

# **NANOSECOND PULSE GENERATOR**

**NPG-18/3500(N)**

**USER MANUAL**

**Copyright © 2014 MEGAIMPULSE Ltd. All Rights Reserved.**

MEGAIMPULSE LTD. PROVIDES THIS MANUAL "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MEGAIMPULSE LTD., ITS DIRECTORS, OFFICERS, EMPLOYEES OR AGENTS BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES (INCLUDING DAMAGES FOR LOSS OF PROFITS, LOSS OF BUSINESS, LOSS OF USE OR DATA, INTERRUPTION OF BUSINESS AND THE LIKE), EVEN IF MEGAIMPULSE LTD. HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES ARISING FROM ANY DEFECT OR ERROR IN THIS MANUAL OR PRODUCT.

SPECIFICATIONS AND INFORMATION CONTAINED IN THIS MANUAL ARE FURNISHED FOR INFORMATION ONLY, AND ARE SUBJECT TO CHANGE AT ANY TIME WITHOUT NOTICE, AND SHOULD NOT BE CONSTRUED AS A COMMITMENT BY MEGAIMPULSE LTD. MEGAIMPULSE LTD. ASSUMES NO RESPONSIBILITY OR LIABILITY FOR ANY ERRORS OR INACCURACIES THAT MAY APPEAR IN THIS MANUAL, INCLUDING THE PRODUCTS AND SOFTWARE DESCRIBED IN IT.

Products and corporate names appearing in this manual may or may not be registered trademarks or copyrights of their respective companies, and are used only for identification or explanation and to the owners' benefit, without intent to infringe.

## **Megaimpulse Ltd. contact information**

Address:	28 Polytechnicheskaya str., St. Petersburg, 194064 Russia
www:	<a href="http://www.megaimpulse.com">http://www.megaimpulse.com</a>
e-mail:	<a href="mailto:mp@power.ioffe.rssi.ru">mp@power.ioffe.rssi.ru</a>
fax:	+7-812-297-3145

# CONTENTS

Package content .....	2
General view of NPG-18/3500(N) nanosecond pulse generator .....	2
Safety manual .....	3
Technical specification .....	4
Front and rear panels view .....	5
Putting the generator into operation .....	6
Triggering of the generator .....	9
Overheat mode .....	10
Output pulse monitoring .....	11
Fuse replacement .....	12
Warranty .....	13

## PACKAGE CONTENT

Please check the package for the following items:

- ✓ NPG-18/3500(N) nanosecond pulse generator (hereinafter "generator")
- ✓ Power supply cable
- ✓ High voltage output coaxial cable
- ✓ User manual



Fig.1. General view of NPG-18/3500(N) nanosecond pulse generator.

# SAFETY MANUAL

## Electrical safety

- NPG-18/3500(N) generator is high voltage equipment. Please be very careful and operate by qualified personnel only.
- There is a risk of electric shock, strong electromagnetic interference, damage of generator or other electronic equipment in case of improper use.
- Do not switch on the generator without proper grounding. We recommend to use grounding cable connected to the terminal at the rear panel of the generator or three terminal power supply outlet with ground contact.
- It is strongly prohibited to switch on the generator without output coaxial cable. There is a risk of electrical arcing on the open coaxial connector and damage of output circuit of the generator. Please use our special high voltage coaxial connector and cable only. Standard UHF, N-type or 7/3-type connectors are not suitable.
- When adding or removing generator to or from the system, ensure that the power supply ON/OFF switch is switched off and power supply cable is unplugged before the output cable is connected or disconnected.
- Please connect or disconnect any equipment, toggle generator from internal to external triggering mode or vice versa while generator is in high voltage OFF state only by HV ON/HV OFF switch.

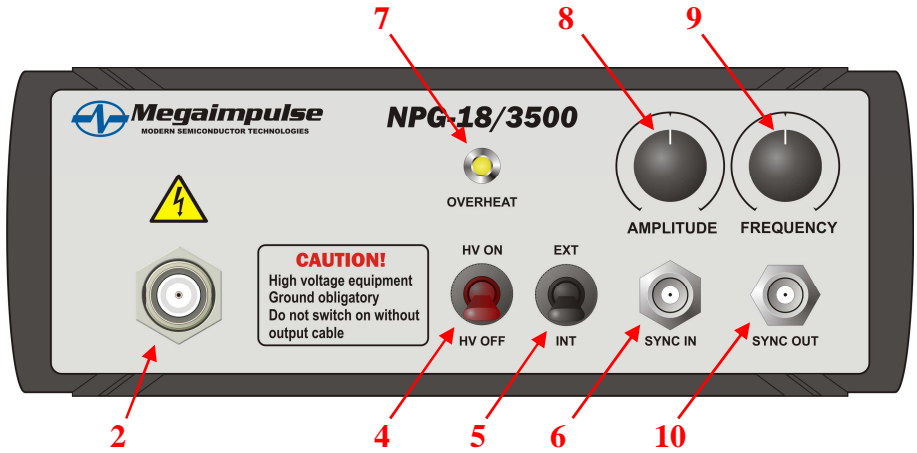
## Operation safety

- Please read this manual before installing and using of the generator.
- Before using the product, make sure that all cables are applicable and not damaged. High voltage connectors should be clean and dry, free from dust, dirt and any obstacles.
- To avoid short circuits keep metal parts like clips, screws and staples away from the generator.
- The generator is designed to work in normal laboratory conditions. Avoid dust, humidity and temperature extremes. Do not place the generator in any place where it may become wet.
- Place the generator on a stable surface.
- If you encounter any technical problem with the generator, please contact with Megaimpulse Ltd. Do not try to repair the generator by yourself.

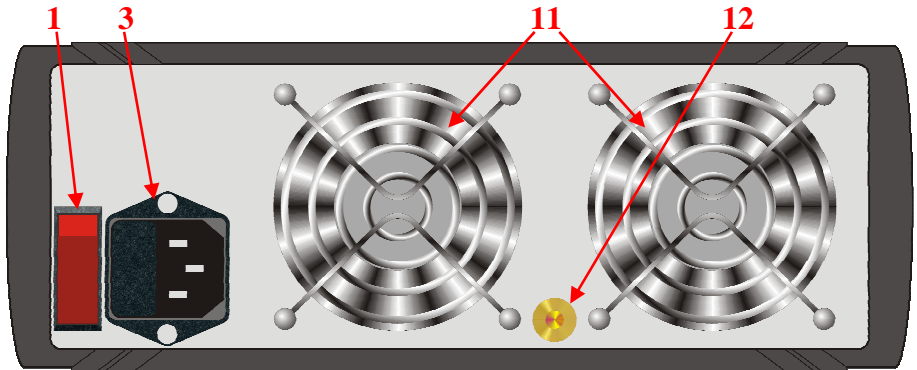
**TECHNICAL SPECIFICATION OF NPG-18/3500(N)  
NANOSECOND PULSE GENERATOR**

Output pulse amplitude (typical)	Regulated 12 .. 20kV at matched 75 Ohm load, up to 40kV at discharge reactor
Pulse polarity	positive (NPG-18/3500) negative (NPG-18/3500N)
Pulse rise time (fast part of output pulse)	< 4 ns
Max pulse energy	30 mJ
Peak pulse power	up to 5.3 MW
Repetition rate	up to 3.5 kHz
Single pulse mode	Yes, in external triggering mode
Triggering	internal or external
External triggering	BNC connector; +2.5 .. +15V amplitude, 50 .. 200 $\mu$ s pulse width
Internal generator delay	1 $\mu$ s
Jitter RMS (typical)	1 ns
Output pulse monitoring	BNC connector, 2.5V@50 $\Omega$ /5V@1M $\Omega$
Generator power supply	AC 110-230V / 50-60 Hz
Size	248 x 90 x 250 mm <sup>3</sup>
Weight	4 kg

## FRONT VIEW



## REAR VIEW



- 1 - power supply ON/OFF switch
- 2 - output coaxial connector
- 3 - power supply connector and fuse holder
- 4 - HV ON/HV OFF - high voltage on/off switch
- 5 - EXT/INT - external/internal triggering switch
- 6 - BNC SYNC IN connector
- 7 - OVERHEAT LED
- 8 - AMPLITUDE regulation knob
- 9 - FREQUENCY regulation knob
- 10 - BNC SYNC OUT connector
- 11 - fans
- 12 - ground terminal

## PUTTING THE GENERATOR INTO OPERATION

- ➔ Please follow strictly the described steps. It helps to prevent damage of the generator, other equipment, and personnel injury.

### Step 1.

Unpack the generator and check the presence into the package of the following items:

- NPG-18/3500(N) generator
- power supply cable
- output 75 Ohm coaxial cable

### Step 2.

Set up the generator. Ground it obligatory by connecting ground cable to terminal at the rear panel (12) or use three terminal power supply outlet with grounding contact.

### Step 3.

Check the output coaxial female connector at the front panel of the generator and co-pair male connector at the cable. Both connectors should be clean and dry, free from dust, dirt and any obstacles. Clean the connectors by alcohol and/or cotton bud if necessary.

Attach the cable connector to the generator front panel connector (2). The tight and firm contact of the connectors is very important for normal operation of the generator. Even small air gap between the connectors may result in arcing, destroying of the generator and the cable.

To obtain good and tight contact the following procedure is recommended:

1. Align both connectors.
2. Hold the generator by one hand to prevent moving and press the cable connector by other hand toward the generator connector.
3. Screw the cable connector nut by hand, usually one or two turns. Do not rotate the cable connector body.
4. Press the cable connector toward the generator connector again.
5. Once more screw the cable connector nut one or two turns.
6. Repeat steps 4 and 5 up to tight contact. Finally screw the cable connector nut firmly by hands.

It is recommended to check whether the tight contact obtained or not after the first test operation of the generator. Unscrew the cable connector; there should be no any ozone or burnt smell from the cable connector or any burnt traces. Please do not connect and disconnect the high voltage connectors many times to prevent the contacts wearing.



#### Step 4.

Connect the other side of coaxial cable to the load. The cone teflon insulator is used at the cable end to prevent the discharge between central cable wire and the cable braid (See Fig.2). You may use additional wires for connection: solder the high voltage signal wire to the central cable wire and screw/solder ground signal wire to the ground clamp. It is recommended to use as short additional wires as possible.

- More than 10 cm additional wires between the load and coaxial cable result in excessive stray inductance and significant reducing of the pulse voltage on the load.

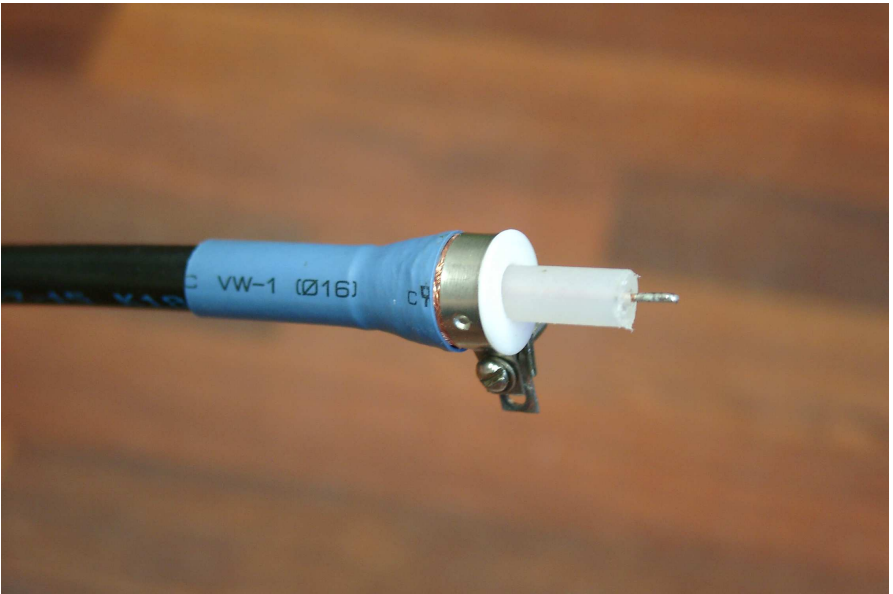


Fig.2. The cone teflon insulator at the cable end.

- The length of output coaxial cable is about 3 meters. Shorter cable may result in damage of the generator in case of operation on short or open load.

#### Step 5.

Toggle HV ON/HV OFF switch to HV OFF state.

Toggle EXT/INT switch to INT state.

Place both "amplitude" and "frequency" knobs to the most counterclockwise position, which corresponds to minimum amplitude and frequency.

Connect power supply cable to power outlet.

Switch on the generator by power switch on the rear panel. The internal fans of the generator should start to rotate.

### **Step 6.**

Switch on the high voltage by HV ON/HV OFF switch. The output high voltage pulses should be generated. The internal red lamp in HV ON/HV OFF switch lights on and indicates the triggering of the generator. Increase the amplitude and frequency by corresponding knobs as necessary. The output pulses frequency in internal triggering mode is about proportional to the rotation angle of FREQUENCY regulation knob. The output pulses amplitude increases proportionally to the rotation angle of AMPLITUDE regulation knob.

### **Step 7.**

Always stop the operation of the generator by HV ON/HV OFF switch, after that you can switch off the generator by power switch. After long time of operation at high output pulse amplitude and frequency please allow fans to rotate several minutes in idle mode for cooling.

## TRIGGERING OF THE GENERATOR

The generator can operate in three different triggering modes:

### Internal triggering

Internal triggering mode is set by switching EXT/INT toggle switch in INT position. No any additional triggering generator is required for operation in this regime. Output pulse repetition rate can be adjusted by FREQUENCY regulation knob at the front panel of the generator.

### External triggering

External triggering mode is set by switching EXT/INT toggle switch in EXT position. External triggering pulse should be applied to BNC SYNC IN connector by coaxial cable. Recommended triggering pulse width is 100  $\mu$ s, the acceptable pulse width is from 50  $\mu$ s to 200  $\mu$ s. Triggering pulse amplitude should be from 2.5V to 15V, which allows to trigger the generator by TTL, CMOS or 3.3V LVTTTL/LVCMOS level pulse. The delay between triggering pulse front and output pulse (internal generator delay) is about 1  $\mu$ s, typical jitter (RMS) is about 1 ns. The internal red lamp in HV ON/HV OFF switch lights on and indicates the generator triggering.

- The maximum allowable pulse repetition rate in this mode is limited by FREQUENCY regulation knob at the front panel of the generator.

Therefore internal generator frequency sets the upper limit for external triggering pulses frequency. Please rotate FREQUENCY regulation knob to the most clockwise position to allow the maximum external triggering pulses frequency. The generator can operate also in single pulse mode.

### Burst mode

Burst operation mode can be simply organized by using external pulse generator. Set EXT/INT toggle switch in EXT position and apply external ENABLE pulse to BNC SYNC IN connector. Output pulse repetition rate is set by FREQUENCY regulation knob at the front panel of the generator and burst length is determined by duration of ENABLE pulse.

## OVERHEAT MODE

NPG-18/3500(N) generator has 75 Ohm impedance coaxial output connector and output cable. If the generator operates on unmatched load with impedance not equal to 75 Ohm then part of energy inevitably reflects from the load, returns back to generator, and dissipate in it. About all of generated energy returns back in case of operation on short or open load. Generator can withstand short or open load, but in case of long time operation in such regime it may be overheated.

OVERHEAT LED lights on in this case and generator stops the operation. Please switch off high voltage by HV ON/HV OFF switch and allow fans to cool the generator for a several minutes. OVERHEAT LED lights off after the cooling and the generator is ready for operation again.

Unfortunately barrier and other discharge type loads have highly nonlinear nature and some reflection of energy inevitably occurs. If the generator overheats while it operates on discharge reactor you can try:

- change the parameters or operation regime of the reactor to increase the part of energy absorbed in it. To estimate the energy reflected from the load check the amplitude of the secondary and following pulses by oscilloscope with high voltage probe connected to the load. You should use 500 MHz or more bandwidth oscilloscope and 40 kV pulse voltage probe, for example Tektronix TDS 3052C and Tektronix P6015A probe;
- reduce pulse amplitude and/or frequency.

OVERHEAT LED blinks for a short time when you switch on or switch off the generator by power switch on the rear panel. This is normal and indicates that the generator control and protection system is in working condition.

## OUTPUT PULSE MONITORING

NPG-18/3500(N) generator has BNC output connector for output pulse monitoring. The pulse amplitude is 2.5 V at 50 Ohm load and 5 V at high impedance load, the pulse width is about 1  $\mu$ s.

The typical oscillograms of external triggering pulse (Channel 1) and SYNC OUT pulse (Channel 2) are shown in Fig.3. The high voltage few nanoseconds rise time output pulse is a source of strong interference. Therefore one can see the noise on the oscillograms at the moment of output pulse generation. The delay between external triggering pulse and output pulse is 1.03  $\mu$ s. The SYNC OUT pulse front precedes the output high voltage pulse for about 0.8  $\mu$ s.

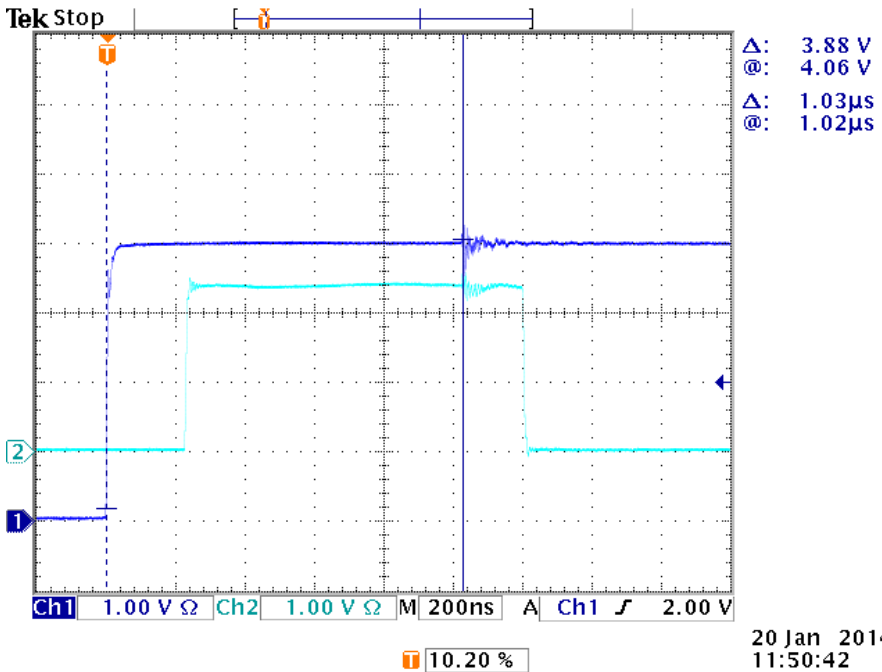


Fig.3. The measurement of internal generator delay. Typical oscillograms of external triggering pulse (Channel 1) and SYNC OUT pulse (Channel 2) of the generator. The internal delay from the front of triggering pulse to high voltage output pulse is about 1  $\mu$ s.

## FUSE REPLACEMENT

- Type of the fuse - 4A/250V slow switching, cylindrical glass 5mm X 20mm

The fuse holder is located in three terminal power supply connector. Please use flat screwdriver or other suitable tool to remove the fuse holder (see Fig.4.).



Fig.4. Removing of the fuse holder by flat screwdriver.

There are two fuses in the fuse holder including one spare fuse (see Fig.5).



Fig.5. Two fuses in fuse holder including one spare (upper in the figure).

## WARRANTY

Please see your sales agreement to determine the warranty period and warranty condition. The generator has warranty seals on the front and rear panels (see Fig.6.)

- Removing of the warranty seals terminates the warranty.



Fig.6. Warranty seals on the front and rear panels.