

**NANOSECOND HIGH VOLTAGE RECTANGULAR
WAVEFORM PULSE GENERATOR
NRG1001**

USER MANUAL

v. 0.1

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SAFETY MANUAL

Electrical safety

- NRG1001 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 using grounding cable connected to the terminal on 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.
- When adding or removing generator to or from the system, ensure that the power supply ON/OFF toggle is switched off and power supply cable is unplugged before the output cable is connected or disconnected.
- Please connect or disconnect any equipment while the 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 circuit, 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. Please, do not try to repair the generator by yourself.

DESCRIPTION AND GENERAL VIEW OF THE GENERATOR

NRG1001 generates rectangular-like pulses with up to 10 kV amplitude and nanosecond rise/fall times. The output pulse amplitude can be adjusted smoothly in three times, whereas the pulse width is fixed to 10 ns. The typical output pulse waveform (at max amplitude) is shown in Fig.1.

Generator has 50 Ohm output impedance and is equipped with 50 Ohm output coaxial cable. It means that the native load impedance should be equal to 50 Ohm, but NRG1001 can operate also with high impedance or non-linear load. Special internal circuit damps the reflected pulses and limits the after pulse ringing within the acceptable range. The maximum output pulse amplitude is 5 kV while the generator operates with matched 50 Ohm load. However, the load impedance is higher in most of practical applications which gives up to double output pulse voltage on the load.

There are internal and external triggering operation modes, which can be chosen by EXT/INT toggle switch. TTL level (+2.4V ... +5V) external triggering pulses should be applied to SYNC IN BNC connector in the first case. Maximum repetition rate is limited to 1 kHz in both modes.

SYNC OUT pulse has +2.5V amplitude on 50 Ohm load and the leading edge of sync pulse precedes output HV pulse by about 300 ns.

Two different output modules are included for the connection to the load. The modules include 1:40 resistive coupler, which together with two 20dB attenuators allows to apply the divided output pulse to the oscilloscope input for registration. One module has 1:3 resistive divider, the second has no it. By the way, it is possible 10 times smooth adjustment of the output pulse amplitude.

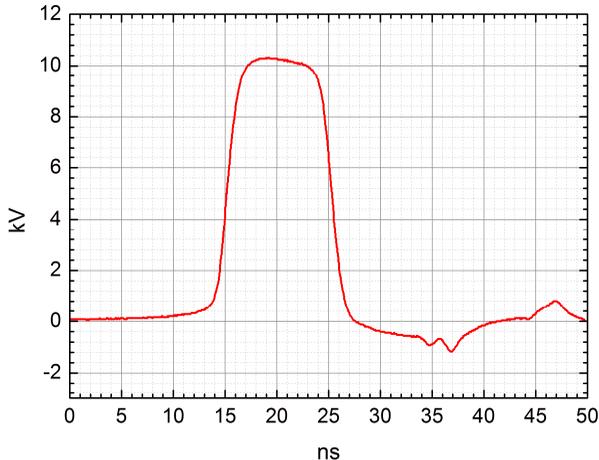


Fig.1. Typical output pulse waveform at max amplitude.



Fig.2. General view of NRG1001 nanosecond high voltage rectangular-like waveform pulse generator.

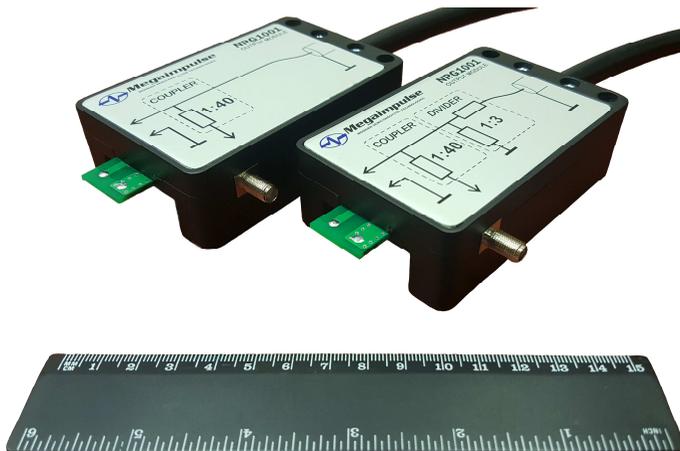
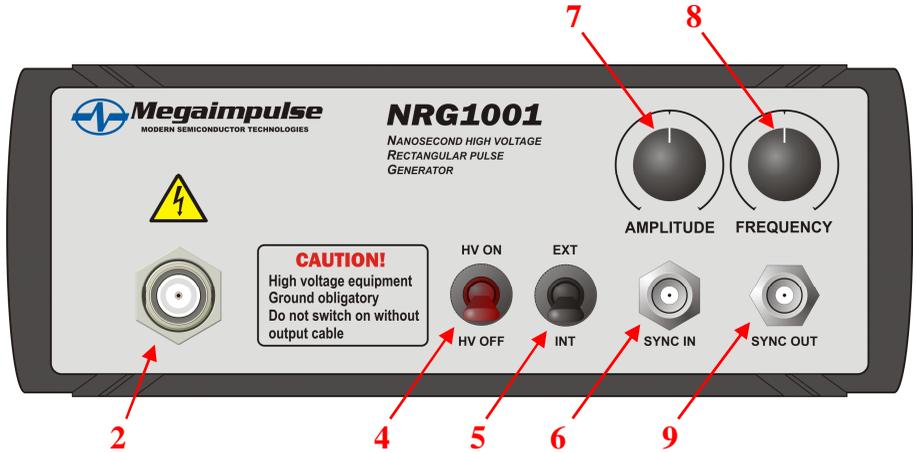


Fig.3. Output modules with integrated 1:40 resistive coupler and with or without 1:3 divider.

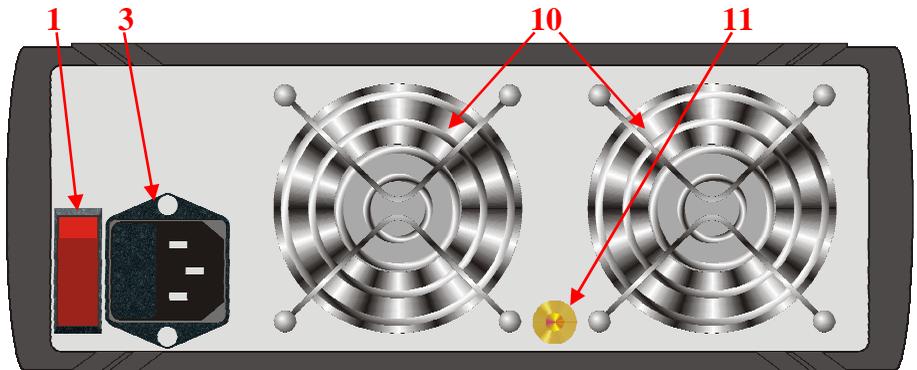
TECHNICAL SPECIFICATION OF NRG1001 PULSE GENERATOR

Output pulse waveform	rectangular-like
Output pulse polarity	positive
Output impedance	50 Ohm
Load	any, including non-matched and non-linear
Output pulse amplitude	smooth regulated within: <ul style="list-style-type: none"> • 3.0 kV .. 10.0 kV on high impedance load, output module without divider; • 1.0 kV .. 3.3 kV on high impedance load, output module with 1:3 divider; • 1.5 kV .. 5.0 kV on 50 Ohm matched load
Output pulse width	10 ns, fixed (FWHM)
Output pulse rise/fall times	2.2 ns .. 4.5 ns / 2.5 ns .. 5.0 ns, depending on the pulse amplitude and load impedance
Repetition rates	from 1 Hz to 1 kHz (internal triggering) from single pulse to 1 kHz (external triggering)
Output connector	special HV coaxial type connector
External triggering	BNC connector, +2.4 .. +5V amplitude
Output pulse monitoring	BNC connector, TTL level
Power supply	AC 110-230V / 50-60 Hz
Size	248 x 90 x 250 mm ³
Weight (without cables)	4.3 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 toggle switch
- 6 - BNC SYNC IN connector
- 7 - AMPLITUDE regulation knob
- 8 - FREQUENCY regulation knob
- 9 - BNC SYNC OUT connector
- 10 - fans
- 11 - ground terminal

PACKAGE CONTENT

Please check the package for the following items:

- ✓ NRG1001 nanosecond rectangular waveform pulse generator
- ✓ Power supply cable
- ✓ High voltage coaxial cable assembly #1 consisting of RG214/U cable, special HV coaxial connector and output module with integrated 1:40 resistive coupler
- ✓ High voltage coaxial cable assembly #2 consisting of RG214/U cable, special HV coaxial connector, output module with integrated 1:3 divider and 1:40 resistive coupler
- ✓ Semirigid coaxial cable assembly with SMA connectors
- ✓ Two 20dB (1:10) attenuators with SMA connectors
- ✓ SMA-to-BNC adapter
- ✓ User manual

Optional item(s):

- ✓ High voltage coaxial cable assembly consisting of RG214/U cable, special HV connector and N-type connector

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 all the above mentioned items.

Step 2.

Set up the generator. Ground it obligatory by connecting ground cable to terminal on the rear panel (**11**) or use three terminal power supply outlet with grounding contact.

Step 3.

Check the output coaxial female connector on the front panel of the generator and co-pair male connectors of the HV cable assemblies. All the connectors should be clean, free from dust, dirt and any obstacles. Clean the connectors by alcohol and/or cotton bud if necessary. After cleaning, please apply a drop of pure silicon oil before mating the connectors. Oil fills air gap between insulators of the co-pair connectors and eliminates possible arcing.

Choose the cable assembly which you want to operate with, depending on the required output pulse amplitude. Output module without the divider allows to get 3kV...10kV pulse amplitude on high impedance load; output module with 1:3 divider gives three times less amplitude. You can connect also cable assembly with N-type connector together with your own sample holder or HV attenuator.

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, destroy the generator and/or 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. Again screw the cable connector nut one or two turns.
6. Repeat steps 4 and 5 up to tight contact.

It is highly recommended to check whether the tight contact obtained or not after the first testing of the generator. Unscrew the cable connector; it should be no any ozone or burnt smell from the connectors or any burnt traces.

During normal operation, please do not disconnect and connect again the high voltage connectors many times to prevent the contacts wearing and contamination. Silicon oil has been already applied to both connectors at the factory. It remains inside the mating connector pair during very long time and prevent arcing.

Step 4.

Attach semirigid coaxial cable assembly to the output module SMA connector; attach two 20dB attenuators and if required SMA-to-BNC adapter for the connection to oscilloscope (see Fig.4). 1:40 coupler together with two 20dB attenuators gives 4000 total division coefficient. 10 kV pulse divided by 4000 times results in 2.5V measured signal which can be directly applied to 50 Ohm impedance oscilloscope input. Some of high bandwidth oscilloscopes allow up to 1V maximum input pulse amplitude only. Please install one more 20dB attenuator (not included) in this case.

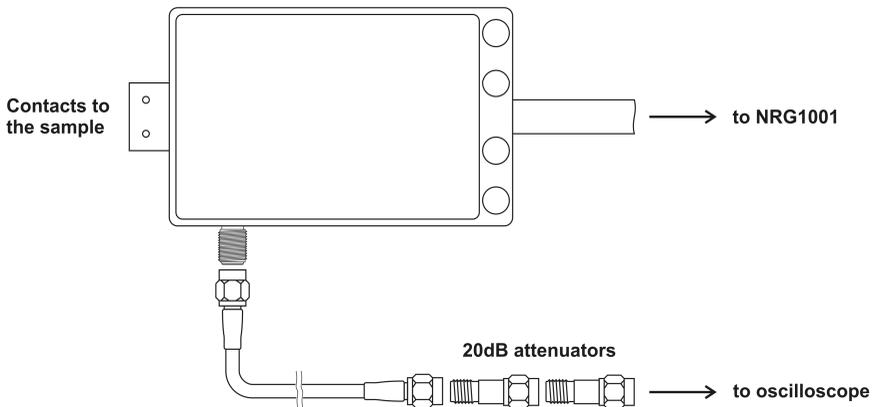


Fig.4. Output module connection to NRG1001 generator, sample and oscilloscope.

- Attach the attenuators just to the oscilloscope input, but not to the SMA coupler output of the module. This improve signal-to-noise ratio of the registered signal.

200 MHz or more bandwidth oscilloscope is recommended for the output pulse monitoring. Please set input impedance of the used oscilloscope channel to 50 Ohm, external division coefficient to 4000 (or keep this coefficient in mind to calculate the measured pulse amplitude), vertical scale to 2 kV/div, time scale to 5 ns/div, edge triggering from the chosen channel.

Step 5.

You can operate without the load to test the generator, or please connect the load / put the electrodes into Petri dish.

Step 6.

Toggle HV ON/HV OFF switch to HV OFF state (down position).

Toggle EXT/INT switch to INT state (down position).

Place "frequency" knobs to the most counterclockwise position, which corresponds to minimum frequency about 1 Hz.

Connect power supply cable to wall power outlet.

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

Step 7.

Switch on the high voltage by HV ON/HV OFF toggle 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.

Register the pulse waveform by the oscilloscope.

- ➔ Always stop the operation of the generator by HV ON/HV OFF switch, after that you can switch off the generator by power switch.

TRIGGERING OF THE GENERATOR

The generator can operate in internal and external triggering operation 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 in EXT position. External triggering pulse should be applied to SYNC IN BNC connector on the front panel. Recommended triggering pulse duration is 100ns...100µs, recommended triggering pulse amplitude is +2.4V...+5V. The delay between triggering pulse front and output pulse (internal generator delay) is about 400 ns. In case of successful triggering the internal red lamp in HV ON/HV OFF switch lights on.

- ➔ 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 the external triggering pulses frequency. Please rotate FREQUENCY regulation knob up to the required position and set corresponding maximum repetition rate.

In case of external triggering the generator can operate in single pulse mode.

Burst mode

Burst operation mode can be simply set by using external pulse generator. Switch EXT/INT toggle in EXT position and apply long external ENABLE signal to SYNC IN BNC connector. Output pulse repetition rate is set by FREQUENCY regulation knob on the front panel of the generator and burst length is determined by duration of ENABLE signal. For example, if you need burst of ten pulses with 1 ms delay between them please set internal repetition rate to 1 kHz and apply 10 ms ENABLE pulse to SYNC IN connector.

SYNC OUT PULSE

NRG1001 generator has BNC output connector for SYNC OUT pulse. The pulse amplitude is 2.5 V on 50 Ohm load and 5 V on high impedance load. The SYNC OUT pulse precedes output HV pulse by about 300 ns.

The oscillograms of SYNC OUT pulse (Channel 1, yellow line) and output HV pulse (Channel 4, magenta line) are shown in Fig.5.



Fig.5. Oscillograms of SYNC OUT pulse (Channel 1, yellow line) and output HV pulse (Channel 4, magenta line).

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.6.).



Fig.6. Removing of the fuse holder by flat screwdriver.

There are two fuses in the fuse holder including one spare (see Fig.7).



Fig.7. Two fuses in fuse holder including one spare (upper in the figure).

WARRANTY

Please see your sales agreement to determine the warranty period and condition. The generator has warranty seals on the front and rear panels (see Fig.8.)

→ Removing of the seals terminates the warranty.



Fig.8. Warranty seals on the front and rear panels.