EKSPLA

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Tunable Diode Pumped Laser System

NT252-1K

TECHNICAL DESCRIPTION
&
USER'S MANUAL

2017
Lithuania

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GENERAL SYSTEM INFORMATION

Section 2

PULSED ND:YAG NL210 SERIES LASER

SECTION 1

GENERAL SYSTEM INFORMATION

SECTION 1

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*Chapter 10 and Chapter 11 might not appear in PDF version of this manual; they may be available as separate file(s).

WARRANTY

The Warranty section provides general warranty information.

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*.

Note:
Small coating inhomogeneities of optical components and color change/discoloration marks are signs of light-material interaction during normal operation and as such are not to be treated as defects, as long as specified output parameters of device are not altered.

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

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Components

Nd:YAG Laser unit **SN PGD188**	1
Power supply *PS81120SR*	1
Power supply *PS81120MSSRp*	1
Control pad	1
CD with software for PC	1
User's manual	1
Set of cables	1

STANDARD SPECIFICATIONS

Pump laser requirements

Wavelength	**1064 nm**
Pulse width	4…7 ns
Pulse energy	~10 mJ
Pulse energy stability, RMS	0.5%
Pulse repetition rate	1000 Hz
Beam divergence	< 5 mrad (full angle @1/e^2)
Beam profile	TEM_{00}
Polarization	horizontal
Jitter RM S (with respect to INT SYNC pulse)	< 0.5 ns
Jitter RMS (with respect to EXT SYNC pulse)	< 0.5 ns
Beam profile	Close to Gaussian
Wavelength	**532 nm**
Pulse width	4…7 ns
Pulse energy	>5 mJ
Beam profile	Close to Gaussian

OPG output specification

Tuning range:	532 nm 669…1064 nm 1065…2600
Pulse duration	3…5 ns
Polarizations: 532 nm 669…1064 nm 1065…2600 nm	 Vertical Horizontal Vertical
Output beam mode	TEM_{00}

OPG general specification

Power	100-240 VAC, 47-63 Hz
Required power	≤ 1500 W
Dimensions: *NT242* *PS81120SR+PS81120MSSRp Series power supply*	 See Figure 2-1 (W×H×L) 520×286×400
Weight *NT242* *PS81120 Series power supply*	 ~60 kg ~40 kg

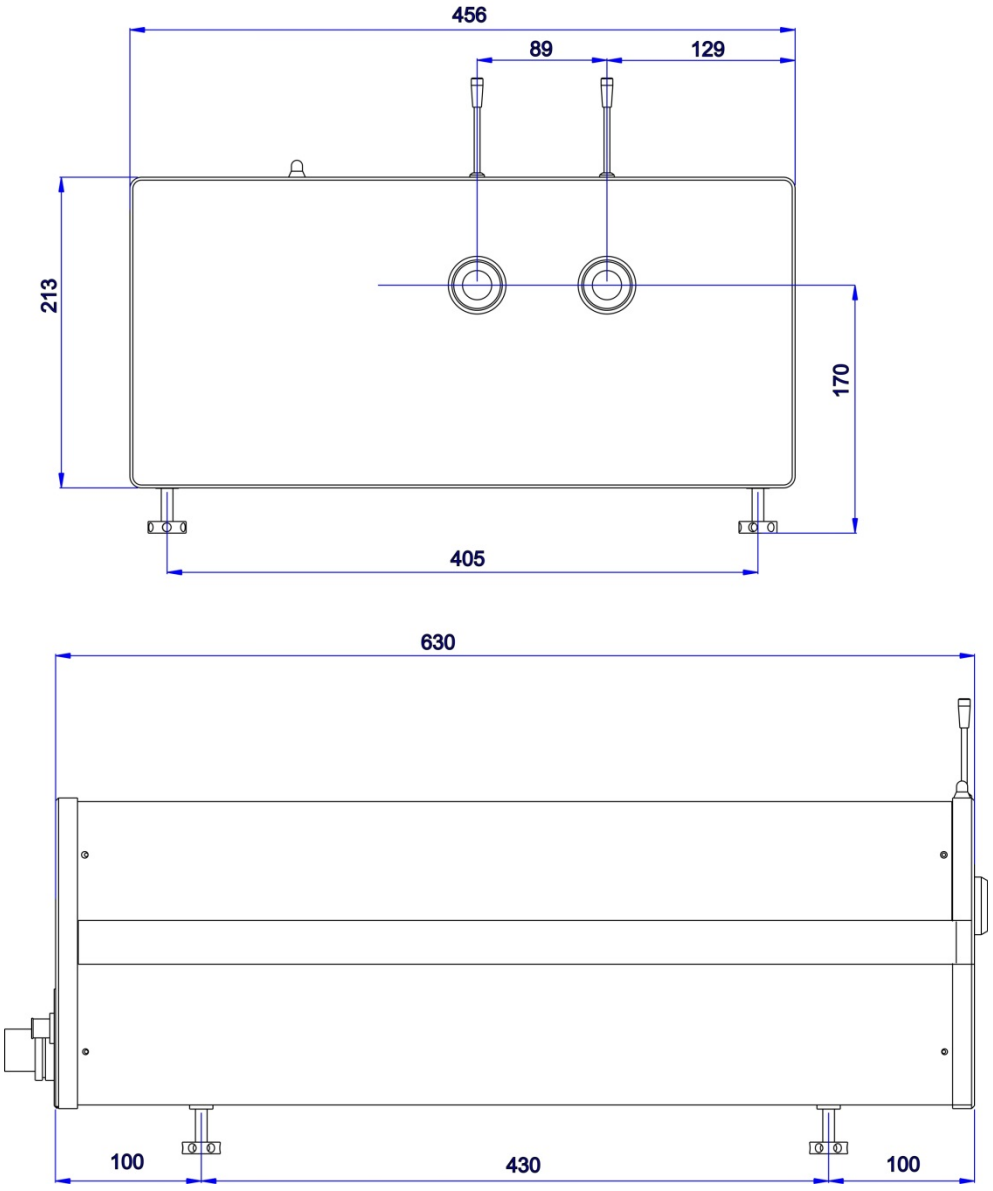


Figure 2-1 Outline drawings of *NT242* system

SAFETY

The *Safety* chapter provides information about safe handling and usage of the *NT242* laser system.

Safety Features and Government Requirements

This laser is a fourth class laser product according to the degree radiation danger, and by definition, relates to certain safety and fire hazards. 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 EN-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.

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).

Labeling

This manual contains user information for the *NT242* laser system. Read this manual carefully before operating the laser system for the first time. Special attention should be given to the material Chapter 3, *Safety*, which describes the safety features built into the laser.

The further listed are the labels attached to the equipment.

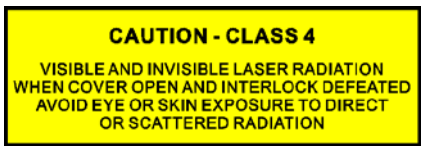
Laser Radiation Warnings

①

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

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

②



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

③

An **aperture label** is located above the system apertures with an arrow pointing to the aperture.

④

Laser hazard label is located on end panel of laser system cover, beside the output aperture.

Electrical Warnings / Identifications

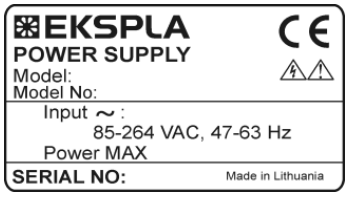
⑤

A **product certification and identification label** is located on the end panel of laser system frame, near the power supply conduit.

⑥

Electrical shock label is located on the cover of high voltage driver on the top of laser head.

⑦

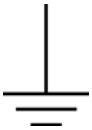


A **product certification and identification label** is located on the rear panel of power supply.

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.



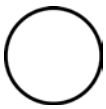
Earth (ground) TERMINAL symbol.

PROTECTIVE CONDUCTOR TERMINAL symbol.

Alternating current symbol.

Three-phase alternating current symbol.

On (Supply) symbol.



Off (Supply) symbol.

Do Not Touch symbol.

(Do not attempt to justify a 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.

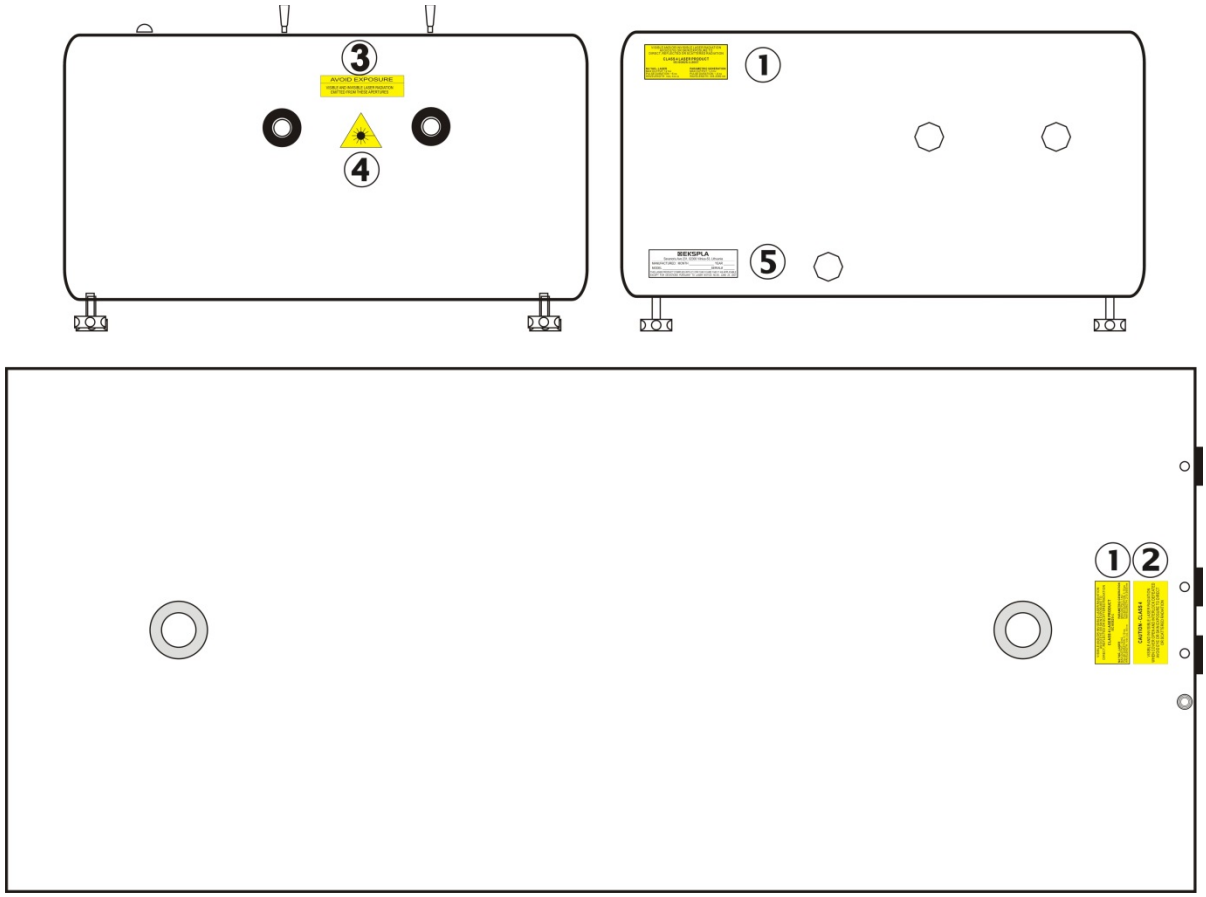


Figure 3-1 General positions of warning labels on the *NT242* laser system (example)

Laser Radiation

The wavelength emitted by a particular laser system is specified on the warning label. All reflections, whether specular or diffuse, from optical components such as steering mirrors and prisms, are dangerous. The 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 parts of the body 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 to only 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 such a way that 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 Section 1 Chapter 3, *Safety*.

Electrical Safety

When you operate the equipment with all safety covers in place, the controls available on the power supply cabinet do not present an electrical hazard. The equipment **must not** be operated with any covers removed and/or interlocks by-passed or defeated. Only qualified personnel can access the equipment.

Do not operate with suspected failure. If you suspect there is damage to this laser, have it inspected by qualified service personal.

Use only the power cord specified for this laser and certified for the country of use.

This power supply is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground.

Use only the fuse type and rating specified for this power supply.

Safety Guide

1. Set up controlled access areas for laser operation.
2. Limit access to the laser to personnel whose presence is 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. Be especially careful when working with IR radiation. Although you cannot see it, this radiation can focus on the retina and cause damage.

PRINCIPLE OF OPERATION

Principle of Operation of *NT242* System

Tuneable Nd:YAG Laser System comprises of the pump laser *NL210*, harmonics generator (SHG), optical parametric oscillator (OPO) in a single device.

The optical layout of the *NT252* system is presented in Figure 4-1 below.

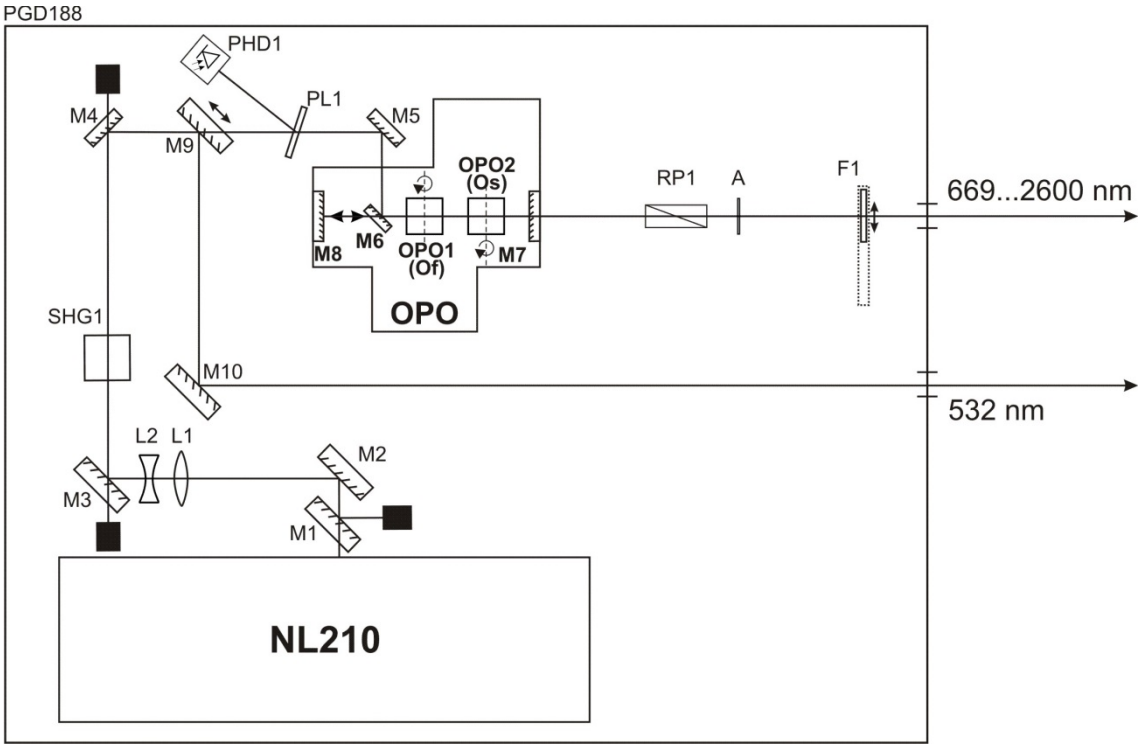


Figure 4-1 Optical layout of the system

The fundamental 1064 nm beam is directed towards the second harmonic generator SHG1. Mirrors M9/M10 direct the 532 nm radiation to the output.

The SHG radiation pumps the optical parametric oscillator (OPO).

The OPO 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 15% conversion efficiency when pumped by second harmonic of a pulsed Nd:YAG laser. The pumping beam is directed by dichroic mirrors to *OPO* cavity. The *OPO* resonator consists of mirrors M7 and M8. Wavelength tuning is achieved by rotation of nonlinear crystals OPO1 and OPO2. Part of 669…2600 nm wavelengths energy is emitted through the mirror M7 towards the output.

Rochon prism RP1 separates the signal wave from the idler. The filters partially clean the spectrum.

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.

OPERATION CONTROLS

There are two ways to control the device: from its control pad and by external PC through RS232 serial interface. Before operating the device, study this chapter carefully.

Initialization

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 (before the power was switched off) and awaits the further commands.

Control from Control Pad

To enable the control pad, it must be connected before switching on device power. The connector for linking the control pad is socket CONTROL PAD on the front of the power supply unit.

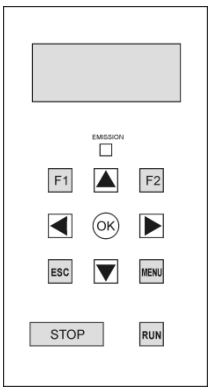


Figure 5-1 Control Pad

Figure 5-1 shows the control pad. This pad contains eleven buttons and an alphanumeric display.

The upper part of the display is intended for PG control and the lower part – for the pump laser. You can switch between PG and pump laser by pushing button ESC for more than 2 sec.

Push-button MENU sets and executes commands. Push-buttons ▲, ▼, ◄ and ► tune the wavelength, drive motors and select commands.

The device manages crystal angles automatically. To obtain output at the required wavelength, simply switch the device on and enter the wavelength value using buttons ▲, ▼, ◄ and ►.

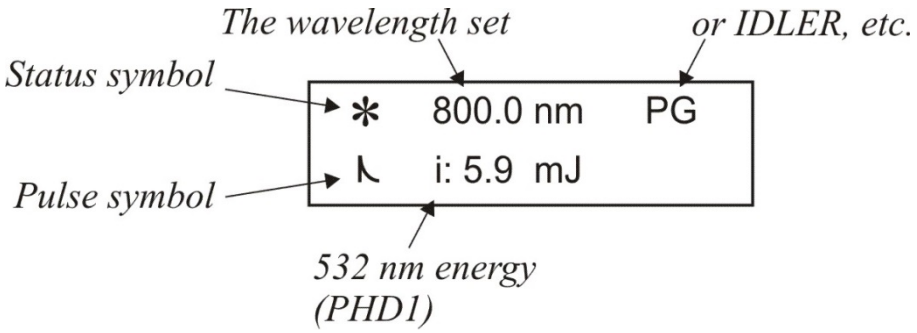
The button MENU provides access to individual components of the device and permits changing regimes of operation. Changing regimes should only be done by a person familiar with operation of the device.

To select the required command, use push-buttons ▲, ▼, ◄ and ►. To execute the command selected, push the button MENU.

Description of Commands

Home window (setting of wavelength)

The display shows:



Status symbol

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

⧖ – The nonlinear crystals are being tuned by stepper motors

► – Wavelength setting

! – 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.

Display shows an average energy of the last 1 pump 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 energy is reduced to the level allowed, push any button to proceed.

Control from UniPG software

Positions of designated optical elements 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/required wavelength tables. Please refer to *UniPG* manual for general information about its use and interface.

All crystals are positioned according to the table 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 as needed, using *UniPG*. All positions below are given at the set wavelength:

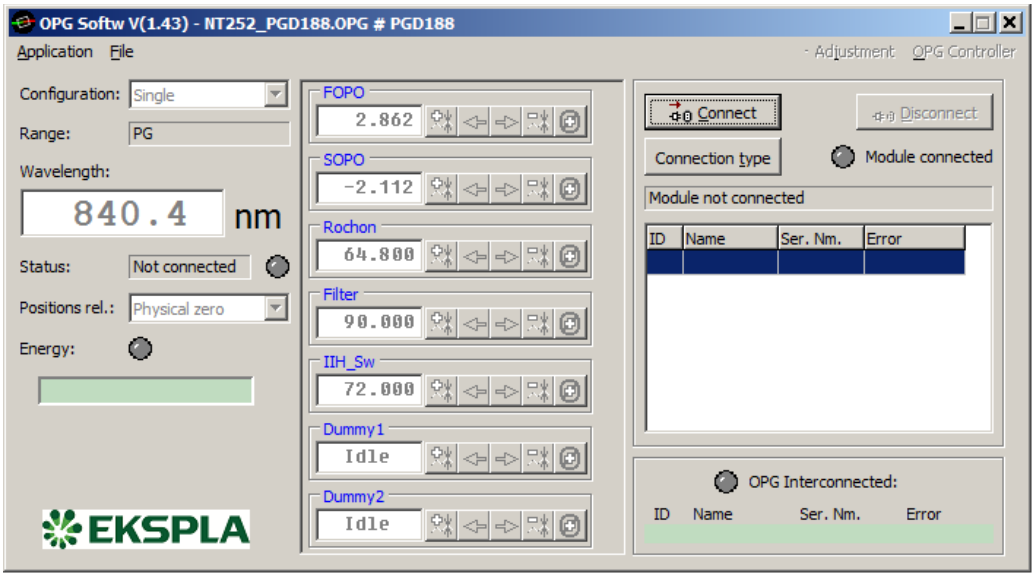


Figure 5-3 UniPG control interface

FOPO – position of first OPO crystal.

SOPO – position of second OPO crystal.

Rochon – position of first Rochon prism RP1.

Filter – position of F1.

IIH_Sw – position of mirror M9.

Dummy1 not used.

Dummy2 – not used.

SETUP PROCEDURE

Note:
Pease read and understand the previous chapters before proceeding with this chapter.

Attention:
Remember that this device is a complex product requiring a certain personnel experience to perform the service adequately. So, we would highly recommend to call for EKSPLA assistance at laser installation (or an assistance of authorised serviceman).

General Requirements

You must not attempt to start up the laser system prior to installation by *EKSPLA* personnel. Damage occurring due to usage before installation is not covered by the *EKSPLA* warranty.

1. Inspect the shipping container for damage related to transportation. If any damage is present, inform *EKSPLA* and the transportation agency immediately.
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 the laser. Inspect it for presence of all components and for damage related to transportation. If any damage is present, inform *EKSPLA*.

The laser and auxiliary units must be placed in an area void of dust and aerosols. Ensure that the installation area complies with the following environmental specifications:

Altitude:	Up to 3000 m
Temperature:	within 18–25 °C
Humidity:	below 80% at temp. below 31 °C
Air contamination level	ISO 9 (room air) or better
Polution degree	1: no pollution or only dry non-conductive pollution
Mains supply voltage fluctuations	Within ±10% from nominal

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

Position the laser system on a solid worktable with access to the laser from all sides.

The actual line power required is specified in the laser technical protocol and on the equipment labeling. The equipment must be operated only from the line power stated. You cannot change the supply specifications.

The equipment must be adequately grounded.

Connecting

1. Fix the laser system to the optical table. Place the power supply near the laser system in a convenient place.

2. Do not install the system in an environment where other equipment is likely to cause a high ambient temperature. The system operates efficiently with an ambient temperature of up to 35°C. Above this temperature, the cooling capacity will not be maintained, as the refrigerant cannot be sufficiently cooled.

3. The power supply unit must be installed in such 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.

4. Interconnect the *NT252* laser system with the power supply:

    - Connect cable to connector LASER on power supply PS81120MSSRp.
    - Connect cable to the socket QSW OUT1 on PS81120MSSRp.
    - Connect the coolant pipe from *NT252* to OUT on the power supply unit PS81120WSR (the flow direction arrows must point from the power supply unit towards the laser).
    - Connect the coolant pipe from *NT252* to IN on the power supply unit PS81120WSR (the flow direction arrows must point towards the power supply unit).

5. Connect socket QSW OUT2 on PS81120MSSRp to socket SYNC IN on PS81120WSR.
6. Interconnect the power supplies using the COOLING INTERLOCK cable.
7. Interconnect LDD sockets on PS81120WSR and PS81120MSSRp.
8. Close the EXT1 socket on PS81120MSSRp with shorting plug (marked EXT1).
9. Connect the control pad to CONTROL PAD socket on the front panel of the power supply.
10. Connect power supply units to the mains.
11. Fill a reservoir following instructions in Chapter 7.

Warning:

Do not operate coolant system below air condensation temperature (dew point) at laser head. Condensation on the diode arrays can seriously damage the pumping heads.

12. *NT252* might also be connected to an external PC by a cable supplied with the device. See Appendix A and contents of CD for details of operation from PC.

Warning:

Connect/disconnect the power cable to/from the device only with power off!

13. Relieve the bolts fixing the rear end panel to the inner breadboard pedestal to the extent (roughly for 90 degrees) that it can move freely a little. This makes breadboard less sensitive to tensions caused by thermal expansion of the panels.

    Do not relieve the front panel bolts (Figure 6-1) because this model has a fiber connector. The fiber connection will be affected if the bolts are released. Release the bolts of the rear end panel only.

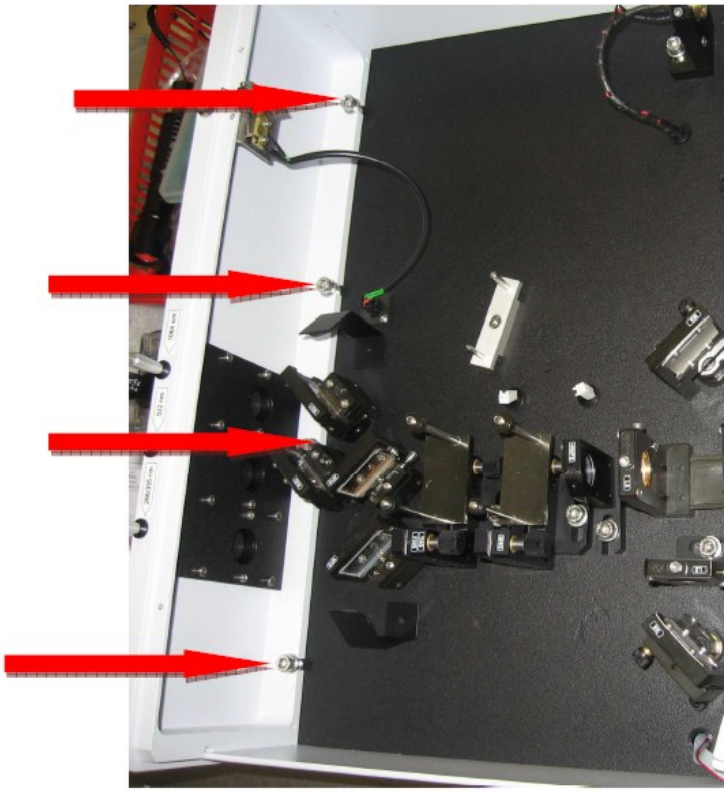


Figure 6-1 Do not relieve the fixing bolts of the front panel; relieve only the bolts of the rear panel

14. Use purge port to fill the system with inertial gases when needed. It is used to fill THG and OPO unit frames.

Attention:
Contact EKSPLA for the specifications of the required inert gases. Warranty void if the system is filled with gases without prior consulting with an EKSPLA engineer.

15. Switch the power switch to *ON* position on both power supply units.

16. Switch the key switch to ON position.

Installation

To put the device into operation, follow the sequence of steps:

1. Switch on the cooler.
2. Switch the *NT252* system on by turning the key on the PSU. Control unit starts self-testing and *Power On* sequence of procedures. If everything completes OK, the device will stop in a position as before the last power switching off. If not, the control pad displays a message '...ERROR...' (See Chapter 8 of this Section).
3. Set the device to 532 nm (set *IIH* on control pad) and check that the output energy is according to *Testing Data*.
4. Set the device to 800 nm wavelength and check that the output energy is according to *Testing Data*.

5. Switch on the pump laser *NL210* and run it in **Max** mode (see Chapter 2 in *NL210* laser's manual).
6. If energy level is too low, adjust the temperature of harmonic crystals (use Remote Control Application or CAN Browser).
7. Set the required pump energy not exceeding the maximum allowed value.
8. Check if the device generates specified output energy in its entire range according to *Testing Data* (see Chapter 9 of this Section). Check output energy at several wavelengths only.

Set up of *OPO*

Attention:
The OPO is very sensitive to the input energy value. To avoid damage of optical components, constantly control the pump energy: whether performing the calibration or set-up procedure and in routine operation as well. In any case, it must not exceed the maximum value specified in Chapter 9 Testing Data of this Section. Follow this requirement rigorously!

Routine operation

Important:
The upper energy limit of 355 nm pump pulses is determined from the point of probable damage of some optical components. This device was tested with maximum average pump energy specified in Chapter 9 of this Section. We do not recommend exceeding this value.

1. Open the output shutters by pulling the knobs up.
2. Wait until *NT252* starts.
3. Switch on the pump laser and run it (see the laser manual for details).
4. Set the minimum pump energy sufficing your application by adjusting ***Tadj delay*** or using external polarizing attenuator.

Note:
If the control unit beeps and indicates a pump energy limit fault, you will need to reduce the pump level below the maximum allowed level that is indicated on the factory settings page of this manual. Once this is done, push any button and proceed with your work.

Note:
As the nonlinear crystals are heated by the pump beam inside the NT252, it will take 20-30 minutes of warm up time after turning on the pump laser or making an energy change for the output energy and wavelength to stabilize. The pump specifications for the NT252 are specified in Chapter 2. Note that changes to other pumping energies may affect the wavelength of your output.

5. Select the required wavelength from *Home* window on the control pad display (see in Chapter 5 *Home window (setting of wavelength)*).
6. After your work is finished, close the shutters.

Attention:
Do not unplug the power cable and Power Supply from mains! Leave it connected at all times. The green LED on the side of system frame must remain lit, indicating that crystals heaters are on.

MAINTENANCE

Attention:
Only qualified personnel should attempt maintenance.

Maintenance Schedule

- **Daily**

After your work is finished, do not forget to close all the shutters (lower the knobs).

- **Weekly**

- thoroughly inspect all optical components. If dust is found on their surfaces, blow it away with a blower (blower-brush).

- inspect coolant level in reservoir gauge. It should be between the MIN and MAX level markings.

- **Monthly**

- check for water leaks.

- check all external hose connections for damage or loosening.

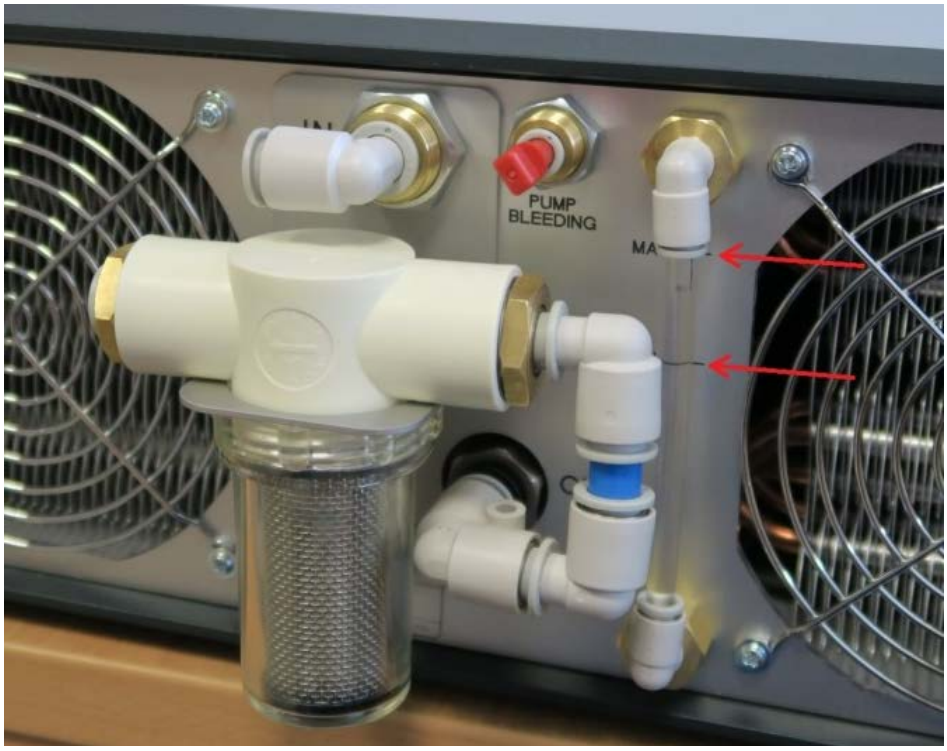


Figure 7-1. Coolant level should be between the MIN and MAX level markings

If the coolant level is below MIN, add coolant to the system:

- Use a standard 20ml disposable syringe without the needle attached.
- Fill syringe with distilled/deionized water.
- Disconnect the upper end of the reservoir gauge tube and attach the syringe.
- Empty syringe into the tube.
- Reattach the gauge tube.

Figure 7-2. Adding coolant to the system using a syringe

Power Supply Coolant Maintenance

Use clean water and clean utensils. The recommended coolant is distilled/deionized water.

Do not turn the laser ON while cooling loop is empty, because pump will run dry and will be damaged.

Even after purging cooling loop with air, coolant is not removed completely. Look out when disconnecting tubes from power supply or amplifier head in order not to spill the coolant on sensitive parts.

In case of coolant freeze, do not turn the laser on. Place power supply below the laser head. Remove blanking plug from PUMP BLEEDING, air release valve. Let the laser to warm up. Drain the coolant. This may save expensive laser diodes from drowning. Send amplifier head to service.

In case of freezing temperatures is real threat, ask service for coolant mixture recommendations. Do not leave the laser in power on position as a short term solution for freezing threat. Single mains voltage sag may send the laser into power off mode.

Coolant replacement

a) Devices and materials required

- Distilled/deionized water, minimum 0.9l.
- >= 1l jar for coolant draining.
- Utility pump. Use supplied hand-operated water pump.
- Several sheets of paper towel.

Attention:
Corrosion caused by improper coolant voids the warranty.

b) Draining the coolant

1. Disconnect laser from the mains.

2. Small spills may happen, therefore several sheets of paper towel under the coolant connectors are recommended.

3. Disconnect tube from OUT/TANK FILL connector. Plunge tube stump in to a jar and hold it low. Connect utility pump to OUT/TANK FILL connector.

Figure 7-3. PS8000 coolant replacement.Ready to purge

4. Make ~10 pump strokes to purge system with air.

5. Disconnect upper end of a reservoir gauge tube and turn the tube upside down. Keep jar under the tube.

Figure 7-4 PS8000 coolant replacement.Ready to purge reservoir

6. Let the coolant drain out. Repeat several pump strokes to purge tube with air.

7. Connect reservoir gauge tube back.

8. Inspect the coolant. It should be colorless and clear. Cloudiness may indicate algae grow, color - corrosion. Both require treatment, contact service for instructions.

c) Filling the laser with coolant

1. Fill jar with minimum of 900ml of distilled/deionized water.

2. Skip the next step in case you are replacing coolant.

3. Disconnect tube from OUT/TANK FILL connector. Plunge tube stump in to a jar. Connect utility pump to OUT/TANK FILL connector.

4. Plunge suction tube stump of the pump in to a jar and hold it immersed.

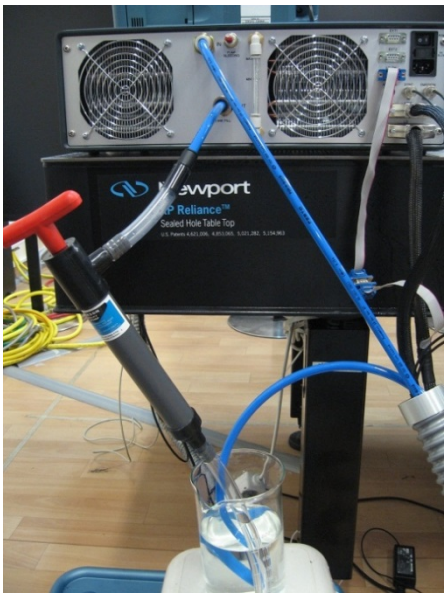


Figure 7-5. PS8000 coolant replacement.Ready to fill

5. Make ~10 pump strokes to fill the system with coolant.

6. Rise tube stump just above the cover of PS8000. Remove blanking plug from PUMP BLEEDING air release valve.

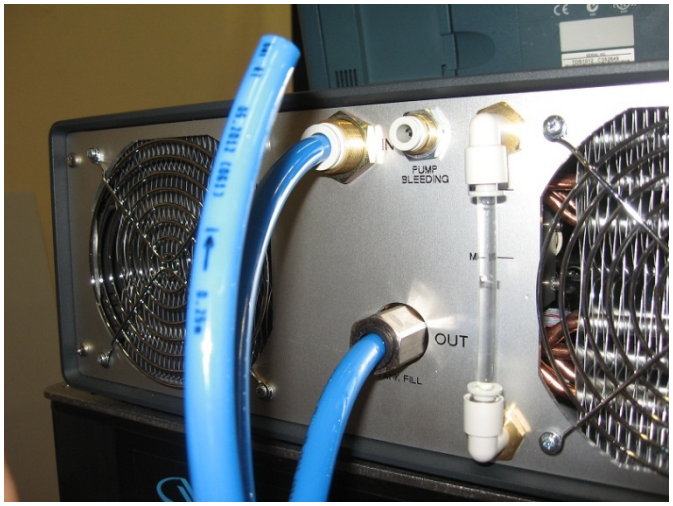


Figure 7-6. PS8000 coolant replacement.Full tank

7. Slowly make about half of stroke with the pump while keeping eye on MIN-MAX reservoir gauge. Stop when MAX level will be reached. You may need to flick gauge tube several times in case the water column is mixed with air.

8. Disconnect pump and reconnect the tube. Do not drain the pump while not sure about final liquid level.

9. When connecting water hoses to PS8000 cooling unit make sure that at least 20 mm of the hose gets into the connector. If not connected properly internal valve will remain closed and water will not flow through the loop.

10. Connect laser to the mains. Turn the mains switch ON. Turn the key-switch ON (laser head).

11. Watch for reservoir gauge level not fall below MIN.

12. In case level is too low, disconnect laser from the mains, reconnect pump and while holding tube stump high add liquid to MAX level again.

Replenish the laser with coolant (if no external chiller is used)

- Use a standard ≥20 ml disposable syringe (without needle).
- Fill syringe with distilled/deionized water.
- Disconnect the upper part of the reservoir gauge tube and attach the syringe.
- Empty syringe into the tube.
- Reattach the gauge tube.

Figure 7-7. Attach the syringe to the upper part of the reservoir gauge tube

Inspection & cleaning of optical surfaces

A dust particle or dirt, if not removed in time, may cause costly damage of optical surfaces. Examine the cleanness of optics in the system regularly and with special care. Following you will find details of how to maintain some critical components.

Open the cover of the system to access the output mirror. First, try to blow any detected dust particle(s) away using pressurised gas (filtered dry nitrogen). If to no avail, attempt cleaning surface with a lint-free cotton swab moistened with a few droplets of pure acetone or methanol.

Note:

Use cotton swabs only with wooden or plastic stems. In case the contaminants endure, the drag method of cleaning can be used. That is, slowly drag a lens tissue or cotton swab saturated with isopropyl alcohol (or methanol) across the surface. If done correctly, the solvent will evaporate uniformly without leaving any streaks or spots.

Caution:

Hygroscopic crystals, such as harmonic crystals must be cleaned only with a squirrel-tail brush, or dust may be blown away with a pressurised gas. In critical cases, use water-free pure ethyl-alcohol or butyl-acetate.

Maintaining Purity of Cooling Water

If a system stays inactivated for a prolonged period (month or more), in a 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 prolonged period of time.

TROUBLESHOOTING GUIDE

Following are some suggestions to assist you in locating the source of problems that may occur when operating *OPO.*

	Symptom	Explanation and remedy
1.	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 cable. Check for mechanical constraints. Press three buttons – ESC, MENU and OK – at once.
2.	Everything seems moving OK, nevertheless the generation is absent	Press three buttons – ESC, MENU and OK – at once.
3.	Beep alarm sounds, *"E lim" + name of the sensor* indicated on control pad.	Pump energy limit exceeded. Lower the energy.
4.	Output wavelength differs from the set one.	Contact *EKSPLA.*

Various errors may be indicated through UniPG software, please consult software manual how to check for errors. If error is active please contact EKSPLA.

Note:

The confusion No.1 occurs, because of if the device has been turned on with either of motors uninstalled, that motor is not further controlled at all. Then that particular motor does not ever turn, and its axis is easily turned by hand.

The similar situation may occur if the device cannot turn the motors due to a mechanical hindrance.

SECTION 2

PULSED ND:YAG *NL210* SERIES LASER

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SECTION 2
CHAPTER 1

PRINCIPLE OF OPERATION

Laser Optical Components

The *NL210* laser head (see Figure 2-2-1) comprises:

- Laser rod R.
- Pockels cell PC.
- Cavity mirrors M4 and M6.
- Beam polarization optics P1, P2 and QWP1, QWP2.

Master Oscillator

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 is maximum essentially holding off the laser under threshold when the pumping starts. At the end of pumping pulse, the cavity is closed, applying 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.

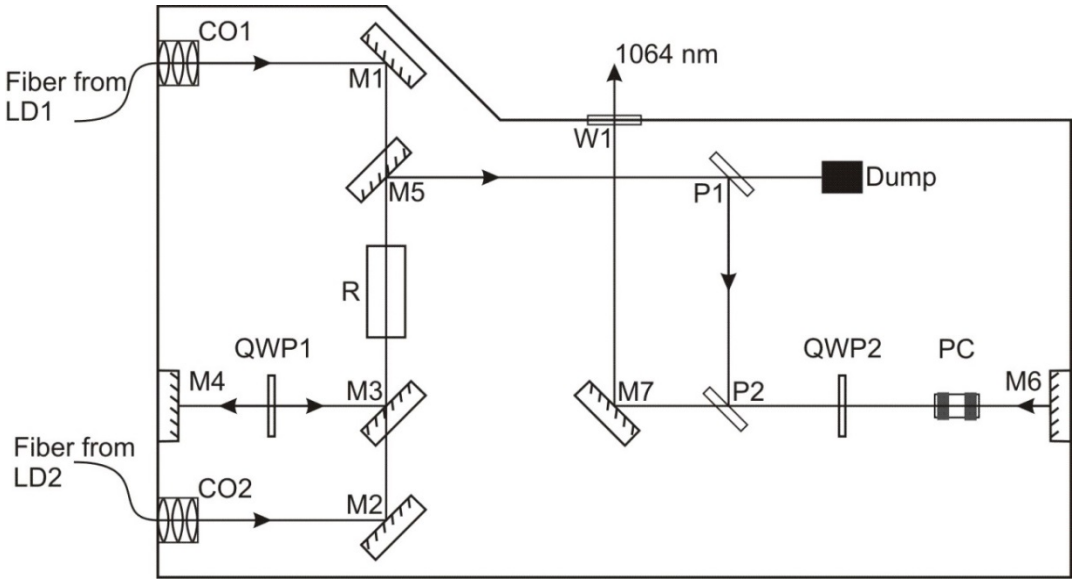

Figure 2-1-1 NL210 master oscillator optical layout

SECTION 2
CHAPTER 2

LASER CONTROL

There are several options of *NL210* control:

1. By the remote control pad connected to the power supply.
2. By the PC USB connection. USB port is located on the front of the power supply.

Detailed information on interfacing of *NL210* series laser to an external computer over the RS232 or USB connector is provided on a software CD.

An optional USB-CAN-LAN-RS232 CONVERTER module is installed into the power supply unit front panel (#10-14 in Figure 2-2-1) Consult its manual for installation and routine operation using the Converter.

Power supply

The front panel controls (see Figure 2-1-1 below):

No.	Control	Function
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 50us to 20ms 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.
9	RS232 connector (DB9M)	Use is optional.

No.	Control	Function
10… 14	USB-CAN-LAN-RS232 CONVERTER	See separate manual for more information

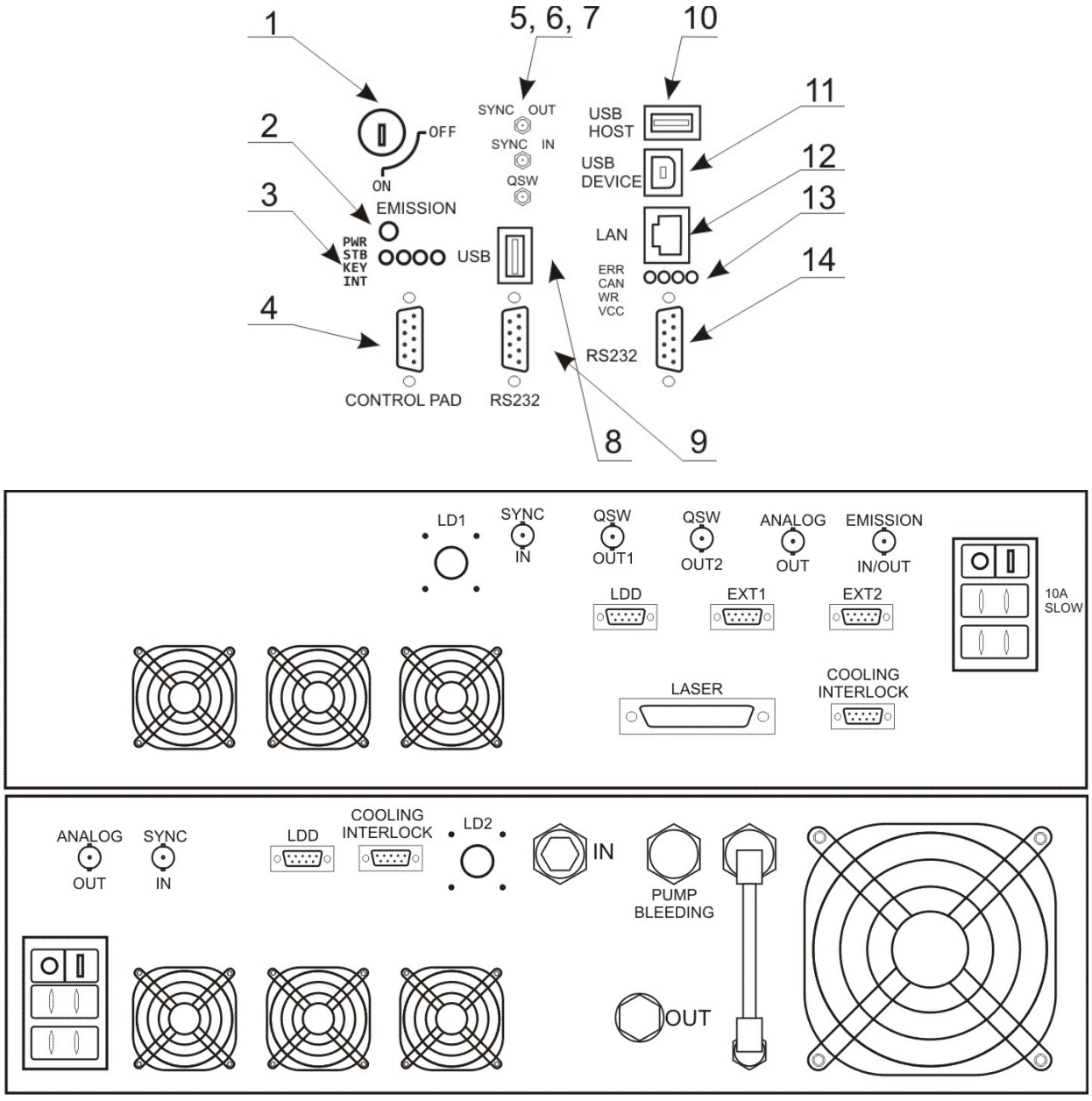

Figure 2-2-1 Front and rear view of the power supply

Note:

Power to the ovens (in which the parametric crystals are placed) remains on when the system is in stand-by mode to maintain a stable, elevated temperature for the parametric crystals.

The rear panel controls (see Figure 2-1-1):

Control	Function
PS81120MSSR	
LD1	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 PS81120WSSR
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.
PS81120WSR	
LD2	Fiber output.
SYNC IN BNC	Laser diode driver sync input.
ANALOG OUT BNC	Laser diode driver current sensor output.
COOLING INTERLOCK	Interlock connection for power supply interconnection.
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 10A slow.

Remote control pad

To enable the control pad, it must be connected to the power supply before power is switched on. The connector for the control pad is on the front panel of power supply *PS81120 Series* (see Figure 5-1).

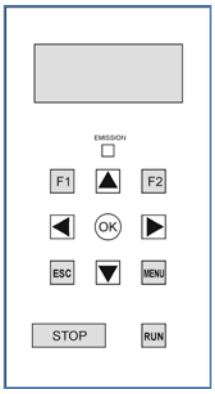

Figure 2-2-2 Control Pad

Figure 2-2-2 shows the control pad. This Pad contains eleven buttons and an alphanumeric display. Names of the buttons are: RUN (start), STOP, MENU, ESC (back), F1, F2, OK (enter), UP (▲), DOWN (▼), RIGHT (►), LEFT (◄).

To select menus press the key MENU. To select the required parameter, use arrow keys ▲, ▼. To execute the selected command, press the key OK.

Functional keys F1 and F2 are context sensitive. When there is an action possible to execute with these keys, the name of the action will be displayed as negative inverted caption in a lower left or right part of the screen respectively.

Pushing the key ESC at any menu point returns you one level back.

An indicator “EMISSION” on the control pad indicates that laser operates.

The remote Control Pad provides access to several functions:

- START/STOP optical pulsing
- Adjust the laser output pulse energy
- Set INTERNAL/EXTERNAL triggering mode
- OPEN/CLOSE external shutter
- Readout of LD current.

A structure of user’s interface of control pad is following: *Main window* → *Main menu* → *Submenu* → *Reading/Setting of parameter*. The submenu may be optional.

After turning on the power supply the control pad display shows a main window having **A**, **B**, concatenated **C** and concatenated **D** fields (see Figure 2-2-3).

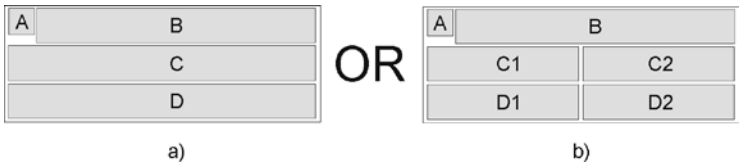

Figure 2-2-3 Main window of control pad

A field **A** is a laser status symbol field. The following symbols can be displayed:

- Laser operation is stopped and it is not ready for operation. It must to wait.
- Laser operation is stopped but it is ready for operation.
- Laser is operating but something is switched off, *e.c.* QSW.
- Laser is operating.
- An error. See list of errors in this chapter below.

Fields **B**, **C**, **C1**, **C2**, **D**, **D1** and **D2** are programmable by user.

Long fields B, C and D have the advantage over the short fields C1, C2, D1 and D2 because the information is given not concise in long field. However you can see more information having short fields than long fields at the same time.

Navigation between the fields is doing by pushing the arrow keys RIGHT/LEFT. A cursor (solid board right-angled) moves in this way: *hidden-B-C-C1-C2-D-D1-D2-hidden-….* *Hidden* is used for hide the cursor.

Press the key MENU on the control pad after choosing a field. Main MENU window will appear (see Figure 5-4). Whole menu tree is shown on Figure 2-2-4.

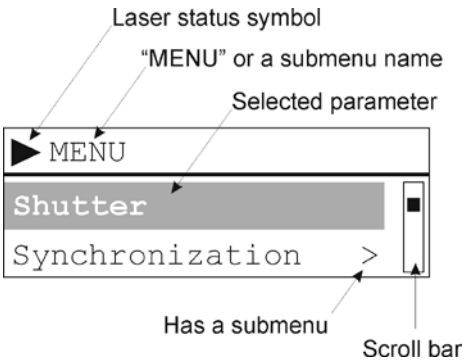

Figure 2-2-4 Main MENU window

On the main MENU window you can choose a preferred parameter using arrow keys UP/DOWN then press OK etc.

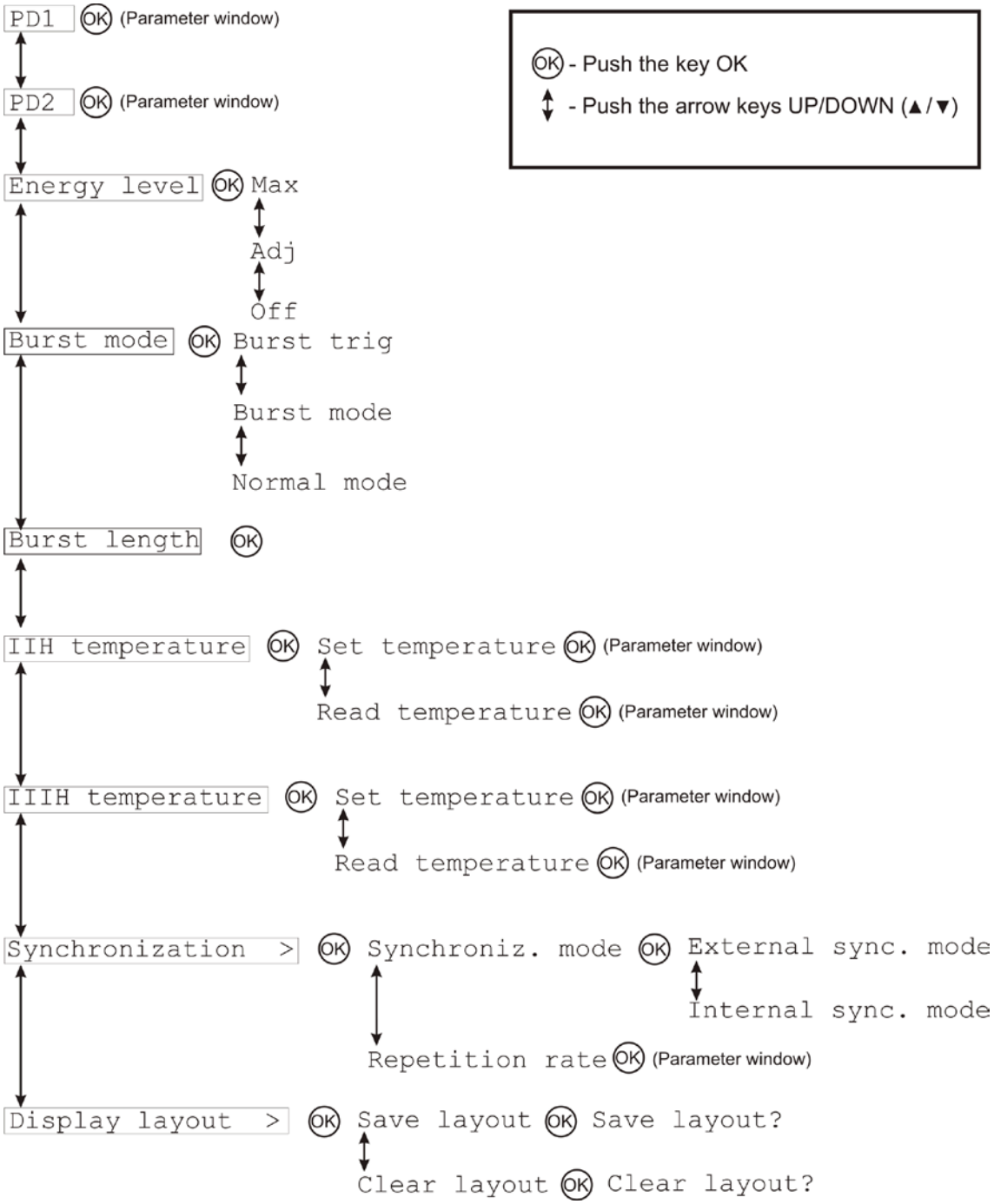

Figure 2-2-5 Menu tree

	Parameter	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.

Some of parameters can be edited in their settings window (see Figure 2-2-6). You can move the cursor by using arrow keys RIGHT/LEFT and change the parameter value by arrow keys UP (increase)/DOWN (decrease).

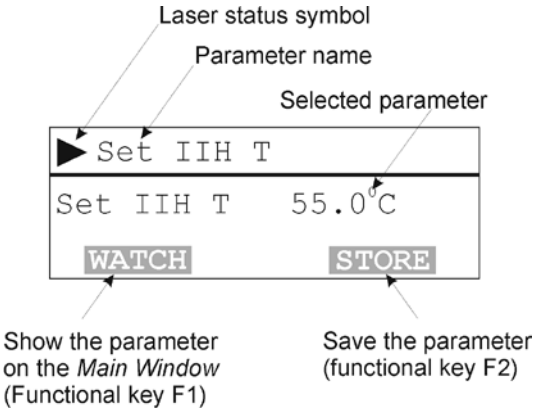

Figure 2-2-6 Setting the parameters

If you want to see an important parameter in chosen field on main window push the functional key F1. "WATCH" caption will blink. If you want to save changes – push F2 ("STORE" will blink).

WATCH command only overwrites and changes but does not save the field content. Perform a command "Save layout" (see Figure 5-5) to save the composed main window. After switching the power supply on/off the saved main window will always appear. If you want to clear all fields, perform a command "Clear layout". WATCH command will not be active if the cursor is in *hidden* position.

The cursor always shows an active field on main window. You can change a parameter being in active field by arrow keys UP/DOWN.

D1 and D2 fields are specific. For example: placing the parameter that has a function key possibility (“Shutter”) in D1 or D2 fields you activate the F1 or F2 keys respectively. Then you can change the parameter or perform a special command using F1 or F2 on the control pad.

A long field **D** is used for error code representing. When an error occurs, the field D blinks and gives an error code with the name of the highest priority of error.

User Input and Output Signals

External Synchronization Using one Sync Pulse

- SYNC IN SMA connector is used to externally trigger NL242 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.
- All modes of operation: adjustment, OFF, batch, frequency divider works while laser is externally triggered.
- 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. If SYNC IN has fixed rate 1000 Hz, set '*Repetition rate*' to 1050 Hz.

External Synchronization Using Two Pulses

In this mode user provides two signals, SYNC IN and QSW IN. SYNC IN pulse should be provided to SYNC IN connector on the front panel of PS81120 power supply; QSW IN pulse should be provided to QSW connector on the front panel of PS81120 power supply.

This can be used to more accurately control firing of the laser and reduce timing jitter. Input is sensitive to pulse rise. QSW IN input impedance is 50 ohm. Pulse parameters: pulse length 100ns...10us, voltage level 3.5…5V @ 50 ohm.

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.

The value for delay between those pulses is calculated as:

SYNC IN delay->Pulse delay + QSW MAX output delay,

where *SYNC IN delay->Pulse delay* and *QSW MAX output delay* are factory set values and may be observed using *CANBrowser (*M_CPU800:18 register*)*. 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).

If SYNC IN has fixed rate 1000 Hz, set '*Repetition rate*' to 1050 Hz.

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

External Interlock

External interlock ability is provided through the DB9 sockets EXT1 or EXT2 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.

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 cycling the ON/OFF key. 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.

SECTION 2
CHAPTER 3

LASER ROUTINE OPERATION

The *Routine Operation* section provides basic operation instructions for the *NL200* series laser including powering up, operating, pausing, and shutting down.

CAUTION

All personnel in the area must wear laser goggles/glasses of the approved type at all times during operation of the laser. This protective eyewear must be effective at the wavelengths generated from the laser. It is assumed that the operator has read Safety chapter and is familiar with laser safety practices and the dangers involved.

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 to start the laser operation.

Note:

Radiation parameters of the laser stabilise after about 20-30 minutes warm-up time.

7. If your application requires, these parameters can be changed by control pad.

Note:

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

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

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

Laser operation in external triggering mode:

External triggering by 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.

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.

Temporarily stopping 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'*.

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.

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:

BBO 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 NT252 system power supply from mains. Leave it connected, when the work is over and the device is switched off.

Resetting the Faults

All faults should be reset by cycling the key switch on the power supply.

Do not use STOP/RUN on the control pad to reset the faults. This procedure resets oscillator driver only and does not affect the amplifier driver.

APPENDIX A

REMOTE CONTROL APPLICATION

To start *Ekspla* laser or system, you need a computer, USB cable and software CD for remote control. Instead of CD there may be downloaded software archive. Go to folder **CAN network \Control panel applications**. Then make a copy of folder content to your hard disk (ControlPanel). Run **ControlPanel.exe** and click "**Connect**" (see Figure A-1).

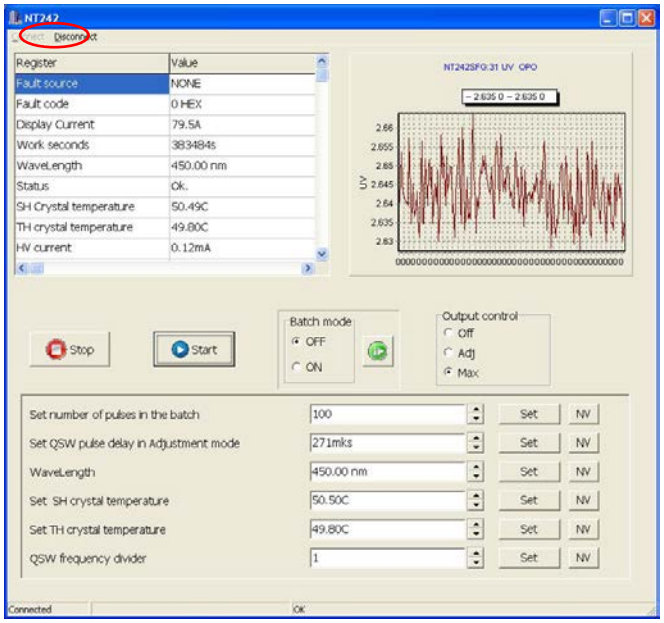

Figure A-1 Connecting to Control Panel application

Short descriptions of some fields and buttons are listed below (see Figure A-2):

1. Parameters window is used to view parameters.
2. Chart. Shows TH pulse energy.
3. Start/Stop laser buttons.
4. Batch mode.
5. Laser Output control.
6. NT242 parameters control.

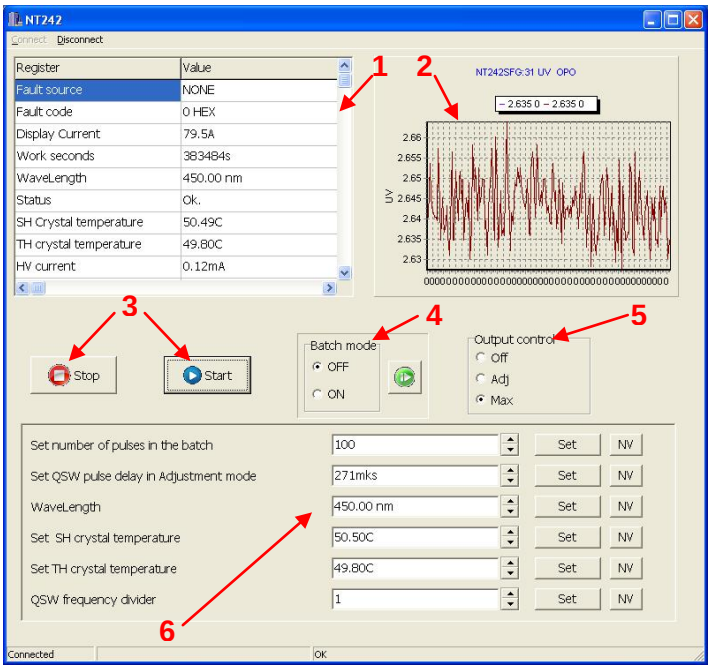

Figure A-2 Main Remote Control Panel application window

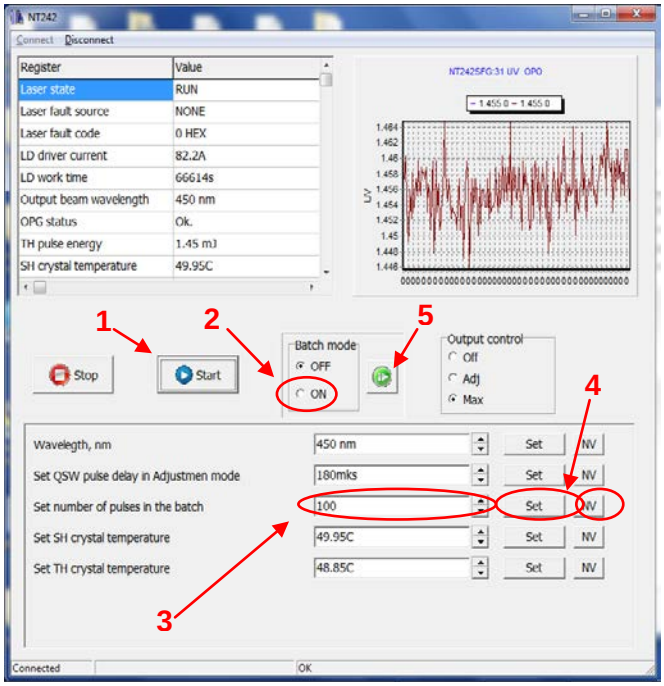

Figure A-3 Using Batch mode

Using Batch mode (Figure A-3):

1. Start the laser;
2. Select the Batch mode ON;
3. Set the number of packets;
4. Click "**Set**" button for temporary settings saving. Click "**NV**" to save settings permanently.
5. Press the green button to start the Batch mode.