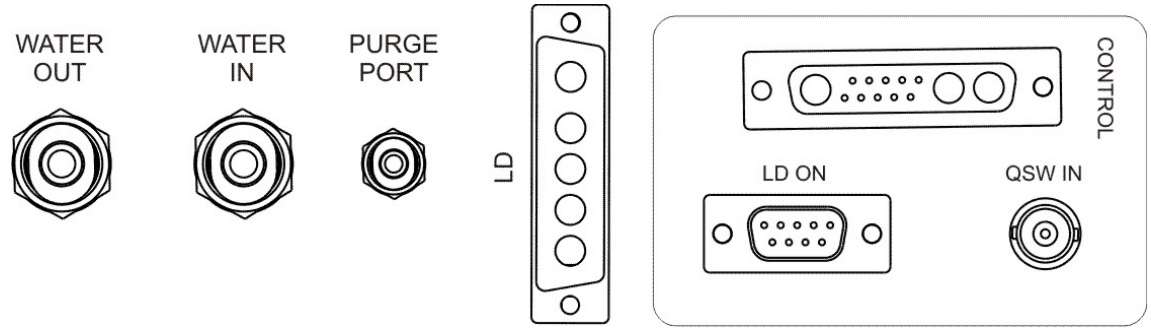


Figure 10 Laser head rear panel connections

Table 8 Laser head rear panel connections

Connection	***Description***
WATER OUT fitting	Used coolant from laser head. Accepts ∅10 mm tubes.
WATER IN fitting	To the laser head. Accepts ∅10 mm tubes.
PURGE PORT	Not used. Reserved for gas generator input.
LD socket	Laser diode driver input.
CONTROL connector	DC power, safety circuits and CAN bus connection.
LD ON connector	Protection and feedback circuits for laser diode head.
QSW IN connector	Signal for Pockels cell driver.

7.3.2. Emission Indicator

Emission indicator lamp is located on the top of the frame (or on the side containing output apertures) close to the output apertures. It illuminates when laser emission is about to occur. Amber light is used so that it is visible when the proper type of safety glasses is used.

7.4. Control Pad

7.4.1. General Description and Connection

- **Description**

The remote control pad is wire-connected to the system and provides access to most important functions, like:

- *START/STOP* optical pulsing

- Adjust and check the laser output pulse energy
- Set *INTERNAL/EXTERNAL* triggering mode
- Control the output wavelength of parametric generator, and others.

The set of provided functions is specific for every system; see 7.5.2 Menu System Menu System for the full description of provided functions.

In systems consisting of an EKSPLA laser and optical parametric generator (either as separate devices or combined into one) typically the same remote control pad is used to control both. To switch the controlled device, press and hold *ESC* button for >2 sec.

The laser control window will appear after switching on the power.

> *Note:*
> *Typically the control pad will have both software packages (for the laser and parametric generator) installed. If the other type of device is not actually present, its' control window will appear empty.*

- **Connection**

To enable the control pad, it must be connected before turning on the system, otherwise the power sequence fault will occur. The connector for the control pad typically is connector *REMOTE CONTROL* on the front panel of *PS5062* power supply (see Figure 9).

- **Layout and Buttons**

Figure 11 shows the control pad. The pad contains eleven buttons and an alphanumeric display.

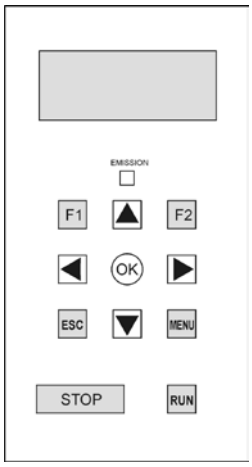


Figure 11 Remote control pad

An indicator *EMISSION* on the control pad indicates that emission is about to occur.

Button functions:

- buttons *RUN* and *STOP* are used to start and stop laser firing.
- *MENU* button invokes menu tree from the main window view.

- *ESC* button - when in a menu system, pressing *ESC* button will return one menu level back; when being at a root level, the pad switches from menu to main window view; see also 7.5.1 Main Window, Customizing the main window.
- *OK* button selects a menu option in menu tree.
- buttons *UP* (▲) and *DOWN* (▼) when in menu mode move through menu options; in an input fields of the main window they increment/decrement numerical values (see also below). Menu options followed by *OK* sign in Figure 14 are activated by further pressing *OK* button; lowest level menu options not noted by this sign are activated by simply selecting them (like *E Max-E Adj-E OFF*).
- buttons *RIGHT* (►) and *LEFT* (◄) select fields in a main window; in numerical input fields they can be used to move a cursor to select a digit.

In numerical input fields *UP* and *DOWN* buttons increment/decrement the value by 1; press and hold the button for a faster change. Use a digit method when dealing with big values – position the cursor using buttons *RIGHT* (►) and *LEFT* (◄) under the digit in question and change it.

Functional keys F1 and F2 are context sensitive. In parameter input windows they serve as shortcuts for *WATCH* and *STORE* commands respectively; if those actions are available for specific parameter, name of the action will be displayed as negative inverted caption in a lower left or right part of the screen respectively.

Some menu options have attached event procedure; when parameters associated with these options are put into special fields D1 and D2 of the main window (see 7.5.1 Main Window), the field is displayed inverted and an attached the procedure can be executed by pressing buttons *F1* or *F2* for D1 and D2 respectively. Procedure actions, when available, are described in 7.5.2 Menu System.

7.5. Laser Control from Control Pad

7.5.1. Main Window

Laser control main window is displayed on the control pad after switching the power by default. To return to the main window display from menu, press *ESC* repeatedly until main window appears.

- **Layout**

Layout of the main window is shown in Figure 12.

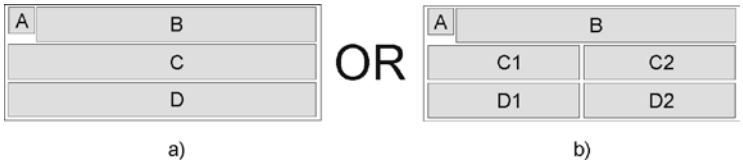


Figure 12 Main window of the control pad

The main window is divided into fields A, B, C and D (see Figure 12). Fields C and D can be further divided into short fields C1/C2 and D1/D2. Long fields B, C and D are suited to display the information that requires the presentation to be not concise. Using layout

with short fields allows displaying more parameters at once. This configuration is fully customizable by a user, as well as the contents of the fields.

Navigation between the fields is done by pressing keys ◄/► and goes cyclically in the following order: *hidden-B-C-C1-C2-D-D1-D2-hidden*. Selected field is indicated by a solid border. *Hidden* field is used to hide the cursor.

Field A is a laser status symbol field. The following symbols may be displayed:


Laser operation is stopped and it is not ready for operation.


Laser operation is stopped but it is ready for operation.


Laser is operating but not firing, because something is switched off, i.e. quality switch.


Laser is firing.


An error occurred.

- **Customizing the main window**

To assign a parameter/action to the field on the main window:

- select the field;
- press *MENU* button, navigate to the needed option, press *OK*;
- if the parameter/action can be put on the main window, *WATCH* caption will appear. Press *F1*.
- Press *ESC* repeatedly until main window appears. The selected parameter/action is displayed in the selected field.

To divide the long field C or D into short fields, select the short field C1/C2 (D1/D2) and assign the parameter/action to it. Any parameter or action previously assigned to the long field will be removed and newly assigned parameter/action will be displayed in a selected short field.

Similarly, to concatenate the short fields, select the long field and assign parameter/action to it. Parameters or actions previously assigned to the short fields will be removed from layout.

Save the layout for future use using *Display layout-> Save layout* menu option.

7.5.2. Menu System

Menu tree is invoked by pressing the *MENU* button. Navigate through the menu tree using buttons ▲ and ▼; select the option by pressing *OK*.

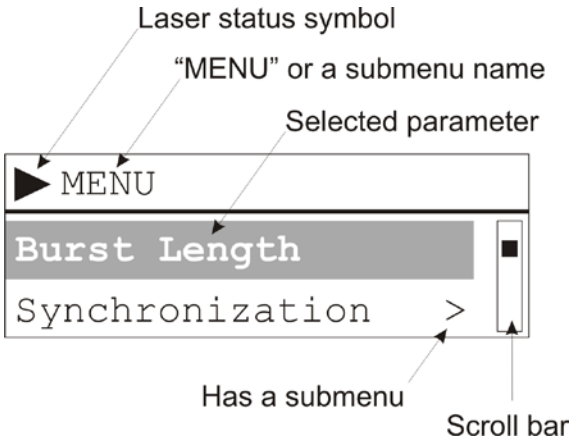


Figure 13 Navigating the menu

The menu tree is shown on Figure 14 below.

Table 9 Menu tree

#	*Control/connection*	*Description*
1	PD1	Not used.
2	PD2	Not used.
3	Energy level	Max – maximum, Adj – adjustment mode with reduced energy, Off – Pockels cell is locked, no generation.
4	Burst mode	Allows switching between normal operation and burst operation mode. To release a burst, select *Burst Mode*, press “OK”, then select *Burst trig* and press button ▲. For another burst, press ▲ again. To switch back to continuous operation, select Normal mode and press OK.
5	Burst length	Determines the number of pulses to be released in a burst mode.
6	IIH temperature	Read the SHG crystal temperature; sets the needed temperature.
7	IIIH temperature	Read the THG crystal temperature; sets the needed temperature.
8	Synchronization	Switching between internal/external synchronization modes. Changing the repetition rate is possible within factory pre-set limits only (specific for each device); setting it outside those limits will have no effect.
9	Display layout	Modifying and saving the layout of a main window.

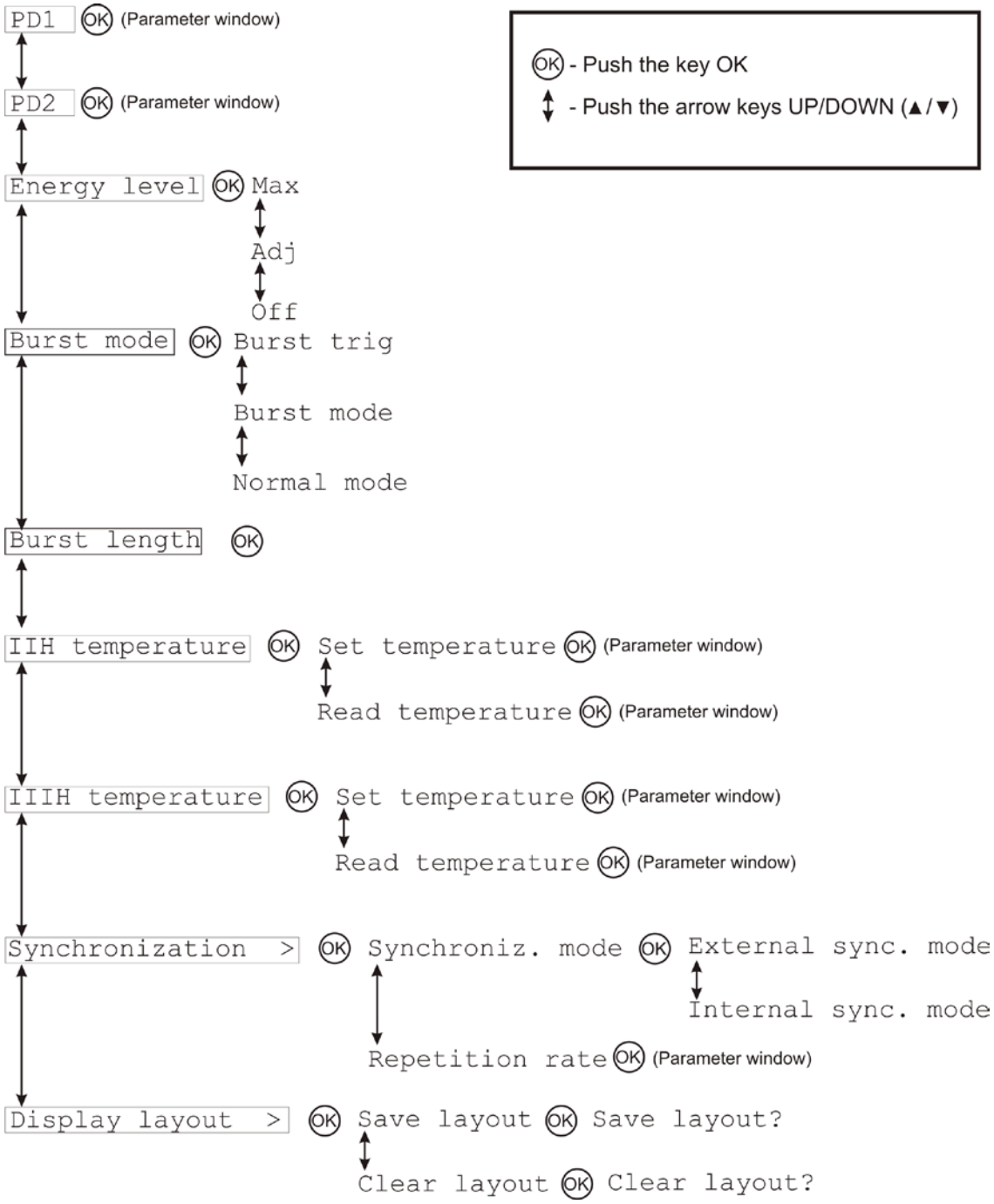


Figure 14 Menu tree

7.5.3. Setting and Editing the Parameters

Many parameters can be edited and set after selecting them through menu or main window. Pick an option using buttons ▲ and ▼ if the parameter has a choice, or edit its' numerical value.

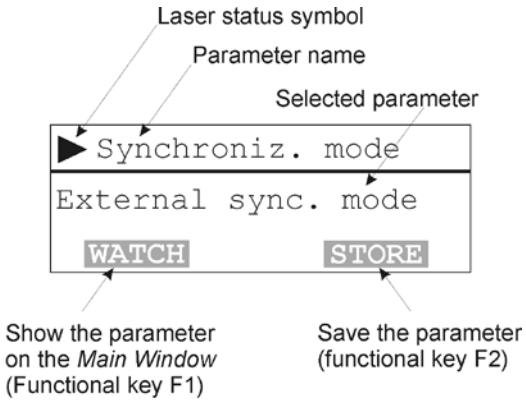


Figure 15 Setting the parameter

If a parameter or actions are available to be put in the field of the main window, *WATCH* caption will be shown. Press *F1* to activate it and put it as a content of currently selected field in a main window.

Press *F2* to *STORE* the value of the parameter into NVRAM; otherwise the changes in values will be valid for current session only.

7.5.1. Factory Setup of the Main Window

The laser is shipped in the following factory recommended configuration of the main window:

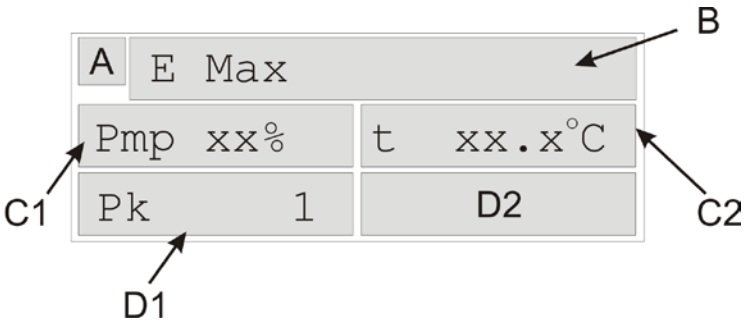


Figure 16 Factory setup of the main window

Field B – energy level - *Max*, *Adj*, or *Off*.

Field C1 – pump voltage in % of nominal value.

Field C2 – set the cooling temperature.

Field D1 – burst length. Attached event procedure: pressing *F1* sets the firing mode to *Burst* and triggers the burst of length defined by a *Burst length* value. Laser remains in a *Burst* mode after this.

Field D2 – not used in factory setup.

7.6. Parametric Control from Control Pad

7.6.1. Home Window (Setting the Wavelength)

After power is switched on, the device performs self-testing and initial *Power On* sequence. When initialization successfully completes, the device sets the wavelength to the last value set by control pad (before the power was switched off) and awaits the further commands.

To switch from laser control to parametric control, press and hold *ESC* button for >2 sec.

The display shows:

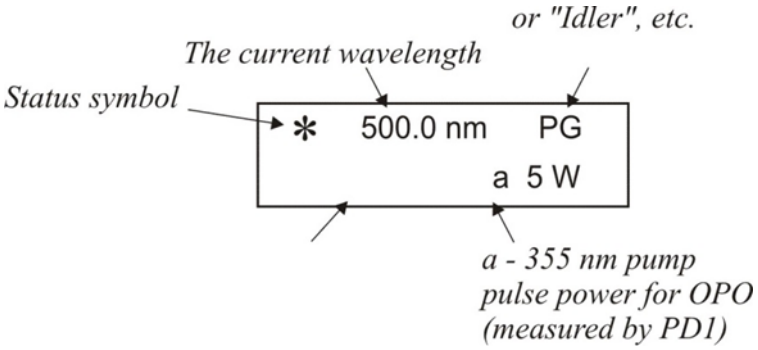


Figure 17 Home window of parametric control

Status symbols:

✻ – Stepper motors of the nonlinear crystals are in the proper positions.

⌛ – The nonlinear crystals are tuned by stepper motors.

► – Wavelength value to be set is being edited.

! – Stepper motors are not in the proper positions or not connected.

The wavelength is adjustable by buttons ▲ and ▼. You can change individual digits: after you press either of buttons ◄ or ►, a cursor will appear, and you will be able to change the digit under the cursor by buttons ▲ and ▼. After the required number has been entered, push the button OK, and the device will set to that wavelength.

To switch to 1064 nm output, set the wavelength to 1 nm. Please note that setting this wavelength is only possible if OPO1 is set in UniPG.

To switch to 355 nm output, set the wavelength to 3 nm.

Display shows an average power of the last 10 3H pulses. The energy meter receives signals from energy monitor. If there is no signal, the averaged power value of the 10 last detected pulses is repeated.

If the energy meter detects a pulse exceeding the maximum allowed value a message '*E lim*' is displayed together with a warning beep. After the power is reduced to the level allowed, push any button to proceed.

7.6.2. MENU button

There is no menu tree in parametric control mode. Instead of that, *Menu* button cycles through additional control windows (optional, depends on a specific device).

7.6.3. Switching Outputs with Pellin-Broca Prism (Optional)

To switch between outputs with cleaned full range spectra and not cleaned high energy idler (see Chapter 5) press *MENU* button until following window appears:

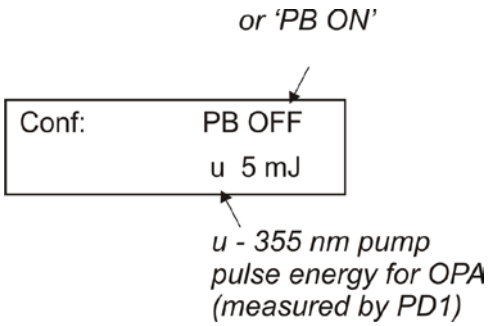


Figure 18 Pellin-Broca prism control window

Select the needed option using buttons ▲ and ▼ and press OK. *PB ON* option provides full range cleaned spectra output; *PB OFF* – not cleaned idler output of higher energy.

7.7. Control from PC

7.7.1. Connecting the PC

To control the system from PC, the PC must be connected to the CAN bus. Typically, the connection is made to connector *RS232* on the power supply front panel.

Some devices may be more specific about connection.

7.7.2. CANBrowser

Ekspla products are organized as a set of modules hooked on a single serial bus – CAN bus. Control of the system is performed by reading and editing various parameters stored in registers of those modules.

Proprietary *CANBrowser* software is used to get a full access to registers on a CAN bus. It is intended mainly as a diagnostic tool for system adjustment and service; routine control is more convenient using a remote control pad or *Remote Control Application*.

CANBrowser is supplied on a software CD attached to the system. Please see *Readme* files about installation and more general information.

After launching the application, *CANBrowser* main window is shown (see Figure 19). After launching application for the first time, choose menu option *Options* and in a new window pick a connection type corresponding to the one implemented in a specific device.

Note:

> *In NT230 series devices the default connection type is RS232 to USB. To use that, a COM port must be properly configured on a PC. To set up a computer COM port, pick the lowest available COM port in Device manager (most likely the COM1 port) and set the bit rate to 19200.*

Pick menu option *Connect* to connect to the modules; choose *Load All* to connect to all modules. Modules in the system and their registers will be shown in a tree view in area *(1)*. Expand the view to see the registers of a specific module by clicking on a + sign.

> *Note:*
> *End user has an access to a limited set of registers only. Full access requires a password and is available for service personnel.*

Double-click the selected register for its value to be indicated in edit area *(2)*. Value will be greyed out if it is read-only. If it can be changed, graphical *Enter* button will appear; edit the value in the field and press the button to set it. This sets the value for current session only (until the power off). For registers, which values can be saved into NV memory and be used in the next session, the *Program* button will also appear.

To monitor more values at once, right-click the register in a tree, and choose *Watch*; register name and value will appear in a watch area *(3)*. Values can't be edited in this area.

> *Note:*
> *Setup of watch and edit areas is valid for the current session only, it is not saved at the exit.*

System messages, including error messages, appear in message area *(4)* at the bottom part of the window.

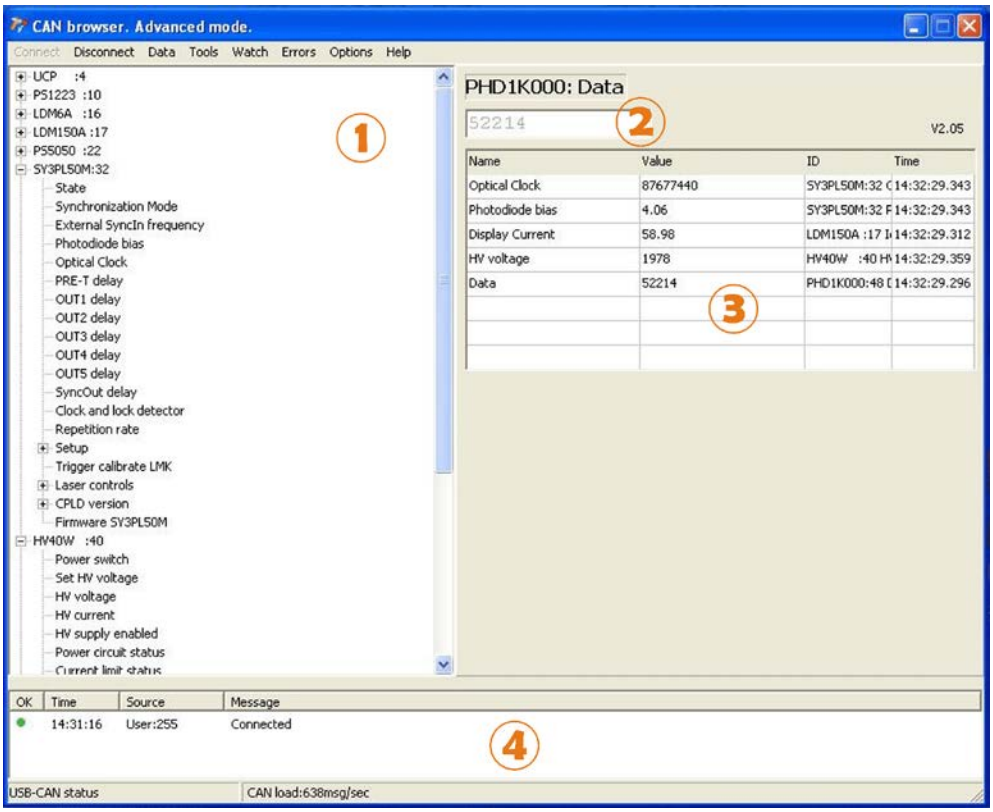


Figure 19 CANBrowser main window. 1 – Tree view of modules in a system; 2- edit area; 3- watch area; 4- message area. Generic view is shown here; in general, each device may have different setup of modules and their displayed registers.

7.7.3. Remote Control Application

Remote Control Application is a software tool intended for day-to-day routine operation control, an alternative for remote control pad.

Remote Control Application is supplied on a software CD attached to the system. To install, go to folder *CAN network \Control panel applications*; copy folder content to your hard disk.

Run *ControlPanel.exe*. After launching application for the first time, choose menu option *Options* and in a new window pick a connection type corresponding to the one implemented in a specific device.

Pick menu option *Connect* to connect to the modules.

Layout and functions of application's main window (see Figure 20):

1. Watch area for monitoring parameters. Each device may have its own specific set of parameters displayed in this area; this set is configured at the factory. Values in this area can't be edited.

2. Energy meter graph; monitors the readings of photodiode.

3. *Start* and *Stop* buttons; they correspond to *RUN* and *Stop* buttons on a control pad.

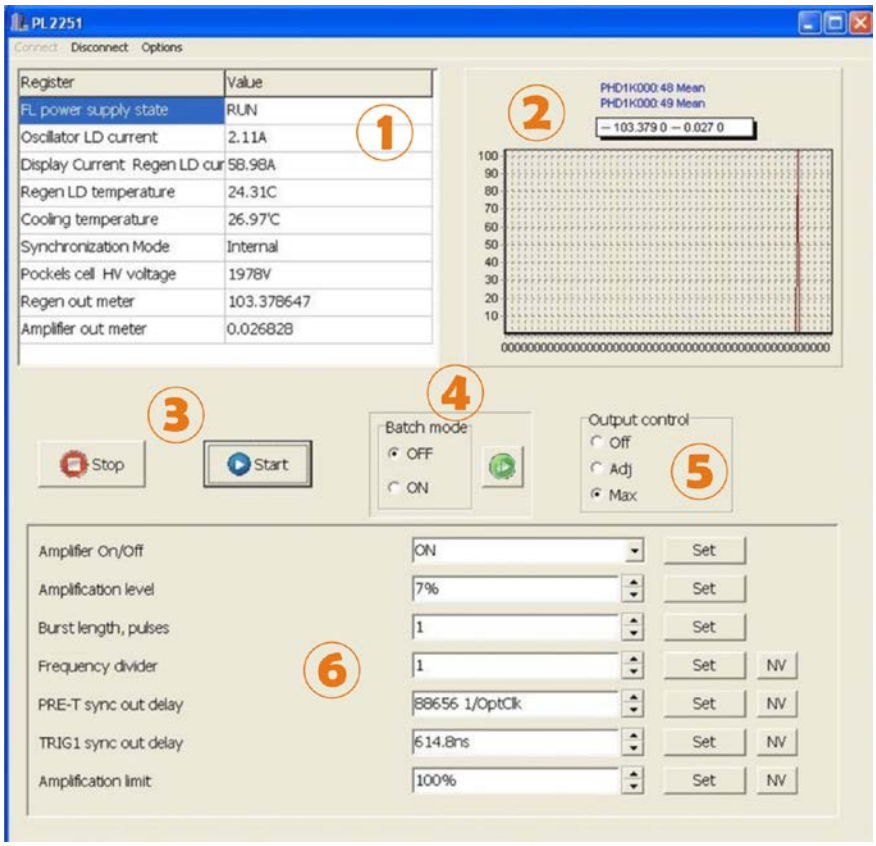


Figure 20 Remote Control Application main window. Generic view; in general, each device may have different set of displayed registers and controls.

4. Switching to *Burst* mode and back (please note, here it is called *Batch mode*). Pressing the green button activates burst trigger. Burst length is set in the control area (6).

5. Output control. Corresponds to *Output level* control on a remote control pad.

6. Control area. Each device may have its own specific set of parameters available to control in this area; this set is configured at the factory. To change the value, edit it in the input field. Press *Set* to save the changed value for current session only; to make changes permanent, press *NV*.

7.7.4. Parametric Control from UniPG Software

Note:
UniPG software control is intended to use for adjustment purposes only; although it is possible to perform routine control, i.e. changing wavelength, using UniPG, the remote control pad or Remote Control Application are intended to use and are more convenient for day-to-day operations instead.

While UniPG driver is connected, the control pad is locked and displays 'PC MODE'. When exiting the UniPG software, press Disconnect, then confirm the restart in a pop-up window. Control pad will continue to stay locked if this procedure is not followed.

Positions of designated optical elements in parametric stage are controlled through *UniPG* software interface. Using this tool, it is possible to perform corrections of

factory pre-set positions, in particular, to adjust values stored in position vs. wavelength tables. Please refer to *UniPG* manual for general information about its use and interface.

All crystals are positioned according to the table(s) logged into the ROM during device manufacturing, and should not require later modifications. Unfortunately, optimum positions of the crystals depend upon many factors varying from one installation to another, or changing with time. For this reason pre-set values may be corrected when needed by using *UniPG*.

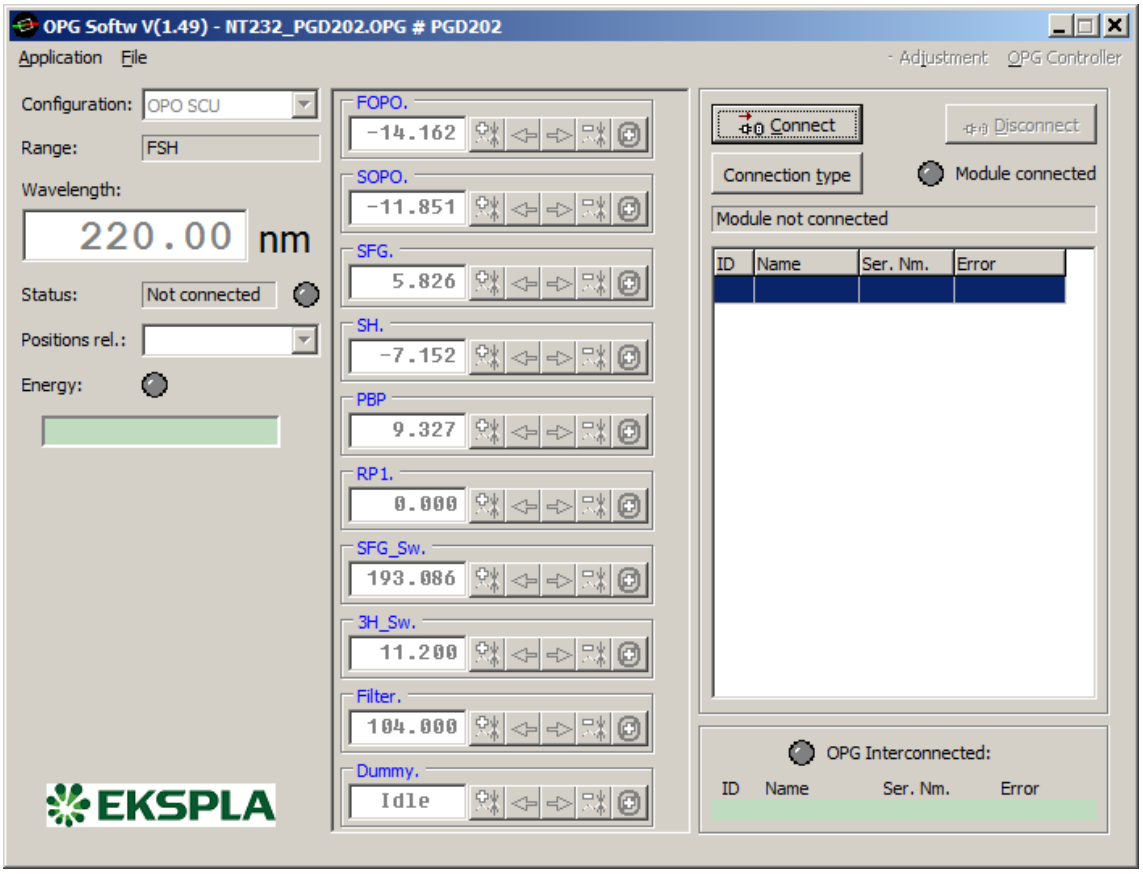


Figure 21 UniPG control interface

Motor controls at the set wavelength:

- *FOPO* – position of first OPO crystal.
- *SOPO* – position of second OPO crystal.
- *SFG* – position of the SFG crystal.
- *SH* – position of the FSH and SSH crystals.
- *PBP* – position of Pellin-Broca prism.
- *RP1* – position of Rochon prism RP1.
- *SFG_Sw.* – position of mirrors M16/M17.
- *3H_Sw.* - position of mirror M7.
- *Filter* - position of holder with filter F1/half-wave plate HWP4.
- *Dummy* – not used.

Note:
Do not forget to save changes: pick menu option OPG Controller-Program.

7.8. User Input and Output Signals

- SYNC IN SMA connector is used to externally trigger NL230 laser. The laser must be set in external trigger mode through control pad or remote control software. Input is sensitive to pulse rise. Input impedance is 50 ohm. Pulse parameters: pulse length 100ns...10us, voltage level 3.5...5V @ 50 ohm.
- QSW IN SMA connector allows the user to inject an external Q-switch trigger. This can be used to more accurately control firing of the laser and reduce timing jitter. Input is sensitive to pulse rise. Input impedance is 50 ohm. Pulse parameters: pulse length 100ns...10us, voltage level 3.5…5V @ 50 ohm.
- All modes of operation: adjustment, OFF, batch, frequency divider works while laser is externally triggered.
- QSW IN will not work as laser firing ON/OFF control for external single shooting or frequency dividing. This is because laser fires in any case QSW IN is present or not.
- Too high SYNC IN frequency is dangerous for the optics outside of the laser resonator. If the laser fires at greater rate than nominal, beam is starting to focus and optical damage will follow shortly. In order to prevent this, fire rate limiting is implemented. Laser pulse is skipped if SYNC IN will appear earlier than previous pulse period ends. This will lead to frequency division by a factor of 2. Pulse period is calculated using '*Repetition rate*' register setting. SYNC IN frequency should be slightly below '*Repetition rate*' setting. For 30 Hz '*Repetition rate*' setting use SYNC IN rate at 29.5Hz. If SYNC IN has fixed rate 30 Hz, set '*Repetition rate*' to 30.5 Hz.

7.8.1. External Synchronization Using Two Pulses

In this mode user provides two signals, SYNC IN and QSW IN. The value for delay between those pulses is calculated as:

SYNC IN–QSW IN delay = "SyncIN->Pulse delay" + "QSW MAX output delay"

where "*SyncIN->Pulse delay*" and "*QSW MAX output delay*" are factory set values and may be observed using *CANBrowser*. If the value of user pulses delay does not fall within ±5μs of predefined delay noted above, the laser will be forcefully triggered by internal pulse, causing a high jitter value (see the diagrams below).

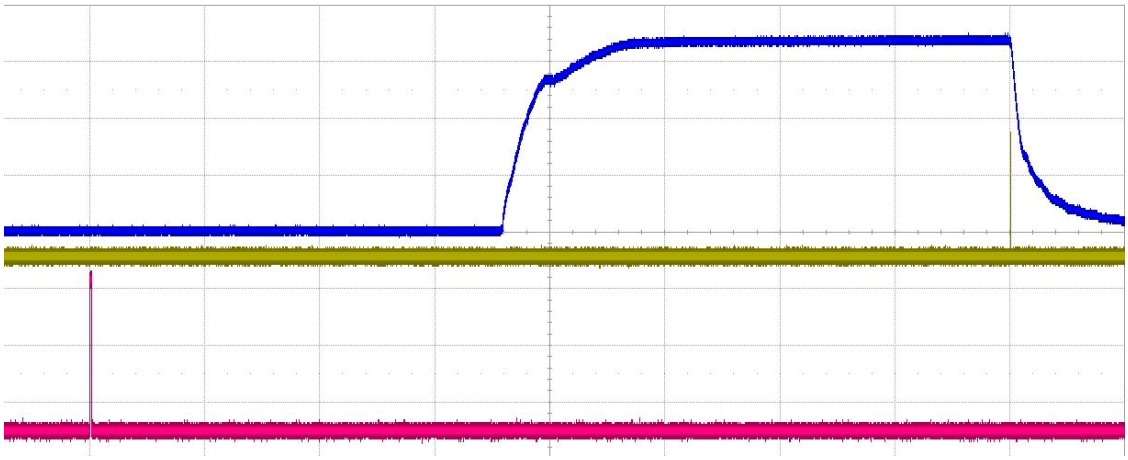


Figure Timing diagram, external synchronization
C1 channel (yellow) - laser output pulse,
C2 channel (red) - SYNC IN,
C3 channel (blue) - pump diode current.
C4 channel QSW IN is hidden in oscillogram.
Measurement is set to delay between SYNC IN and optical pulse.

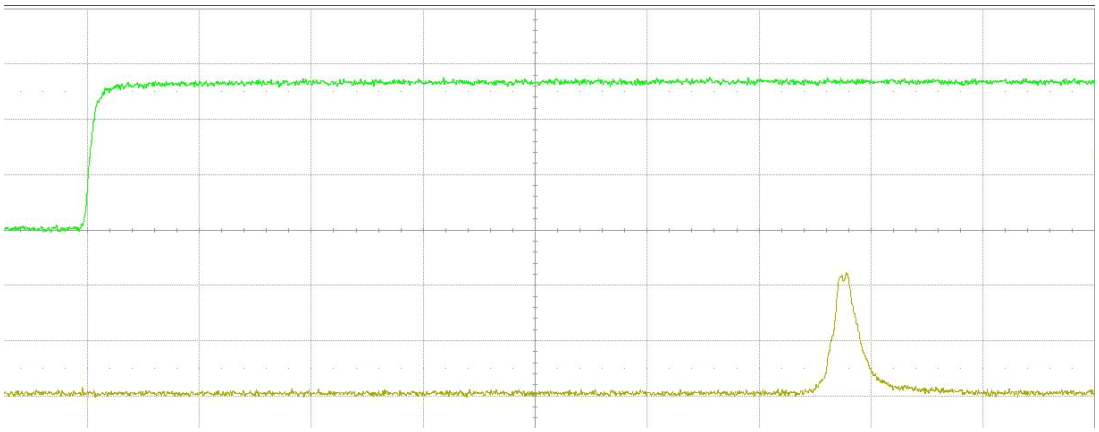


Figure Timing diagram, external synchronization, QSW IN and optical pulse
C1 channel (yellow) - laser output pulse,
C2 channel (red) - SYNC IN is hidden,
C4 channel (green) - QSW IN pulse.
Measurement is set to delay between QSW IN and optical pulse.
Measured jitter is 148.54ps and distribution is close to Gaussian.

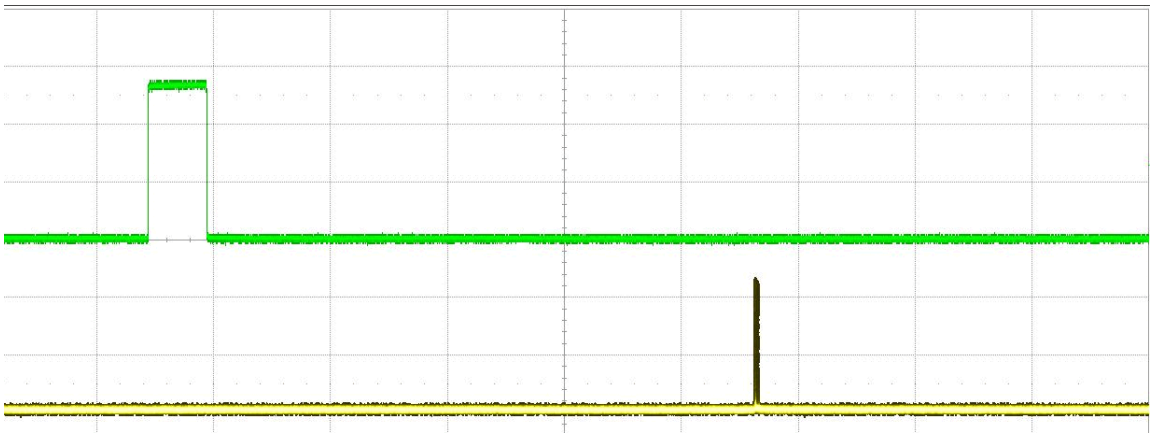


Figure Timing diagram, external synchronization, QSW IN and optical pulse.
Delay SYNC IN to QSW IN is just below 395μs and do not fall within limit of 400±5μs
C1 channel (yellow) - laser output pulse,
C2 channel (red) - SYNC IN is hidden,
C4 channel (green) - QSW IN pulse.
Measurement is set to delay between QSW IN and optical pulse.
Measured jitter std dev is >35ns and distribution is linear within 125ns.
Jitter is high because QSW IN is ignored.

7.9. External Interlock

External interlock ability is provided through the DB9 sockets EXT1 or EXT2 on the rear of the *PS8000 Series* power supply. A shorting plug is supplied if operation without the remote interlock is required. However, regional safety standards often require the use of a remote interlock.

If pins 6 and 8 are disconnected, the laser operation is blocked (pin 3 may be used instead of 6, they both are grounded). When the contacts are short-circuited again, the laser operation is restored by pressing RUN on the Control pad. No AC or DC current is allowed to supply to these contacts. External interlock circuitry must be isolated from other electrical circuits or grounds. The circuit current does not exceed 10 mA and voltage does not exceed 5 V.

The Routine Operation chapter provides basic operation instructions for the *NT230* series laser including powering up, operating, pausing, and shutting down the system.

Caution:
Use of controls and adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

8.1. Operating the laser

1. Turn the power switch on the power supply to position ON.
2. Turn the key-switch on power supply to position ON (if it is in position OFF).
3. Ensure that laser output is directed at an intended target.
4. Open the laser output shutter/(s).
5. Wait while the symbol □ appears on the laser control pad display.
6. Press button RUN on the laser control pad. Laser starts pulsing.

Note:
Radiation parameters of the laser stabilise after about 15 minutes warm-up time.

Note:
Pulse duration increases and pulse stability becomes worse if the LD pump level is reduced or the laser operates in the adjustment mode.

The laser system starts generating almost immediately; cold- and warm start warm-up timers are needed to achieve stable beam parameters at a specified level.

8.1.1. Changing the Laser Output Mode

1. Access **Energy level** submenu on the laser control pad.
2. Press the button ▲ or ▼ to switch the laser mode between '*Adj*' (reduced energy), '*Max*'(maximal energy) and '*Off*' (no output).

8.1.2. Changing the Synchronization Mode

1. Access **Synchronization** → **Synchroniz. mode** submenu on the laser control pad.
2. Press ▲ or ▼ to change synchronization mode. The indication **Internal sync. mode** means internal synchronization, **External sync. mode** – external.

8.1.3. Laser Operation in External Triggering Mode (One Sync Pulse)

Set EXT SYNC (external synchronization) using the Laser control pad or CAN Browser application. 3.5...5 V positive pulses must be supplied to the SMA connector SYNC IN on the front panel of *PS8000 Series* power supply.

8.1.4. Laser Operation in Burst mode:

Note:
Burst mode is available in internal synchronization mode only.

Use CANBrowser application or control pad.

1. Activate the burst mode using CAN Browser → CPU8000 → Synchronization → Continuous/Burst mode/Trigger burst selector Burst mode option.
2. Set pulse number in burst using CAN Browser → CPU8000 → Synchronization → Burst length menu option.
3. Initiate pulsing using CAN Browser → CPU8000 → Synchronization → Continuous/Burst mode/Trigger burst selector Trigger burst option. Pulsing will stop when the number of pulses set is reached. Pulsing can be stopped at any time using the STOP button on the Control pad.
4. Alternatively, use the control pad. Switch to the burst mode by using Burst mode menu (see Chapter 2 Laser Control); set the burst length by Burst length menu.

8.2. Pausing and Stopping the Laser

8.2.1. Pausing Laser Operation

1. Access **Energy level** submenu on the laser control pad.
2. Press the button ▲ or ▼ to switch the laser mode to '*Off*' (no output).
3. To restart operation, access **Energy level** submenu and switch the laser mode to '*Max*' or *'Adj'*.

8.2.2. Temporarily Stopping Laser Operation

1. Press the button STOP on the laser control pad to stop laser operation.
2. Press the button RUN again to start laser operation.

8.2.3. Turning the Laser Off

1. Press the button STOP on the laser control pad to stop the laser.
2. Close the laser output shutter/(s).
3. Turn the power switch on the power supply to position OFF.
4. To prevent unauthorized laser operation turn the key on the power supply to position OFF and pull it out (it is not necessary).

Note:
Fully turn off the laser if you intend it for a prolonged time. Otherwise, leave the POWER switch on to keep the crystal heaters operating. STANDBY indicator LED will be lit in this case.

This chapter contains information on routine laser maintenance schedule and list of all the procedures intended for the user. Maintenance beyond listed in this chapter, or marked as requiring the special experience, should be performed by a trained engineer and requires a certain experience in this area.

9.1. Regular Maintenance

9.1.1. Schedule

- Weekly
  - inspect cleanness of all surfaces of the optical components; clean if necessary.
  - visually inspect the laser rod and laser head output mirror.

9.1.2. Cleaning the Optical Surfaces

The cleanness of optical surfaces is one of the key presumptions to the stable operation of the laser. A dust particle or dirt, if not removed in time, may cause a costly damage of optical surfaces. The dust is most dangerous on the output surface of the amplifier rod, where the energy density is the highest.

- Safety

  Caution:
  The power supply, control and cooling units must be turned off and the key switch removed.

- Devices and materials required
  - rubber air blower pump or pressurized gas (dry nitrogen).
  - lenses cleaning tissue.
  - solvent, as pure ethanol, methanol, acetone or isopropyl alcohol.
  - right angle prism or inspection mirror.
  - lint-free cotton swabs on wooden or plastic stems.
  - electric torch.

- Inspection

Inspect optical components; use a right angle prism or inspection mirror if a direct access is impossible.

To inspect the surfaces of the laser rear mirror, Pockels cell and polarizer, open the laser head cover and illuminate these components through the rear mirror (using a flashlight): steer the light using an auxiliary small mirror.

Warning!
The following procedure is to be performed with laser head removed while system is powered. Make sure all necessary precaution measures are taken while performing this operation. Do not defeat the interlock. Do not press any other buttons except turning the key to ON.

Inspect the surfaces of output mirror and laser rods with flash lamps simmer glowing. To ignite the simmer, turn the key switch to *ON*. The surfaces of the output mirror and rod will be readily seen through the laser output aperture. Use dark background for better visibility.

Laser head components are not serviceable by the user; call service if inspection reveals contamination of these components.

- **Dry cleaning**

Blow the detected dust particle(s) away using a hand-held rubber air blowing pump or pressurized gas (filtered dry nitrogen). Avoid commercially available non-dehumidificated pressurized air; condensing water vapor may cause heavy staining.

- **Wet cleaning**

If dry cleaning is not successful, perform a wet cleaning.

Note:
Cleaning optical components with solvents requires a certain level of experience, especially when components in their holders have a limited access. It is surprisingly easy to introduce even more staining. We recommend calling service personnel when thorough cleaning is required.

Attempt cleaning the surface by a lint-free cotton swab moistened with a few droplets of solvent.

For mirrors and polarizers the drag method of cleaning can be used to remove the remaining contaminants after the dirt and dust have been blown away with a pressured gas. Slowly drag a lens tissue or cotton swab saturated with solvent across the surface. If done correctly, the solvent will evaporate uniformly without leaving any streaks or spots.

Caution:
Hygroscopic crystals, such as Pockels cell and BBO-type crystals, must be dry cleansed only, using a squirrel-tail brush, or dust may be blown away with pressurized gas. In critical cases, use water-free pure ethyl- or butyl-acetate. These crystals are highly hygroscopic, therefore water containing solvents can do unrecoverable damage to them.

9.2. Preparation for Transportation

Before transporting the laser:

1. *(water cooled systems only)*

   Remove the water from all water pipes and the cooling system.

Flush the cooling system with a 40% ethyl alcohol and water mix. Then remove the mix.

2. Carefully repack the laser in the same way as it was packed by the manufacturer. Please follow the original packing list.

This page is intentionally left blank

Chapter 10 TROUBLESHOOTING

The Troubleshooting Guide provides information and solutions for potential problems with *NT230* series laser.

10.1. Errors

10.1.1. Error Indication

Laser stops in case one or more errors are detected. Control pad shows module name and error code in a long field D; previous information placed in field(s) D is replaced by this error message. If several errors have occurred simultaneously, only the one occurred first is shown.

Full list of errors occurred may be reviewed using CANBrowser software, see 7.7.2 CANBrowser.

CANBrowser also may be used to see the list of all possible errors and their descriptions, start the CANBrowser and choose menu option *Errors->List available*.

10.1.2. Resetting the Fault

Fault occurrence does not necessarily mean a permanent device failure.

To reset the fault, perform the *RUN* command again. Some faults, like the ones originated in flash lamp power supply units or interlock circuit, may be reset only by turning the key to *OFF* and then back to *ON* position.

After resetting the fault control pad layout reverts back to the saved one.

10.2. Most Common Problems

This section provides suggestions in locating the source of basic problems that may occur.

Table 10 Most common problems

Symptom	***Possible cause and remedy***
One of stepper motors does not move	- the motor cable is detached - the motor is hindered mechanically - the device power has been turned on with the stepper motor disconnected Check the motionless motor's cable. Check for mechanical constraints. Press three buttons – ESC, MENU and OK – at once.

Symptom	*Possible cause and remedy*
Everything seems moving OK, nevertheless the generation is absent	Press three buttons – ESC, MENU and OK – at once.
Note 'NVRAM ERROR + ...' is displayed after the device has been turned on; here '...' indicates a list of constants which values have overrun the set limits. The list may include: NM - Name WL - Wavelength CP - Number of corrections Of - Offsets KU - EM calibrate MU - Maximum energy	- NVRAM failure - transients in the powering circuitry The NM, WL, Of, KU, MU errors can be caused by the customer's inaccuracy in setting the relevant parameters (they happen beyond the limits allowed). Turn the device off and on again. If the note persists, it is an evidence of NVRAM failure. If not, perform the calibration procedures and you are ready to proceed with your work.
Output wavelength differs from the set one.	Consult Chapter 6 *Installation*. Call *EKSPLA*.
Output energy is considerably less than specified thought pumping energy is nominal.	Surface of the nonlinear crystals can be damaged and/or an increased scattering appears inside the device.

10.3. Reporting a Problem

If a problem cannot be explained and remedied using measures described above, please call the service. The following information is necessary to provide an effective support:

- serial number;
- short description of the problem and circumstances;
- dump of the state of CAN registers; see below;
- full list of errors occurred; see below.

10.3.1. Performing a Memory Dump

1. Put the laser in its' routine working condition, if available; for this:
    a. Perform a warm start;
    b. Press *RUN*, wait for approx. 5 minutes

2. Start the CANBrowser.
3. Choose menu option *Connect-> Load all*.
4. Choose menu option *Data->Save to CSV*.
5. Save the file and attach it to the message.

10.3.2. Generating an Error List

1. Start the CANBrowser.
2. Choose menu option *Connect-> Load all*.
3. Choose menu option *Errors -> Clear list*.
4. Reproduce the error.
5. Choose menu option *Errors->Save list*.
6. Save the file and attach it to the message.

This page is intentionally left blank

11.1. System Identification

Model **NT230-100-SH-SF**

Serial No **PGD202**

11.2. Datasheet of Components

Table 11 System electrical components

Component Name	*Type*	*Serial Number*
Power supply	PS8001DR-48	18-891
Cooling unit	HYDAC RKHW-00400-L-R22-MI-17-DI	2300023231
Laser diode	QD-Q1903-L3-EKS	C010003, 4

Table 12 System optical components

Component Name	*No in optical layout*	*Characteristics/Code*
NL230 series laser[1]		
Cavity mirror 0º	OC	P5BK7-BK7MO75V664X8301-DP5
Pockels cell	PC	P5BBO-BBOXS06C20Z1-AA0
Laser rod	R	P5YAG-G11N5-50W0/0A1
Cavity mirrors 0º	RM	P5BK7-BK7SO73V30001-0H0
Thin-film polarizers	P1, P2	P5UVS-UVSAR56D1-PA5
Tunable parametric stage		
Mirror	M1, M2	P5BK7-BK7AR561-H15
Mirror	M3, M4	P5UVS-UVSAO86321-SA5X
Mirror	M5	P5UVS-UVSAR533D2G-S05-SX
Mirror	M6	P5YAG-YAGAO633D2TC-S00
Mirror	M7	P5UVS-UVSAR563-H15-S
Mirror	M8	P5UVS-UVSAO86D3-H05-SX
Crystal	OPO1	P5BBO-BBOJ295E143D2TC-AA-1
Crystal	OPO2	P5BBO-BBOJ295E143D2TC-AA-2

[1] Labeling according to Figure 5

Component Name	*No in optical layout*	*Characteristics/Code*
Second harmonic crystal	SHG	P5LBO-LBOH1S0615S1-AA0
Third harmonic crystal	THG	P5LBO-LBOH2S0615T1-A00
Half wave plate	HWP1, HWP2	P5KKV-KKVTO41M21-AA0
Half wave plate	HWP3	P5KKV-KKVTO41A2D2G1-AA0
Window	PL1	P5UVS-UVSAO753-A00
Prism	PR1	P5UVS-UVSPS590DG1-A00-PO
Rochon prism	RP1	P5BBO-BBOPS211EA9UE-RH
Filter	F1	P5FIL-K18FAO72FGG2TC-SA0
Window	W1	P5UVS-UVSAO7321-AA0
Window	W2	P5UVS-UVSAO7521-AA0
Window	W3, W4	P5UVS-UVSAO733-AA0
Window	W5	P5UVS-UVSAO73D1G1-AA0
Window	Dump	P5M23-M23AO7221-A10
Window	Dump	P5UVS-UVSAO72-11
SH/SFG		
Polarizer	P1	P5UVS-UVSAR76C1-PA5
Mirror	M16	P5UVS-UVSAR563D1F6-SA5-S
Mirror	M17	P5UVS-UVSAR561D2G-SS5-P
Mirror	M18…M21	P5BK7-BK7AR561-H15
Half wave plate	HWP4	P5KKV-KKVTO41A2D2G1-AA0
Filter	F2	N02FAO19E3-00 N03FAO193E3A-00
Crystal	FSH	P5BBO-BBOSJ17606B1B4-AA0
Crystal	SSH	P5BBO-BBOSJ17606B4C-AA0
Crystal	SFG	P5BBO-BBOMJ1070606CD1-AA0
Pelin-Broca	PBP1	P5UVS-UVSPS2A9D25-PB
Prism	PR2	P5UVS-UVSPS790-000
SCU Unit		
Pelin-Broca	PBP2	P5UVS-UVSPS2A9D25-PB
Prism	PR3, PR4	P5UVS-UVSPS790-000