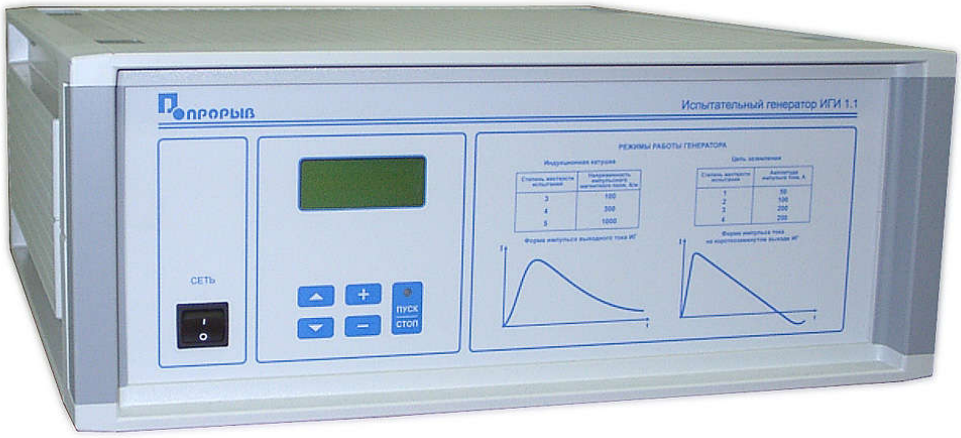
НАУЧНО-ПРОИЗВОДСТВЕННОЕ ПРЕДПРИЯТИЕ



Test generator of pulsed magnetic field IGI 1.1

TECHNICAL PASSPORT

№

TEST GENERATOR
OF PULSED MAGNETIC FIELD
IGI 1.1

MANUAL
EQUIPMENT QUALIFICATION PROCEDURE

CONTENTS.

1. Product features.

1.1. Test generator of pulsed magnetic field (hereinafter – test generator IGI 1.1) is manufactured by "PRORYV" Research and development enterprise.

1.2 . Test generator IGI 1.1 is designed to generate rated pulsed magnet field (with spark inductor IK 1.1), and microsecond noise current in protective and signal earthing circuits, when making tests of the technical equipment (hereinafter – TE), which may be exposed by noise in accordance with GOST R 50649-94, GOST 32137-2013, IEC 1000-4-9-93.

2. Technical specifications.

In a mode as indicated in GOST R 50649-94, GOST 32137-2013 item 4.2.1.7 and IEC 1000-4-9-93 (with spark inductor IK 1.1):

- Density of field (peak value) — 100, 300, 600, 1000 A/m
- Current pulse-rise time as of 0.1-0.9 — 6.4 μs ± 30%
- Current pulse-rise time as of 0.5 level — 16 μs ± 30%
- Polarity of current pulses — positive and negative
- Pulse-repetition period — 20 sec
- Pulse phase displacement as per network voltage (with 10 ° pitch) — 0-350°

In a mode as indicated in GOST 32137-2013 items 4.2.1.14 and 5.2.14.

- Current pulse amplitude — 50, 100, 150, 200 A ± 20%
- Current pulse-rise time as of 0.1-0.9 — 4 μs ± 30%
- Current pulse-rise time as of 0.5 level — 300 μs ± 20%
- Polarity of current pulses — positive and negative
- Pulse-repetition period — 60 sec
- Pulse phase displacement as per network voltage (with 10 ° pitch) — 0-350°
- Effective internal resistance — 2 Ohm ± 30%
- Import power — 30 W max
- Dimensions — 450×434×169 mm
- Device mass — 8 kg max
- Service life of IGI 1.1 — 10 years

3. Packing contents.

The package includes:

- test generator IGI 1.1 — 1 unit
- mains cable — 1 unit
- 1A fuse — 2 units
- technical passport — 1 unit

4. Feature and operation concept.

4.1 The functional chart of the test generator IGI 1.1 is shown in **Figure 1.**

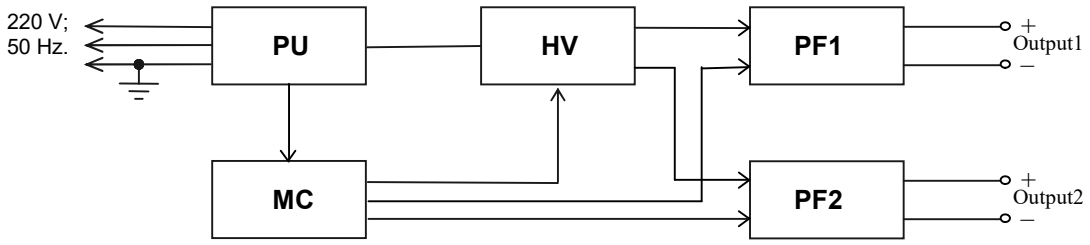


Fig. 1 The functional chart of the test generator IGI 1.1

1. Power Unit (PU)
2. Microprocessor Controller (MC)
3. High Voltage Transducer (HVT)
4. Pulse Formers (PF1 and PF2)

4.2. The power unit (PU) generates + 5V, + 15V, -15V and + 300V, which are required for appropriate functioning of the microprocessor controller and the high voltage transducer.

4.3. The high voltage transducer (HVT) generates voltage ranging from 0.1 to 3 kV, which is required for charging the pulse former storage capacitors.

4.4. The microprocessor controller (MC) generates start pulses for the pulse formers, which are synchronized with the circuit voltage phase, and controls the operation of the high voltage transducer, a keyboard, and a LCD display.

4.5. The pulse formers (PF1 and PF2) are designed to generate pulses of an appropriate form and amplitude.

5. Safety precautions.

5.1. Only persons who have read and understood "The rules of technical operation of electric installations of consumers", have an approved group-based electrical safe work practices (not less than level 3), have been instructed on safety measures for work with electronic test equipment, and have examined technical specification and the manual, are permitted to use the test generator.
5.2. The repair of the generator shall be done only by the manufacturer's representatives.

5.3. ***Do not cut the test generator into mains when the upper cap is removed.***

5.4. A protective ground connection is required.

5.5. When the output cables are connected to the generator, spark inductor and tested TE, the test generator shall be disconnected from the power network.

5.6. Do not touch output cables, spark inductor, and the tested TE of when test pulses are brought.

6. Preliminary starting procedure.

6.1. After transfers in winter or high humidity conditions, the product should be kept under normal conditions 2 hours minimum before using.

6.2. Check 1A fuse is inserted in the rear panel holders.

6.3.Connect the protective ground to the connecting device ⏚ on the rear panel by a wire sections of 1.5 mm ^{2} min.

6.4. Depending on the type of testing, connect the intertwined cables of the spark inductor IK 1.1 or cables intended for connecting to the ground circuit of the TE, to the output connectors.

6.4 Connect the power cable to the socket on the rear panel and to the power outlet 220 V ; 50 Hz. Turn on the test generator by "**POWER (СЕТЬ)**" switch. The message shown in Figure 2 should be displayed. If the message "**MISCONNECTION! (НЕПРАВИЛЬНОЕ ПОДКЛЮЧЕНИЕ!)**" is displayed, turn off the generator and upturn the plug. If the same message is shown when you turn it on again, check the existence and integrity of the power ground.

7. Working sequence.

7.1. After the generator is turned on by "**POWER (СЕТЬ)**" switch, text and an arrow cursor appear in the top line (ref. Figure 2). The cursor is moved by "↓" and "↑" keys.

7.2. By means of "+" and "-" buttons turn on the necessary generator mode (Spark inductor (Инд. катушка) or Ground circuit (Цепь заземления)) by placing the cursor to the appropriate line.

When "**Spark inductor (Инд. катушка)**" mode is turned on, a text as shown in Figure 2 appears on the display.

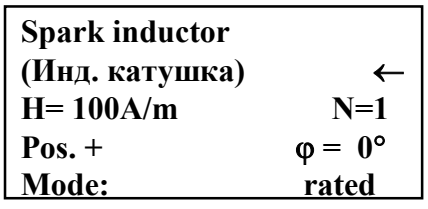


Figure 2

7.3. The output pulse amplitude at load with spark inductor is set by "+" and "-" keys. The cursor shall be located in "**H=___A/m**" position. The following values can be selected: **100**, **300, 600**, **1000A/m** for the coil IK1.1.

Ground circuit	**←**
I= 50A	**N=1**
Pos. +	**φ = 0°**
Mode:	**rated**

Figure 3

The output pulse amplitude at bringing noise to the ground circiuts is set by "+" and "-" buttons. The cursor shall be located in "**I=___A**" position. The following values can be selected: **50**, 1**00, 150, 200 A**.

7.4. The number of test pulses is set at the cursor position "**N = _**" ranging from **1** to **5**, and the polarity (+/-) – at the cursor position "**Pos." _**".

7.5. The phase displacement of test pulses in relation to supply voltage is selected by moving the cursor to "**φ = ___°**" position by "+" and "-" buttons. The values ranging from **0°** to **350°** with **10°** pitch can be set.

7.6. When setting the cursor to "**Mode: (Режим):**" line by using "+" and "-" keys, select normal (**norm (норм)**) or cycle (**cycle (цикл)**) operation mode. In the cycle mode the specified number of set amplitude pulses is brought one by one in positive and negative polarity for each phase shift value ranging from 0° to 350°.

7.7. Green color of "**START (ПУСК)**" LED indicates that the generator is ready to start. The generator is started by pushing "**START/STOP (ПУСК/СТОП)**" button. The high voltage transducer is turned on and "**START (ПУСК)**" LED shows red. After the required voltage is set (the time of charging depends on the set output pulses amplitude and does not exceed 10 seconds), the launch is started. A current pulse of the specified amplitude is formed at the generator output. A pulse of positive polarity with a 10 V amplitude is formed at "**TRIGGERING (СИНХРОНИЗАЦИЯ)**" output during the launch. The "**START (ПУСК)**" LED is turned off and then shows green when the generator is ready for a new start.

7.8. In the cycle mode after pushing "**START/STOP (ПУСК/СТОП)** button the generator generates pulses with 20 sec period at load with spark inductor and 60 sec at bringing pulses to the ground circuit. By pushing "**START/STOP (ПУСК/СТОП)**" button, an operation cycle is terminated. The generator does not react on commands from other buttons during an operation cycle.

8. Maintenance.

8.1. The maintenance of the test generator after the end of the warranty period shall be performed by the manufacturer under a particular contract.

8.2. The manufacturer shall provide warranty service for the generator over 24 months after work acceptance is made in accordance with the contract.

8.3. The warranty obligations shall not apply to equipment with clear mechanical or other damage caused by malfunctioning, mistreatment or accidents.

8.4. The warranty period is terminated if the repair is to be completed by the Customer or any third party.

9. Problems and solutions.

9.1. Possible problems and solutions of fixing them are indicated in Table 2.

Table 2.

Kind of malfunction	Probable cause	Solutions
1. When "**POWER (СЕТЬ)**" switch is turned, LCD backlight does not work.	1A fuse is missing or blown-out.	Change 1A fuse in the rear-panel holder.
2. The "**MISCONNECTION! (НЕПРАВИЛЬНОЕ ПОДКЛЮЧЕНИЕ!)**" message is shown on the display.	Phase and zero wires of the supply outlet and generator are mismatched.	Upturn the plug in the outlet.
	Protective ground does not connected or damaged	Connect the ground connector to ground bus of a room.

9.2. Otherwise, contact the manufacturer.

10. Equipment qualification procedure.

10.1 The test generator shall be qualified according to the methodology described below.
The qualification frequency of the test generator during its operation and storage process is to be defined by an enterprise using the equipment in accordance with the conditions and intensity of its operation. It is recommended to conduct it biennially.

10.2 The list of standardized accuracy characteristics of the test generator is shown in Table 2.

Table 2.

Pulse parameters in an operation mode as indicated in GOST R 50649, GOST 32137-2013 item 4.2.1.7 with spark inductor IK 1.1				
Density of field amplitude, A/m	**100**	**300**	**600**	**1000**
Current pulse amplitude, A ± 20% *	37.7	113	226	377
Current pulse-rise time as of 0.1-0.9, μs ± 30%	6.4			
Duration of current pulses as of level 0.5, μs ± 30%	16.0			
Pulse parameters in an operation mode as indicated in GOST 32137-2013 items 4.2.1.14, 5.2.14.				
Current pulse amplitude, A	**50**	**100**	**150**	**200**
Current pulse amplitude at output short circuit, A ± 20%	50.0	100.0	150.0	200.0
Current pulse-rise time as of (0,1-0,9) levels, μs ± 30%	4.0			
Duration of current pulses as of level 0.5, μs ± 20%	300.0			
Effective internal resistance, Ohm ± 30%	2.0			

***Note:** The intensity of magnetic field in the center of the inductor equals $H = K * I$, where I is the inductor current value, K is the inductor coefficient, for the spark inductor IK 1.1 it equals K=2.65 m^{-1}±1%.

10.3. The recommended measurement tools for testing the generator are shown in Table 3.

Table 3.

Measurement tools	**Technical specifications**	**Type**
Digital oscilloscope	Pass-band 10 Mmhz min	TDS 2022
Pulse voltage divider	Dividing ratio 1:200 ± 1% Input resistance 10 kOhm ± 1% Maximum voltage 5kV min Pass-band 5 Mmhz min	IDM 5.1
Instrument shunt	Impedance of 0 ÷ 0,1 Mmhz frequency 0,01 Ohm ± 1%	IShM 3.1

Note: The usage of other measurement tools which are compatible with the required accuracy is permissible. But the arbitration tools are the ones specified in the given list.
All the control and measuring equipment has to be accepted (calibrated) and have the qualification certificate.

10.4. Generator qualification and measurement of main metrological characteristics

10.4.1. The pre-starting procedure of the test generator shall be conducted in accordance with item 6 of the present passport. It is recommended that the tests be carried out 10-15 minutes after the generator is connected to the power network. The oscilloscope using to measure parameters shall be grounded. The point of ground wire connection shall be determined in accordance with a minimum of noise on the output pulse oscillogram. It is recommendable to connect it near the input connector of the vertical deflection amplifier.

10.4.2. The amplitude of the current pulses at the generator output at load with the spark inductor is measured by the current transducer, which is series-connected with the inductor. The entrance cables shall be intertwined. The oscilloscope connected to the current transducer is set in waiting mode with external triggering. The external trigger is connected to "**TRIGGERING (СИНХРОНИЗАЦИЯ)**" output of the test generator located on the back panel. The amplitude of the sync pulse is around 10 V, and the length is around 2.5 μs. The base of the oscilloscope is set in position 1 μs/point. The amplitude of current pulses is calculated using a formula (10.1).

$$I_{изм} = \frac{U_{изм}}{R_{ш}} \qquad (10.1),$$

where $I_{max(макс)}$ is the amplitude of the current pulse; $U_{mst(изм)}$ is the amplitude of the measured voltage pulse; $R_{shunt(ш)}$ is the resistance of the current transducer.
The results of the measurements for the all three set values of the amplitude are recorded in the protocol (see Passport, Table 4).
The deviation of measured values from the rated ones is calculated using a formula (10.2):

$$\Delta I = \frac{I_{изм} - I_{ном}}{I_{ном}} \times 100\%. \quad (10.2)$$

The results of the measurements are recorded in the protocol (see Passport, table 4).

10.4.3. Current pulse-rise time for all set values of the amplitude is measured by the oscilloscope when the value of the oscilloscope base is 1 μs/point as of levels $(0.1 \div 0.9)I_{max}$. The results of the measurements are recorded in the protocol (see Passport, table 4). The deviation of measured values from the rated ones is calculated and recorded in the protocol.

10.4.4. Current pulse-rise time for all set values of the amplitude is measured by the oscilloscope when the value of the oscilloscope base is 5 μs/point as of level $0.5I_{max}$. The results of the measurements are recorded in the protocol (see Passport, table 4).
The deviation of measured values from the rated ones is calculated and recorded in the protocol.

10.4.5. Repeat the actions according to item 10.4.2 - 10.4.4 for the negative polarity of the output pulses.

10.4.6. The amplitude of the current pulses at the generator output in the mode as per GOST R 50746-2000 item 5.2.14 is measured by means of the current transducer connected to the generator output cables. The cables shall be intertwined. The oscilloscope connected to the current transducer is set in waiting mode with external triggering. The external trigger is connected to "**TRIGGERING (СИНХРОНИЗАЦИЯ)**" output of the test generator located on the back panel. The amplitude of the sync pulse is around 10 V, and the length is around 6 μs. The base of the oscilloscope is set in position 0.5÷1 μs/point. The amplitude of current pulses is calculated using a formula (10.1). The results of the measurements for set values of the amplitude are recorded in the protocol (see Passport, Table 4).
The deviation of measured values from the rated is calculated using a formula (10.2). The results of the measurements are recorded in the protocol (see Passport, table 4).

10.4.7. Current pulse-rise time is measured for all set values of the amplitude when the oscilloscope base value is 0.5 μs/point as of levels $(0.1 \div 0.9)I_{max}$. The results of the measurements are recorded in the protocol (see Passport, table 4).
The deviation of measured values from the rated ones is calculated and recorded in the protocol.

10.4.8. Current pulse-rise time is measured for all set values of the amplitude when the oscilloscope base value is 50 μs/point as of level $0.5I_{max}$. The results of the measurements are recorded in the protocol (see Passport, table 4).
The deviation of measured values from the rated ones is calculated and recorded in the protocol.

10.4.9. To calculate the effective internal resistance, the amplitude of voltage at no-load the output of the generator is measured. The voltage divider connected to the generator output, and the oscilloscope with the base of 1 μs/point. The values of effective internal resistance for all four set values of the current amplitude are calculated using a formula (10.3):

$$Ri = \frac{U_{макс}}{I_{макс}} \qquad (10.3),$$

and is recorded in the protocol (see Passport, table 4). The deviation from the rated values is calculated and recorded in the protocol.

10.4.10. Repeat the actions according to item 10.4.6 – 10.4.9 for the negative polarity of the output pulses.

Table 4.

Pulse parameters at load with the spark inductor IK 1.1								
Density of field amplitude, A/m	**100**		**300**		**600**		**1000**	
Polarity	+	-	+	-	+	-	+	-
Current pulse amplitude, A								
Deviation, %								
Current pulse-rise time as of 0.1-0.9, μs								
Deviation, %								
Current pulse-rise time as of 0.5, μs								
Deviation, %								
Pulse parameters in an operation mode as indicated in GOST 32137-2013 items 4.2.1.14, 5.2.14.								
Current pulse amplitude, A	**50**		**100**		**150**		**200**	
Polarity	+	-	+	-	+	-	+	-
Current pulse amplitude at output short circuit, A								
Deviation, %								
Current pulse-rise time as of 0.1-0.9, μs								
Deviation, %								
Current pulse-rise time as of 0.5, μs								
Deviation, %								
Effective internal resistance, Ohm								
Deviation, %								

11. Maintenance conditions

Climate conditions

The generator shall be operated under normal climate conditions

- surrounding air temperature ***(25 ± 10) ^{o} C;***
- relative air humidity ***45 - 80 %;***
- atmospheric pressure ***84.0 – 106.7 kPa (630-800 mm Hg).***

General requirements of electric power.

The generator is powered by a single-phase AC network with a frequency of 50 Hz, nominal voltage of 220 V ± 10%. The sections of the wires should correspond to the maximum loads of the test equipment. The workplaces shall have euro sockets with the connected grounding pins. The sockets and protective ground connected devices shall be located in close proximity to the generator. The connection of the protective ground to the "ground" connecting device located on the rear panel of the generator require a flexible wire having sections of 1,5 mm minimum.
Do not use dividing transformers to power the generator.

12. Shipment

The packed device is transported by all kinds of transport, provided that it is protected against precipitation.

When the device is transported by an air plane, it shall be placed in a heated sealed compartment.

The holds of ships and carbodies used for shipment shall not have cement, coal, chemicals, etc.

The shipment of the device shall be carried out at air temperature ranging from -25 °C to + 55 ° C, relative air humidity up to 95% at +55°C temperature

13. Storage precautions

The device shall be stored in heated space under the following conditions:
air temperature from 283 to 308 K (from 10 to 35 °C);
relative air humidity 80% at 298 K (25 ºC) air temperature;
There shall be no dust, acid vapor, grease alkali and corroding gases in the storage space;
do not store unpacked devices on the top of one another.
The storage of the packed device is acceptable.

14. Certificate of acceptance.

Test generator IGI 1.1, manufacturing number , meets the technical requirements and is approved as ready for service.