NT342 Series

Tunable Nd:YAG Laser System

Technical Description
User's Manual

NT342 Rev. 1712

2018
Lithuania

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

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1.1. Legal Disclaimer

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1.2. Generalized and/or Incomplete Information in the Manual

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

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 Because of this the manual occasionally may contain information which is outdated, incomplete, or erroneous; or it may omit some information about the specific system.

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

1.3. Special Attention

Please pay special attention to Chapter 4 for information about safe handling and usage of the NT342 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

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02300 Vilnius
Lithuania

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Fax: +370 5 2641809
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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 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

NT342C-10-SH-SF-ATTN2-FC-AW

3.1.2. Manufacturer

EKSPLA

3.1.3. Intended Fields of Use

Scientific research requiring a tunable source of nanosecond pulses in UV/visible/near-IR range.

3.1.4. Main Components of the System

Table 1 Main components of the system

Component	***Quantity***
Laser head NT342C-10-SH-SF-ATTN2-FC-AW **S/N PGL472**	1
Power supply PS5062 series	1
Control pad with cable	1
Set of cables and accessories	1
User’s manual with software CD	1

3.2. Beam Characteristics

Table 2 Pump beam output characteristics

Parameter	***Specifications***
Wavelength, *nm*	355
Max output pulse energy when optimized for OPO, *mJ*	<130 mJ
Pulse energy stability, *StdDev*	<3.5%
Pulse duration, *ns*	4…6
Beam profile	"Hat-top" in near field, without hot spots
Beam divergence, *mrad*	<0.6
Repetition rate, *Hz*	10
Jitter of SYNC OUT relative to optical pulse in internal synchronization mode, *ns*	<0.5

Table 3 OPO beam output characteristics

Parameter		***Specifications***
Wavelength range, *nm*	SH/SFG	210…409
	Signal	410…709
	Idler	710…2600
Output pulse energy, *mJ*	OPO[1]	<60
	SH/SFG[2]	<12
Linewidth, *cm*$^{-1}$		<4[3]
Wavelength setting precision, *nm*	SH/SFG	1
	Signal	0.05
	Idler	0.1
Pulse duration (FWHM@450 nm), *ns*		3…5
Typical beam diameter, *mm*[4]		5
Typical beam divergence, *mrad*[5]		<2
Polarization	SH/SFG	Horizontal
	Signal	Horizontal
	Idler	Vertical

[1] Measured at 450 nm. See tuning curves for typical outputs at other wavelengths.
[2] Measured at 340 nm. See tuning curves for typical outputs at other wavelengths.
[3] <8 $^{cm-1}$ for 210…409 nm range (if applicable).
[4] Beam diameter is measured at 450 nm at the $1/e^2$ level and can vary depending on the pump pulse energy.
[5] Full angle measured at FWHM@450 nm.

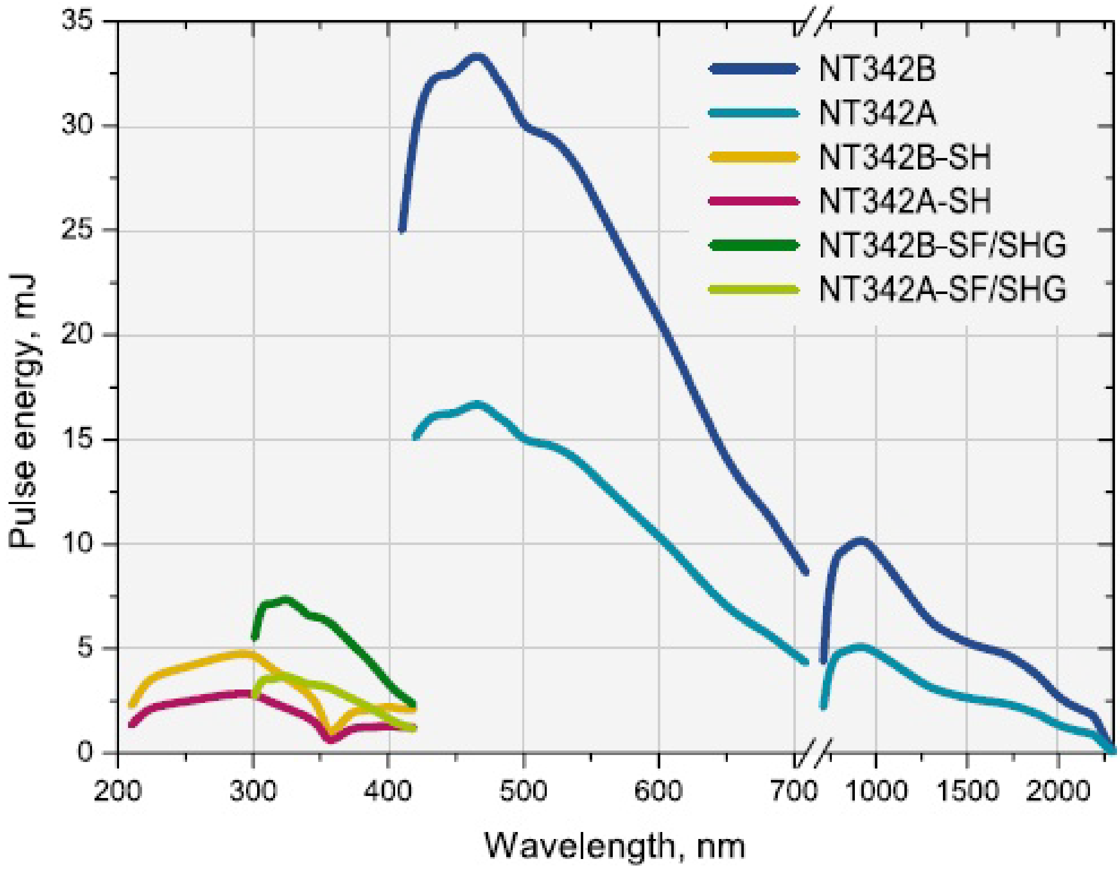

Figure 1 Typical shapes of tuning curves for NT342 series lasers

The specific output energy depends on the model.

3.3. Power Supply Requirements

Table 4 Power supply requirements

Parameter	*Specifications*
Supply voltage, *VAC*	200…240
Frequency, *Hz*	50/60
Phase	1
Amps, *A*	16
Power consumption, *kW*	<3.5

3.4. Liquids and Gases

Table 5 Liquids and gases

Fluid/gas	*Specifications/Information*
Distilled/deionized water	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

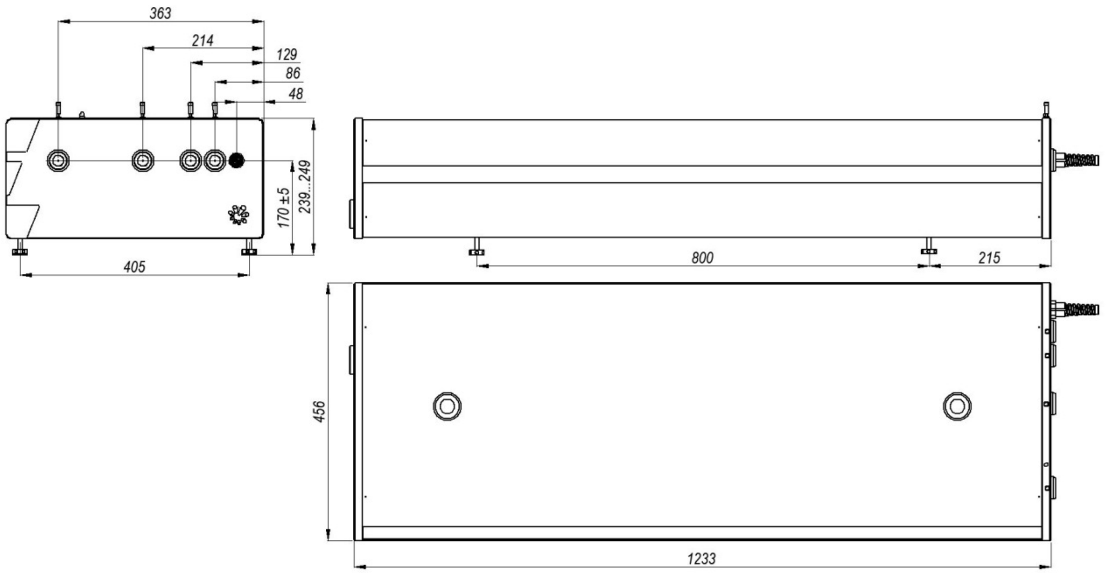

Figure 2 Outline drawing and dimensions of NT342 series laser

3.6.2. Beam Position(s)

See figure(s) in 3.6.1 Laser External Dimensions.

3.6.3. Weight

~70 kg

3.6.4. Placing and Fixing

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

3.6.5. Power Supply Mechanical Dimensions

See separate manual.

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This chapter provides information about safe handling and usage of the *NT342* 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 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 in73/23 EEC and amended in 93/68 EEC). The Low Voltage Directive requires that lasers comply with the IEC-60825-1 (Radiation Safety of Laser Products) and IEC-1010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use).

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

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

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

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

4.3. Electromagnetic Compatibility

This NT342 system complies with the European requirements for electromagnetic compatibility as defined in the Electromagnetic Compatibility Directive 89/336/EEC.

This system is intended for use in an ISM (Industrial, Scientific and Medical) Environment. Operation of this system in a different EMC environment may require that the user take remedial action in addition to the normal installation and operation described in this manual to resolve potential electromagnetic compatibility problems. *EKSPLA* makes no claims beyond those listed below concerning the compatibility of this system in EMC environment other than ISM environment.

4.4. Labeling

Labels attached to the equipment are listed below.

4.4.1. Laser Radiation Warnings/Identification

①

A **laser hazard label** is located on the top cover.

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

②

Laser hazard labels are located beside the apertures, and on the cover on the right side of the frame.

③

Cover hazard labels are located on covers of laser head.

④

Cover hazard labels are located on both sides of top cover.

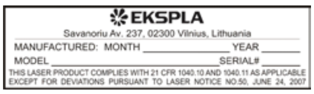
⑤

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

4.4.2. Electrical Warnings

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

4.4.3. Identification Labels

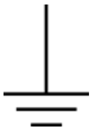


A **product certification and identification label** is located on the side panel.

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

Hot surface labels are located on some crystal ovens.

Risk of danger label.



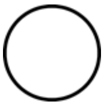
Earth (ground) terminal symbol.

Protective conductor terminal symbol.

Single-phase alternating current symbol.

Three-phase alternating current symbol.

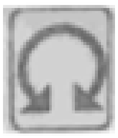
On (Supply) symbol.



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.

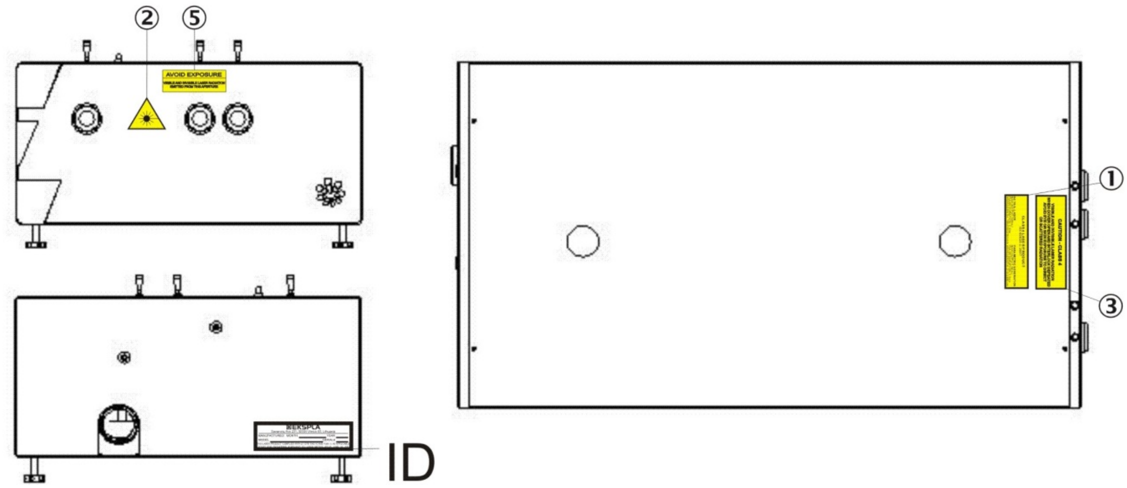


Figure 3 Warning label positions on the NT342 series laser

4.4.5. Laser Radiation

This spectrometer can emit laser radiation of different wavelengths:

Fundamental radiation	1064 nm	Infrared	Completely invisible
2nd harmonic radiation	532 nm	Visible (green)	Visible
3rd harmonic radiation	355 nm	Ultraviolet	Completely invisible
~~4th harmonic radiation~~	~~266 nm~~	~~Ultraviolet~~	~~Completely invisible~~
~~5th harmonic radiation~~	~~213 nm~~	~~Ultraviolet~~	~~Completely invisible~~
Parametric output	210…2600 nm	Ultraviolet - infrared	Visible/completely invisible

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

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

4.5. 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.

4.6. Back Reflection Safety

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

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

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

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

4.7. Safety Interlock

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

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

4.8. Remote Interlock Connector

Break connector on the back panel of power supply is provided for use as an external interlock connection (normally closed).

Shorting connector is supplied to short the connector when remote interlock is not used. 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.

4.9. Key Control

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

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

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

4.10. Main disconnect switch

Break mushroom emergency switch located on the front panel of the power supply can cut off power to the entire laser.

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

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

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

4.11. 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.

4.11.1. Laser head

a) 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.

b) Safety requirements

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

4.11.2. Power supply

a) 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.

b) 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.

4.12. 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.

5.1. Main Functional Parts

The laser system is comprised of following functional parts:

- Pump laser head NL300;
- 2nd and 3rd harmonic generators (SHG, THG);
- Optical parametric oscillator (OPO);
- Separate harmonics outputs;
- UV extension (SH) and sum frequency generation (SFG);
- Spectra cleaning module (PBP/RAP);
- Attenuator;
- Fiber coupling.

Optical layout of the system is presented in Figure 6.

5.2. Pump Laser NL300

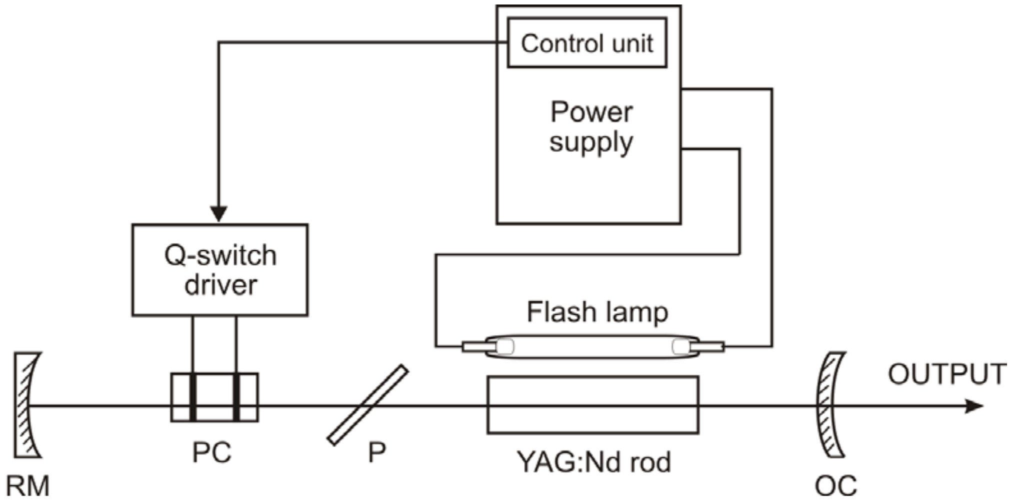


Figure 4 Optical/electrical scheme of NL300 series laser head

The laser operates in resonator quality modulation mode (also referred to as resonator losses' modulation). The laser geometry is an unstable resonator comprising of a concave rear mirror RM (99% reflection) and a convex output coupler OC – variable reflectivity mirror. Divergence of the output beam depends on the radius of curvature of the rear mirror and the thermo-induced lens in the laser rod. Thermo-induced lensing is proportional to pump power. In order to get a properly collimated output beam, the pumping level must not exceed the level preset at the factory (see 12.2 Factory Settings).

The Pockels cell PC together with a proprietary driver induces considerable steady losses in the resonator. While PC high voltage is present, generation is not possible (Q-switch is closed). When a high voltage is off, losses in the resonator are minimized and laser pulse is generated (Q-switch is opened). Laser timing charts are presented in Figure 5.

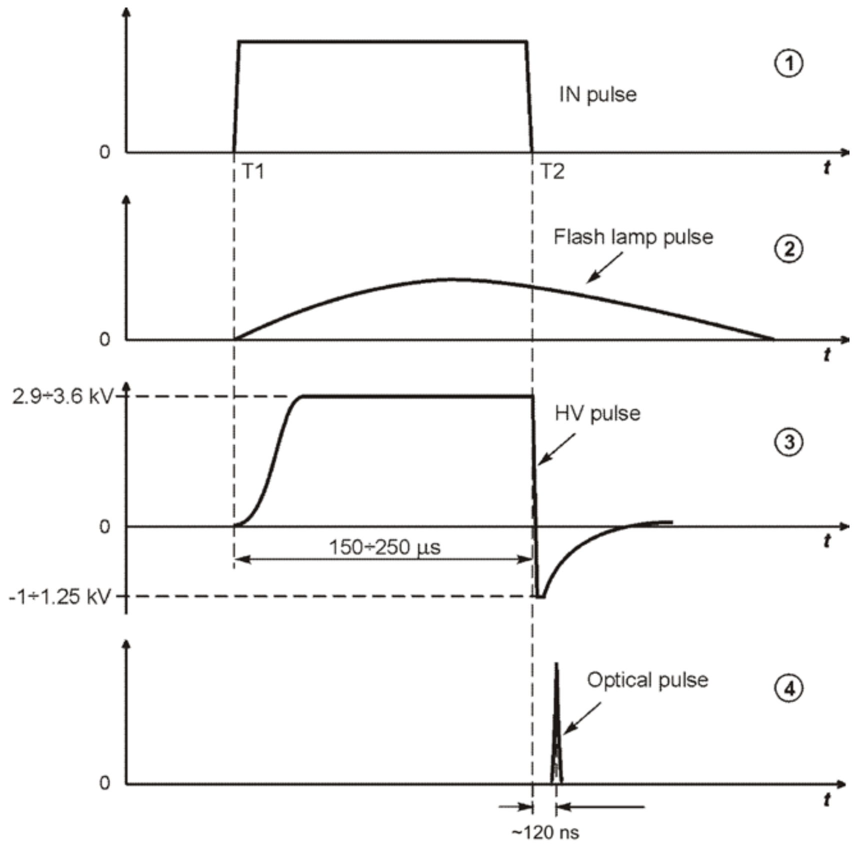


Figure 5 NL300 timing charts

The external triggering pulse applied to the input *IN* on power supply or triggering pulse generated by the internal control unit (chart ①) at T1 starts the discharge of power supply capacitors through the flash lamp (chart ②) and closes the Q-switch (chart ③), inducing high resonator losses. The Q-switch remains closed until maximum inversion in the Nd:YAG rod is achieved. At this moment Q-switch opens (chart ③), losses in the resonator are minimized, and a very short and powerful optical pulse is generated (chart ④).

The delay between the firing flash lamp and opening of Q-switch is determined by duration of the triggering pulse (chart ①) and is adjusted at the factory for each laser individually. Delay can be further adjusted using the remote control pad (see 7.5.2.h) Synchronization).

5.3. Tunable parametric stage

5.3.1. Harmonic generators

Pump laser generates pulses of the fundamental Nd:YAG radiation (1064 nm). This fundamental Nd:YAG radiation is converted into the second (532 nm) and third (355 nm) harmonics in harmonics generators SHG and THG. Further the fundamental and 2nd harmonic are separated by mirror M3 and directed to the dump.

Motorized mirror M13 either directs 3rd harmonic radiation to its' own output or lets it into the OPO.

5.3.2. Optical Parametric Oscillator (OPO)

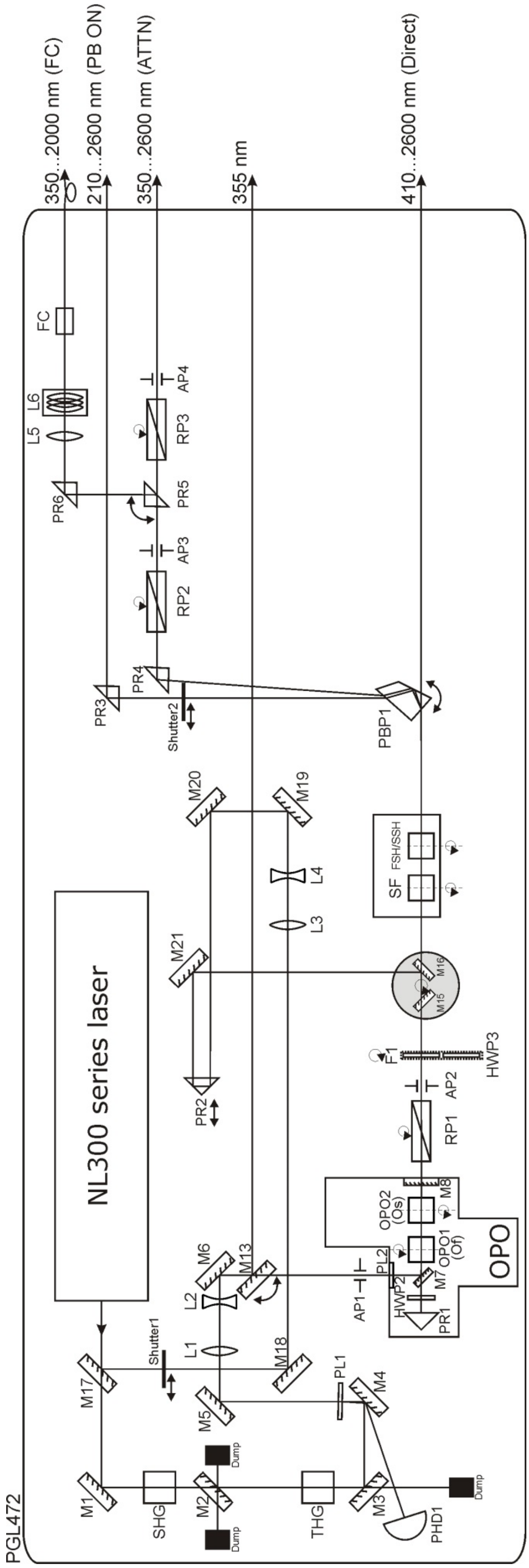


Figure 6 Optical layout of the NT342C-10-SH-SF-ATTN2-FC-AW laser system

Photodiode PHD1 monitors pump beam (355 nm) energy entering the OPO. This input energy must not exceed the specified value. If this energy limit is violated, a warning beep sounds.

The optical parametric oscillator is a solid state continuously tunable source of visible and near IR radiation. Based on type II BBO nonlinear crystals, the OPO covers 410…2600 nm wavelengths with up to 30% conversion efficiency when pumped by third harmonic of a pulsed Nd:YAG laser. The pumping beam is directed to the OPO cavity by dichroic mirror M8. The resonator with image rotation and double-passing of the pump beam is used to reduce OPO beam divergence and line width. The retroprism PR1 and half-wave plate HWP2 form rear mirror of resonator. The output coupling mirror M9 reflects back the pump beam and partially reflects OPO beam. Wavelength tuning is achieved by rotation of nonlinear crystals OPO1 and OPO2.

> *Attention!*
> *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 NT342 system power supply from mains. Leave it connected, when the work is over and the device is switched off.*

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

5.3.3. UV Extension (SH) and Sum Frequency Generation (SFG)

SH and SFG are type I BBO crystals. SH crystals generate the second harmonic from the OPO signal and cover 210…295 nm wavelength range. SFG crystal generates sum frequency of signal wave from OPO and fundamental wave from laser to cover 296…409 nm wavelength range.

The 1064 nm pulse is directed by mirrors M17…M21; its' delay is adjusted by prism PR2.

5.3.4. Spectra Cleaning Module

Device also employs a scheme for 210…2600 nm spectra cleaning. It consists of a Pellin-Broca Prism (PBP) and one or more right-angle prisms (PR3, PR4). Cleaning the idler radiation using this scheme produces lower energy output in idler range because of losses in Pellin-Broca prism due to different polarization of the idler. Pellin-Broca prism, placed on a motorized stage, allows switching between spectrally cleaned 210…2600 nm output with a lower energy level in idler range (*PB ON*), or not cleaned idler output in 350...2600 nm range of a higher energy level (in this product, outputs *ATTN* and *FC*). In a cleaned output mode the angle of the prism is automatically adjusted to compensate for spectral dispersion.

5.3.5. Attenuator

Pellin-Broca prism PBP directs 350...2600 nm radiation towards the right-angle prism PR4. Rochon prism RP2 acts as the attenuator, while RP3 preserves a set polarization of the output beam.

5.3.6. Fiber Coupling

Prism PR5 directs the 350...2000 nm radiation towards an array of lenses (L5 and L6) and fiber coupling FC.

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This chapter provides information about connecting and configuring the *NT342* series system.

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

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

6.1. General Requirements

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

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

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

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

6.2. Environmental Conditions

See 3.5 Environmental Conditions.

6.3. Laser System Layout

The NT342 series laser system typically is comprised of a freestanding power supply unit and a laser head that are interconnected by a flexible umbilical. A remote control pad is attached to the power supply unit for remote access to various functions.

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

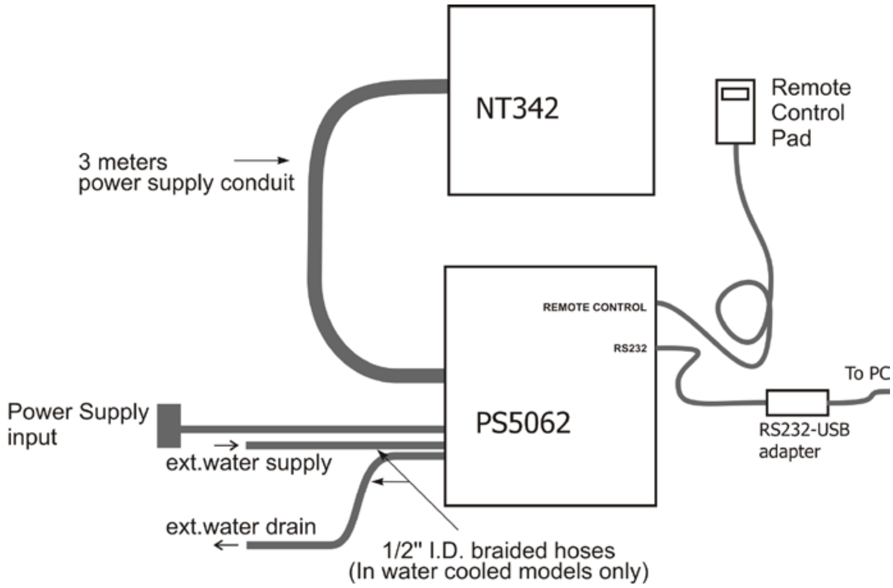

Figure 7 Typical layout of the NT342 laser system

6.4. Laser Installation Procedure

1. Inspect the shipping container for damage related to transportation. If any damage is present, inform EKSPLA and the transportation agency.

2. To avoid condensation forming after bringing the shipping container from the cold storage or transportation site, allow the box to warm up to room temperature (approx. 3...4 hours) before opening it.

3. Unpack and inspect contents for exterior damage related to transportation. If any damage is present, inform EKSPLA and the transportation agency.

4. Laser is usually shipped with umbilical cord already fixed to the laser frame and with all connections that this cord is carrying already made at the laser side.

5. Fix laser head to optical table using the provided clamps. Place the power supply unit near the laser head.

6. Remove cover from the laser head. Check all optical mounts for tightness and proper placement. Check all water connections to verify all quick-disconnects are properly seated.

7. 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 8. This makes breadboard less sensitive to tensions caused by thermal expansion of the panels.

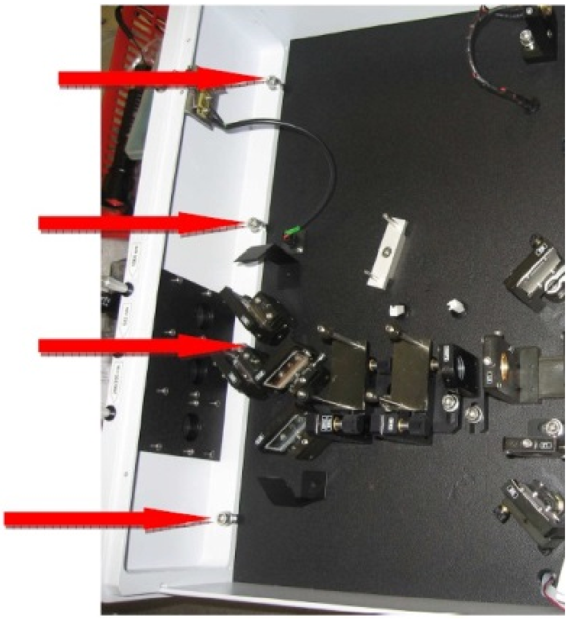

Figure 8 Relieving the fixing bolts. Generic view; internal optical components may look different

8. Fill *PS5062* power supply with coolant; refer to *PS5062* manual.
9. For water-water cooled models, link up the connector *WATER SUPPLY IN* to the external water pipe. Link up the quick-connector *WATER SUPPLY OUT* to water outlet pipe.
10. Connect the control pad to *REMOTE* connector on power supply unit.
11. Connect the PC via *RS232* connector on the front panel of power supply unit, using a supplied RS232-USB adapter (see Figure 9).
12. Connect remote interlock connector *BREAK* on a power supply with a remote interlock control circuit used in your environment; otherwise, leave the shorting plug in place.
13. Equipment is designed to be grounded through mains power ground connection. Connect the ground terminal on a back panel of power supply unit to the ground terminal in your location if grounding through mains connection is unavailable or cannot be relied upon.
14. Connect the power supply's power cable to the mains.
15. Turn on the key switch on the power supply unit to *ON*. LED *ERROR* can possibly activate, indicating there is an air in the pump. In this case cycle the power key a few times to remove the air from the pump.
16. Check for the coolant leakage.

Warning!
Procedure described below assumes that the laser will operate with cover removed and cover interlock defeated, which is a potentially dangerous situation. Make sure all necessary precaution measures are taken while performing this operation.

17. Defeat the cover interlock.

18. Start the laser operation, see Chapter 8. Check the output beam for availability (along the beam path after mirror M3).

19. To view the infrared radiation, use a special IR visualizer or burn paper. It is recommended to enclose burn paper in a clear plastic bag to avoid depositing paper particles onto the optics surfaces. Hold the bag so that the reflection from its surface is directed downwards.

20. Check the beam profile.

21. Stop the operation. Close the laser cover.

6.5. Installation and Adjustment of Harmonic Crystals

To ensure the maximum level of harmonic generation the generator crystals need to be adjusted.

Caution:
The harmonics crystals must be placed into and removed from the laser only when the laser operation is stopped.

Harmonic crystals are moist-susceptible; keep them with a moist absorbing material while not installed.

1. Stop the laser operation. Open the cover.

2. Insert second harmonics crystal *SHG* assembly; fix assembly into a holder, use 4 M2 screws. Connect the powering wire.

3. Insert third harmonics crystal *THG* assembly; fix assembly into a holder, use 4 M2 screws. Connect the powering wire.

4. Wait for approx. 5…30 minutes for crystal heaters to reach the pre-set temperature (waiting time depends on ambient conditions); LED's on the holder should start blinking.

5. Leave the cover open. Defeat the cover interlock.

Warning!
Procedure described below assumes that the laser will operate with cover removed and cover interlock defeated, which is a potentially dangerous situation. Make sure all necessary precaution measures are taken while performing this operation.

6. Put the key switch to *ON* position. Start the laser operation. Set output level (see 7.5.2.a) *Output level*) to *E Adj*.

7. Check if the beam is not clipped by nonlinear crystal or other optical components.

8. Obtain the second harmonic output by slightly turning the adjustment screw, marked *IIH*, on the side panel. Control the appearance of the 2nd harmonic generation visually.

Note:
The harmonic energy depends on a crystal angle as function $\sin^2(x)/x$. *The side maximums are near the main one, the conversion efficiency with the crystal tuned for a side maximum is much lower though. By adjusting the crystal holders, make sure you have found the central maximum and not the side one.*

9. Obtain the maximum of the third harmonic output by slightly turning the adjustment screw, marked *IIIH*, on the side panel. Control the output energy visually using the indicator paper. Little iteration of steps (8) and (9) may be needed.

10. Enable the cover interlock; close the cover. Cycle the key to reset the interlock error.

11. Change the output level to *E Max*; repeat steps (8) and (9); some iteration may be needed. Control the output energy by checking photodiode readings on a control pad, or using an external energy meter.

6.6. Parametrics Installation and Adjustment

Warning!
Procedure described below assumes that the laser will operate with cover removed and cover interlock defeated, which is a potentially dangerous situation. Make sure all necessary precaution measures are taken while performing this operation.

6.6.1. OPO Installation and Adjustment

1. Remove the laser cover; defeat the interlock. Start the operation.

2. Set the output level to *E Adj*; rise the *Adj. EO delay* (see 7.5.2.h) Synchronization) to the extent that third harmonic output would be barely visible. Use the UV visualizer paper placed between mirrors M3 and M4.

3. Place the target between mirrors M3 and M4, check if the back reflection from the mirror M9 goes straight back. If it does not, adjust the mirror M9 using adjustment screws outside of OPO compartment.

4. Enable the cover interlock; close the cover. Cycle the key to reset the interlock error.

5. Launch the UniPG software. Refer to UniPG manual about operations using that software.

6. Set the OPO crystals to optical zero (532.1 nm wavelength). Use *Adjustment-Optical zeros – Go to zero* command for OPO crystals.

7. Reduce the *Adj. EO delay* to the point where the 532 nm beam becomes barely visible. Control visually at 210…2600 nm output.

8. Misalign one of the OPO crystals by approx. 3° using the UniPG. Slowly turn the other crystal until the generation threshold is reached. Save this crystal position as its optical zero by pushing button.
9. Misalign the second crystal. Find the optical zero for the other crystal and save it.
10. Set both crystals to the newly found zero positions.
11. Save the changes performing *OPG Controller – Program* in UniPG.
12. Set the *Adj. EO dela*y as per Table 8 in Chapter 12.
13. Set the output level to *E Max*.
14. Check the beam profile. If needed, improve it by slightly adjusting the P1 prism adjustment screw, accessible outside of OPO compartment (requires opening of the laser cover).

6.6.2. SH/SFG Adjustment

Optional, for devices with SH and/or SFG option installed.

1. Start the operation.
2. Set the output level to E Max.
3. Launch the UniPG software. Refer to UniPG manual about operations using that software.
4. Set the crystals to optical zero. Use Adjustment-Optical zeros – Go to zero command for SH and SFG crystals.
5. Maximize the output energy at SH optical zero by slowly turning SH crystal. Save this crystal position as its optical zero by pushing button.
6. Repeat procedure for SFG crystal.
7. Set both crystals to the newly found zero positions.
8. Save the changes performing OPG Controller – Program in UniPG.
9. Check the output energy on a few points in parametric wavelength output range. SH/SFG assembly is more sensitive and occasional corrections of the curve may be needed (see UniPG manual for more instructions):
    a. Set the desired wavelength. Adjust the position of the motor to maximize the output. Press button to enter the correction. Save the changes performing OPG Controller – Program in UniPG.
    b. Try to adjust already existing correction points. Pick them using and buttons.

c. Do not add corrections at the wavelength corresponding to optical zero.

d. Insert new corrections only after existing neighboring correction points have been already optimized.

6.7. Optical Fiber Installation and Adjustment

1. Remove the laser cover.
2. Put the fiber holder into the laser through the fiber output port.
3. Remove the protective cap from the fiber holder and put the end of it into the adjustable sleeve of fiber coupler.

Warning
Avoid accidentally hitting any surface with the fiber end during this operation – it may damage the fiber input surface.

Figure 6.7.1 Fiber holder with protective cap

4. Slide the fiber holder to the sleeve while the black marking appears and fix it with screw.

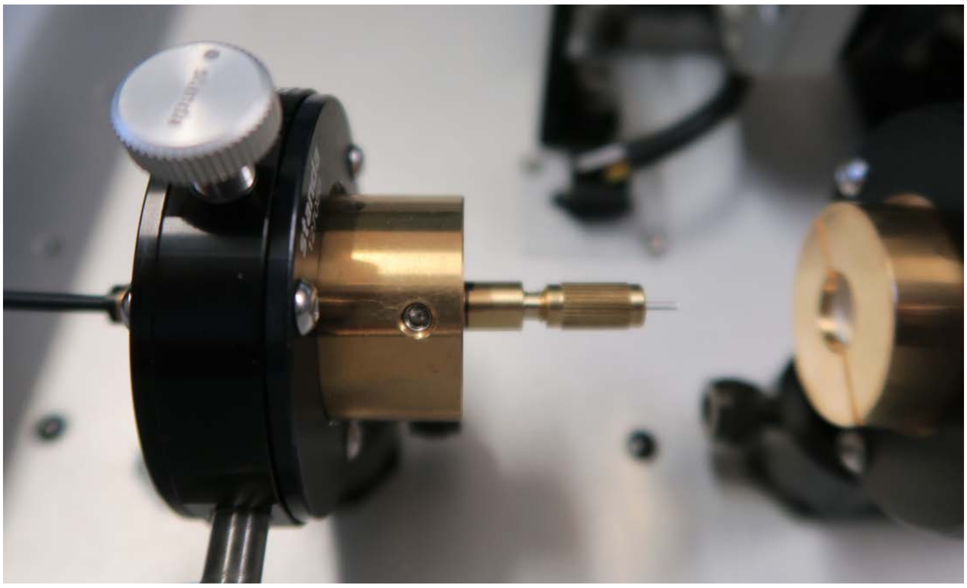

Figure 6.7.2 Fiber coupler

5. Run the laser and measure pulses energy at the fiber output. Adjust the fiber coupler adjustment screws if necessary.

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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; control from PC software is available as well, using RS232 connection.

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

Master oscillator and parametric stage are controlled by different boards using different communication protocols. As a consequence, different software is used to control those subsystems. Master oscillator and parametric stage control is explained separately in this chapter.

7.2. Power Supply

7.2.1. Front panel

The front panel controls, connections and indicators (see Figure 9). Also consult the separate *PS5062* manual):

POWER - mains key-switch. Switches laser control unit, flash lamp power supply and cooling on and off. Removal of this key (in position OFF only) prevents laser operation by an unauthorized person.

BREAK - an emergency mushroom head switch for immediate shut down of the whole system.

To restart laser operation after the emergency shut-down, turn the key switch to the *OFF* position and switch it *ON* again after a pause of ~ 10 seconds.

SERVICE - disconnects flash lamp high voltage without stopping the rest of a system. To apply HV back, press the button again.

VOLTAGE - 10-turn tuner with an integrated locking lever for flash lamp pump level control (controls the voltage level on the capacitor bank). The pump level is indicated on the remote control pad's display (in percent of the maximum value).

REMOTE - remote control pad connector.

IN - BNC type connector for external triggering pulse. 50Ω input resistance.

OUT **-** BNC type connector; provides sync pulse for external use.

EMISSION – indicates that laser emission is about to occur.

ERROR – indicates activation of the safety interlocks or power supply faults.

POWER - indicates the laser state:

– *Standby*. Key is in *OFF* position. Only laser frame and crystal heaters are powered on. *POWER* LED is yellow.
– *Working*. Key is in ON position. *POWER* LED is green.
– *Power sequence fault*. *POWER* LED is red. Mains power is connected after the key switch was set to *ON* position or safety circuit fault has occurred. Cycle the key switch to *OFF* and again to *ON* position to get the laser to working state.

BREAK - indicates the state of safety circuits:

– *Working*. LED is blank.
– *Laser mechanical guard circuit is open*. *BREAK* LED is red. LED will go off as soon as circuit is closed. In case the circuit break has occurred while laser was in *Working* state, *Power sequence fault* will also be triggered, see description for *POWER* above.
– *Emergency stop circuit is engaged. BREAK* LED is yellow. Emergency mushroom-head button is pressed or *BREAK* connector circuit is open. LED will go off as soon as circuit is closed. In case the circuit break has occurred while laser was in *Working* state, *Power sequence fault* will also be triggered, see description for *POWER* above.

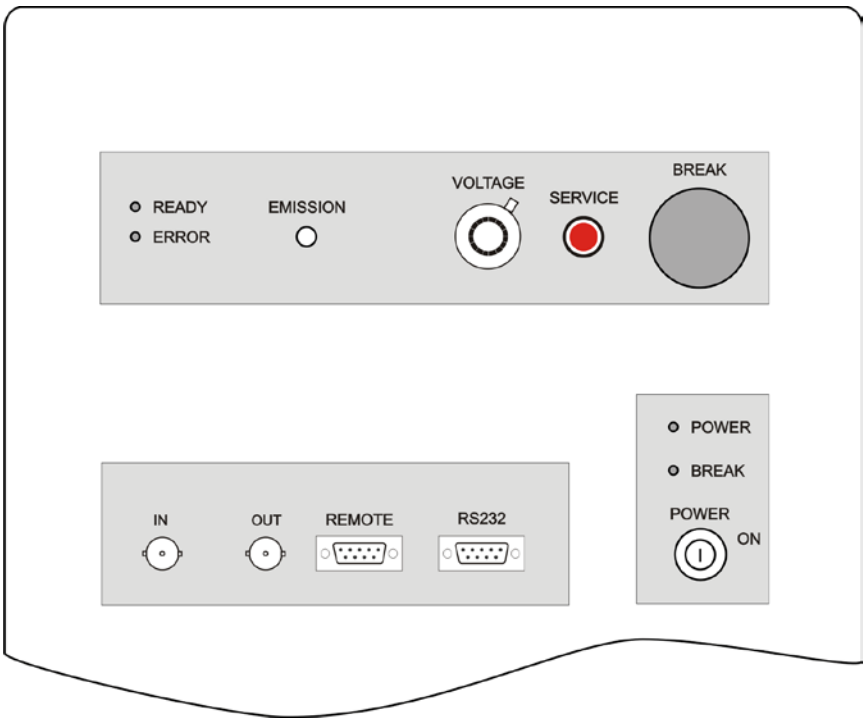

Figure 9 Front panel of the power supply unit

7.2.2. Back Panel

Please consult the *PS5062* manual.

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

a) 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 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.*

b) Connection

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

c) Layout and Buttons

Figure 10 shows the control pad. The pad contains eleven buttons and an alphanumeric display.

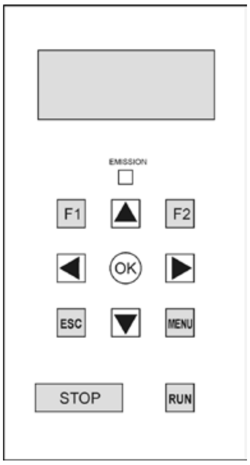

Figure 10 Remote control pad

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

Button functions:

- buttons *RUN* and *STOP* are used to start and stop laser firing.
- *MENU* button invokes menu tree from the main window view.
- *ESC* button - when in a menu system, pressing *ESC* button will return one menu level back; when being at a root level, the pad switches from menu to main window view; see also 7.5.1.b) 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 13 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.

a) Layout

Layout of the main window is shown in Figure 11.

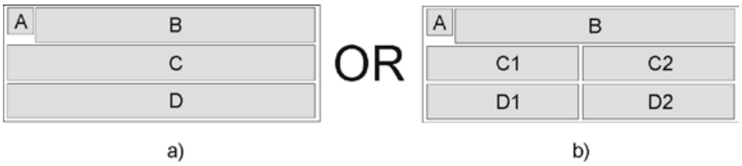

Figure 11 Main window of the control pad

The main window is divided into fields A, B, C and D. 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.

b) 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*.

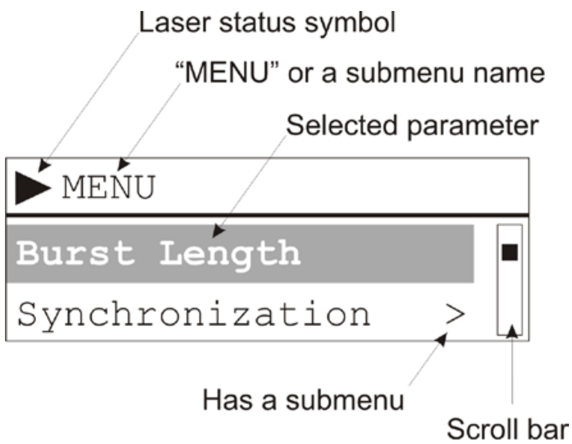

Figure 12 Navigating the menu

The menu tree is shown in Figure 13 below.

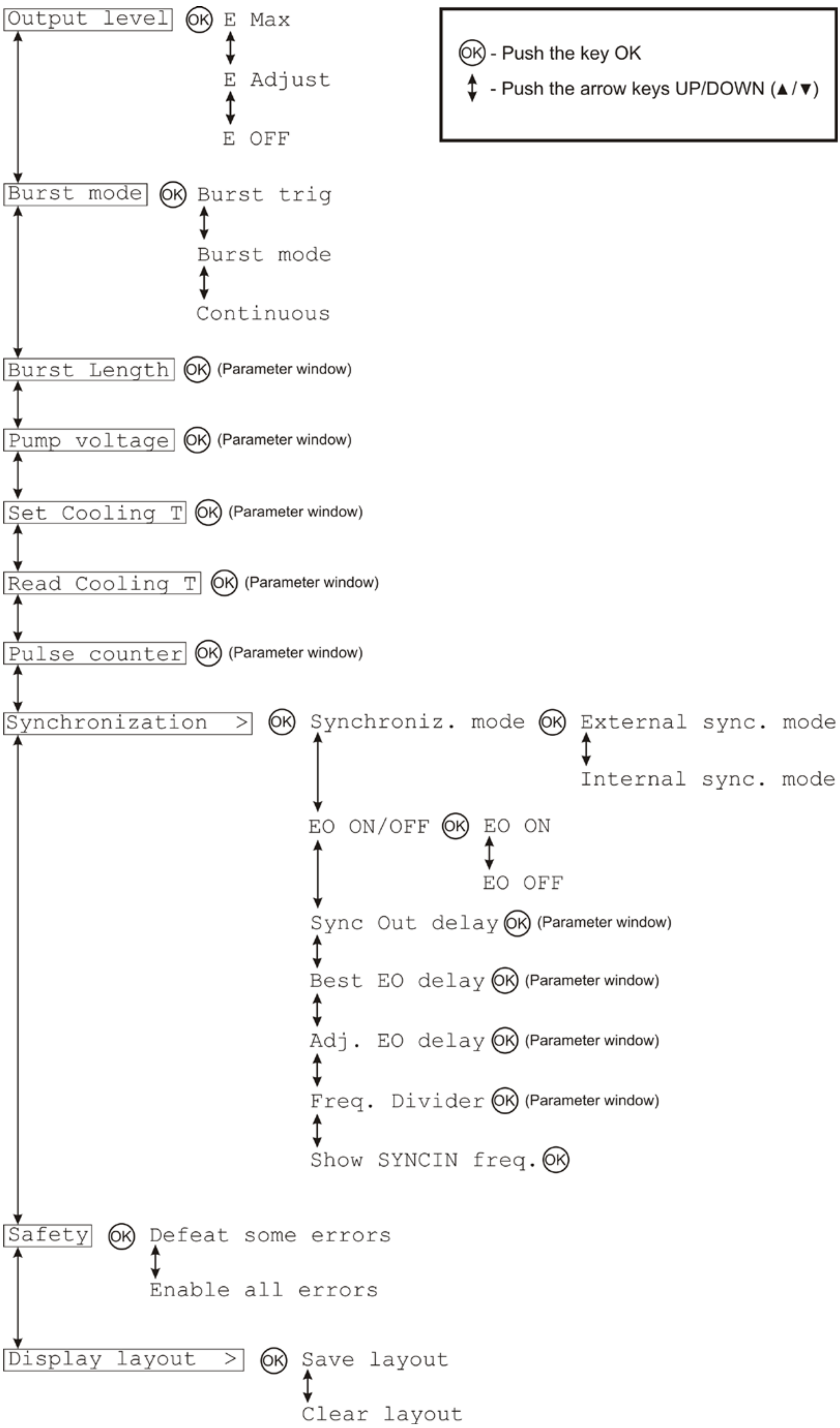

Figure 13 Menu tree

a) Output level

Changes the Q-switch delay in master oscillator:

- *E Max* – operating mode. Maximum laser output pulse energy available at the oscillator output (Q-switch timing is optimized, see also *Best EO delay*).
- *E Adjust* – adjustment mode. Oscillator output pulse energy is approx. 10% from the nominal value. The Q-switch is intentionally delayed relatively to the optimum timing to ensure reduced laser output pulse energy.
- *E OFF* – minimum mode. Flash lamps remain flashing to ensure thermo-stability, but Q-switch is closed.

b) Burst mode

Burst trigger – releases the burst. Please note that switching the laser to burst mode does not start bursts automatically, *Burst trigger* must be activated. It is activated by selecting the *Burst mode*, and then pressing *UP* (▲) button.

Burst mode – switches firing mode to burst.

Continuous mode – switches firing mode to continuous.

c) Burst length

Allows setting the number of pulses in a single burst. To select the number of pulses in the burst use buttons ▲ and ▼.

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

d) Pump voltage

This option is enabled in laser systems with PS5062 series power supply only; otherwise it is not displayed by control pad. It allows control of laser flash lamp pump voltage in percent’s of a maximum value. This value can be controlled in parallel using a *VOLTAGE* controller on *PS5062* front panel.

e) Set Cooling T

This option is enabled in laser systems with PS5062 series power supply only; otherwise it is not displayed by control pad. It allows setting the cooling water temperature.

f) Read Cooling T

This option is enabled in laser systems with PS5062 series power supply only; otherwise it is not displayed by control pad. It displays the cooling water temperature.

g) Pulse counter

This menu is enabled in laser systems with PS5062 series power supply only; otherwise it is not displayed by control pad. Displays the number of shots made.

h) Synchronization

Synchroniz. Mode - sets a synchronization method. When *External sync. mode* is set, the laser is triggered by external signal.

> *Note:*
> *Supplying triggering pulses is not sufficient to start laser generation. Button RUN should be clicked once. See 8.3 Operating the System in External Synchronization Mode.*

Triggering pulse repetition rate should be set the same as in internal synchronization mode. WRONGF error is generated when supplying external sync pulse of not allowed repetition rate.

> ***Attention:***
> ***When internal synchronization is selected, do not apply an external sync pulse. It is recommended to ensure that no cable is connected to the SYNC IN connector.***

EO ON/OFF – switches the Q-switch (Pockels cell) control on/off. When *ON*, the Q-switch is further governed by control pulses with timing determined by *Output level* parameter. When *OFF*, the high voltage is off, Q-switch is not functioning and oscillator runs in free-running mode, producing long duration (~100 μs) pulses. Harmonic generation is not effective at these pulse durations, so in this mode only 1064 nm pulses can be used at the output (for systems with H-2H option).

SyncOut delay – controls the delay of an output sync pulse relative to a Q-switch pulse (see Figure 5, chart ③). Indicated in arbitrary units, equivalent to 125 ns. Can be adjusted in a -64000…62815 range when operating in internal triggering mode, and in 0…63015 range when operating in external triggering mode.

Best EO delay – sets the value for delay between lamp flash and Q-switch pulse to be used when in *MAX* mode. Delay is indicated in arbitrary units, equivalent to 125 ns. The absolute delay value (in microseconds) is calculated using the following equation: *(Best EO delay)* × 0.125 μs + 20 μs.

Adj. EO delay - sets the value for delay between lamp flash and Q-switch pulse to be used when in *Adj* mode. Delay is indicated in arbitrary units, equivalent to 125 ns. The absolute delay value (in microseconds) is calculated using the following equation: *(Adj. EO delay)* × 0.125 μs + 20 μs.

> ***Caution:***
> ***The value Delay MA (OPO), indicated in 12.2 Factory Settings, is optimized for OPO performance. Shorter delay values can be used ONLY when OPO stage is bypassed, i.e. when using 3H output, or when using H/2H outputs (with H-2H option installed). The value of shorter Delay MA (MAX), indicated in 12.2 Factory Settings, is optimized for maximum 1H/2H/3H output.***
>
> ***Using short delay when working in OPO range may lead to irrevocable damage to OPO optical components. Please be aware that there is no automatic safety other than warning beep in this situation.***

Frequency divider – Q-switch repetition ratio is divided by a factor set here, while retaining the pump repetition rate unchanged (thus avoiding changes to thermal lensing in the laser rod).

Show syncin. Freq. - shows the input sync pulse repetition rate.

i) Safety

Defeat some errors – allows the system to ignore shutter interlock. Once this option is activated, the system stays in this mode until the next power cycle, or until *Enable all errors* option is used.

Enable all errors – resets the system to full error control.

j) Display Layout

Save layout - saves the configuration of the main window. All changes made to the layout of the main window are valid for current session only, i.e. until the next power off. Use *Save layout* to make them permanent.

Clear layout - clears all fields except field A on the 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.

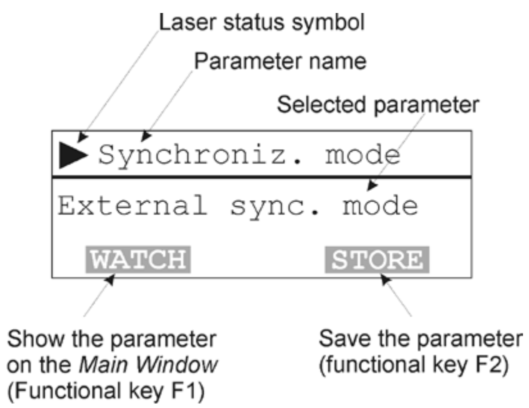

Figure 14 Setting the parameter

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.

7.5.4. Factory Setup of the Main Window

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

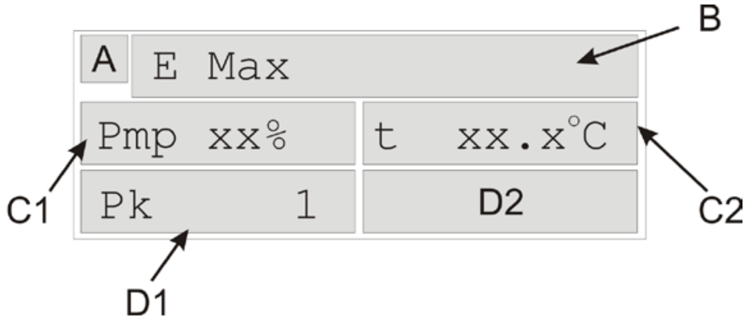

Figure 15 Factory setup of the main window

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

Field C1 – pump voltage in % of nominal value.

Field C2 – set the cooling temperature.

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

Field D2 – not used in factory setup.

7.6. Parametric Control from Control Pad

7.6.1. Home Window (Setting the Wavelength)

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

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

The display shows:

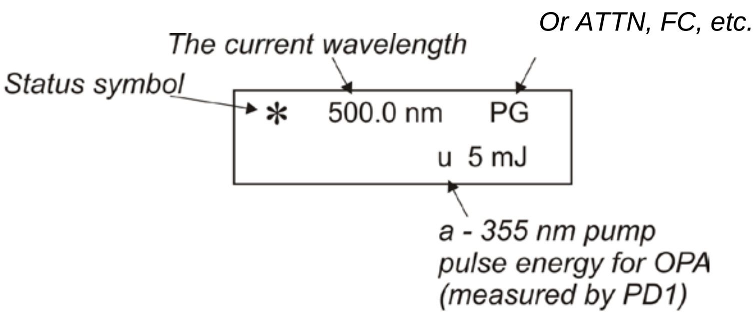

Figure 16 Home window of parametric control

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.

Use navigation buttons ▲, ▼, ◄ or ► to set the wavelength. After the required value has been entered, push the *OK* button, and the device will be set to that wavelength.

To switch to 355 nm output, reduce wavelength below lower limit of the current parametric range.

Display shows averaged energy of the last 10 pump pulses. If there is no signal, the averaged power value of the 10 last detected pulses is kept on display.

If the energy meter detects a pulse exceeding the maximum allowed value a message *E lim* is displayed together with a warning beep. Stop the operation, reduce the energy (most usually iby setting a proper delay value) and then proceed.

7.6.2. MENU button

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

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

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

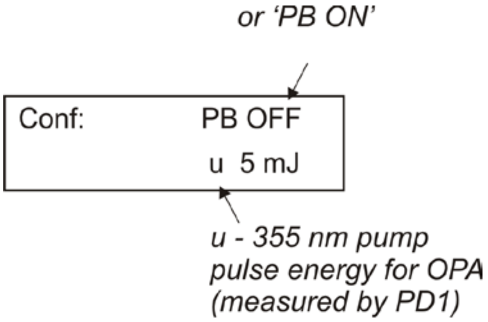

Figure 17 Pellin-Broca prism control window

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

7.7. Control from PC

7.7.1. Connecting the PC

To control the system from PC, the PC must be connected to the CAN bus. Typically, the connection is made to connector *RS232* on the power supply front panel, (see Figure 9).

Some devices may be more specific about connection; see 6.4 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 18). 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 NT342 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.*

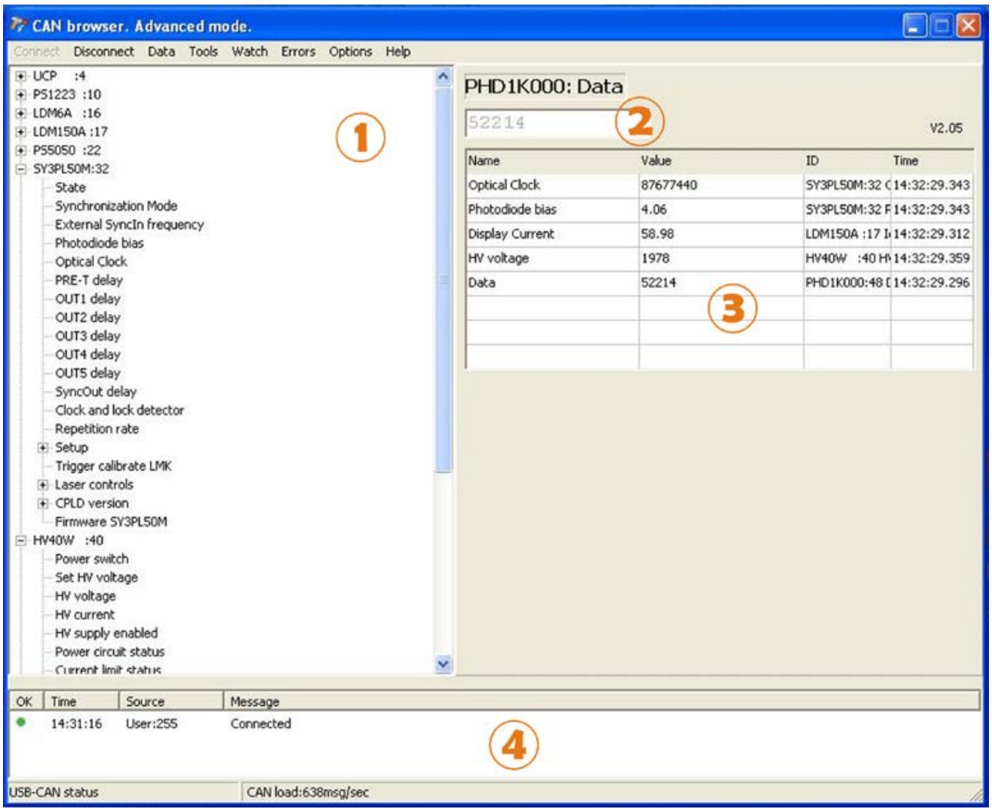

Figure 18 CANBrowser main window.

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.

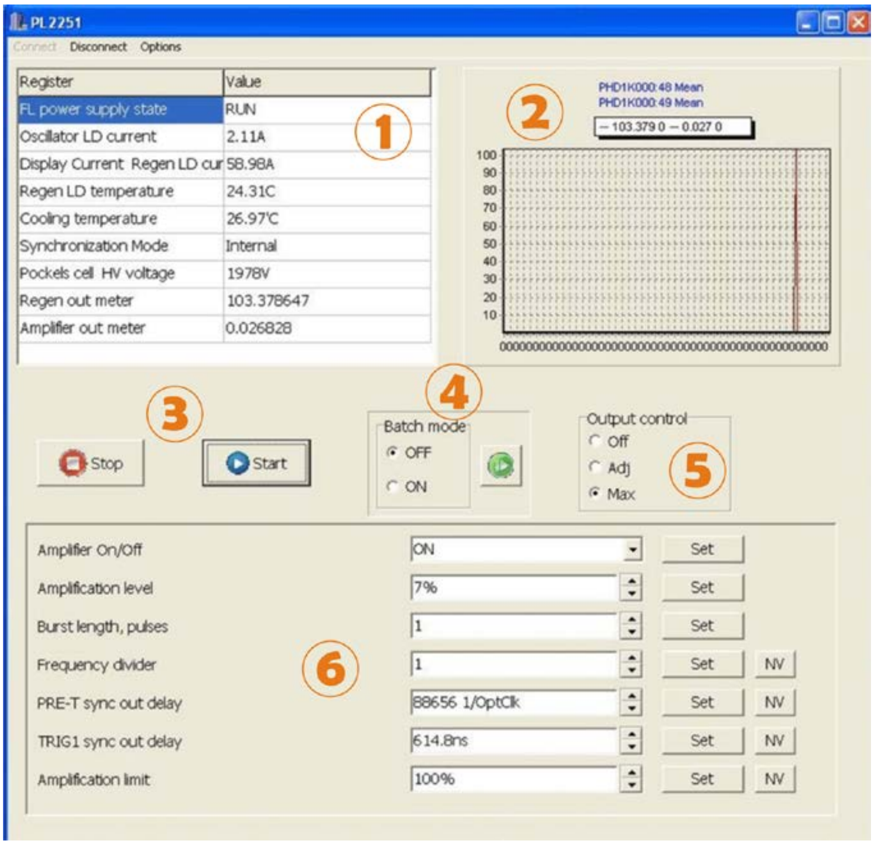

Figure 19 Remote Control Application main window. Generic view; in general, each device may have different set of displayed registers and controls.

Layout and functions of application's main window (see Figure 19):

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*.

Motor controls at the set wavelength:

- *FOPO* – position of first OPO crystal.
- *SOPO* – position of second OPO crystal.
- *SH* – position of SH (in case of extended SH system - FSH or SSH, switched automatically) crystal.
- *SFG* – position of SFG crystal at the set wavelength.
- *PB* – position of Pellin-Broca prism PBP at the set wavelength and configuration. Several factory pre-set configurations exist, see 5.3.4 Spectra Cleaning Module.
- *ATTN* – position of Rochon prism RP2.
- *Signal_Bl.* – position of Shutter2.
- *FC_Sw.* – position of prism PR5.
- *FRochon* – position of Rochon prism RP1.
- *SFG_Sw.* – position of holder with mirrors M15/M16.
- *SRochon* – position of Rochon prism RP3.
- *Filter* – position of the filter F1 and plate HWP2.
- *IIIH_Sw.* - position of mirror M13.
- *IH_Sw.* – position of Shutter1.

Some of these values should not require any further adjustments under normal circumstances and are not editable by the user.

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

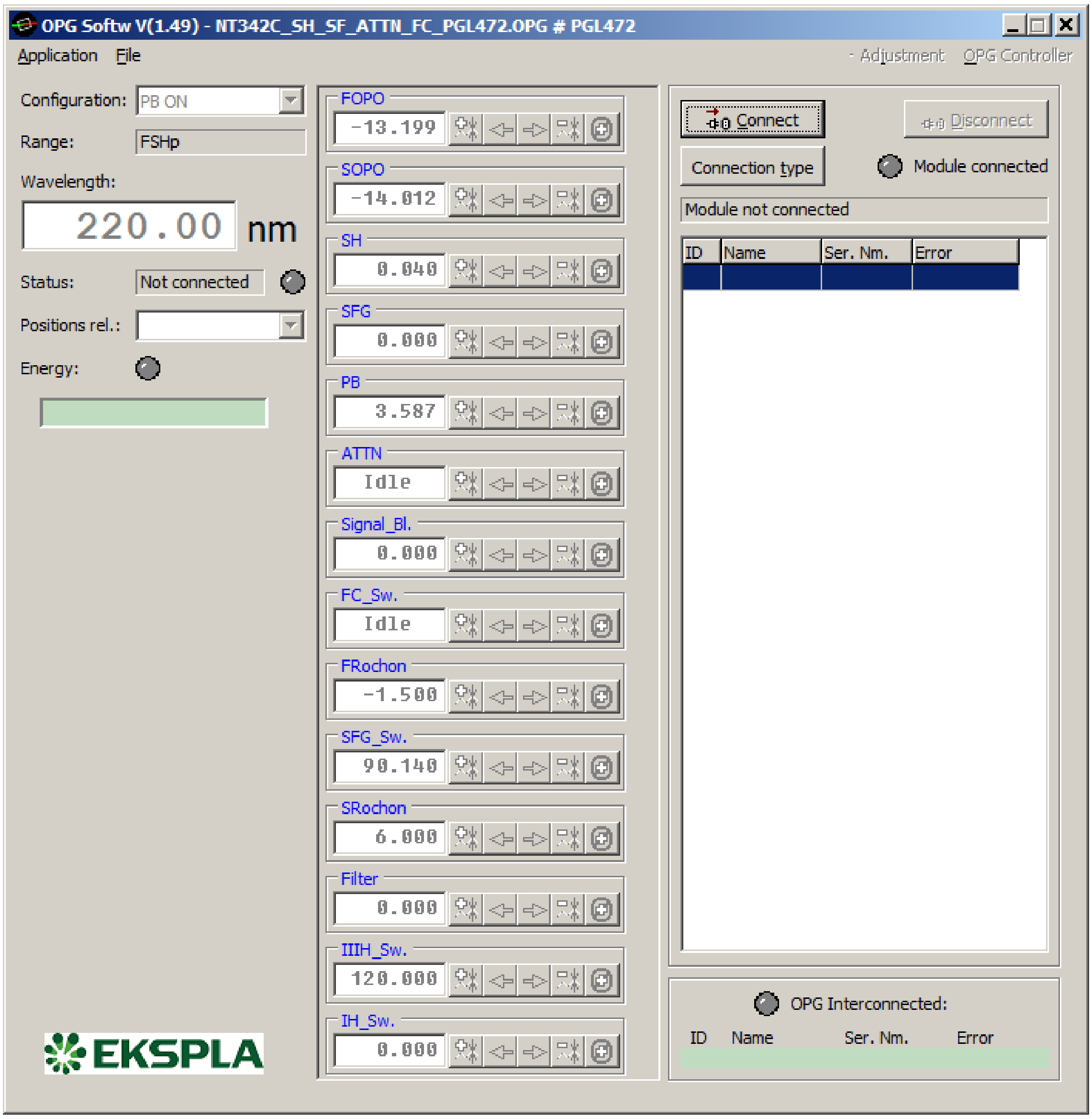

Figure 20 UniPG control interface

7.7.5. ATTN Software Control

To control the system through the custom-made software, install it from CD, *ATTN Control Software Installer* folder.

> *Note:*
> *This software requires administrator permissions to run successfully Requires Windows 7 or higher.*

When first using the software, the maximal attenuation (minimal transmittance) angle of the attenuator is automatically set, but in order to confirm this:

– Open the *Configure* menu;

- By changing the MIN transmission angle value in the popup window, find the actual minimal transmission angle;
- Press *Store*;
- The setup is completed; when using the software next time, the minimal transmittance angle will be set automatically.

Select the COM port and click *Connect*.

Proceed to the main window. Most of control parameters are described in Remote control pad section.

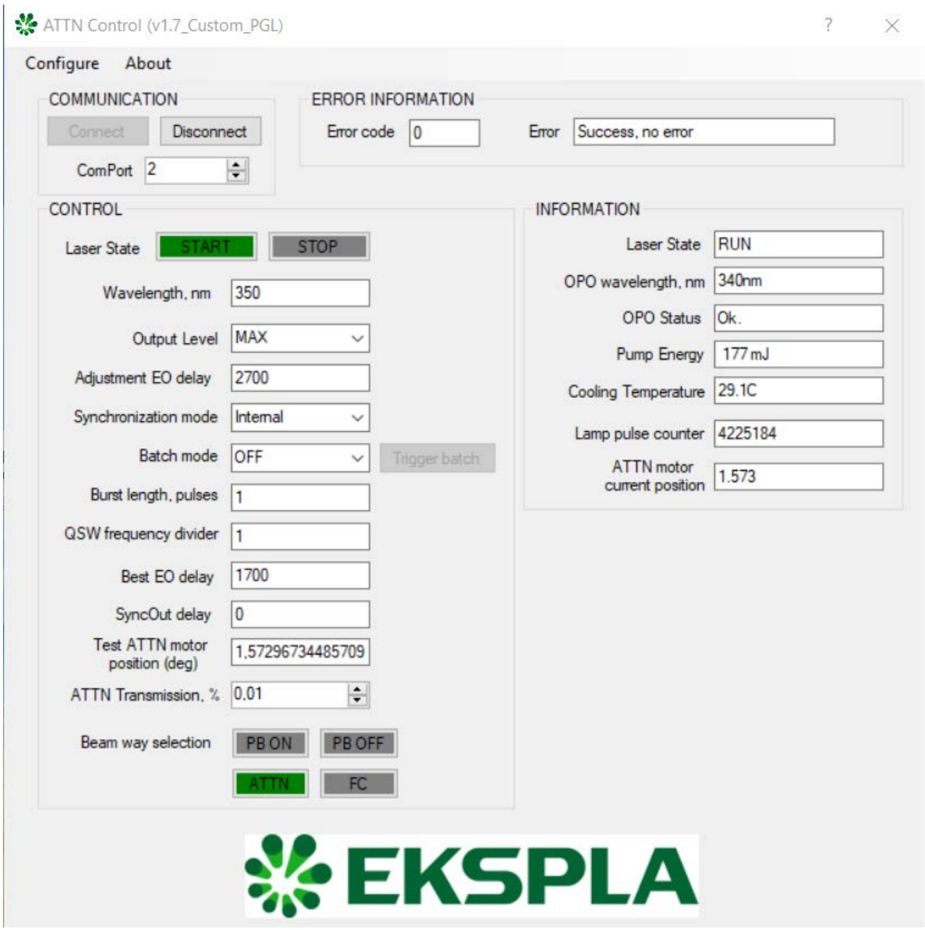

Figure 21 ATTN software control

In addition, the control window contains attenuator controls:

Test ATTN motor position (deg) changes the rotation angle of the corresponding RP2 Rochon prism (in degrees). Please note, the corresponding *ATTN Transmission* value in this case is not refreshed.

ATTN Transmission sets the transmission value in %, using the pre-set minimum point and theoretical curve. The default start-up value is 0.01%.

To set the angle corresponding to minimum transmittance, pick menu option *Configure*, and in a new window enter the angle and press *Store*.

The three *Beam way selection* buttons change the output of the laser by automatically turning the required motors of optical elements:

- *PB ON* – directs the OPO beam to PR3 and moves M20 out of the beam path. Output available at PB ON 210...2600 nm aperture.
- *PB OFF* – directs the OPO beam to the PB OF 410...2600 nm aperture.
- *ATTN* – directs the OPO beam toward the attenuators via PR4.

Factory pre-set minimum position is indicated in Chapter 10 Factory settings. Number of motor steps is configured at factory and should not be changed.

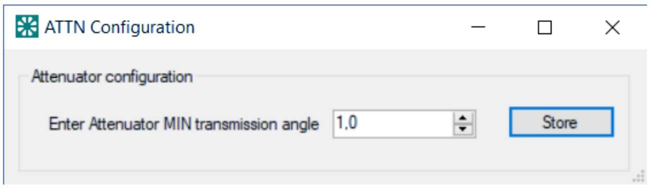

Figure 22 Software control configuration

7.8. External triggering

The laser can be synchronized by a single external sync pulse when the laser is in the external synchronization mode (see 7.5.2.h) Synchronization). A 3...5 V sync pulse should be applied to *IN* input. Input resistance is 50Ω. The sync pulse rise triggers the flash lamp and the fall triggers the Q-switch (see Figure 5). Sync pulse duration must be chosen for optimal delay between lamp flash and Q-switching. See 7.5.2.h) Synchronization about *Best EO delay* and *Adj. EO delay* parameters.

7.9. User Output Signals

Output sync pulse is available at the *OUT* connector on the front of the power supply (see Figure 9). Pulse characteristics:

- amplitude >4 V @ 50 Ω
- rise time 50 ns
- duration >5 µs
- jitter in respect to optical pulse: ±0.5 ns (internal triggering); ±125 ns (external triggering).

Output sync pulse delay relative to Q-switch is controlled by *SyncOut delay* parameter, see 7.5.2.h) Synchronization.

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The Routine Operation chapter provides basic operation instructions for the *NT342* series laser including powering up, operating, pausing, and shutting down the system.

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

8.1. Turning On the System (Cold Start)

1. Plug in the mains.
2. Wait for ~30 minutes for crystal heaters to provide a set temperature.
3. Proceed to warm start.

> *Note:*
> *It is recommended to keep the laser plugged to the mains all the time. Nonlinear crystals are heated to maintain a stable temperature slightly above ambient. This controls humidity on optical surfaces and reduces self-misalignment of resonators due to thermo-cycling. Standby power consumption depends on the ambient temperature and is in a range of 30…60 W.*

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

8.2. Operating the System

8.2.1. Laser Daily Turn-on (Warm Start)

1. A warm start can be performed when the laser is plugged to the mains for at least 30 minutes.
2. Make sure the out coming laser beam path is clear of any unwanted objects. The system is ready for operation.
3. *(For water-water cooled models)* Open the external water tap.
4. Turn the key to *ON* position.
5. Press the *RUN* button on the control pad (alternatively, use the software controls).
    a. Because the default power level is Off, the laser begins firing idly.
    b. Allow 10…15 minutes for the temperature in the cooling loop to stabilize.
6. Open the shutter for the currently selected output.
7. Choose the required *Output level*, see *7.5.2.a) Output level*.

8. Allow it to operate for approx. 1…3 minutes (depends on the repetition rate) to establish a thermal equilibrium to ensure the stable operation at the specified output parameters.
9. Check if 3H pump energy indicated by the control pad (or, alternatively, control software) reaches the level specified in Testing data (at *E Max* output level).
10. Set the wavelength.

8.2.2. Switching the Firing Mode

1. In *Normal* mode the laser is firing continuously.
2. When *Burst* firing mode is selected, pressing the *RUN* button alone makes the laser to fire idly. To produce the burst, for each burst a *Burst trigger* option must be activated in addition (see 7.5.2.b) Burst mode).
3. Optionally, a control pad shortcut may be used to produce bursts with more convenience. Assuming the factory setup of the main window layout is active, the procedure is as follows:
   a. have the main window opened;
   b. navigate to field D1;
   c. use buttons ▲ and ▼ to change the burst length (optional);
   d. press the *F1* button; this simultaneously switches to *Burst* mode, activates *Burst trigger* and produces the burst.
4. After completing the burst, laser generation is stopped by electro-optics. Pump lamps continue flashing to maintain thermal equilibrium.
5. When switched back to *Normal* firing mode, the laser starts to fire automatically if it previously was in *RUN* mode (i.e. the *STOP* button was not pressed before switching to *Normal* mode).

8.2.3. Temporarily Stopping System Operation

This procedure is intended for a temporary stop of the system operation.

1. Press the *STOP* button on the Control Pad.
2. Press the *RUN* button on Control Pad to resume the operation. After some idle flashes, the laser begins generating pulses at the energy level and wavelength set previously.

8.2.4. Switching Outputs

a) Switching to 3H (355 nm) output

1. Set the wavelength below parametric range (210 nm).

b) Switching Back to Parametric Output

1. Set the wavelength to parametric output range.

8.2.5. Turning Off the System

1. Press the *STOP* button on the Control Pad.
2. Close the shutter(s).
3. Turn the key to *OFF* position.
4. *(For water-water cooled models)* Close the external water tap.

8.3. Operating the System in External Synchronization Mode

In external synchronization mode the flash lamp discharge is determined by the rise of sync pulse and the opening of Q-switch is tied to the fall. Therefore the duration of sync pulse should be set according to the rules determined in 7.5.2.h) Synchronization.

To obtain the optimal sync pulse duration in microseconds, look for *Synchronization->Best EO delay* value at a control pad. The absolute delay value (in microseconds) may be calculated by following equation: *(Best EO delay) × 0.125 µs + 20 µs*. If required sync pulse duration cannot be set precisely, it may be extended a little (round up). Several microseconds will not significantly influence the output energy. Do not round down.

Caution:
The value Delay MA (OPO), indicated in 12.2 Factory Settings, is optimized for OPO performance. Shorter delay values can be used ONLY when OPO stage is bypassed, i.e. when using 3H output, or when using H/2H outputs (with H-2H option installed). The value of shorter Delay MA (MAX), indicated in 12.2 Factory Settings, is optimized for maximum 1H/2H/3H output.

Using short delay when working in OPO range may lead to irrevocable damage to OPO optical components. Please be aware that there is no automatic safety other than warning beep in this situation.

Since the delay in this mode is controlled by duration of the sync pulse, there is no difference between *E Max* and *E Adj* output levels. However, if *E Off* output level is set, system will ignore the fall of a sync pulse and will set the delay using internally stored value, which ensures that the generation will not occur.

When working in internal synchronization mode, while having the cable connected to IN connector, external sync pulse or electromagnetic noise induced at the cable may disrupt the internal generator. It is always recommended to disconnect the external sync cable when working in internal synchronization mode.

8.3.1. Avoiding the Focused Glancing Reflection

The system is designed to operate at thermal equilibrium, with thermal lens established in a rod. At a cold start, when the thermal lens is not established yet, the radiation is not collimated properly. Glancing reflections of this radiation from the surfaces of the rod or other components may focus and damage optical components of the system.

To avoid this, an internal controller board has an in-built algorithm which denies opening of a Q-switch until thermal lens forms. However, this safety measure is bypassed in external synchronization mode, so the following procedure is highly recommended:

1. Set the duration of external sync pulse to 500 μs.
2. Use external pulse to start the laser.
3. Give some time for thermal lens to form (approx. 7 seconds).
4. Lower the pulse duration to optimal.

8.3.2. Normal Firing Mode

7. Provide a 3…5 V signal to *IN* connector on a power supply unit front panel. Signal repetition rate must be the same as nominal (10 Hz).
8. Switch to external synchronization mode using the control pad *(Menu->Synchronization->Synchroniz. Mode ->External*).

Attention
Please follow the procedure described in 8.3.1 Avoiding the Focused Glancing Reflection when performing a cold start in external synchronization mode.

9. Press the RUN button.

Please note, that external sync pulses govern pump diodes and/or lamps, so in a prolonged absence of sync pulses the laser cools down and leaves the optimal thermal equilibrium. To reach the optimum state some warm-up time will be needed after providing the pulses.

Note:
If the external sync pulse source was provided after switching to external synchronization mode, or external source was temporarily switched of during the operation, it is possible for the system to hang with WRONGF error indicated on a control pad. In this case, cycle the key and press RUN on the pad.

8.3.3. Burst Firing Mode

Burst mode in external synchronization mode works the same way as in internal. *Burst trigger* action must be activated to produce each burst using procedures described in 8.2.2 Switching the Firing Mode.

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

9.1. Regular Maintenance

9.1.1. Schedule

a) Monthly

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

For water cooled systems:

- check for water leaks.
- check all external hose connections for damage or loosening.
- check water level.

b) Each 6 months

For water cooled systems:

- check the secondary water gauze on the inlet port and clean it if necessary.
- change the coolant in inner cooling loop. Consult cooling unit manual for procedure.

  Note:
  Depending on the purity of the water used, the period may go down to 3 months.

c) Yearly

For water cooled systems:

- replace the deionizer and particle filter cartridges, if they are present (depends on a type of cooling unit). Consult cooling unit manual for procedure.

9.1.2. Cleaning the Optical Surfaces

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

a) Safety

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

b) 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.

c) 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.

d) 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.

e) Wet cleaning

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

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

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

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

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

9.2. Maintaining the Output Energy

The output energy of OPO or 3H beam may not meet the specifications due to following causes:

1. Third harmonic output energy is low:
    a. Harmonic crystals are misaligned;
    b. Insufficient flash lamp pump energy;
    c. Optical elements are dirty or stained;
    d. Misalignment in a master oscillator.
2. OPO energy is low:
    a. OPO crystals are misaligned
    b. (Optional) for systems with SH/SFG module output energy in SH/SFG range is low – SH/SFG crystals are misaligned.

Diagnose the cause and remedy it using procedures described below.

If 3^{rd} harmonic output energy, indicated on a control pad is low:

3. (*Optionally*) Check 3H output energy with an external energy meter when available. If energy satisfies the specification, call service for photodiode calibration/adjustment.
4. Adjust harmonic crystals as described in 6.5 Installation and Adjustment of Harmonic Crystals.
5. If adjustment does not help, check the IR beam profile. If the profile is distorted, check cleanness of optical components and perform cleaning if necessary. If cleaning does not help, or if contamination was discovered within the master oscillator cavity, call service.
6. If profile is OK, proceed to 9.3 Countering the Ageing of Flash Lamps.

If output energy in parametric range is low, while having no problems with 3H output, adjust OPO optical zeroes, using procedure in 6.6.1 OPO Installation and Adjustment.

9.3. Countering the Ageing of Flash Lamps

9.3.1. Ageing of the Flash Lamps

Flash lamps deteriorate when producing big number of shots, because slowly evaporating electrodes produce an opaque coating on the inside surface of the tube. This causes laser output power to decrease.

To counter this effect, flash lamp pump voltage must be increased.

9.3.2. Rising the Lamp Pump Voltage

Please keep in mind that there are many circumstances apart from the deteriorating of the flash lamp that may lead to decrease in output energy. Exercise caution and use your best knowledge when increasing the pump voltage.

To diagnose if the aged flash lamps are the likely cause, use the following procedures:

1. Check that the laser output beam profile is undistorted; this means that energy decrease is not related to optics contamination/damage or misaligned beam path.
2. Check that output decrease originates in a master oscillator; indications of this is decrease in 3H energy displayed on control pad, while SHG/THG crystals are properly aligned and their alignment is not the cause of a loss in output energy.

Increase flash lamp pump voltage until output energy specification is met. Consult the power supply manual about how to change the pump voltage. It should be noted, that increased pump voltage by itself accelerates the electrode evaporation, so it is only a temporary solution. As a rule of thumb, if an increase of a nominal pump voltage by 10% is needed, the beam profile will deteriorate; increase by >20% should not be considered as a viable solution anymore.

If increasing the flash lamp pump voltage is impossible or does not produce the desired effect, flash lamp(s) must be inspected and replaced.

9.3.3. Flash lamp Replacement

Consult the power supply unit/cooling unit manual.

Warning!
Failure to follow this procedure may lead to injury and severe equipment damage. Always wear safety goggles to protect the eyes from flying debris—the flash lamp can potentially explode.

This procedure must be performed only with cabinet isolated from mains.

Pockels cells and harmonics crystals are highly hygroscopic. Take special care to keep the moisture away from them when replacing flash lamps.

1. Make sure the laser system is switched off and isolated from mains supply.
2. Allow at least two minutes to elapse since disconnecting mains.
3. Open laser head cover.
4. Release the fast connector on a coolant supply hose. Since the cooling unit pump is off, the water will drain down the lines quickly if cooling unit is placed below the laser head. If not, ensure that the water will not spill on optics and electronics. Apply the connector back.
5. Unscrew two fixing screws on the sides and remove the laser chamber compartment cover.

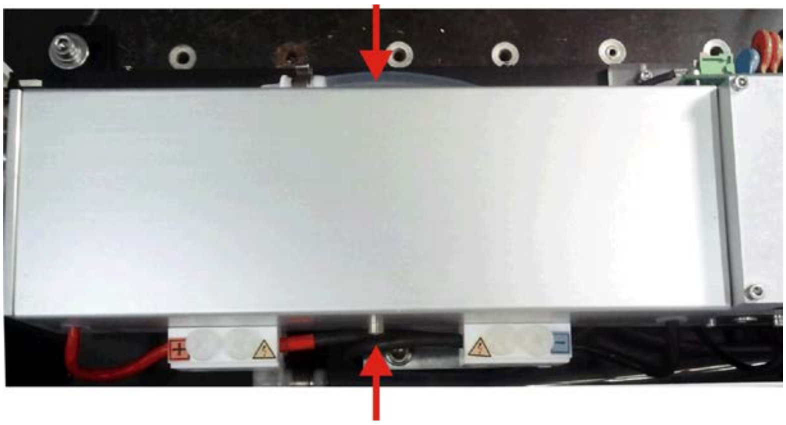


Figure 23 Laser chamber compartment cover

6. Unscrew six screws fixing the upper part of the laser chamber (pointed by green arrows in Figure 24. Do not release the four screws holding the underlying plate, pointed by red arrows!).

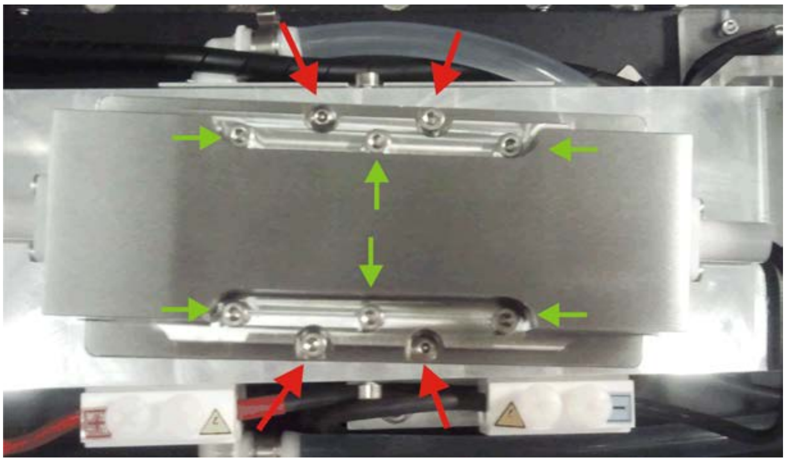


Figure 24 Screws fixing the upper chamber part

7. Remove the outer plastic caps covering electrode fixing screws (Figure 25). Release screws fixing the electrodes of the flash lamp. Disconnect electrodes.

Figure 25 Disconnecting the electrodes

8. Lift the upper part of the laser chamber and put it on clean solid surface upside down. Rinse the residual moisture, if needed.

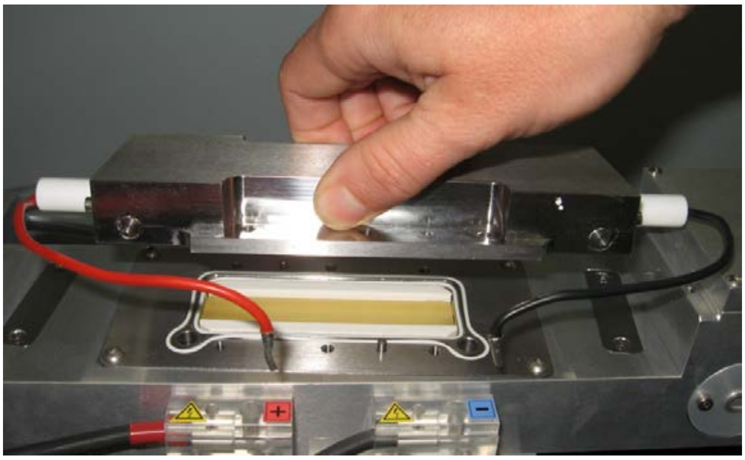


Figure 26 Lifting the upper part of the laser chamber

9. Unscrew the screws fixing the lamp end caps and pull the caps off; see Figure 27.

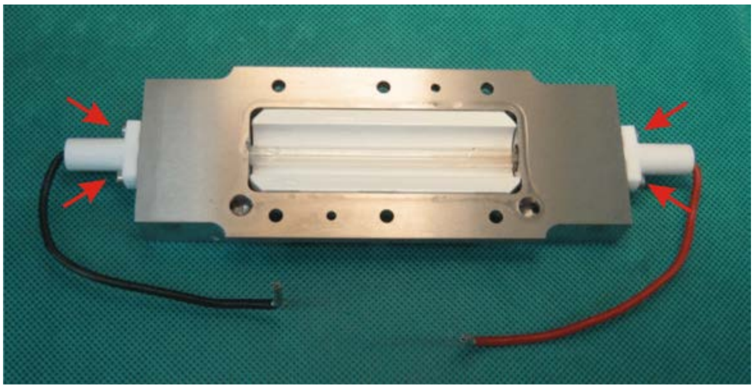


Figure 27 Removing lamp end caps

10. Carefully pull the lamp out; see Figure 28 . If necessary, gently work it to make the silicon seals release. Be careful to avoid any bending force that may break the lamp.

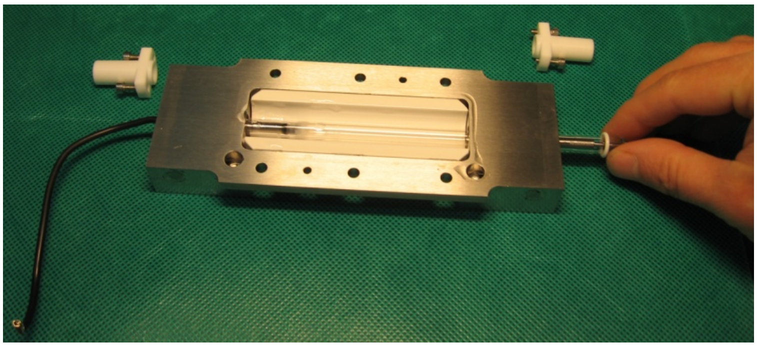


Figure 28 Pulling the lamp out

11. Cleanse a new flash lamp with methanol or acetone and insert it into pump chamber. Take care to ensure correct polarity: red painted end is positive.

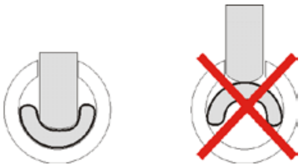
12. Reassemble lamp caps; tighten them carefully, do not over-tighten.

13. Make sure that silicon seal is properly placed in its channel (trapezoid with curved angles).

14. Return the upper part of the chamber to its place and fix by screws. Make sure that seal channel position is matched on both upper and lower parts.

15. Reconnect the electrodes. Put back the plastic covers.

Attention:
Ensure that a contact layer inside is facing outwards from electrode. Otherwise electrodes may burn out because of a resulting small contact area.



16. Connect the power supply to mains.

17. Switch on the power supply, press button *Service* on the power supply. For 1…2 min watch for water leakage to appear at the lamp plates. If leakage is detected, switch the power supply unit off and eliminate the reason of leakage.

18. Place back the laser chamber cover; secure it with the screws.

19. As a precaution measure, decrease the lamp pump voltage to ~50V below the factory setup (see Chapter 12) in order to prevent the optics damage in case the laser is over-pumped by the new flash lamp which emits more light than the old one. (If the setup value is unknown at the time of replacement, decrease voltage to ~200V below the last one used.) Start operating and increase flash lamp voltage until you obtain specified output energy, if needed.

9.4. Fiber Maintenance

Note:
The tools shown are optional and not provided by EKSPLA.

Note:
This information is for reference only! Service should be performed by an experienced serviceperson.

1. Stop the laser beam and remove the fiber holder;
2. For fiber repair, use the tools shown in the picture below:
    a. Diamond wedge scribe;
    b. Teflon tubule;
    c. Stripping tool (M44S67).

Figure 29 Tools for fiber repair

3. Unscrew and remove the fiber clamp;

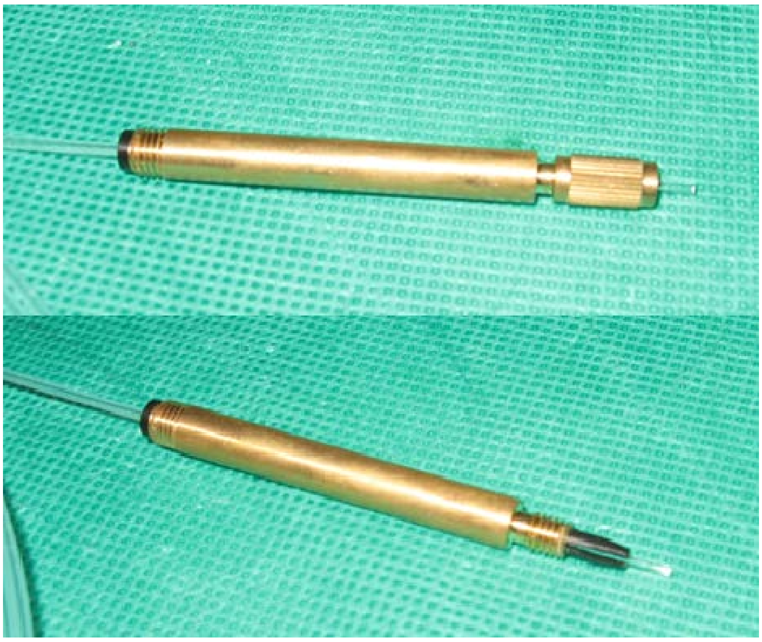


Figure 30 Unscrew (top) and remove (bottom) the fiber clamp

4. Push away the fiber holder from fiber end and remove the sleeve (black);

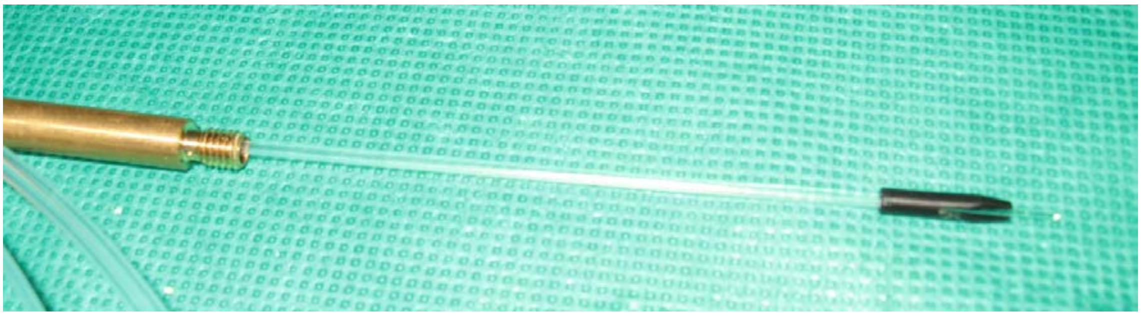


Figure 31 Remove the black sleeve

5. Insert the fiber into the stripping tool. Remove 3 centimeters of fiber coating. This requires at least three uses of the stripping tool;

Figure 32 Insert the fiber into the stripping tool and remove fiber coating

6. Carefully put back the sleeve and the fiber clamp;

Figure 33 Put the sleeve and the fiber clamp back on the fiber

7. Take the diamond wedge scribe and make a cut on the fiber approx. 2 centimeters from fiber end. **Try to hold the scribe tool perpendicularly to the fiber!**

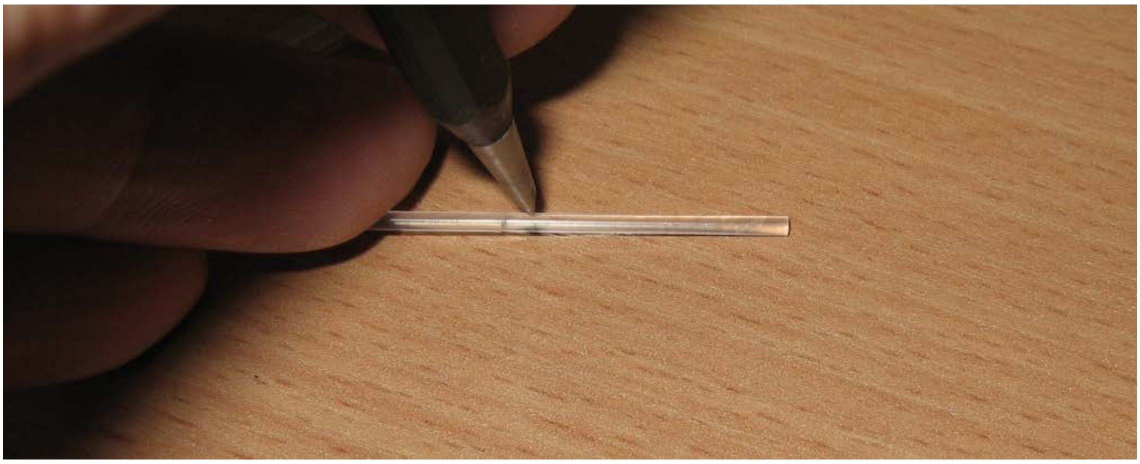


Figure 34 Scribe the fiber perpendicularly using the diamond wedge

8. Slot the scribed fiber into the teflon tubule and break off the damaged section of the fiber;
9. Move back the fiber holder and screw it to fiber clamp;
10. Install the fiber.

    Warning
    Avoid accidentally hitting any surface with the fiber end during this operation – it may damage the fiber input surface.

11. If need be, optimize the fiber output energy by adjusting the fiber coupler with adjustment screws.

9.5. Power Supply Coolant Maintenance

Consult the power supply unit/cooling unit manual.

9.6. 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.

9.7. 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.

9.8. Fuses

Fuse quantity	***Fuse type***	***Function***
Rear of the power supply		
2	16 A slow	Protection of the power supply against current overload and short circuit damage

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The Troubleshooting Guide provides information and solutions for potential problems with *NT342* 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*.

Some errors are also indicated by power supply indicator LED's, see 7.2.1 Front panel.

10.1.2. Resetting the Fault

Fault occurrence does not necessarily mean a permanent device failure.

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

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

10.2. Most Common Problems

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

Symptom	***Possible cause***	***Remedy***
Laser does not start.	No mains connection.	Check the mains cable and connection. Check the mains disconnection switch.
	A fuse in the power supply has blown.	Check fuses; replace if needed.
Laser is not working; red LED illuminates on a power supply unit.	Mains power has been connected after the key switch has been set to ON position.	Set the key switch to OFF and then to ON again.

Symptom	***Possible cause***	***Remedy***
Laser does not work: the Control Pad display does not illuminate, LED *POWER* illuminates continuously, without blinking	Bad connection to the Control pad.	Check the connection of Control Pad cable. Then cycle power with key switch.
	Control pad has been connected *after* switching on the mains power.	Cycle power with key switch.
	Control pad or its cable is defective or broken.	Call service.
Laser does not work: *SHUTTER* is indicated on control pad and in a CAN message.	Safety interlock circuit is open.	Check the cover, shutters and mirrors M10 & M11. Then cycle power with the key switch.
Laser does not work; control pad is shut down.	Remote safety interlock circuit is open.	If remote interlock circuit is employed, check it (doors, etc.) If it is not, remote interlock connector must be properly shorted using a provided plug.
Laser does not work: *COOLING* is indicated on control pad and in a CAN message.	Coolant flow in internal cooling loop is broken.	Check coolant tubes connecting power supply unit and laser. Check coolant connections within the laser.
	Coolant level in reservoir is too low.	Refill the coolant.
	Cooling capacity is not sufficient.	Check that external cooling tubes are not accidentally clamped. Check that external tap water flow is sufficient. Check that external water temperature is low enough (10ºC below the T_{WATER} (ºC) temperature, see Factory Settings, is recommended). Check that cooling water temperature is set properly (use menu option *Read Cooling T*). The value indicated in Factory Settings should be used. For air-water cooled systems – check if the air flow to the fans in a cooling unit is obstructed (by the walls, other devices, etc.).
Laser does not work: *OVERHEAT* is indicated on control pad and in a CAN message.	Temperature inside the power supply has exceeded the value allowed.	Ensure that the fan is not covered. After temperature falls below the maximum allowed, supply switches ON automatically.

Symptom	*Possible cause*	*Remedy*
Lamps are not flashing. *EMISSION* is indicated on control pad and in a CAN message.	Unsuccessful attempt to fire the simmer. Flash lamp, power wiring, power supply failure, insulation breakdown.	If the message is preceded by a code 0009, check the flash lamp and the flash lamp powering circuit. If the message is preceded by a code 0008 then turn power supply OFF and ON. If the problem persists, contact service.
The flash lamp flashes idly, without laser pulses produced	Power supply voltage may be too low.	Provide proper voltage.
	EO modulation may be switched off.	Set EO to ON, see 7.5.2.h) Synchronization.
Free running radiation is visible at the output using a fast photodiode and oscilloscope when the Q-switch is off.	EO control voltage is not adjusted properly for Q-switch to fully close resonator.	Slightly adjust the EO modulation control voltage using the CANBrowser.
The output beam spatial profile is irregular and/or uneven; the pulse energy is below specifications.	Optical components are stained, covered with dust, or damaged.	Clean the components. Contact service for replacements.
Pressing *Run* button on a pad does not start continuous firing.	Laser is in a *Burst* mode.	Switch to *Normal* firing mode. If *Burst* mode is assumed indeed, use *Burst trigger* to produce a burst.
Pressing *Run* button on a pad does not start firing.	Laser is put into external synchronization mode without providing an external sync pulse.	Provide an external sync pulse, or switch to internal synchronization.
Laser does not start in external sync mode; *WRONGF* error is indicated.	External sync pulse has wrong repetition rate.	Provide the external sync pulse with proper repetition rate (10 Hz)
Laser does not start in external sync mode; no error is indicated.	External sync pulse level too low.	Provide the external sync pulse with proper level (3…5 V)
Laser is not working in internal synchronization mode with external sync cable connected.	External sync pulse interrupts the board.	Disconnect the external sync cable.
3H output energy is lower than expected	*Output level* is set to *E OFF* or *E Adj*.	Set the proper Output level.
	The delay value for the corresponding output level is set too big.	See about setting the EO delay in 7.5.2.h) Synchronization.
	SH/TH crystals are misaligned.	See 6.5 Installation and Adjustment of Harmonic Crystals
	Flash lamp(s) have aged.	See 9.3 Countering the Ageing of Flash Lamps

PG troubleshooting		
"!" status symbol is displayed on a control pad .	Motor(s) are not in a proper position.	Investigate the error message in UniPG or CANBrowser for more details; check the motor.
	Motor cable is detached.	Check the cable of motionless motor.
	The motor is hindered mechanically.	Check for mechanical constraints.
	Device power has been turned on with the stepper motor disconnected.	Press three buttons – *ESC*, *MENU* and *OK* – at once.
Everything seems moving OK, nevertheless the generation is absent.		Press three buttons – *ESC*, *MENU* and *OK* – at once.
Beep alarm sounds, *E lim* + name of the sensor is indicated on control pad.	Pump energy limit exceeded.	Stop the operation; lower the energy.
Output energy is lower than specified.		Refer to procedures in 9.2 Maintaining the Output Energy
Output wavelength differs from the set one.		Call service.

10.3. Error List (Contents of ERROR.TXT)

Module name and CAN ID	***Error name***	***Error code***	***Short explanation***
SM5 :61	NOHOME0	2H	Failed to find home position for motor
SM5 :61	HOMING0	10H	Looking for home position
HV40W :40	HVMAXCUR	1H	Overcurrent protection
MaxiOPG :31		400H	No Response cId61 ! SRochon. SM5 200step
MaxiOPG :31		100H	Home Error L2 ! SFG_Sw. RotH 1.8°/64 600mA.
MaxiOPG :31		80H	Home Error L1 ! FRochon. RotH 1.8°/64 600mA.
MaxiOPG :31		200H	Home Error L3 ! FC_Sw. RotH 1.8°/64 600mA.
MaxiOPG :31		40H	Home Error M6 ! ATTN. Motor 1.8°/512
MaxiOPG :31		20H	Home Error M5 ! PB. Motor 0.9°/512
MaxiOPG :31		10H	Home Error M4 ! SFG. Motor 0.9°/512
MaxiOPG :31		8H	Home Error M3 ! SH. Motor 0.9°/512
MaxiOPG :31		4H	Home Error M2 ! SOPO. Motor 0.9°/512
MaxiOPG :31		2H	Home Error M1 ! FOPO. Motor 0.9°/512
MaxiOPG :31		1H	Energy limit!
NL30x :8	WRONGF	20H	Wrong ext. trigger frequency
NL30x :8	SHUTTER	10H	Shutter interlock

Module name and CAN ID	Error name	Error code	Short explanation
NL30x :8	FLASH	8H	Flash lamp error
NL30x :8	COOLING	4H	COOLING
NL30x :8	OVERHEAT	2H	OVERHEAT
NL30x :8	EMISSION	1H	PS error, no emission

10.4. 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.

10.4.1. Making 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.

10.4.2. Making 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.

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11.1. System Identification

Model **NT342C-10-SH-SF-ATTN2-FC-AW**

Serial No **PGL472**

11.2. System Electrical Components

Table 6 System electrical components

Component Name	***Type***	***Serial Number***	***Characteristics***	
Power supply	PS5062AM	37261	Supply voltage	200…240 VAC
			Frequency	50/60 Hz
			Phase	1
			Amps	16

11.3. System Optical Components

Table 7 System optical components[1]

Component Name	Type	No in optical layout	Characteristics/Code
NL300 series laser			
Laser rod	Nd:YAG		P5YAG-G11N8G-120W3/3A1
Flash lamp	QXF1649		P5FLL-FLFd5x90
Cavity mirror		RM	P5BK7-BK7SO76V18001-0H0
Output coupler	D8G	OC	P5BK7-BK7MO75V664X8301-D8G
Pockels cell	DKDP	PC	P5DKD-DKDXS10255/51-AA0
Thin-film Polarizer		P	P5UVS-UVSAR76C1-P06
Harmonics generators and guiding optics			
Mirror		M1	P5BK7-BK7AR561-H15-S
Mirror		M2, M3	P5UVS-UVSAR56321-SA5-S
Mirror		M4…M6, M13	P5UVS-UVSAR563-H15
Second harmonic crystal	LBO	SHG	P5LBO-LBOH1S410S1-AA0

[1] Labelling according to Figure 4 and Figure 6.

Component Name	Type	No in optical layout	Characteristics/Code
Third harmonic crystal	LBO	THG	P5LBO-LBOH2S415T1-AA0
Plate		PL1	P5UVS-UVSAO753-A00
Lens		L1	P5UVS-UVSLO73X01503-AA0
Lens		L2	P5UVS-UVSLO73V01253-AA0
Optical parametric oscillator (OPO)			
Plate		PL2	P5UVS-UVSAO753-AA0
Mirror		M7	P5UVS-UVSAR533D2G-S05-SX
Mirror	YAG	M8	P5YAG-YAGAO633D2TC-S00
First OPO crystal	BBO, II	OPO1	P5BBO-BBOJ2118143D2TC-AA-1
Second OPO crystal	BBO, II	OPO2	P5BBO-BBOJ2118143D2TC-AA-2
Achromatic $\lambda/2$ retardation plate		HWP2	P5KKV-KKVTO41A2D2G1-AA0
Prism	Image rot.	PR1	P5UVS-UVSPS290DG1-A00-POX
Rochon prism		RP1	P5BBO-BBOPO3BUE-RH
Aperture		AP2	P5FIL-N12FOO92D9
Filter	KC18	F1	P5FIL-K18FAO72G2TC-AA0
UV extension (SH/SF)			
Mirror		M15	P5UVS-UVSAR56D1F65-AA5-S
Mirror		M16	P5UVS-UVSAR561D1F653-SS5-S
Mirror		M17	P5UVS-UVSAR56151-DA5-S
Mirror		M18…M21	P5BK7-BK7AR561-H15-S
Lens		L3	P5UVS-UVSLO73X01251-AA0
Lens		L4	P5UVS-UVSLO73V01001-AA0
Prism		PR2	P5BK7-BK7PS79021-A00
Achromatic $\lambda/2$ retardation plate		HWP3	P5KKV-KKVTO41A2D2G1-A00
Sum frequency crystal	BBO	SFG	P5BBO-BBOMJ10907E06CD1-AA0
First Second harmonic crystal	BBO	FSH	P5BBO-BBOSJ197E06B4C-AA0
Second Second harmonic crystal	BBO	SSH	P5BBO-BBOSJ197E06B1B4-AA0
Spectra cleaning module			
Pellin-Broca prism		PBP1	P5UVS-UVSPS2A9D25-PB
Prism		PR3	P5UVS-UVSPS290
Attenuator module			
Prism		PR4	P5UVS-UVSPS290

Component Name	Type	No in optical layout	Characteristics/Code
Rochon prism		RP2, RP3	P5BBO-BBOPO3BUE-RH
Aperture		AP3, AP4	P5FIL-N12FOO92D9
Fiber coupling			
Prism		PR5, PR6	P5UVS-UVSPS290
Lens		L5	P5UVS-UVSLO73X0025
Lens array		L6	P5SLC-SLCBS21BX0019C-00M
Fiber		FC	L5LWP-LWWF14M-FC0