

ELGEO Ltd.

Research & Production Company

# **IP-1000M Transmitter**

**Operating manual**

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This operating manual is intended for study of the IP-1000M transmitter (hereinafter – transmitter) with the purpose of its proper operation and maintenance works.

Only specialists with sufficient knowledge and experience in IP measurements and acquainted with this manual can be admitted to operating of the transmitter.

## 1 Overview and main functions of the transmitter

### 1.1 Main functions of the transmitter

1.1.1 The transmitter is intended for the Induced Polarization (IP) and resistivity surveys in different geological situations for exploration of a variety of mineral resources, groundwater and for civil engineering purposes.

1.1.2 Operating conditions:

- Temperature range, °C .....from -10 to +40;
- Relative humidity with temperature up to 30 °C,  
no more than, %..... 90.

### 1.2 Technical specifications

1.2.1 The IP-1000M transmitter is intended for generating current pulses through a pair of the grounded current electrodes for exploration with IP or Resistivity methods. Two types of current waveforms are available: rectangular current pulses with 50 % duty cycle - for Time-domain modification of the IP method and square wave current – for Frequency-domain IP. In these modes the transmitter is controlled by the internal crystal timing source. Also the transmitter has operation mode with external synchronization (EXT mode). In this mode the transmitter is controlled by external source of synchronization pulses (receiver or GPS synchronizer).

1.2.2 Possible stabilized output current values: 0,01; 0,015; 0,02; 0,03; 0,05; 0,075; 0,1; 0,15; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 0,8; 0,9; 1,0; 1,1; 1,2; 1,3; 1,4; 1,5; 1,6; 1,7; 1,8; 1,9; 2,0; 2,2; 2,4; 2,6; 2,8; 3,0; 3,2; 3,4; 3,6; 3,8; 4,0 A.

1.2.3 Inaccuracy of setting the output current – not more than 2 %.

1.2.4 Output voltage range – 40 to 800 V for current range 0,01 – 2 A, and 40-400 V for current range 2,2 – 4,0 A.

1.2.5 Duration of current pulses for operation in Time-domain mode: 1; 2; 4; 8; 16; 32; 64 s.

1.2.6 Base frequencies (repetition rates) for operating in Frequency-domain mode: 4,88; 2,44; 1,22; 0,61; 0,3; 0,16; 0,08 Hz (Exact frequency values are  $625/2^n$ , n = 7,8,9,10, 11,12,13).

1.2.7 Maximum output power is 1000 W.

1.2.8 Load resistivity range providing stabilization of output current: 10 Ohm - 80 kOhm.

1.2.9 Any external 50/60 Hz - 220V power source (motor generator) can be used to power the transmitter. The possible range of input voltage: **200-245 V**.

1.2.10 Weight - 12 kg.

### 1.3 Contents of delivery

The standard transmitter delivery contents is presented within the Table 1.1.

Table 1.1

Name	Quantity, pcs.
1 IP-1000M transmitter	1
2. Power cable	1
3 IP-1000M transmitter. Operating manual	1

## 2 Description and functions of the transmitter

2.1 The IP-1000M transmitter is intended for generating the impulse electrical field in the investigated ground. The transmitter is applied to the grounded current line that consists of the current electrodes and current-carrying wires. It generates pulses of stabilized current with 50 % duty cycle (for Time Domain IP) or square wave current (for Frequency Domain IP). Current pulse duration and current value are user defined.

2.2 The transmitter converts the input AC voltage 220V/50Hz into stabilized output pulse current within 0.01 to 4 A range with maximal output voltage 800 V. When operated in Time-domain mode (i.e. 50% duty cycle), the transmitter provides with preprogrammed pulse duration from 1 to 64 seconds by factor of two. In Frequency-domain mode the transmitter generates square wave current with preprogrammed frequencies from 0.08 to 4.88 Hz by factor of two.

The output current is measured during time-on; the real current value is displayed when not stabilized. The preset current value is displayed during time-off. Protection against short-circuit failure at the output, output break fault, against current line overvoltage and against overheat is also provided.

2.3 The following elements for control, indication and connection are placed on the transmitter front panel:

- «**220 V**» connector – for connection of the input power voltage;
- «**AB**» connector – for connection of the output current cables;
- «**SYNC**» plug socket for the synchronization (reference) cable between the transmitter and external source of synchronization pulses (receiver or GPS synchronizer);
- **keypad** to control the transmitter;
- «**POWER**» – the transmitter power toggle switch;
- the power-on light indication lamp;
- two indicator lamps « + », « - » - for light indication of the opposite polarity current pulses;
- the liquid crystal display (LCD) – displays the transmitter status, functions, current parameters, voltage of the input power source and output voltage at the «**AB**» connector;
- «**10 A**» - two safety fuses to protect the transmitter input circuit;
- « **⊥** » connection terminal for grounding of the transmitter.

2.4 The transmitter is turned-on with the "**POWER**" toggle switch, the power-on light indication lamp lightens at that. The LCD displays the following characteristics and messages in course of operation:

- "**AB ON**" or "**AB OFF**" - this indicates whether the output voltage is connected or disconnected from the «**AB**» output;
- "**Tp= \*\*** ", "**F= \*\*\*** " or "**EXT**" - indicates whether the Time-domain current waveform (\*\* is pulse duration in seconds), Frequency-domain square wave current (\*\*\*) is frequency in Hz) or external synchronization mode is set;

- **"STAB OK"** or **"NOT STAB"** - indicates whether the output current is stabilized or not, displayed during time-on;
- **"PAUSE"** - displayed when time-off;
- Amplitude of the output current into the load in amperes or milliamps;
- input power voltage (Uac) in volts and output voltage at the **"AB"** connector (U) when the **"U"** button is pressed;
- **"PWR LIM."** - this message appears on the LCD when the output power exceeds the allowable level; at the same time the output current is reduced down to the safe value automatically;
- **"!!!EMERG. SHUTDOWN!! Uac=\*\*\* V"** - this message appears on the LCD when the input voltage goes beyond the allowable bounds; the output voltage is disconnected from the **"AB"** connector at the same time (**"AB OFF"** mode);
- **"!!!OVERLOAD AB!! Press STOP"** - indication of the output current overload failure in a case of drastic drop of the load resistance, the output voltage is disconnected from the **"AB"** connector at the same time (**"AB OFF"** mode). This situation might happen either when output short-circuit, or when one tries to install too little current in the low resistance load. To exit from this state one may need to turn the transmitter power off and to turn the transmitter on again using the toggle switch **"POWER"**. This message may also be due to failure of the transmitter. To verify this, turn the transmitter power off, disconnect the load from the connector **"AB"**, turn the transmitter power on and press **"START"** key. If after that the LCD displays **"OVERLOAD"** message again, the transmitter must be repaired.
- **"OVERHEAT!!! t = {number} ° C"** - this message appears on the LCD when the temperature inside the transmitter case exceeds 85° C; the output voltage is disconnected from the **"AB"** connector at the same time (**"AB OFF"** mode). Here {number} is the temperature inside the transmitter case. The transmitter will be switched to **"AB ON"** mode automatically when the temperature drops down to 75° C.

The keypad provides with setting the following functions:

- **"START"** - switching on the output voltage at the **"AB"** connector;
- **"STOP"** - switching off the output voltage at the **"AB"** connector;
- **"←"** and **"→"** are used to set the current pulse duration or the current base frequency;
- **"↑"** and **"↓"** - setting the pulse current in the load;
- **"MODE"** - in **"AB OFF"** mode provides with switching between the Time-domain, Frequency current waveform and EXT modes; in **"AB ON"** mode provides with switching on and off the acoustic alarm when failing stabilization of the output current. When the acoustic alarm is on, the graphic symbol of a bell is displayed on the right down of the LCD;
- **"☀"** - switches on and off the LCD backlight;
- **"U"** - provides with indication of the input power voltage (Uac) and output voltage at the **"AB"** connector (U).

### 3 Operation with the transmitter

#### 3.1 Operating limitations

3.1.1 The transmitter is operable over the temperature and humidity range that are presented in the Chapter 1.1.2.

3.1.2 Avoid exposing the transmitter to direct sun rays or drastic temperature drop in the course of operation.

3.1.3 Avoid the strong mechanical impact on the transmitter.

3.1.4 Avoid ingress of moisture, dirt or foreign particles inside the transmitter case.

3.1.5 The transmitter should not be used during a thunderstorm. To avoid damage to the transmitter by lightning, grounded line must be disconnected from "AB" connector.

### 3.2 Setting up the transmitter and its use

3.2.1 Inspect the transmitter for any physical damage.

3.2.2 Position the current electrodes according to the IP array chosen, connect current cables to the "AB" connector of the transmitter.

3.2.3 Ground the transmitter using the " $\perp$ " grounding terminal on its front panel.

3.2.4 Connect the transmitter's "220 V" plug to the motor generator 220 V, 50 Hz using the power cable.

**ATTENTION! Check the input power voltage applied to the IP-1000M transmitter, it must be limited to 200-245 V range, otherwise the protection switches the transmitter off.**

3.2.5 Turn the transmitter on with the "POWER" switch, the power indicator lamp lights up and the LCD display turns on. The output voltage is not applied to the "AB" output yet (the LCD displays "AB OFF").

3.2.6 Set the appropriate operation mode of the transmitter with the "MODE" key. "Tp= \*\* " will be displayed for the Time-domain current waveform (\*\* is current pulse duration in seconds) and "F= \*\*\* " will be displayed for the Frequency-domain square wave current (\*\*\* is frequency in Hz) in the right upper part of the LCD display. EXT mode must be set when the external synchronization is used only.

3.2.7 Set the appropriate current pulse duration (time-on) or the current frequency with "←" and "→" keys.

3.2.8 Set the appropriate pulse current with "↑" and "↓" keys. The current value is displayed in the left upper part of the LCD display. In the course of the following operation, the time-on and the current value can be modified without switching the output voltage off with the "STOP" key.

**When installing the current one should remember that maximum output voltage is 400 V for the currents in the range of 2.2 - 4.0 A.**

In addition, it should be borne in mind that the transition from 2 A to 2.2 A and back takes approximately 2 seconds.

3.2.9 Apply the output voltage to the "AB" connector by pressing the "START" key (check, whether the current line is grounded first). "AB ON" message appears on the LCD display.

As soon as the output voltage is applied to the "AB" connector, the indicator lamps "+", " - " indicate the current pulses passing through the current line (during time-off both indicator lamps are off). The actual current value and stabilization status ("STAB OK" or "NOT STAB") are displayed on the LCD screen during time-on, "PAUSE" message is displayed during time-off. "NOT STAB" message can be accompanied by sound signal as well. Current stabilization is not possible when the current value assigned is too big for the actual load resistance (a special case - when the current line is broken or not attached at all). In that case the operator should reduce the current value until "NOT STAB" message disappears. When a minimal current value (10 mA) is set but "NOT STAB" message is still displayed, that means that the current line is broken (check it for integrity) or the maximal output voltage is too low for the actual load resistance (very high load resistance).

Input and output voltage values can be temporarily displayed (for about 3 seconds) on the LCD display by pressing "U" key.

Any time the operator can use "**STOP/START**" keys to switch-off and switch-on the output voltage at the "**AB**" connector of the transmitter.

When the transmitter work mode is set ("**AB ON**"), use the "**MODE**" key to turn the "**NOT STAB**" sound signal on or off. When the sound signal is on, the graphic "bell" symbol is displayed in the down right part of the LCD display.

When the output power of the transmitter exceeds the allowable level, the output current is automatically reduced down to the safe value and the LCD displays "**PWR LIM.**" message (power limitation). This message can be deleted by single pressing the "↓" key.

When the transmitter input power voltage goes out of the safety limits, the transmitter switches to "**AB OFF**" mode and the LCD displays "**!!EMERG. SHUTDOWN!! Uac= \*\*\* V**", where \*\*\* is the value of actual input power voltage in volts. When that happens, the operator should set the appropriate power voltage value (200-245 V).

In a case of the drastic decrease of the load resistance (i.e. the output short failure) the transmitter switches to "**AB OFF**" mode and the LCD displays "**!!OVERLOAD AB!! Press STOP**". This situation might happen either when output short-circuit, or when you try to install too little current in the load with low resistance. Press the "**STOP**" key, turn the transmitter power off and check correctness of the AB line connection and current value. To exit from this state one may need to turn the transmitter power off and turn the transmitter on again using the toggle switch "**POWER**". After that press the "**START**" key. If after this LCD displays "**!!OVERLOAD AB!! Press STOP**" again, the transmitter broke down probably. To verify this, turn the transmitter power off using the toggle switch "**POWER**", disconnect the load from the connector "**AB**", turn the transmitter power on and press "**START**" key. If after that the LCD displays "OVERLOAD" message again, the transmitter must be repaired.

When the temperature inside the transmitter case exceeds 85° C, the transmitter switches to "**AB OFF**" mode and the LCD displays "**OVERHEAT!!! t = \*\* °**", where \*\* is the value of the temperature inside the transmitter case. The transmitter switches to "**AB ON**" mode automatically after lowering the temperature to 75° C.

3.2.10 To turn the transmitter off press the "**STOP**" key first, then turn off the transmitter power using the toggle switch "**POWER**" (put it down) and turn off the motor generator 220 V, 50 Hz.

### 3.3 Safety instructions

3.3.1 Never let any people use or maintain the transmitter without giving all the necessary industrial safety instructions on usage of high-tension current sources. Read the operating manual carefully before use the transmitter.

3.3.2 When using IP or Resistivity arrays with grounded current line, provide with reliable bidirectional radio communication between operator and field workers.

3.3.3 The current line grounding points must be protected from illegal access.

3.3.4 The transmitter and motor generator (power source 220V/50 Hz) must be grounded, grounding resistance must be not more than 10 Ohm.

3.3.5 Never use safety fuses that are intended for bigger current than specified in this operating manual.

## 4 Maintenance

4.1 The transmitter can be maintained by the specialists with the necessary experience in servicing of the electronic instruments.

4.2 The transmitter requires the basic maintenance procedures that are listed in the Table-4.1

Table 4.1

Maintenance procedures	Maintenance interval frequency
1 External examination of the transmitter	Every time when the transmitter is used
2 Preventive cleaning of the connectors and plug sockets	Every 100 hours
3 General checkout of the transmitter workability	Before starting measurements

4.3 In the course of external examination test the transmitter for the mechanical defects.

4.4 For the preventive cleaning of the connectors and plug sockets use brush and rectified alcohol.

4.5 Perform general checkout of the transmitter corresponding to the point 3.2 of this manual.

## **5 Storing and transportation**

5.1 The transmitter should be stored at a temperature of 10°C to 35°C and maximum relative humidity of 80% at 25°C.

Check that the storage area does not contain acid or alkali vapors, aggressive gases and other harmful admixtures causing corrosion of metals..

5.2 Transportation should be carried out by any kind of covered vehicle. When onboard an aircraft (helicopter) the transmitter should be placed in a heated and tight compartment. The transmitter should be transported at temperature of -30°C to 50°C and maximum relative humidity of 95% at 25°C.