NT252 Series

Tunable Diode Pumped Laser System

Technical Description
User's Manual

NT252 Rev. 1908

2019
Lithuania

CONTENTS

**Such chapters as* Factory Settings *might not appear in the PDF version of this manual; they may be available as separate file(s).*

List of Figures

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1.1. Legal Disclaimer

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, the *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 Because of this the manual may occasionally contain information which is outdated, incomplete, or erroneous; or it may omit some information about the specific system.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 (p. 11) for information about safe handling and usage of the NT252 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 Ave 237
02300 Vilnius, Lithuania
Phone: +370 5 2649629
Fax: +370 5 2641809
E-mail: ekspla@ekspla.com
Web: http://www.ekspla.com

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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 inhomogeneities, color change/discoloration marks on optical components are signs of light-material interaction during normal routine operation and as such are not to be treated as defects, as long as specified output parameters of the 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

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3.1. General Information

3.1.1. Model

NT252-1K-SH-DRY

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 NT252-1K-SH-DRY **S/N PGD217**	1
Power supply PS81120 series	2
Control pad with cable	1
Set of cables and accessories	1
User’s manual with software CD	1

3.2. Standard Beam Characteristics[1]

Table 2 Standard pump laser requirements

Parameter		Specifications
Wavelength, *nm*		1064 532
Pulse duration (@1064 nm), *ns*		3…6
Maximal pump pulse energy, *mJ*	1064 nm	9
	532 nm	5
Beam quality		Hat-top in near field, without hot spots
Beam divergence, *mrad*		<2
Pulse energy stability of 532 nm pump, *%* (*StdDev*)		<2.5
Pulse repetition rate, *Hz*		1000

Table 3 Standard parametric output specifications

Parameter		Specifications
Wavelength tuning range, *nm*		
	Fundamental radiation	1064
	Second harmonic radiation	532
	SH	335…668.99
	Signal	669…1063.99
	Idler	1064…2600
Pulse energy		
	Fundamental radiation	~9 mJ
	Second harmonic radiation	~5 mJ
	SH	200 μJ @ 400 nm
	OPO	1100 μJ @ 750 nm
Tuning resolution, *cm^{-1}*		
	SH	2
	Signal	1
	Idler	1
Pulse duration, *ns*		2…4
Linewidth, *cm^{-1}*	SH	<13
	OPO	<8
Typical beam diameter, *mm*		3×6
Typical beam divergence, *mrad*		<2×5
Beam pointing stability, *μrad (RMS)*		≤50

[1] The specifications in this subchapter are for standard products. They may be different for your device.

Parameter	Specifications
Polarizations SH Signal Idler	 Horizontal Horizontal Vertical

3.3. Power Supply Requirements

Table 4 Power supply requirements

Parameter	Specifications
Supply voltage, *VAC*	100…240
Frequency, *Hz*	47…63
Phase	1
Power consumption	<1.5 kW

3.4. Liquids and Gases

Table 5 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. Laser External Dimensions

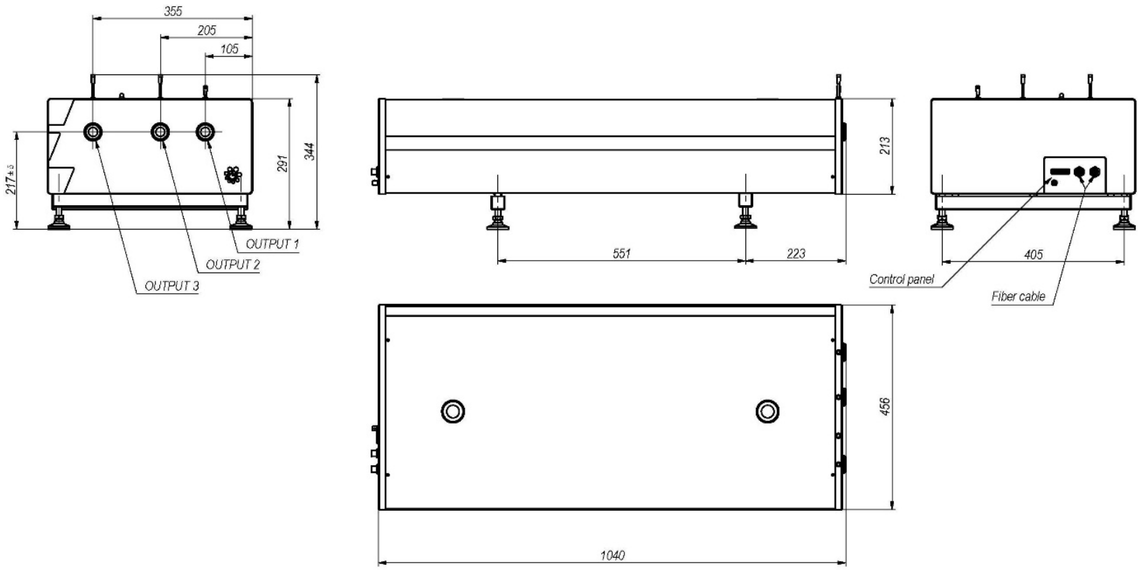

Figure 1 Outline drawing and dimensions of NT252 series laser

3.6.2. Mass

~70 kg.

3.6.3. Beam Position(s)

See figure(s) in 3.6.1 Laser External Dimensions (p. 8) and the table below.

Table 6 Beam positions for different system configurations

Configuration	***Output 1***	***Output 2***	***Output 3***
NT252	669…2600 nm		
IH		1064 nm	
IIH			532 nm
SH	335…669 nm		

3.6.4. Power Supply Dimensions

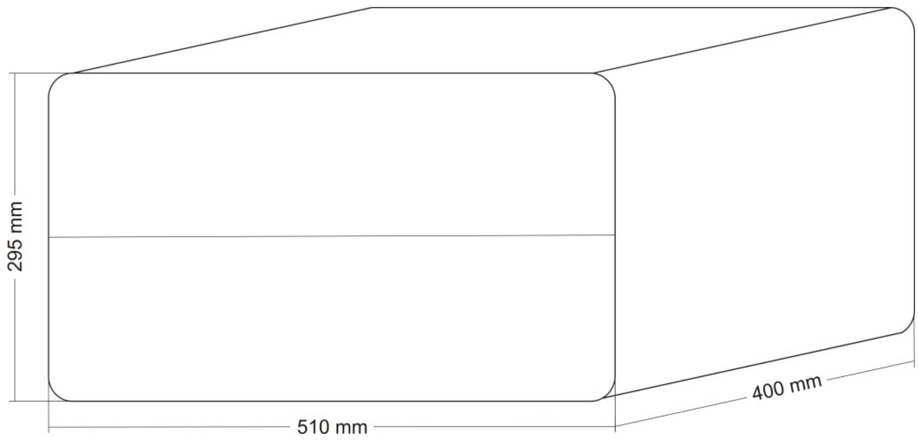

Figure 2 Outline drawing and dimensions of PS8000 series power supply

3.6.5. Placing and Fixing

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

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This chapter provides information about safe handling and usage of the *NT252* 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 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 in 2014/35/EU). The Low Voltage Directive requires that lasers comply with the IEC-60825-1 (Radiation Safety of Laser Products) and IEC 61010-1 (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.

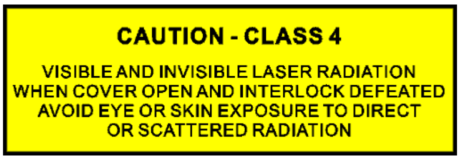
4.3.1. Laser Radiation Warnings/Identification

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.

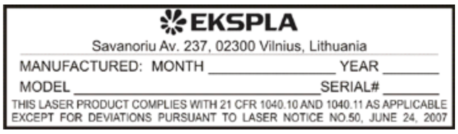
③

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

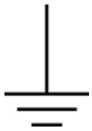
Strong magnet labels are located on the top of Faraday rotators.

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.



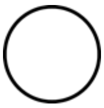
Earth (ground) terminal symbol.

Protective conductor terminal symbol.

Single-phase alternating current symbol.

Three-phase alternating current symbol.

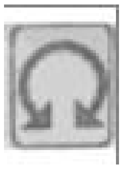
On (Supply) symbol.



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.

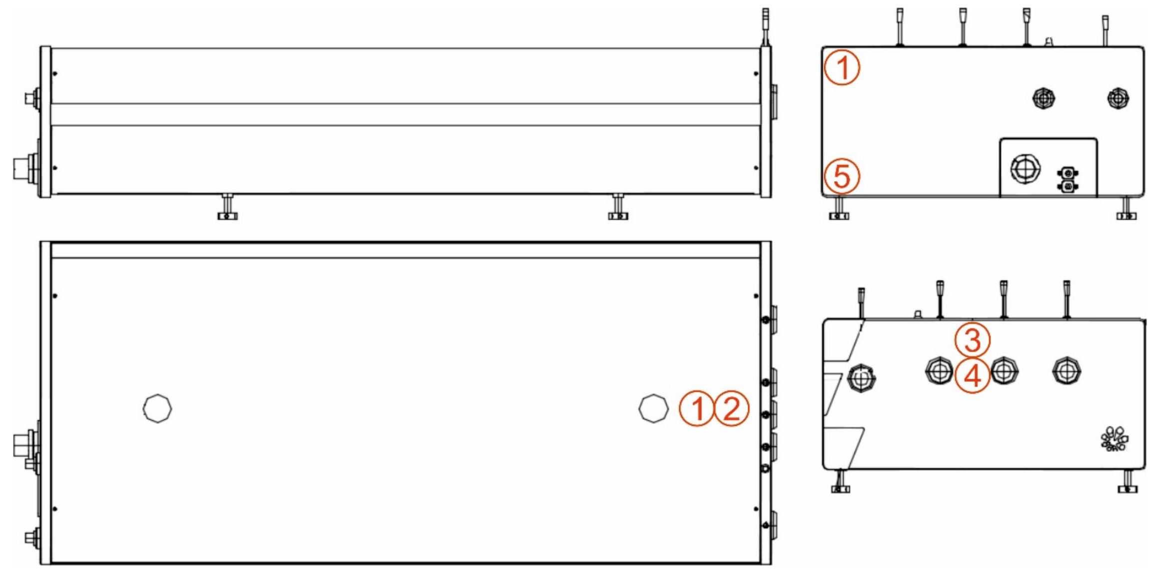


Figure 3 General warning label positions on the NT252 series laser[1]

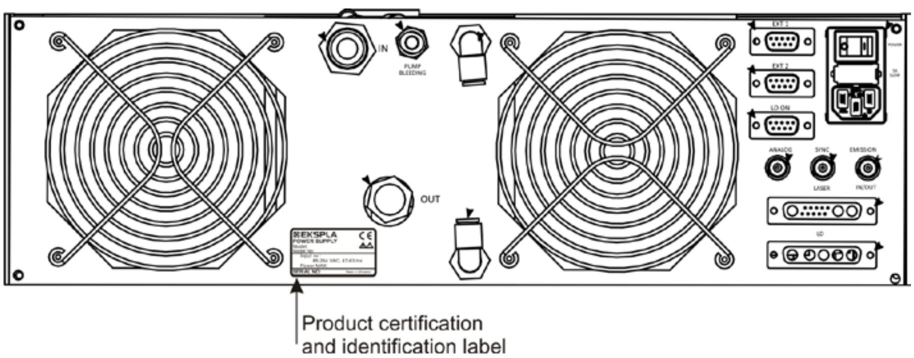


Figure 4 Warning label positions on the power supply

4.3.5. Laser Radiation

This laser can emit laser radiation of different wavelengths, see table below.

Table 7 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
3rd harmonic	355	Ultraviolet (UV)	Invisible
Parametric	335…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

[1] Labeling according to symbol lists above.

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 and other components may form an additional resonator with uncontrollable radiation profiles.

High energy radiation focused inside the laser resonator may cause severe damage to 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 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 and EXT1 sockets on the rear of the *PS81120 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 the *ON* position. Removal of the key prevents operation of the laser.

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

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

4.9. Main Disconnect Switch

POWER switch(es) located on the rear panel(s) of the power supply(-ies) 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.

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5.1. Main Functional Parts

The laser system is comprised of following functional parts:

- Master oscillator - pump laser NL210;
- Harmonics output(s);
- Tunable parametric stage (Optical parametric oscillator - OPO);
- Second harmonic stage (SH).

Optical layout of the system is presented in Figure 6 and Figure 5.

The power supply unit(s), directly connected to the mains power supply, contain(s) the necessary components to power-up and cool the laser heads.

The cables connecting the laser head to the power supply unit(s) may contain cooling water tubes, laser diode power cables, Q-switch triggering and power cables and safety interlock lines.

5.2. Master Oscillator (NL210)

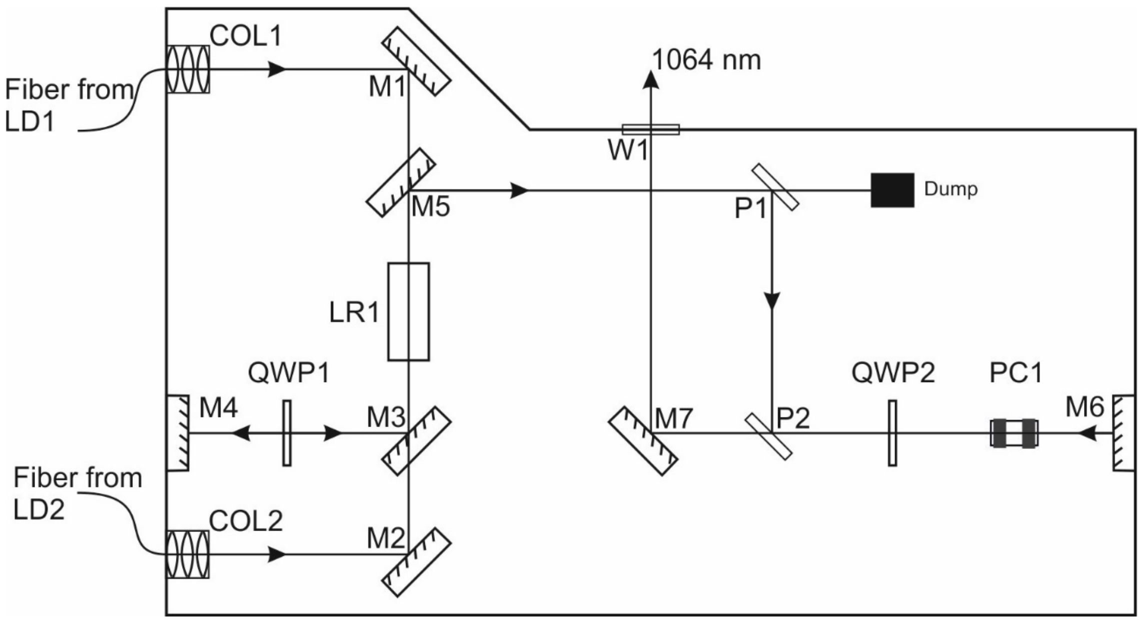

Figure 5 Optical layout of NL210 series laser head

The laser head contains the laser cavity and Pockels cell driver. The laser cavity body is machined from a single aluminum 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.

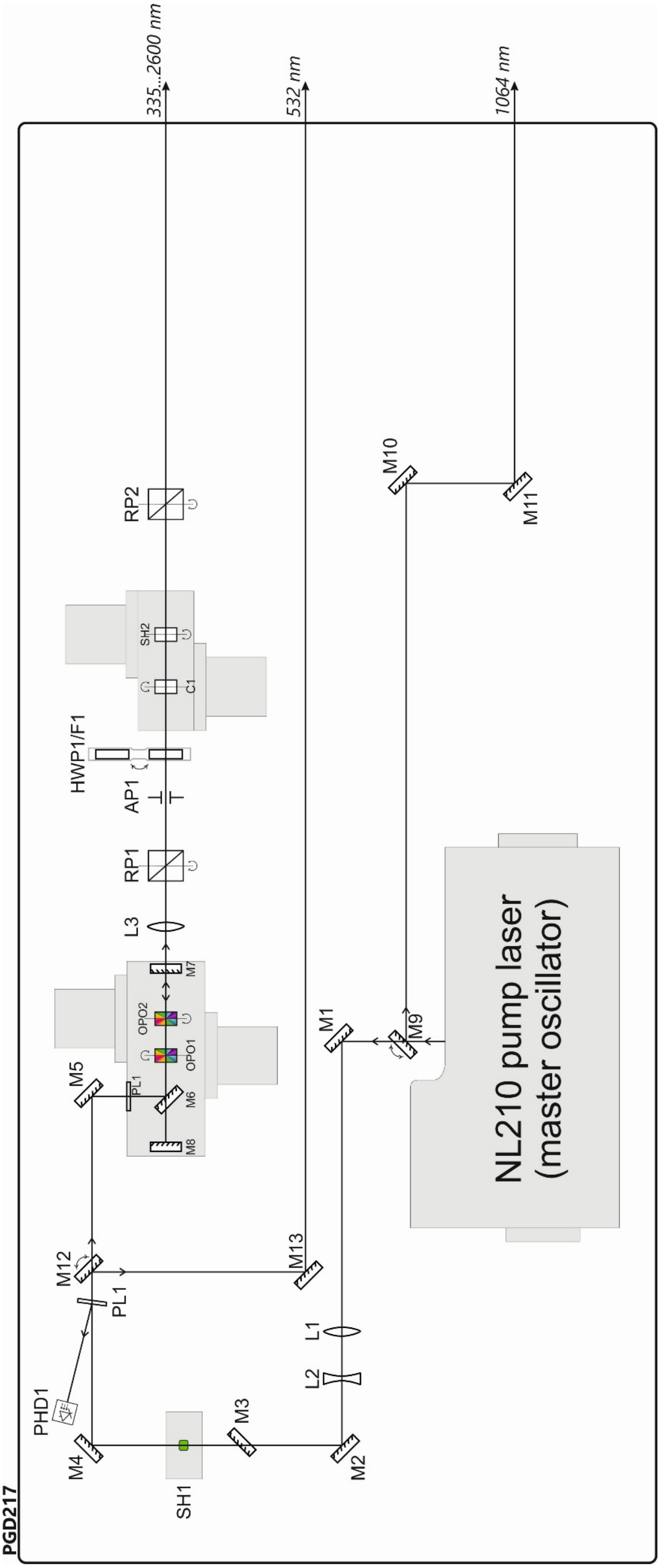

Figure 6 Optical layout of the NT252-1K-SH-DRY laser

5.2.1. Generation of Optical Pulses

A way of realizing a source of short nanosecond pulses essentially independent of gain is to replace the permanent optical output coupler with a time-varying output coupler, allowing the Q-switched pulse to rapidly build up in a low-loss cavity, and then dump the whole energy contained in the resonator when the intracavity power has reached its maximum.

The output coupling holds off the laser under threshold when the pumping starts. At the end of pumping pulse, the cavity is closed, applying a high voltage (HV) pulse on the Pockels cell, and the intracavity power builds up rapidly in a low-loss resonator. When this intracavity Q-switched pulse has reached its maximum intensity, the output coupling is switched again to 100% (zero voltage on PC) the whole intracavity energy to be dumped out with one cavity round trip.

A BBO Pockels cell was chosen for its low insertion losses, high damage threshold. The BBO Pockels cell was driven by the HV switch with rise and fall time of a few nanoseconds, allowing the cavity to generate dumped pulses of 4…7 ns duration.

A beam is directed from resonator to output by polarizer P2 and mirror M7.

5.3. Tunable Parametric Stage

The 1064 nm radiation from NL210 can be directed two ways by moving the motorized mirror M9. If M9 is up, the beam is directed towards 1064 nm output. If M9 is down, the beam is directed towards the optical parametric oscillator. The OPO is pumped by 532 nm, generated in SH1 crystal.

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 669…2600 nm wavelengths with up to ~30% conversion efficiency when pumped by second harmonic of a pulsed Nd:YAG laser. The pumping beam is directed by dichroic mirrors to the OPO cavity. The OPO resonator consists of mirrors M7 and M8. Wavelength tuning is achieved by rotation of nonlinear crystals OPO1 and OPO2. The energy is emitted through mirror M7 towards the output.

Rochon prism RP1 separates the signal wave from the idler.

5.4. Sum Frequency/Second Harmonic Generator

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.

SH2 is a type I BBO crystal. It generates the second harmonic of OPO signal and idler waves to cover the 335…669 nm wavelength range.

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

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This chapter provides information about connecting and configuring the *NT252* 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.

Attention!
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 systems, 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. 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. Moisture may damage the device. Inside the shipping box, the laser is separately wrapped in plastic packaging. Prevent condensation forming on the device: allow laser packaging inside the shipping box to warm up to room temperature (at least 4 hours).

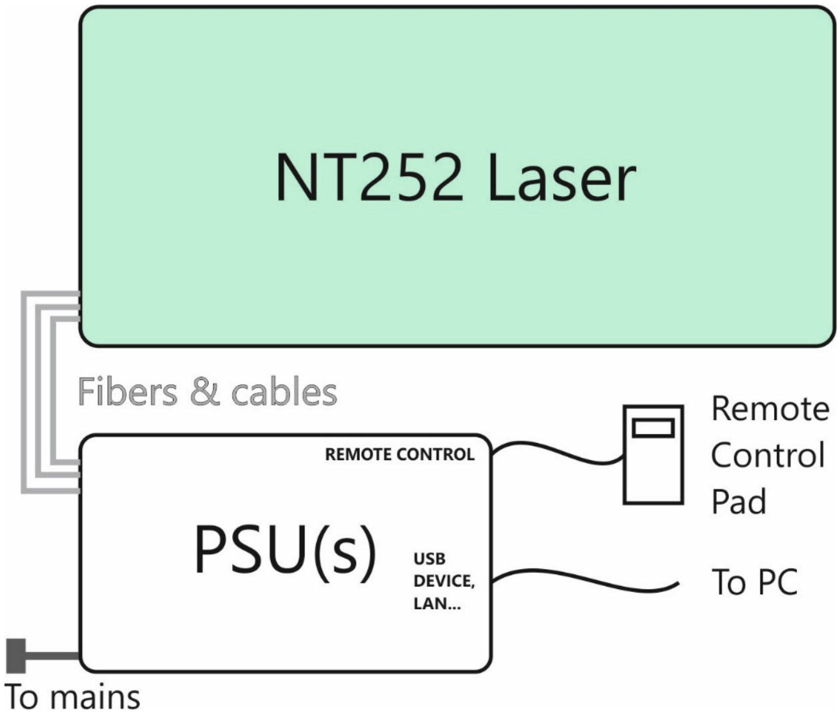

Figure 7 Layout of the system

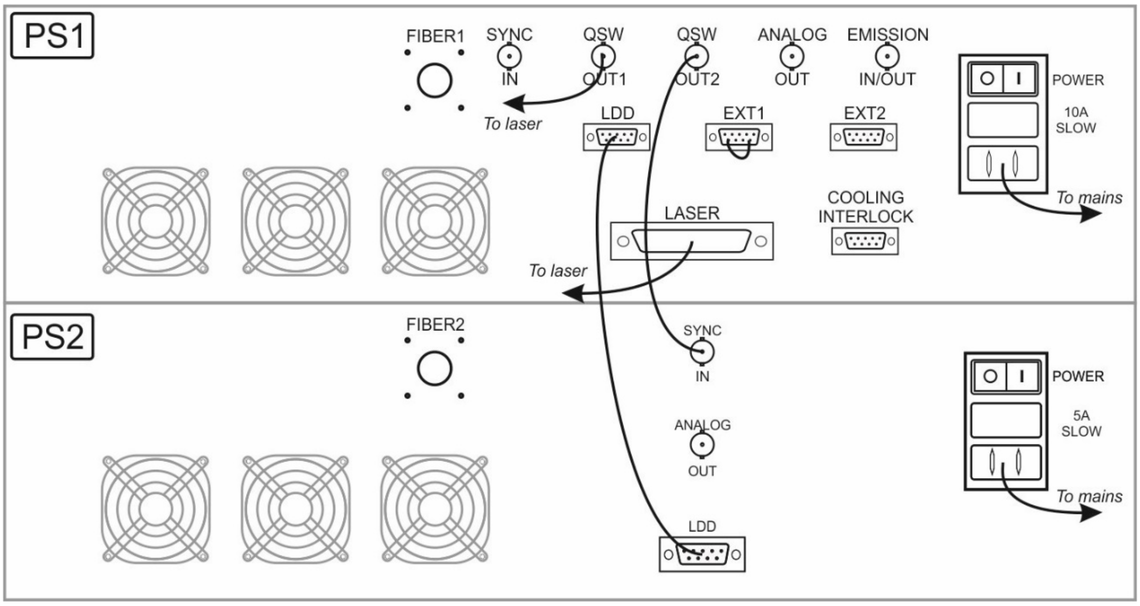

Figure 8 Connections on power supply rear panels

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 any other external devices adjacent to the laser.
5. Make the connections according to Figure 8:
6. Relieve the bolts fixing both end panels to the inner breadboard pedestal to the extent (roughly for 90 degrees) that panels can move freely a little, see Figure 9. This makes breadboard less sensitive to tensions caused by thermal expansion of the panels.

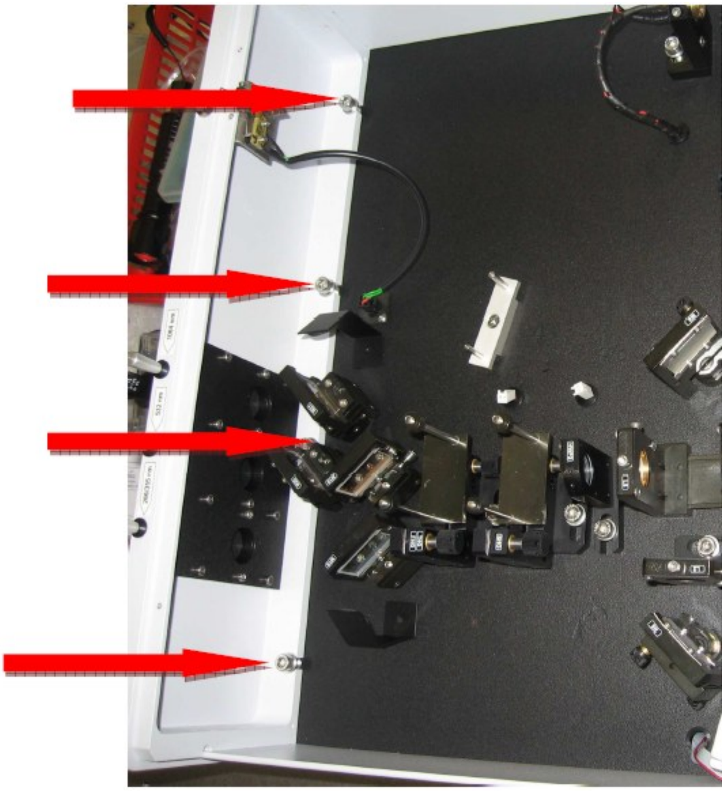

Figure 9 Relieve fixing bolts (marked by red arrows)

7. Switch the power switches on the rear panels of power supplies to the ON position.

8. Connect the device to a PC, see 7.7 CONTROL FROM PC (p.39).

9. Turn the key switch on the power supply front panel to the ON position. The device starts up.

10. Set the device to 1064 nm ("IH", go below parametric range in control pad) and observe output energy.

11. Set the device to 532 nm ("IIH", go below parametric range in control pad).

12. Via the control pad, set the laser mode to MAX and observe 532 nm output energy.

    a. If energy is below specifications, adjust the temperature of SH1 crystal.

13. Run *PgSoftw* application; for details, see 7.7.4 PARAMETRIC CONTROL FROM UNIPG SOFTWARE (p.43) and separate *PgSoftw* manual.

14. In software, set the device to 840.4 nm.

    a. If energy is below specifications, adjust the angle of OPO1 crystal for maximum energy at the wavelength and save the new optical zero.

15. Set the laser to *MAX* mode.

16. Check that the device generates the specified energies in the signal (669…1064 nm) and idler (1065…2600 nm) ranges according to Chapter 13 Test Data.

17. In software, set the device to 500.0 nm.

    a. If energy is below specifications, adjust the angle of SH2 crystal for maximum energy at the wavelength and save the new optical zero.

18. Set the laser to *MAX* mode.

19. Check that the device generates the specified energies in the SH range (335…669 nm) according to Chapter 13 Test Data.

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.

A separate device, the USB-CAN-LAN-RS232 CONVERTER, is installed in one of the power supplies. Detailed information on using the converter is presented in a separate manual.

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

7.2. PS81120 Series Power Supplies

7.2.1. Front Panel

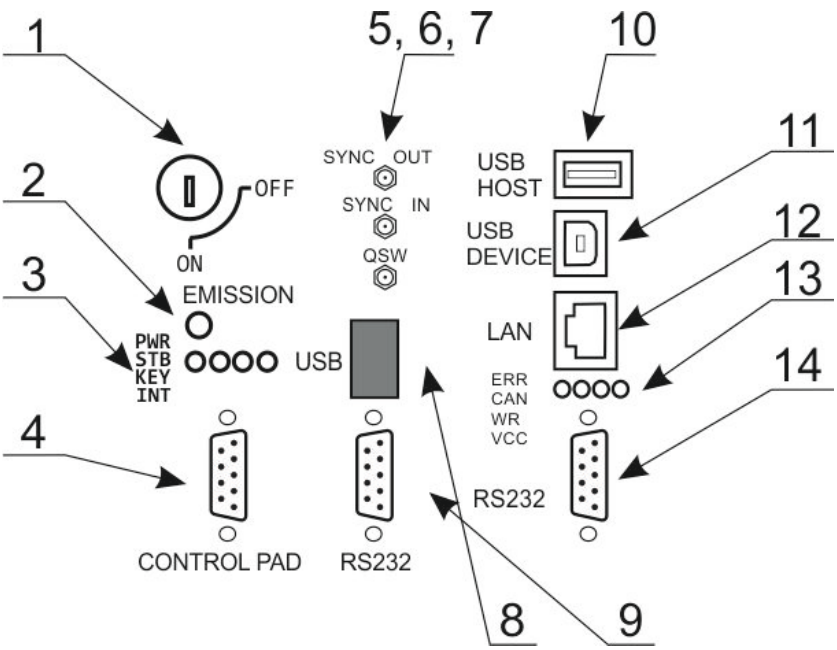

Figure 10 Control panel of the power supply

Table 8 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. The Key in in ON position. INT Blue LED. Interlock circuit is closed. It is non triggered, real time indicator. The system will not operate with the Interlock open. Laser modules enter Fault state when trying to run the laser with the interlock open.
4	CONTROL PAD (DB9F)	Port for control pad connection.
5	SYNC OUT (SMA)	Internally generated sync pulse, adjustable in 1us steps from 50 μs to 20 ms with respect to optical pulse.
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	USB device connector, laser remote control function. This connection is not active. Use the USB DEVICE connector to the right.
9	RS232 connector (DB9M)	For control through PC. Use is optional.
10…14	CONVERTER group	See separate manual.

7.2.2. Rear Panel

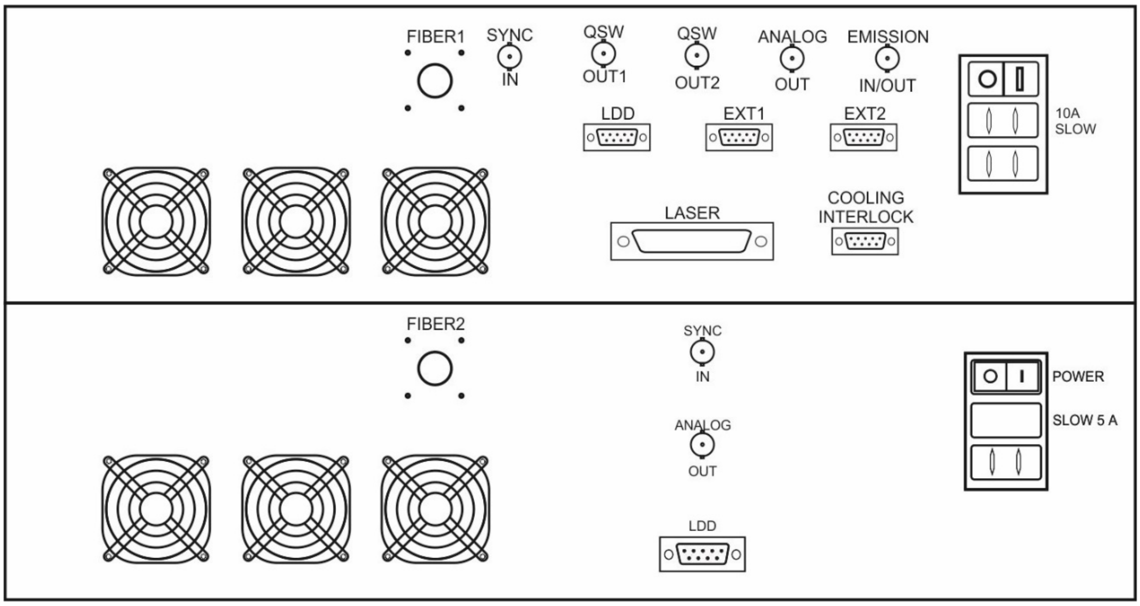

Figure 11 Rear panel of the power supply

Table 9 Power supply rear panel connections

Control/connection	***Description***
PS81120MSSRp	
FIBER1	Fiber output.
SYNC IN (BNC)	Laser diode driver sync input.
QSW OUT1 (BNC)	Laser diode driver Q-switch control pulse.
QSW OUT2 (BNC)	Sync pulse output for amplifier driver PS81120SR
ANALOG OUT (BNC)	Laser diode driver current sensor output.
EMISSION IN/OUT (BNC)	Emission indicator circuit.
LDD (DB9)	CAN bus connector for communication between oscillator and amplifier drivers.
EXT1 socket (DB9F)	Remote interlock connection. Laser ships with short inserted to EXT1.Break the short and use pins for remote shutdown to comply with lab safety regulations. Use dry relay contacts to short pins for normal operation; pins 3(or 6) and 8 are used.
EXT2 socket (DB9F)	Auxiliary remote interlock connection. Shorted inside by default; ask service to activate it.
Mains socket	AC power IEC inlet, fuse holder, line switch. Chassis Plug 16 A. Fuse 10A slow.
LASER socket (D-SUB 13W3 F)	DC power, safety circuits and CAN bus connection.
COOLING INTERLOCK	Interlock connection for power supply interconnection.
PS81120SR	
FIBER2	Fiber output.
SYNC IN (BNC)	Laser diode driver sync input.
ANALOG OUT (BNC)	Laser diode driver current sensor output.
LDD (DB9)	CAN bus connector for communication between oscillator and amplifier drivers.
Mains socket	AC power IEC inlet, fuse holder, line switch. Chassis Plug 16 A. Fuse 5A slow.

7.3. Laser Controls

The following connections and controls are accessible on the laser:

7.3.1. 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 *CONTROL PAD* on the front panel of power supply (see Figure 10).

- **Layout and Buttons**

Figure 12 shows the control pad. The pad contains eleven buttons and an alphanumeric display.

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

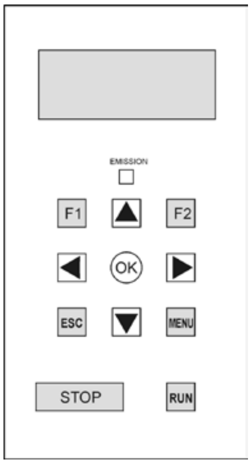

Figure 12 Remote control pad

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 15 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 13.

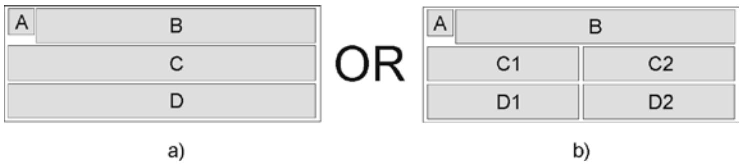

Figure 13 Main window of the control pad

The main window is divided into fields A, B, C and D (see Figure 13). 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*.

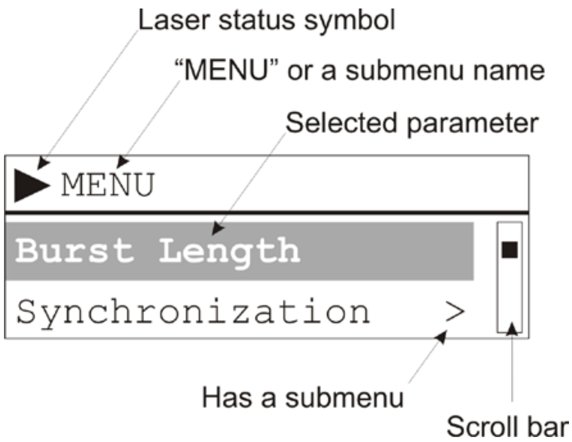

Figure 14 Navigating the menu

The menu tree is shown on Figure 15 below.

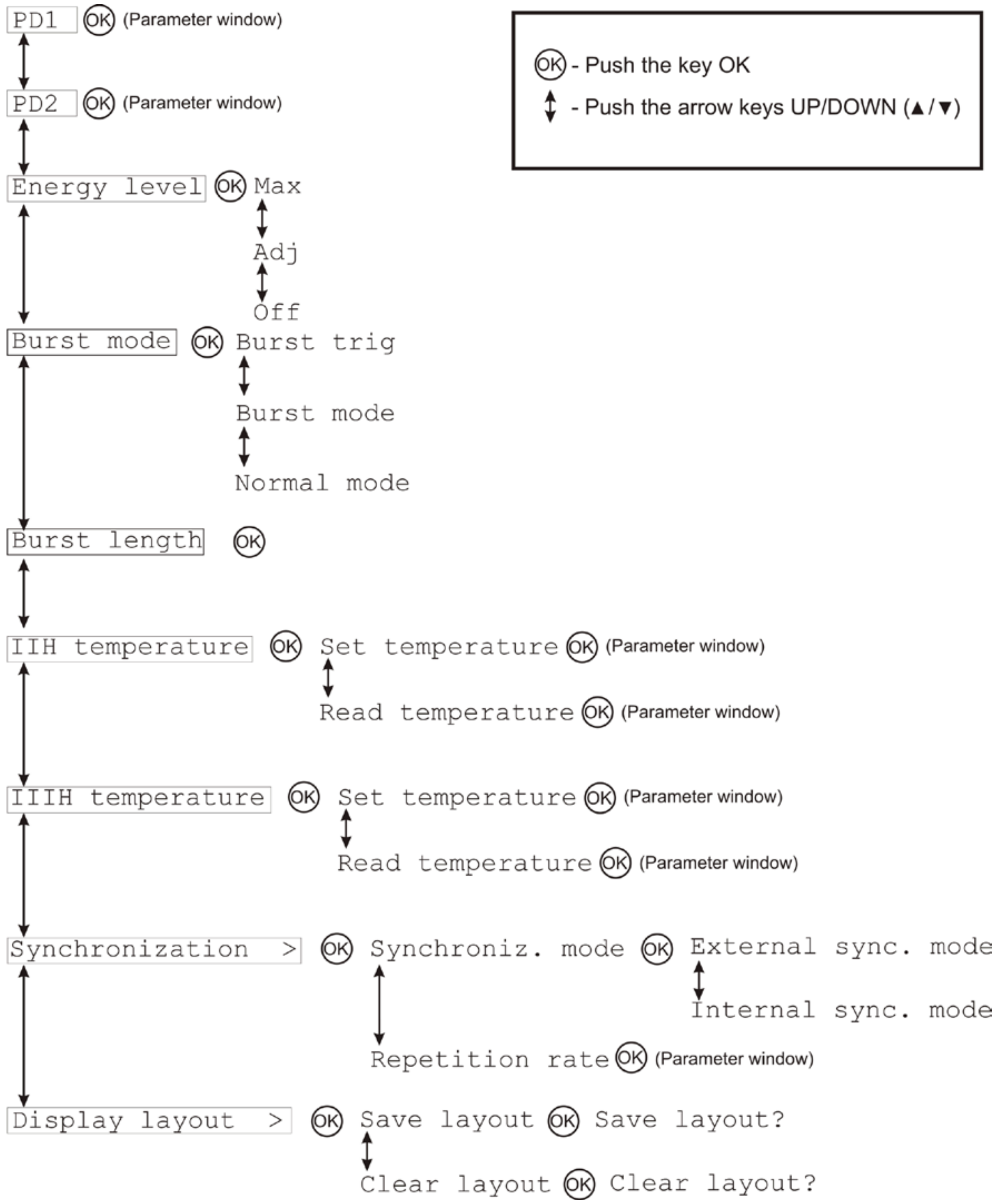

Figure 15 Menu tree

Table 10 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 SH1 crystal temperature; sets the needed temperature.
7	IIIH temperature	Not used.
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.

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.

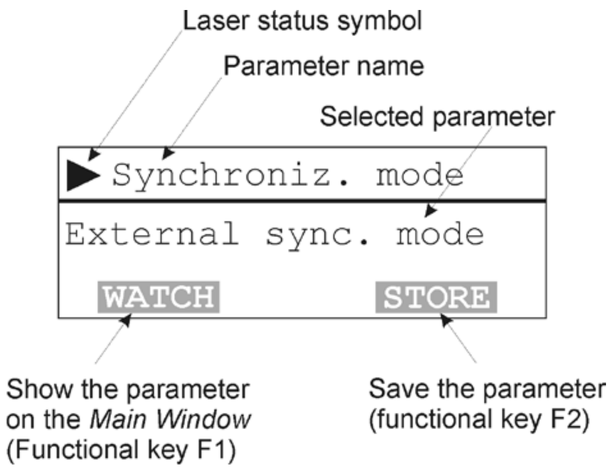

Figure 16 Setting the parameter

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:

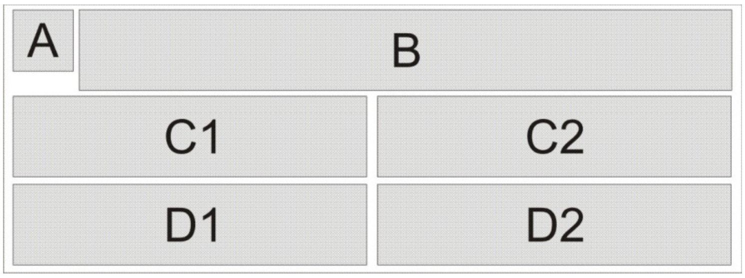

Figure 17 Factory setup of the main window

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

Field C1 – not used.

Field C2 – not used

Field D1 – not used.

Field D2 – 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.

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:

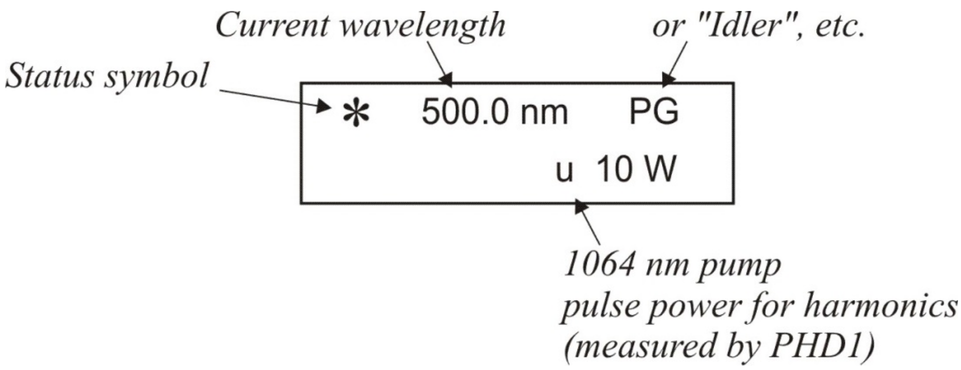

Figure 18 Home window of parametric control

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 1064/532 nm output, go below parametric range on the control pad.

The display shows an average power of the last ten 1H pulses.

If the power 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).

7.7. 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 USB DEVICE connector on the power supply front panel.

Some devices may be more specific about connection; see 6.3 Laser Installation Procedure for recommended 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 NT252 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.*

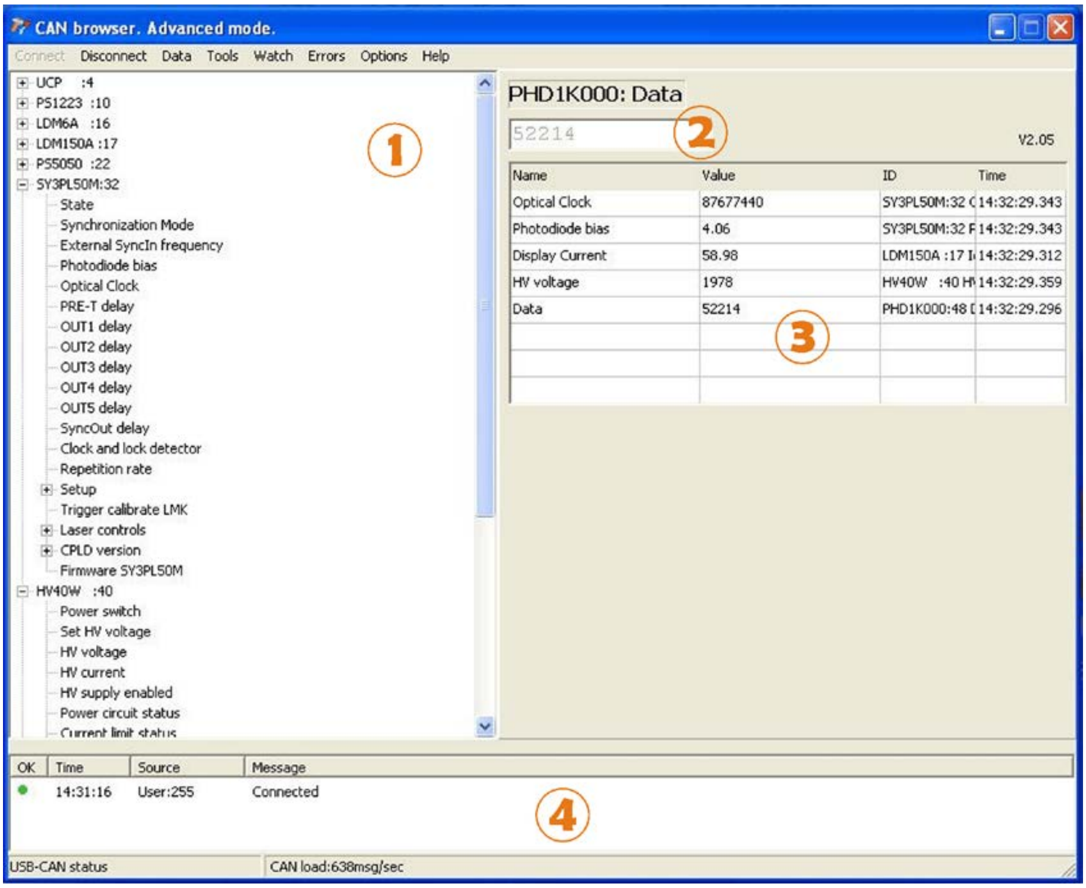

Figure 19 CANBrowser main window.

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.

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.

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.

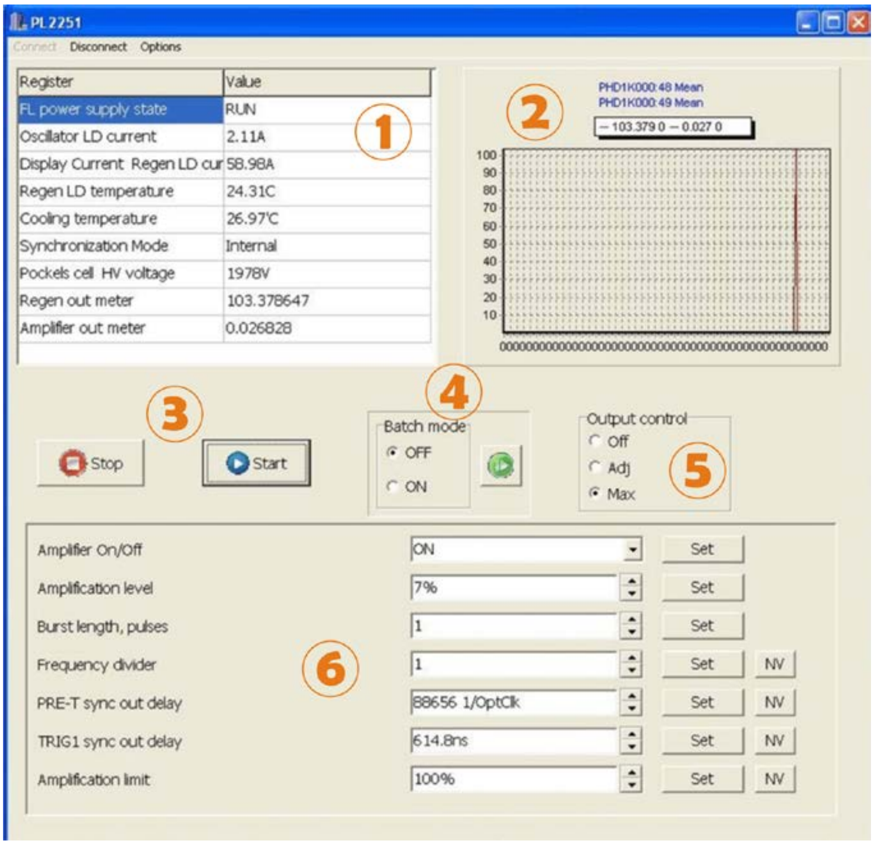

Figure 20 Remote Control Application main window.

Generic view; in general, each device may have different set of displayed registers and controls.

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.
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*.

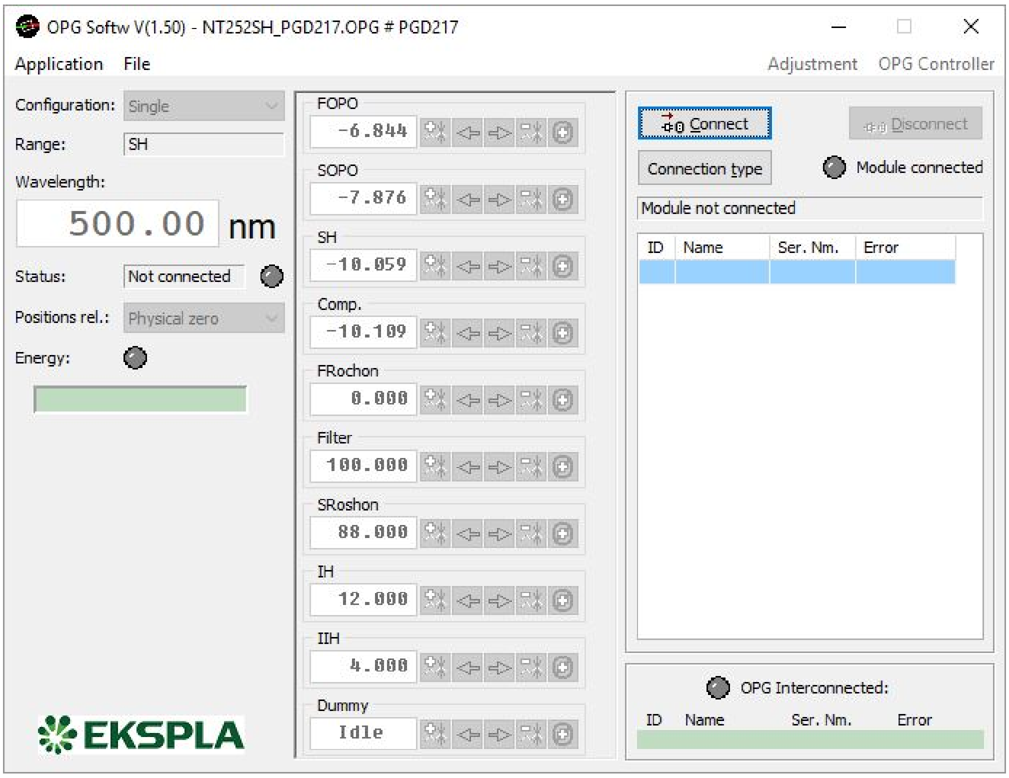

Figure 21 UniPG control interface

Positions of motors at the set wavelength:

- *FOPO* –first OPO crystal.
- *SOPO* –second OPO crystal.
- *SH* –SH1 crystal
- *Comp.* – compensator.

- *FRochon* –Rochon prism RP1
- *Filter* – half-wave plate HWP1 / filter F1.
- *SRochon* –Rochon prism RP2.
- *IH* – mirror M9.
- *IIH* –mirror M12.
- *Dummy* – not used.

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

7.8. User Input and Output Signals (External Triggering)

The laser can be triggered and controlled by external pulses. The laser must be set to external synchronization mode through the control pad or remote control software (see 7.5.2 Menu System and 7.7 Control from PC).

- SYNC IN (SMA) connector is used to externally trigger the NL210 pump laser. The operation of the system is sensitive to the SYNC IN pulse rise. It is recommended to set your external generator to supply pulses with rise time of ~5 ns Input impedance is 50Ω. Pulse parameters: pulse length 100 ns...10 µs, voltage level 3.5...5V @ 50Ω.
- QSW IN (SMA) connector allows the user to supply an external Q-switch trigger. This can be used to accurately control firing of the laser and reduce timing jitter. The operation of the system is sensitive to the QSW IN pulse rise. It is recommended to set your external generator to supply pulses with rise time of ~5 ns. Input impedance is 50Ω. Pulse parameters: pulse length 100ns...10µs, voltage level 3.5...5V @ 50Ω.

The laser timing diagram is presented in Figure 22.

At time T1, the user-provided SYNC IN pulse arrives to the synchronization board. The minimal delay between the triggering pulse (either external or internal) and the optical pulse is ~160 µs (hardware limit). The number of additional control boards (n_b), such as laser diode drivers, may add additional hardware delay, starting at T2 – this is also usually 160 µs. The most common *"SyncIN -> Pulse" delay* is ~160 µs.

At T3, the diode pump control pulse is emitted by the diode drivers and the diode current starts growing (see chart ②). The delay between T3 and T4 is called the *QSW output delay*. The diode pump current is maintained for the duration of this delay.

At T4, either internally or supplied by the user, the Q-switch pulse applies high voltage to the Pockels cell (~40 ns duration). The optical pulse follows ~50 ns after T4.

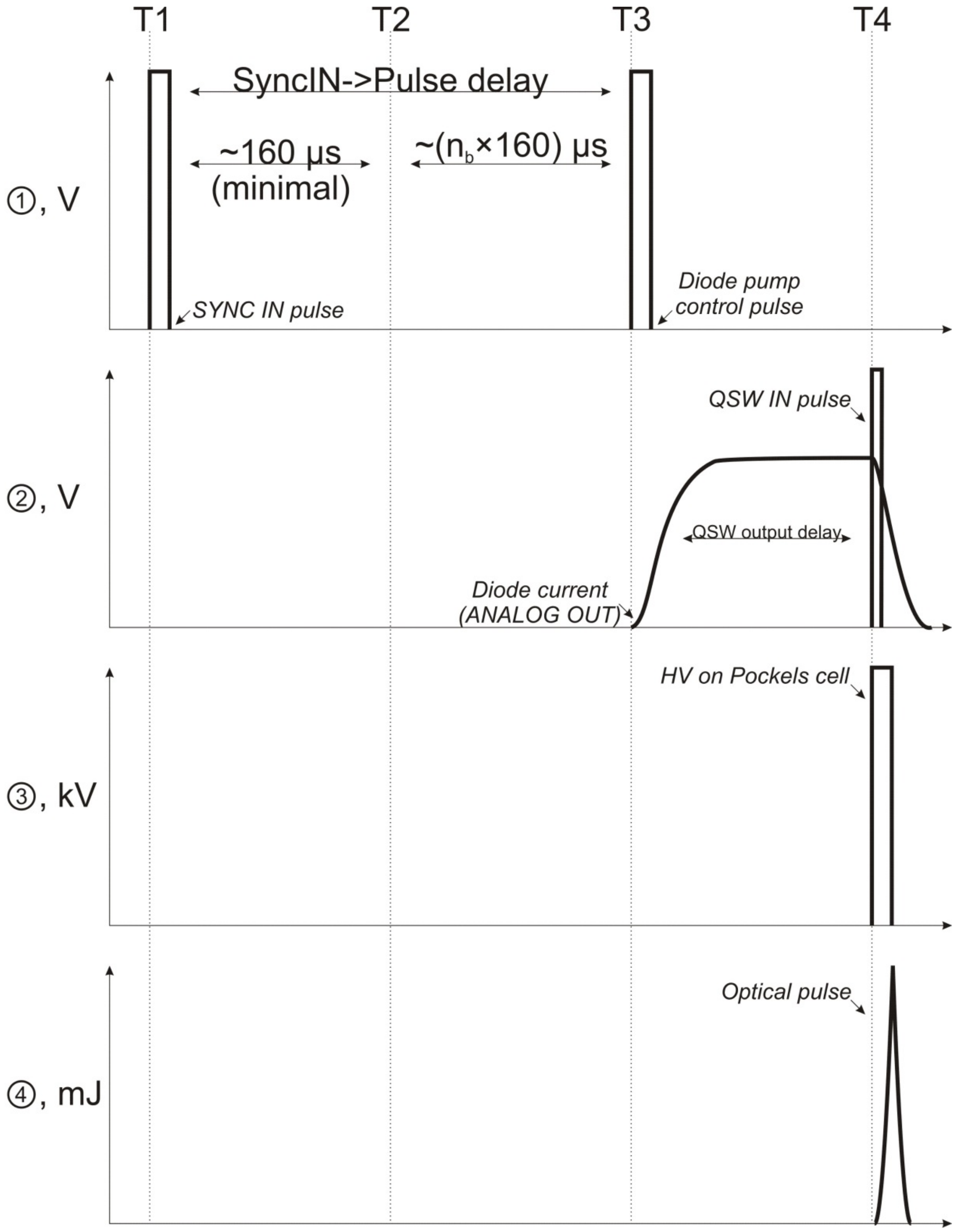

Figure 22 Laser timing diagram

7.8.1. External Synchronization Using One Pulse (SYNC IN)

In this synchronization mode, the laser is able to perform all functions.

Increase the value of *Repetition rate* in external synchronization mode by 5%, e.g. to 1050 Hz.

> *Note:*
> *When switching back to internal synchronization mode, set Repetition rate back to 1000 Hz.*

Connect the cable from your external pulse generator to the SYNC IN connector (SMA) on the power supply.

Set laser synchronization mode to external.

The system is sensitive to the repetition rate of the SYNC IN pulse. A high repetition rate may damage the optical elements due to thermal lensing effects. A repetition rate limiter is implemented in the device. A laser pulse is skipped if SYNC IN appears earlier than the end of the previous pulse. Such situation leads to a frequency division by a factor of 2, because the synchronization board skips one internal synchronization pulse. The synchronization board "looks" for the SYNC IN pulse according to the *Repetition rate* register value. In internal synchronization, the value of *Repetition rate* is only that – the repetition rate. In external synchronization, however, this value is the limiting value for the repetition rate limiter.

7.8.2. External Synchronization Using Two Pulses (SYNC IN & QSW IN)

In this synchronization mode, the laser may be started/stopped and the energy may be changed between MAX and ADJ levels – all other functions are disabled.

The user provides two signals – SYNC IN and QSW IN. The delay between these pulses must be set in the laser control software and in the external generator. The delay between SYNC IN and QSW IN pulses is calculated using the formula:

Delay between SYNC IN and QSW IN pulses = „SyncIN->Pulse delay" + „QSW output delay"

- The value of „SyncIN->Pulse delay" is indicated in Factory Settings.
- There are two possible values for QSW output delay, depending on the laser mode:
  - MAX: the *QSW MAX output delay* value is also indicated in Factory Settings.
  - ADJ: the *QSW ADJ output delay* value is obtained:
    - Stop the laser;
    - Set energy level to ADJ;
    - Look up *QSW ADJ output delay* in control software;

When the *QSW output delay* value is entered into the register, the same value must be used in providing the external pulses. The tolerance is ±5 µs. If the pulses do not arrive at the expected moment, the laser will operate as if it is set to single pulse synchronization mode – this will lead to a high jitter.

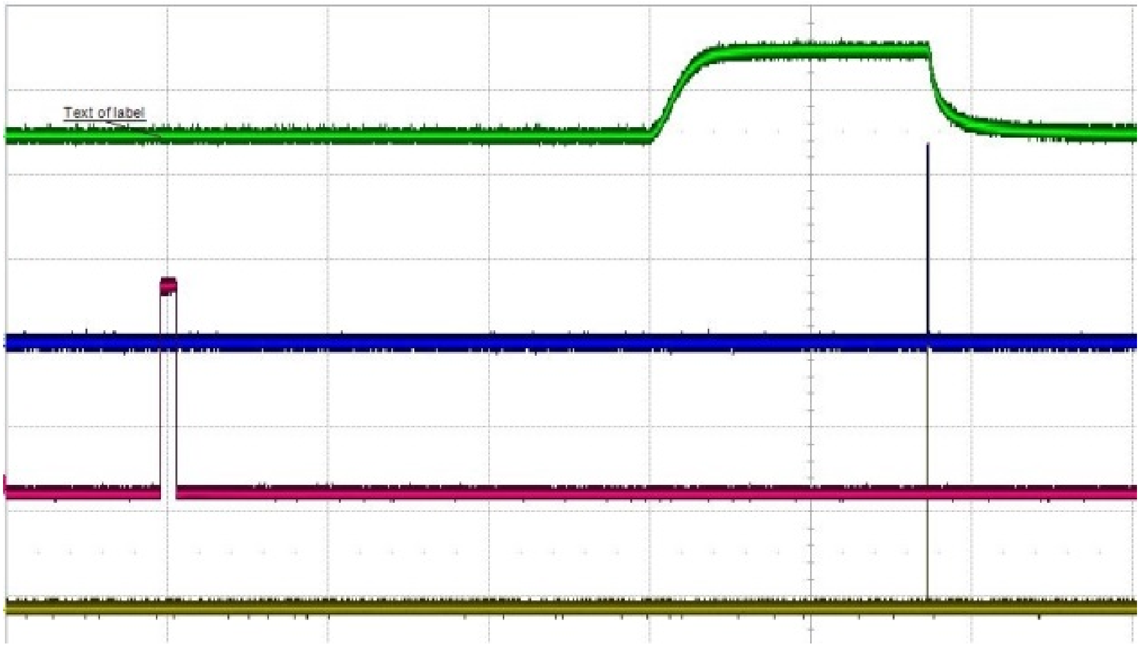

Figure 23 Correct two-pulse external synchronization example

Red – SYNC IN, green – ANALOG OUT (diode pump current shape), blue – QSW IN, yellow – optical pulse.

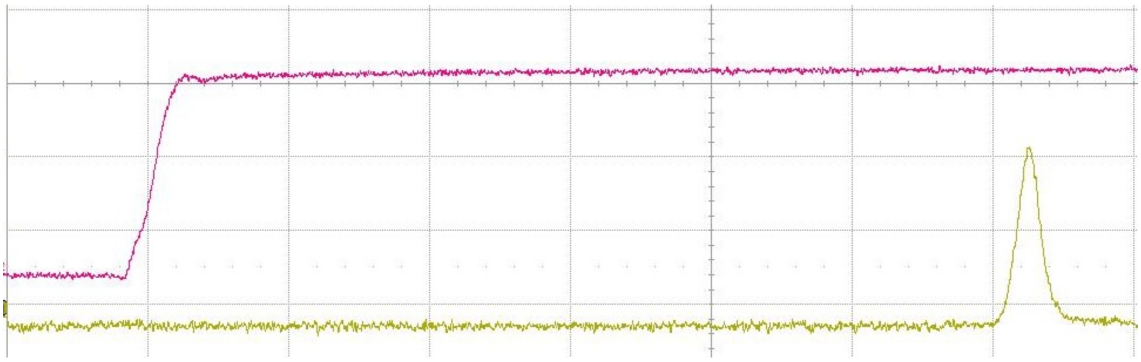

Figure 24 External synchronization – QSW IN & optical pulses

A zoomed in portion of the previous figure. Red – QSW IN, yellow – optical pulse.

7.9. External Interlock

External interlock ability is provided through the DB9 sockets EXT1 on the rear of the 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 *NT252* 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.

Note:
BBO/LBO crystals are highly hygroscopic. To prevent condensation they must be maintained constantly at an elevated temperature. For this, crystal heaters are equipped with their own separate power supply circuit that must be kept turned on at all times. Do not unplug the NT242 system power supply from mains. Leave it connected, when the work is over and the device is switched off.

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 required 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 10-30 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.
7. Select parameters:

- Laser output mode:
  - Access **Energy level** submenu on the laser control pad.
  - Press the button ▲ or ▼ to switch the laser mode between '*Adj*' (reduced energy), '*Max*'(maximal energy) and '*Off*' (no output).
- Synchronization mode:
  - Access **Synchronization** → **Synchroniz. mode** submenu on the laser control pad.
  - Press ▲ or ▼ to change synchronization mode. The indication **Internal sync. mode** means internal synchronization, **External sync. mode** – external.

8.1.1. Laser Operation in External Triggering Mode

Set EXT SYNC (external synchronization) using the Control pad or CAN Browser/Remote control application.

3.5...5 V positive pulses must be supplied to the SYNC IN connector (SMA) on the front panel of the power supply.

See 7.8 User Input and Output Signals (External Triggering) above for more information.

8.1.2. Laser Operation in Burst Mode

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

Use CANBrowser/Remote control 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.

8.1.3. Temporarily Stopping Laser Operation

> ***Attention!***
> ***The shutters of the beam apertures are not intended to be used as beam-stops. They are to be used when the laser is turned off, or in an emergency. Do not use the shutters to stop the laser beam is regular 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'*.

8.1.4. 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.

8.1.5. Turning 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.

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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. Maintaining Purity of Cooling Water

If a system stays inactivated for a prolonged period (month or more), in certain environmental conditions the cooling water may become infested with rapidly growing microscopic algae.

To prevent this infestation, completely flush the system of the coolant and keep it dry for the period of inactivity.

> ***Attention:***
> ***EKSPLA does not accept responsibility for damage caused by algae infestation if the system was left without proper maintenance for a prolonged period of time.***

9.2. Regular Maintenance

9.2.1. Schedule

> *Note:*
> *See separate manuals of external chiller and gas generator for their maintenance instuctions.*

- **Weekly**

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

9.2.2. 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.

9.3. Preparation for Transportation

Before transporting the laser:

1. *(water cooled systems only)* Remove the water from all water pipes and the cooling system.
2. *(water cooled systems only)* Flush the cooling system with a 40% ethyl alcohol and water mix. Then remove the mix.
3. Carefully repack the laser in the same way as it was packed by the manufacturer. Please follow the original packing list.

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The Troubleshooting Guide provides information and solutions for potential problems with *NT252* 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. Error List (Contents of ERROR.TXT)

Table 11 Errors

Module name and CAN ID	***Error name***	***Error code***	***Short explanation***
C1 :54		8H	Overtemperature warning
C1 :54		4H	Fault
C1 :54		2H	No Motor Power
C1 :54		1H	Motor Home error
SH1 :53		8H	Overtemperature warning
SH1 :53		4H	Fault
SH1 :53		2H	No Motor Power
SH1 :53		1H	Motor Home error
SOPO :52		8H	Overtemperature warning

Module name and CAN ID	Error name	Error code	Short explanation
SOPO :52		4H	Fault
SOPO :52		2H	No Motor Power
SOPO :52		1H	Motor Home error
FOPO :51		8H	Overtemperature warning
FOPO :51		4H	Fault
FOPO :51		2H	No Motor Power
FOPO :51		1H	Motor Home error
LDCO48BP:50	TECDrvOT	1000H	TEC driver overheat
LDCO48BP:50	TECDrvEr	200H	Warning:TEC driver overcurrent/undervoltage
LDCO48BP:50	PowerDwn	100H	PowerDown
LDCO48BP:50	TSensor	1H	Temperature sensing limit
LDCO48BP:48	TECDrvOT	1000H	TEC driver overheat
LDCO48BP:48	TECDrvEr	200H	Warning:TEC driver overcurrent/undervoltage
LDCO48BP:48	PowerDwn	100H	PowerDown
LDCO48BP:48	TSensor	1H	Temperature sensing limit
TK6 :44	PowerDwn	100H	PowerDown
HV40W :40	HVMAXCUR	1H	Overcurrent protection
M_LDCO48:34	TECDrvOT	1000H	TEC driver overheat
M_LDCO48:34	TECDrvEr	200H	Warning:TEC driver overcurrent/undervoltage
M_LDCO48:34	PowerDwn	100H	PowerDown
M_LDCO48:34	TSensor	1H	Temperature sensing limit
M_LDCO48:33	TECDrvOT	1000H	TEC driver overheat
M_LDCO48:33	TECDrvEr	200H	Warning:TEC driver overcurrent/undervoltage
M_LDCO48:33	PowerDwn	100H	PowerDown
M_LDCO48:33	TSensor	1H	Temperature sensing limit
MidiOPG :31		2H	Home Error L2 ! SRoshon. Rot 1.8°/64 600mA.
MidiOPG :31		1H	Home Error L1 ! FRochon. Rot 1.8°/64 600mA.
MidiOPG :31		40H	No Response cId54 ! Comp. MiniOPG Slave
MidiOPG :31		20H	No Response cId53 ! SH. MiniOPG Slave
MidiOPG :31		10H	No Response cId52 ! SOPO. MiniOPG Slave
MidiOPG :31		8H	No Response cId51 ! FOPO. MiniOPG Slave
LDCO48BP:29	TECDrvOT	1000H	TEC driver overheat
LDCO48BP:29	TECDrvEr	200H	Warning:TEC driver overcurrent/undervoltage
LDCO48BP:29	PowerDwn	100H	PowerDown
LDCO48BP:29	TSensor	1H	Temperature sensing limit
LDCO48BP:28	TECDrvOT	1000H	TEC driver overheat
LDCO48BP:28	TECDrvEr	200H	Warning:TEC driver overcurrent/undervoltage
LDCO48BP:28	PowerDwn	100H	PowerDown
LDCO48BP:28	TSensor	1H	Temperature sensing limit

Module name and CAN ID	*Error name*	*Error code*	*Short explanation*
M_CPU800:18	ERRLow	2000H	Rep. rate low
M_CPU800:18	EHmdTemp	1000H	Temperature limit exceeded
M_CPU800:18	Humidity	800H	Critical risk of condensation
M_CPU800:18	HumWarn	400H	Warning: Risk of condensation
M_CPU800:18	FlowIntl	200H	No coolant flow
M_CPU800:18	PowerDwn	100H	Power Down
M_CPU800:18	SrcMaxW	80H	Current Source Power Dissipation Limit Exceeded
M_CPU800:18	CoolIntl3	40H	Cooling Interlock 3
M_CPU800:18	CoolIntl2	20H	Cooling Interlock 2
M_CPU800:18	LDMaxIm	10H	LD Mean Current Exceeded
M_CPU800:18	LDMaxIp	8H	LD Peak Current Exceeded
M_CPU800:18	CoolIntl1	4H	Cooling Interlock 1
M_CPU800:18	ExtIntl	2H	External Interlock
M_CPU800:18	SlaveErr	1H	Slave module error
M_CPU800:17	ERRLow	2000H	Rep. rate low
M_CPU800:17	EHmdTemp	1000H	Temperature limit exceeded
M_CPU800:17	Humidity	800H	Critical risk of condensation
M_CPU800:17	HumWarn	400H	Warning: Risk of condensation
M_CPU800:17	FlowIntl	200H	No coolant flow
M_CPU800:17	PowerDwn	100H	Power Down
M_CPU800:17	SrcMaxW	80H	Current Source Power Dissipation Limit Exceeded
M_CPU800:17	CoolIntl3	40H	Cooling Interlock 3
M_CPU800:17	CoolIntl2	20H	Cooling Interlock 2
M_CPU800:17	LDMaxIm	10H	LD Mean Current Exceeded
M_CPU800:17	LDMaxIp	8H	LD Peak Current Exceeded
M_CPU800:17	CoolIntl1	4H	Cooling Interlock 1
M_CPU800:17	ExtIntl	2H	External Interlock
M_CPU800:17	SlaveErr	1H	Slave module error
CPU8000 :16	ERRLow	2000H	Rep. rate low
CPU8000 :16	EHmdTemp	1000H	Temperature limit exceeded
CPU8000 :16	Humidity	800H	Critical risk of condensation
CPU8000 :16	HumWarn	400H	Warning: Risk of condensation
CPU8000 :16	FlowIntl	200H	No coolant flow
CPU8000 :16	PowerDwn	100H	Power Down
CPU8000 :16	SrcMaxW	80H	Current Source Power Dissipation Limit Exceeded
CPU8000 :16	CoolIntl3	40H	Cooling Interlock 3
CPU8000 :16	CoolIntl2	20H	Cooling Interlock 2
CPU8000 :16	LDMaxIm	10H	LD Mean Current Exceeded
CPU8000 :16	LDMaxIp	8H	LD Peak Current Exceeded

Module name and CAN ID	Error name	Error code	Short explanation
CPU8000 :16	CoolIntl1	4H	Cooling Interlock 1
CPU8000 :16	ExtIntl	2H	External Interlock
CPU8000 :16	SlaveErr	1H	Slave module error

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.

11.1. System Identification

Model **NT252-1K-SH-DRY**

Serial No **PGD217**

11.2. Components

Table 12 System electrical components

Component Name	***Type***	***Serial Number***
Power supply	PS81120MSSRp	19-1017
Power supply	PS81120SR	19-1018
Laser diode	JOLD 120-QPXF 2P	PP_19047
Laser diode		PP_19027

Table 13 System optical components[1]

Component Name	Name in layout	Characteristics/Code
NL210 series laser		
Fiber	Fiber1, Fiber2	P5LWP-WF600/720/HP-5M-SMA
Fiber adapter	-	P5BND-BND-SMA905-ADS-56
Collimator	COL1	P5BK7-BK7LO43X005618-SA0
	COL2	P5BK7-BK7MO43VX00328-AA0
Window	W1	P5BK7-BK7AO731-AA0
Mirror	M1, M2	P5UVS-UVSAR538-H05
	M3, M5	P5UVS-UVSAR5318-SA5-P
	M4	P5BK7-BK7SO75X11001-0H0
	M6	P5BK7-BK7SO75V08001-0H0
	M7	P5BK7-BK7AR561-H05
Laser rod	LR1	P5YAG-G05N3-12W0/0A18/18
Quarter-wave plate	QWP1, QWP2	P5KKV-KKVTO4CL41-AA0
Polarizer	P1, P2	P5UVS-UVSAR56D1-PA5O

[1] Labeling according to Figure 6 and Figure 5.

Component Name	Name in layout	Characteristics/Code
Pockels cell	PC1	P5BBO-BBOXS0420Z1-AA0
Harmonics generation and guiding optics		
Mirror	M1, M2	P5UVS-UVSAO861-H05
	M3…M5	P5BK7-BK7AO8621-SA5-S
	M9	P5BK7-BK7AR562-H15
	M10, M11	P5UVS-UVSAO861-H05
	M12	P5BK7-BK7AR562-H15
	M13	P5BK7-BK7AO862-H05
Lens	L1	P5BK7-BK7LO73X00801-AA0
	L2	P5BK7-BK7LO73V00751-AA0
Crystal	SH1	P5BBO-BBOSJ110812F7JCC35E-
Plate	PL1	P5BK7-BK7AO752-A00
Tunable parametric stage		
Plate	PL2	P5BK7-BK7AO752-AA0
Mirror	M6	P5BK7-BK7AR532F7J-S05-S
	M7	P5BK7-BK7AO752GI15GJ-SD0
	M8	P5BK7-BK7AO75F8J3-H00
Crystal	OPO1	P5BBO-BBOJ295E142F8TC-AA-1
	OPO2	P5BBO-BBOJ295E142F8TC-AA-2
Prism (Rochon)	RP1	P5BBO-BBOPO08A9UE-RH
Aperture	AP1	P5FIL-N12FOO92D9
Filter	F1	P5FIL-IK5FAO72F8TC-SA0
SH		
Lens	L3	P5BK7-BK7LO73X1000
Half-wave plate	HWP1	P5KKV-KKVTO41A2KT-AA0
Compensator	C1	P5UVS-UVSCR100812GF8J-AA0
Crystal	SH2	P5BBO-BBOSJ110812F7JCC35E-
Prism (Rochon)	RP2	P5BBO-BBOPO08A9UE-RH