



TECHNICAL DESCRIPTION
OPERATING INSTRUCTIONS

CABLE AND PIPE LOCATOR SUCCESS AG-511N

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Introduction

The Cable and pipe locator «Success AG-511N» is a search-diagnostic kit with extended operating temperature range on the basis of a receiver with the LED display AP-014 and the small self-powered «AG-105» tracer portable generator.

The locator is designed to survey areas of ground before digging, the search slopes of electric cables and conductive underground utilities, determine the depth of their occurrence, searching places of power cable damage

Application:

- Detection of cables and metal pipelines underground up to 6 m depth
- Measurement of the depth by passive “electromagnetic” method
- Distance of tracing from the place of transmitter connection is up to 3 km
- Survey the ground before the ground works (BB mode)
- Tracing of the buried utility without direct connection to it.

The application field

- Housing and public utilities
- Electricity networks
- Heating systems
- Water utilities
- Organizations conducting earthworks, etc.

Operating conditions

Ambient air temperature, °Cfrom -30 до +50
 Relative humidity, %up to 85 at t=35 °C
 Atmospheric pressure, kPa.....from 84 up to 106
 Degree of protection against external influences..... IP 54

1 The general description

1.1 Composition of the set



1.2 The principle of operation

The principle of operation of the Cable and pipe locator «Success AG-511N» is based on phenomenon of electromagnetic induction. The electromagnetic «EMD-247» sensor records variable electromagnetic field which is being produced around a cable under research of it or a pipeline and converts an electromagnetic signal into a power signal. An electrical signal enters the receiver, where it is passing amplification and filtering (the selection signal of the given frequency). The location of the maximum of electromagnetic field intensity measured above the ground, corresponds to the axis of the desired communication. The operator on the signal in the head phones and the LED indicator determines the location of the alignment and possible defects of communication.

Specification AP-014

AP-014 receiver	
Frequencies of the receiver's filter	Main filter frequency 50 Hz /100 Hz /512 Hz / 1024 Hz 8192 Hz / 32768 Hz.
«Broadband», (frequency range)	0.05...8.2 KHz
Gain factor	100 dB
Visual indication	LED scale – 7 values.
Gain factor	Headphones - natural, filtered and synthesized signal. Built-in emitter - synthesized signal.
Visual indication	Voltage 1.8 to 4V. - alkaline batteries AA type 1.5 V (2 pcs.).
Time of continuous operation not less than	10 hours
Operation temperature	-30°C...+50°C
Location precision , m	± 0,3
Ingress protection rating	IP54
AP-014 receiver dimensions	145x70x24 mm
Weight of the electronic unit	0,15 kg

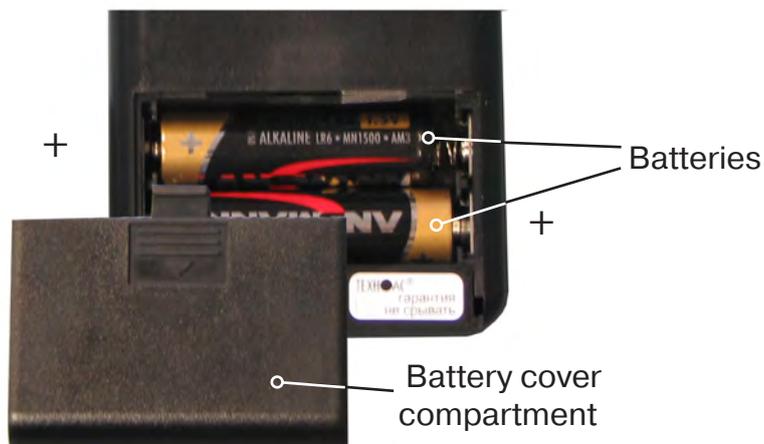
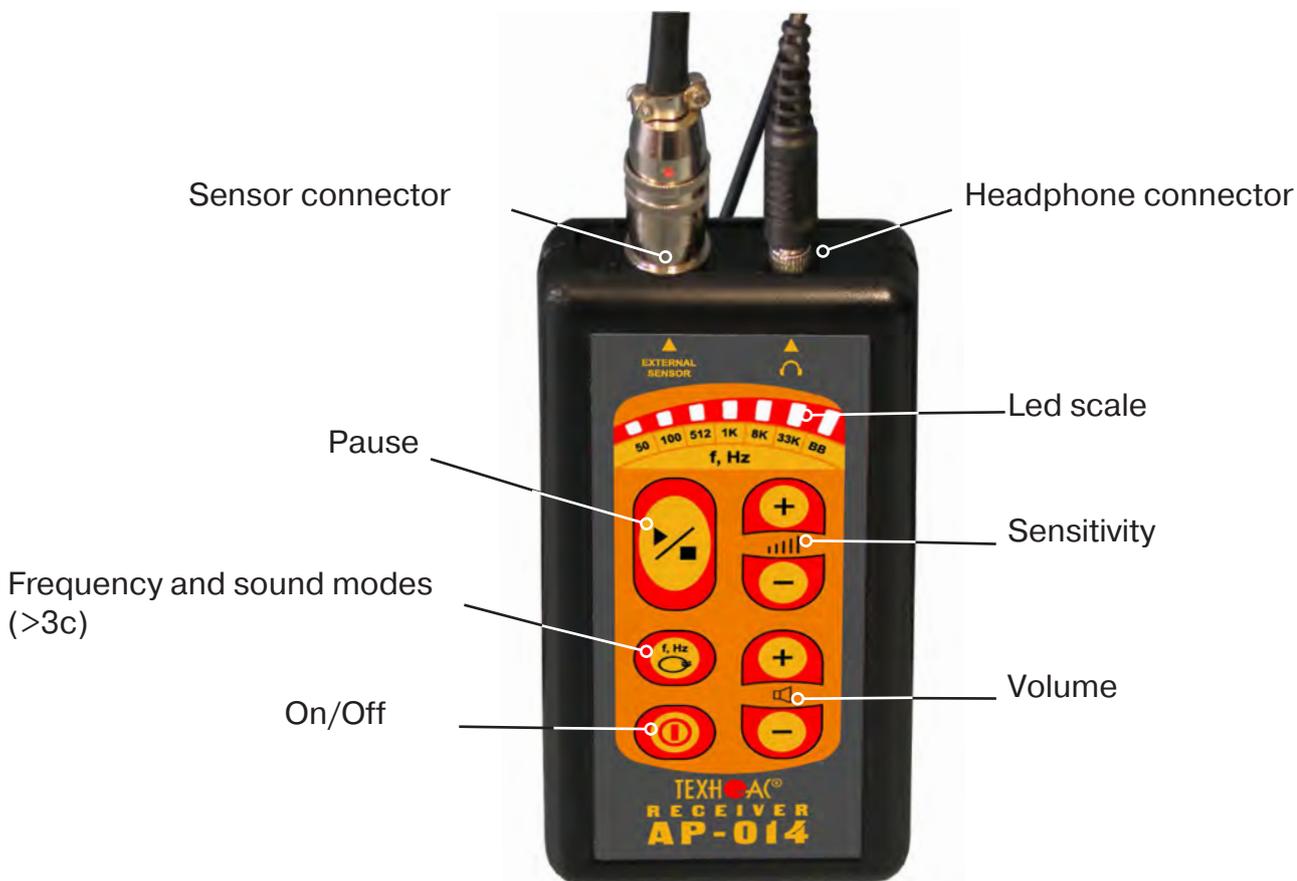
Electromagnetic sensor EMD-247

Type of transducer	Resonant ferrite magnetic antenna
The center frequencies of filter	50 Hz /100 Hz / 512 Hz / 1024 Hz / 8192 Hz / 33 kHz
Type power	From the receiver
Switching filters	Forced (by a receiver)

2. Receiver AP-014

Receiver «AP-014» is made in the dimensions of the cell phone, has a built-in micro CPU control, membrane keypad and led indicator of seven LEDs.

2.1 General view and buttons mapping.



2.2 Receiver control and indication modes

The receiver can work with acoustics or electromagnetism sensors. This set is intended for operation with the electromagnetic EMD-247 sensor. The type of the sensor is determined automatically. For an acoustic sensor there is only a broadband reception mode, as evidenced by the constantly blinking right LED box marked WB. For an electromagnet sensor there are several reception frequencies.

The light emitting diode scale executes indication of several functions:

- this is an indication of a power battery condition,
- a frequency of the received signal is switched in a circle,
- a sensitivity is more-less,
- a volume is more-less.

To understand where you are, one needs to know the following: at startup the scale is checked, i.e. consistently included 4 cycles of running lights, then a slight pause, then highlighted the level of battery power state for 5 seconds, then the signal strength is displayed.



- **Activation/deactivation of the receiver.** The receiver turns on when one-time pressing the «Activation/deactivation of the power» button. When you turn on, the device consistently:

- Enable animation plays («running lights» on the LED display);
- About 4 seconds indicates battery charge (if all the LEDs are lit, than the charge is maximum, if the first led light blinks, the device is turned off or the batteries are low):



Weak battery charge



Maximum battery charge

- Sound plays when the instrument turns on;

4. If the «EMD-247» sensor is attached for around 2 seconds, one light emitting diode of the light emitting indicator diodes displays the operating filter frequency (for example, 1024 Hz – «1k»),



(when the acoustic «AD-227» sensor is connected to the receiver, the filter frequency is not displayed);

5. It is turning into the operating mode, the LED display is indicated by the input signal level at a selected frequency:



Low input level



High input level

and a synthesized audio signal is given on headphones.

Turning off the receiver is performing by briefly pressing the button «Power On / Off».



- The choice of the operating frequency. The LED indicators of the receiver on the front panel have inscriptions, corresponding to certain frequencies of the receiver: «50» 50 Hz, «100»: 100 Hz, «512»: 512 Hz, «1к» – 1024 Hz, «8к» – 8192 Hz, «33к» - 32768 Hz, «WB» «Wide band» (0,05...8,60 kHz). Operating frequency is selected by consistent briefly pressing the button «Switching frequencies and operating modes» and is displayed on the display corresponding flashing led for two seconds.



-Adjustment of the **receiver sensitivity and volume** levels is being made by the corresponding buttons «more» and «less».

During adjustment and for 2 seconds afterwards the sensitivity level is displayed on the scale by the blinking light emitting diode.

Change of the level is occurring step by step. When you change the level on five steps, there is switching of the indication to the adjacent LED (at increasing increasing on the first, at reducing on the left.)

Change of the sensitivity level can be made by a short press of the «more» and «less» buttons, as well as by their retention for achievement of the required level.



- **Change of the way of audio indication.** During long retention of the button «*Frequency switch*» the device switches the mode of audio indication. Three audio indication modes are implemented in the receiver:

-The **sound generation mode.** The sound being fed to headphones is generated by the device and modulates at frequency depending on the selected filtering frequency signal level. This mode is selected by default during activation of the device.

- The **natural sound mode.** The sound is fed to headphones through the filter on the chosen one frequency in straightness off the sensor.

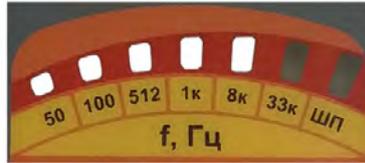
- The **mode of the built-in speaker.** The sound signal is generated by the device and modulates at frequency, depending on the selected filtration frequency signal level, and is fed into the built-in speaker. In this mode a natural sound feeds to headphones as in the «Natural sound mode».



- **Increase and reduction of headphones volume level.** The volume in headphones level is changing with the corresponding «Change of volume» on headphones buttons. The volume level is displayed on the light emitting diode indicator with help of the blinking light emitting diode.



Increase and reduction of headphones volume level. The volume in headphones level is changing with the corresponding «Change of volume» on headphones buttons. The volume level is displayed on the light emitting diode indicator with help of the blinking light emitting diode.



Change of the volume in headphones level does not affect the input level.



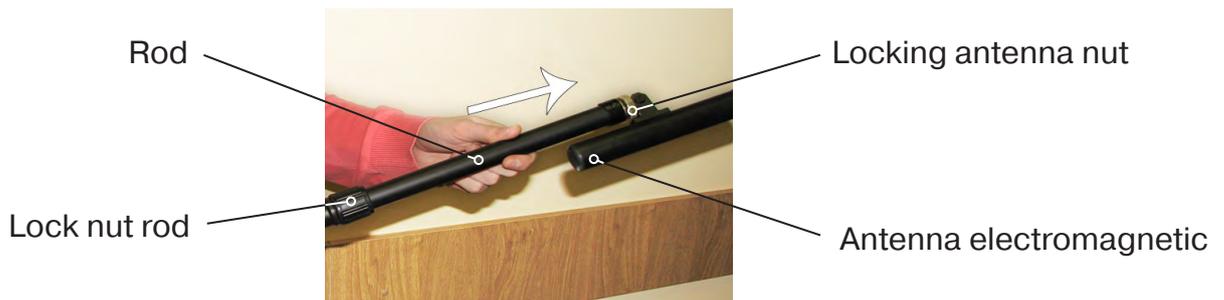
- **The mode «Pause».** When pressing the «Pause» button, any audio indication stops and in pressing the light emitting diode indicator displays input level measured at the moment of the «Pause» button pressing. The exit from the mode is being carried by a repeat press of the button.



Mode «Stop / Pause» is recommended to use with the acoustic sensor to mute the sound in headphones in order to eliminate noise that occur when moving and installing the sensor.

3. Electromagnetic sensor EMD-247

The set uses electromagnetic sensors «EMD-247» on the basis of resonance ferrite magnetic antenna. Resonance frequencies of the antenna: 50 Hz, 100 Hz, 512 Hz, 1024 Hz , 8192 Hz and 32768 kHz. Switching of resonance is forced (controlled by the receiver).



The EMD Rod for easy transportation is sliding. Antenna of the electromagnetism sensor can take three positions relative to the boom: at 0°, 45°, 90° degrees.

To bring the electromagnetic sensor from the vehicle into working position, it's necessary: to loosen the lock nut rod, to slide the rod to the desired length and to fix the locking nut.

To change the electromagnetic antenna position relative to the rod, it's necessary to loosen the fixing nut, mount the antenna to the desired position, to fix the position by the locking nut



4. Transmitter AG-105

AUTONOMOUS • POWERFUL • PORTABLE • MEASURING

Device introductory information

4.1 Purpose of use and physical configuration

The AG-105 is an automatic utility locating transmitter designed for the generation of the propagating electric oscillations in the traces of the buried utilities using electromagnetic method of the trace search.

Field of application:

- Housing maintenance and utilities sector;
- Communications industry;
- Electric power and heat supply industries;
- Gas supply.

The device is shown in the enclosure-case containing:

- 1 - information panel on the inner side of the cover;
- 2 - battery holder with the handle in the center for removing;
- 3 - push-button and LED indication panel.

DISTINCTIVE FEATURES

The extremely high output power and autonomous operating time for such a compact battery set (“type C”x8) and small size of the device.

The universal power supply provides an opportunity to reach the output power of over **20W**. In the autonomous power supply mode the “life cycle” depends on the quality of the batteries applied “type C”.

For example, under initial output power of **7W** in the continuous oscillation mode the “life cycle” is **approximately** equal to **5 hours** and under initial output power of **15 W** in the intermittent modulation mode the “life cycle” is approximately **25 hours** (with the use of standard “fresh” batteries, e.g. “Energizer C”). Using high-capacity batteries (for example, “Duracell ULTRA”), the duration of the autonomous operation can be extended by 20-30%. If “12V” external battery (e.g. automotive) is connected the operation time is defined by the battery capacity. When connecting to the external power source of “15V” the operating time is not limited.

The dimensions of the portable device in the casing amount to **216x180x105** mm and **weight** does not exceed **2 kg**.

The above-mentioned features are secured by the application of the unique superefficient modification circuit technology of power amplifiers composition **CLASS D**. Pulse output amplifier reaches **85% efficiency** which is particularly important for the energy consuming devices with an autonomous power supply.

AG-105 is the best-in-class of the “portable utility locating transmitters with low-powered autonomous power supply” in terms of the qualitative characteristics, namely “power – operating life– dimensions – weight”.

The device generates a sine-shaped signal continuously “Co” or discontinuously “Pu” for utility (cables and steel pipelines) locating and special dual-frequency signal “2F” for identification of “someone else’s” utility or for flaw detection of earth leakage.

Such a unique (among other transmitters) peculiarity as uncommonly high potential output current (more than **5A**) make it possible to carry out utility locating of not quite adapted to such procedure the extraordinary low-resistance utilities (e.g. “earthed” pipelines) when the significant part of the output current inefficiently flows to earth already near the connection point.



The **Internal transmitting inductor** creates quite intense electromagnetic field under relatively low energy consumption. There is a possibility to connect the **external induction transmitting antenna** which produce intense emitting and provide an immediate access to the “buried” utilities. An add-on **transmitting induction “clamp”** let inducing a current effectively into the specifically “chosen” utility from others nearby (inclusive of the one under voltage).

Several **protection** levels against all sorts of unacceptable factors ensuring the highest level of reliability.

The internal “multimeter” displays the following readings according to the operator’s choice: **voltage, current, resistance, output power or power supply voltage.**

In case of decrease of the “energy potential” (output voltage) of the power source during the oscillation process (for example, batteries self-discharge) the signal strength is automatically proportionally (incrementally) decreasing and consequently the consumed power. This program system extends batteries’ “life cycle” considerably. Therefore while searching **there is no premature “path loss”** and the decrease of signal level is offset by the options for the manual or automatic adjustment of the sensitivity of receivers made by “TECHNO-AC”.

The ingress protection rating of the casing is **IP65** which completely precludes any ingress of the dust or water jets when lidded. The operating temperature range is **-30°C to +60°C** with the external (battery or mains supply).

4.2 Control and indication elements

See - Appendix 3

4.2.1 Display (functional fields of the front panel)

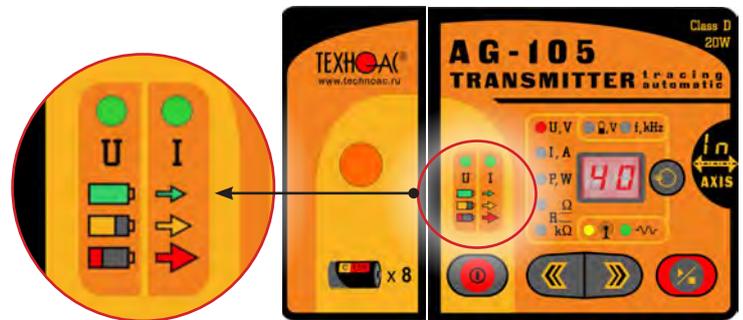
«**Electrical power supply field**» always displays rough estimates of the power supply source condition in the current mode of operation using three coloured light emitting indicators.

1) The results of energy potential assessment of the power supply source (feasible operability index with current energy consumption level). Three categories of the output voltage of the power supply source «U» are determined under the specific value of the absorbed current in the actual operating mode:

- **green** colour of the indicator «U» – «nominal» voltage (high energy potential of the batteries or powerful external source);
- **yellow** colour of the indicator «U» – «acceptable» voltage (medium energy potential of the batteries);
- **red** colour of the indicator «U» – «cut-off» voltage (energy potential of the batteries almost used up, possible «unexpected» shutdown).

2) The category of the ABSORBED CURRENT «I» rate is specified based on the concordance between measured value of the current and the figure of the one of the three ranges specifically set by the program for the actual operating mode:

- **green** colour of the indicator «I» – «low» absorbed current;
- **yellow** colour of the indicator «I» – «medium» absorbed current;
- **red** colour of the indicator «I» – «high» absorbed current.



Colour combinations «U ↔ I».

The possibility in principle to raise the output signal level «U,B» depending on the combination of the indicators colours «U ↔ I» (if no other restrictions are in place)	Colour of the glow	
	«U»	«I»
YES	green	green
	yellow	green
	green	yellow
NO	yellow	yellow
	red	any
	any	red

NOTES for «Internal parameters field» and «Output parameters field»

- 1) **Red** colour of the glow of any indicator means that «oscillation» is in progress.
- 2) Parameter or mode the value of which is displayed in the «Digital field» in the «stop» passive mode is singled out by the flash of the relevant indicator.

4.2.2 «Internal parameters field»

according to the operator choice shows the following numerical values of the following parameters in the «Digital field».

1) POWER SUPPLY VOLTAGE in volts «**U, V**»:

- the lack of the glow – another display parameter is chosen;

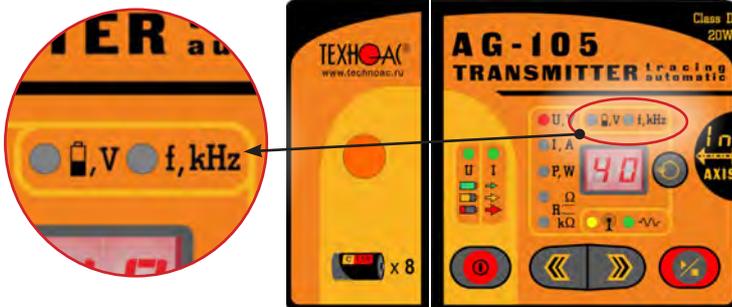
- **green** colour glow – power supply voltage in the «stop» mode;

- **red** colour glow - power supply voltage in the «oscillation» mode.

2) FREQUENCY of the generated signal in kilohertz «**f, kHz**»:

- the lack of the glow – another display parameter is chosen;

- **green** colour glow in the «stop» mode – the set frequency of the output continuous «Co» or pulse «Pu» signal is indicated in the «Digital field».



4.2.3 «Output parameters field»

(only in «oscillation» mode) at the choice of operator signifies via **red** colour the value of the specific output parameter that is indicated in the «Digital field»:

- «U, V» - output voltage in volts;
- «I, A» - load current in amperes;
- «P, W» - load power in watts;
- «R, Ω» - load resistance in ohms;
- «R, kΩ» - load resistance in kilohms.



NOTE

In «antenna» modes «In» and «An» the only value available is «U, V».

4.2.4 «Modes field»

in accordance with the operator choice shows operating modes under various load types and different «modulation» options of the output signal.

1) «ANTENNA» - on / off «ANTENNA» mode and type of connection of transmitting antenna:

- the lack of the glow – earrings or clamp are connected to the output (there is no transmitting antenna);

- **green** glow – no equipment is connected to the output, internal transmitting inductor is only operable «In»;

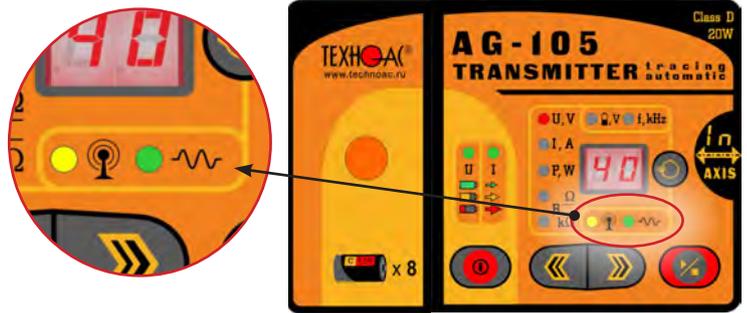
- **yellow** glow – external induction transmitting antenna «An» is connected to the output.

2) «MODULATION» - on / off «MODULATION» (special form signal) and type of the special form:

- the lack of the glow – no modulation (continuous signal «Co» of the «regular» sine form);

- **green** glow – pulse modulation mode «Pu»;

- **yellow** glow – dual-frequency modulation mode «2F».



NOTE

«Modes field» always indicates information about the set operating modes irrespective of whether oscillation process is running or stopped due to non-use of the red colour (the colour signifying the «oscillation» mode).

4.2.5 «Digital field»

at the discretion of the operator displays either **numerical** parameter value (power supply voltage «U,V» / signal frequency «f,kHz» / output voltage «U,V» / load current «I,A» / load power «P,W» / load resistance «R,Ω / kΩ») **or symbolic** notation of the mode:

«In» - internal transmitting inductor;

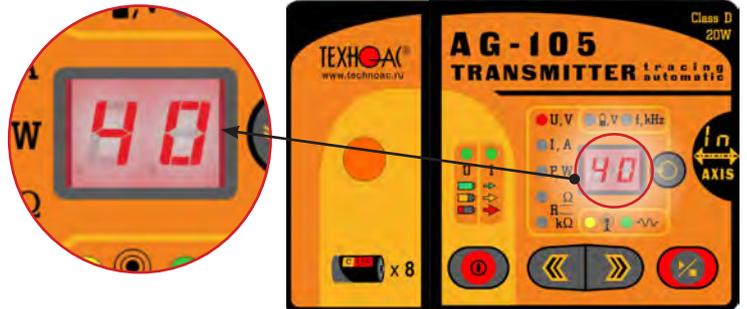
«An» - external induction transmitting antenna;

«Co» - continuous oscillation mode;

«Pu» - pulse modulation mode;

«2F» - dual-frequency modulation mode.

The type of the displaying value in the «Digital field» is defined by the CHOICE button and indicated by the glow of the relevant indicator in one of the surrounding functional fields.



4.2.6 Control (buttons)

POWER «I» by sequenced presses the electrical power supply of the device can be switched on and off.

CHOICE «O» by sequenced presses PARAMETER or MODE indication can be chosen to be shown in the «Digital field».

MORE / LESS «<>» by sequenced presses the parameter (mode) in the «Digital field» set by the CHOICE button «O» can be decreased / increased (adjusted).

START/STOP «</>» by sequenced presses the device can be switched from «stop» to «oscillation» mode and back.



4.3 Ways of external commutation

Three-pin connector
«EXTERNAL SUPPLY»

for battery supply or main supply source. As illustrated the rubber cover protects the connector when unused from the external factors.

Five-pin connector «OUTPUT»

for output cable connection with (“alligator”) clips, transmitting antenna or induction «clamp». As illustrated the rubber cover is removed for making external sources connection possible.



4.4 Accessories



Output cable
 («clips (earrings)»)

is designed for «contact» connection of the transmitter outlet to the utility under examination and earthing point



Earthing rod

is used as earth «return» of the electric current in case of «contact» way of connection to the utility under examination with the use of output cable (“clips”)



External battery cable

is designed for connection to the battery as the external power supply source. Clamp with red adhesive tape corresponds with the positive potential «+», the clamp with black adhesive tape relates to the negative potential «-»



**Extra accessories, optional*

Induction transmitting antenna

IEM-301.5 designed for “non-contact” connection of the device outlet to the utility under examination.



**Extra accessories, optional*

Transmitting induction
 «clamp»

CI-110 is designed for highly efficient induction of the trace current to particularly “allotted” utility or for “non-contact” connection to the utility under voltage



**Extra accessories, optional*

Mains power supply
 adapter

AG114M.02.020 (GS60A15-P1J «MEAN WELL»-based) is for the connection of the device to the mains with the voltage of 220V

4.5. Design and function

Convenient and user-friendly control and indication units with explanations, the elementary control algorithm backed by automation (“intuitive interface”), several protection levels from emergency modes, all these things help any untrained operator to master the device within the shortest period.

The automatic adjustment allows to generate the specific signal current at the wide range of the load resistance. The transmitter can be connected to the load directly via connecting wires (“contact” way of connection) or by “non-contact” (induction) method with the use of the internal transmitting antenna or with the extra accessories involved, e.g. external transmitting antenna or induction “clamp”.

The circuit solution of the power amplifier is implemented in the unique upgrade of the CLASS D technology and provide the highest degree of efficiency among all the known circuit design concepts for the power amplifiers. Thanks to the above-mentioned the relatively long “life cycle” in the autonomous mode at such a high initial maximum output power is achieved despite the light weight and small size of the device.

The values of the output current set by the program at the automatic adjustment with the load of “occasional” resistance are optimum judge from the sensitivity of the majority of cable avoidance tools and are equal to 0.2A at “low” frequencies 512Hz «0.5» and 1024Hz «1.0» and 0.1A at “high” frequencies 8192Hz «8.2» and 32768Hz «33». During the automatic adjustment load voltage incrementally increase until the moment when the values of the absorbed current and load current will not exceed the figures set by the program. If pre-set load current value is not achieved due to the high load resistance then maximum possible output voltage is defined. Upon completion (or interruption by START/ STOP «» buttons) of the automatic adjustment process, the manual control over the voltage (current, power) is available via buttons LESS/ MORE«».

Under power supply voltage decrease during oscillation (e.g., batteries self-discharge) the signal output voltage is lowering proportionally (incrementally) (and consequently absorbed power) as the supply source “energy potential” reduce. This program system extends batteries’ “life cycle” considerably. Therefore while searching there is no premature “path loss” and the decrease of signal strength is offset by the wide range of options for the manual or automatic adjustment of the sensitivity of receivers made by “TECHNO-AC”.

WARNING! ENERGY SAVING!

All operations with output voltage (current, power) under connected load lead to the changes of the energy consumption (and consequently “life cycle” of the autonomous power supply). Watch the indicators of the power supply voltage “U” and absorbed current “I” in the “electrical power supply field” so that the time is enough to perform utility locating. In order to save energy operate the device at the minimum sufficient load power. Always use “economy” pulse mode “Pu” when applicable. The operation breaks help to partially restore the capacity. Therefore “net” operating time with interruptions is always more than time of continuous operation all other conditions being equal. The fall of environment temperature at the autonomous battery power supply has an adverse effect on the “life cycle” of the power supply set (especially crucial at sub-zero temperatures). Always have a backup set of batteries.

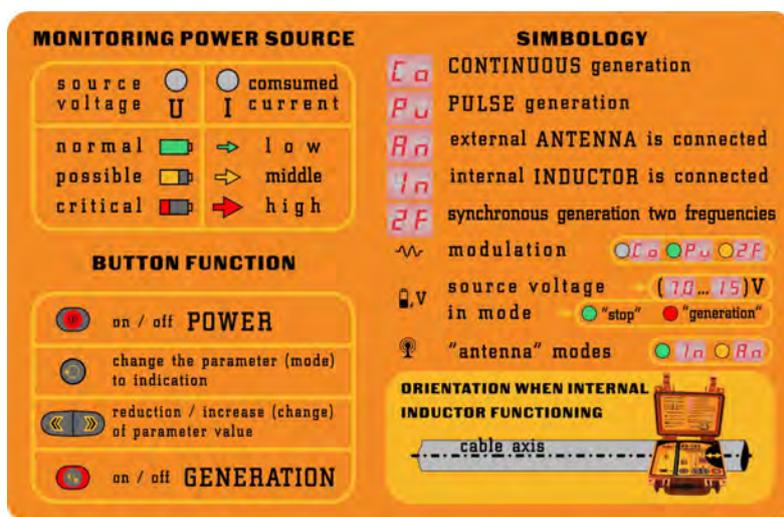
NOTE

While changing batteries use only all 8 elements of “type C” produced by the same company, from same series and condition (all 8 cells are always operable or inoperable altogether). ALKALINE 1,5V batteries are recommended.

It is highly recommended to convince that all 8 elements have approximately the same charge level. The assessment can be done with the help of direct-current voltage voltmeter if all 8 elements are manufactured by the same company, marked with the same series and of same condition.

If the batteries kit has undergone full “life cycle” in the “energy consuming” continuous mode “Co” it is still likely to be used for quite a long time in “economy” pulse mode “Pu” at “low” output power (up to 2 hours at the initial power of 5W).

4.6. Illustrative use information about «Power supply monitoring», «Buttons functionality», «Symbols»



On the inner side of the cover one can see information on the principle of the following information types representation, namely POWER SUPPLY MONITORING, BUTTONS FUNCTIONALITY AND SYMBOLS of the “Digital field” and the front side of the panel

4.7. «Multimeter» of the output parameters

In the “Digital field” during oscillation with the use of “clips” or “clamp” the approximate values of the output parameters are indicated:

- load signal voltage in volts «**U, V**»;
- load current in amperes «**I, A**» (minimum measured and indicated value – 0,05A «.05»);
- load power in watts «**P, W**»;
- load resistance in ohms or kilohms «**R, (Ω / kΩ)**».

In «antenna» modes «In» or «An» only «U,V» is indicated (output signal voltage applied to the antenna).

The accuracy of measurements is enough for situation assessment at load resistance up to 800Ω.

The parameter which value should be indicated in the “Digital field” is set by the “CHOICE” button «» in the “Output parameters field” immediately during oscillation process.

4.8. Sound signals

The sound signals correspond with the specific events and conditions.

«**Welcome tune**» consists of 9 notes activating by the device switching on via pressing POWER «**I**» button.

«**High**» note while pressing CHOICE «**⊖**» button during the automatic adjustment – the relevant action took place.

«**High**» note while pressing MORE «**▶**» button — the increase (alteration) of the parameter value (mode).

«**Low**» note while pressing LESS «**◀**» button — the decrease (alteration) of the parameter value (mode).

«**Very low**» note by pressing one of the buttons LESS / MORE «**◀ ▶**» - the action is not allowed by the program.

Double note signal by pressing CHOICE «**⊖**» button in the “stop” mode – the relevant action took place.

Dual sound signal by pressing START / STOP «**▶◀**» – initiation or shutdown of the oscillation.

Triple note signal by pressing START / STOP «**▶◀**» - the manual interruption of the automatic adjustment.

The **sequence of the rising notes ending with the triple note signal** – the full cycle of the automatic adjustment.

Double note sequence («siren») - output current overload.

Sequence of the triple note “alarms” – hardware current safety system activation

Sequence to the quadruple note “alarms” – power supply voltage is unacceptably low.

«**Quick**» **sequence of the similar «high» note** — power supply voltage is unacceptably high.

«**Farewell phrase**» consists of the three falling notes during manual shutdown of the device by the pressing POWER «**I**» button.

5. Working with the device

Prior to the “contact” connection it is necessary to make sure that the utility under examination has no voltage to “earth” and also that there are no works carried out or scheduled to be conducted which execution can lead to deliberate or accidental contact with conductive part which is under the voltage;

If the examination of cable under voltage is required one should use “non-contact” method of connection with the help of the transmitting antenna or induction “clamp”.

Attention

!Make sure that the transmitter is turned off, before connecting it to the electric load.

5.1 Preparatory activities



5.1.1 Remove the battery set by simply pulling up by the handle and insert 8 power supply elements into it observing the polarity (batteries or NiMh accumulators). Put the battery set back.

5.1.2 When the transmitter is being turned on, it indicates the type of power supply. In order to change the type of power supply, you have to turn on the transmitter holding “**⊖**” button.

After that, you can switch the type of power supply by pressing “**◀**” and “**▶**”. You can choose between battery “**⊖**” or accumulator “**▶**”.

To confirm your choice of power supply type, press start button “**▶◀**”.

NOTE: Using the accumulators without corresponding transmitter setting, may cause their malfunction.

7.1.3 Choose the load type from the options:

- “**clips**” (connect “output cable” to the connector “OUTPUT” on the back panel);- **internal transmitting inductor «In»** (no connections allowed to the “OUTPUT” connector on the back panel);

5.1.4 Connect the output of the device to the utility under examination via contact or non-contact (induction) method (in accordance with the chosen utility locating method). The contact method is more efficient for “utility locating” but not always convenient and absolutely unsuitable for cables locating which are “under voltage”.

NOTE

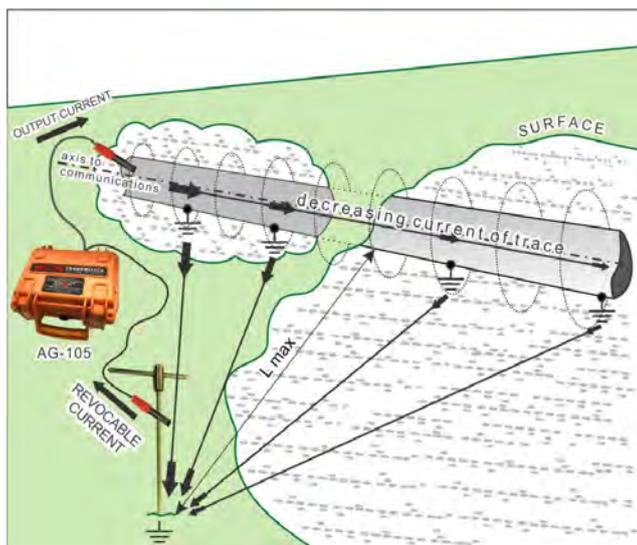
In the article only classical methods of “contact” and “non-contact” connection are represented in various circumstances. Special connection options such as “conductor-conductor”, “conductor-armour”, “armour-earth”, “parasitic capacity of unconnected multi-conductor cable” and others used under the specific conditions and only for “flaw detection” are considered in the “utility locating methods” indicating in the descriptions of the utility locators.

1) Base method of the “contact” connection to the utility.

The “clips” are used (“output cable” with “alligator” clips) and earth rod.

One clip should be connected to the input of the utility under examination and the second one to the earth rod (or to the relevant earthing, e.g. standard earthing bus) at maximum distance from the utility. It is essential to provide close contact with utility and earth.

The opposite end of the utility under examination should be earthed for creating the paths for earth return of the signal revocable current.



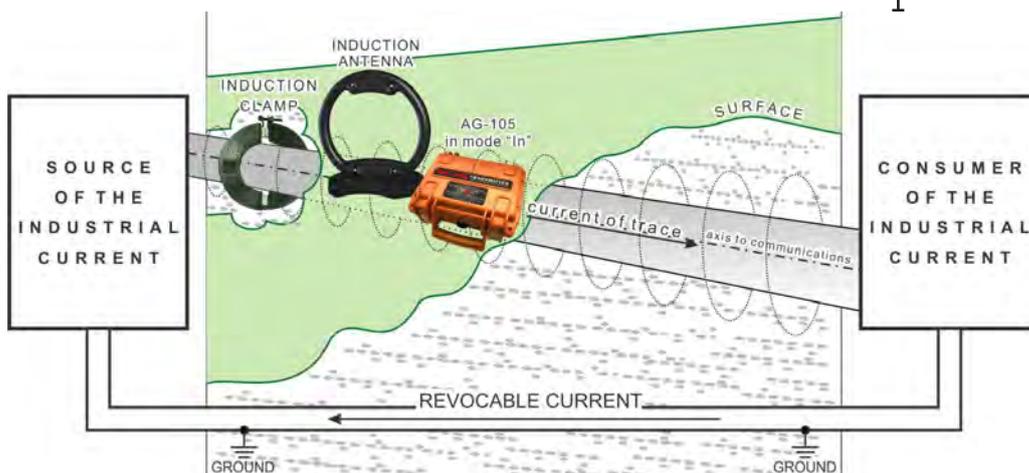
Special option – bare PIPE IN THE GROUND. The ground contact is possible along the entire length of the utility and in any segment. The additional earthing of the pipe is useless.

In this case the resistance between the connection to the pipe and earthing point (rod or other standard earthing bus) is extremely low.

“Revocable” current is reduced considerably the farther the location from the connection point. Nevertheless owing to the unique (for this type of devices) “reserve” of the output current (more than 5A at the load less than 0.8Ω) it offers high probability of the successful utility locating at a considerable distance from the connection point.

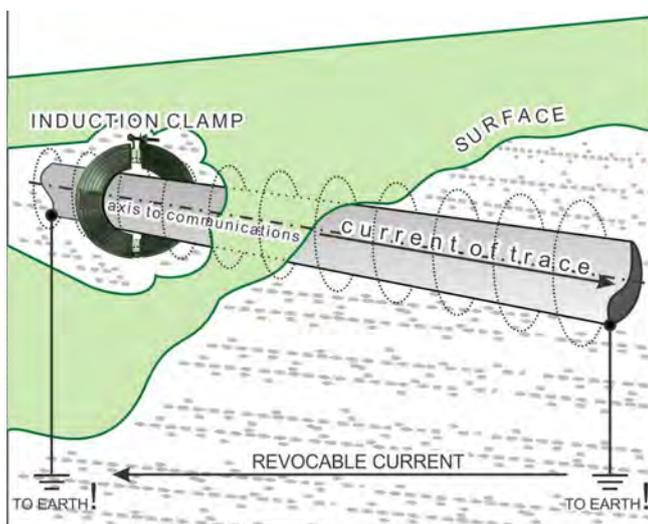
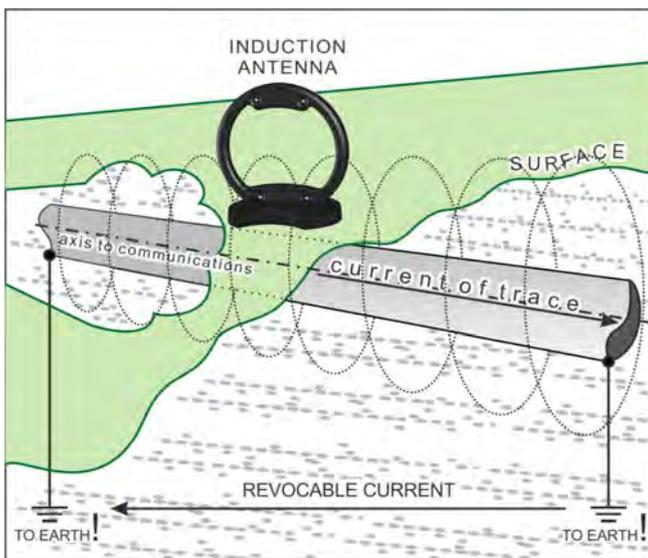
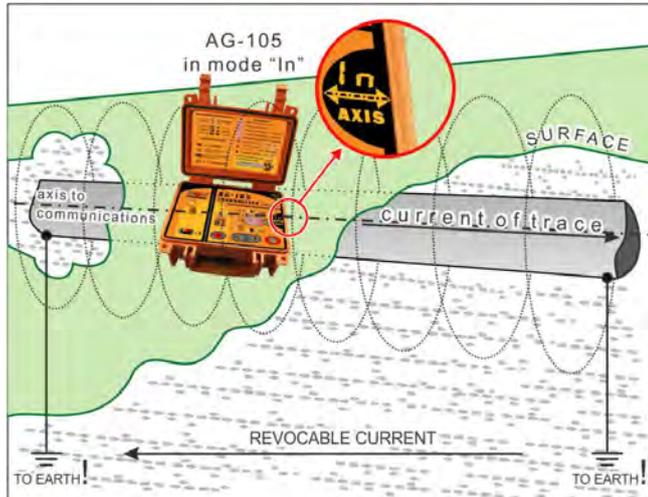
The diminishing of the signal at the distant pipeline sections is offset by the considerable “reserve” for the manual or automatic adjustment of the sensitivity of receivers made by “TECHNO-AC”.

NOTE for “non-contact” connection methods («In» / «An» / «clamp»).



If the utility forms part of the complete electrical circuit “source – utility – consumer” (as per illustration) then in case of the specific electric properties of these chain loops the utility locating via the “non-contact” connection method («In» / «An» / «clamp») is quite likely without additional earthing.

In this example “revocable” signal current of “high” frequency (0.5...33kHz) “overlaps” the current of “low” (industrial) frequency (50 / 60Hz) which is not preventing from the utility locating and the flow path for “revocable” current of the signal already provided.



2) If the internal transmitting inductor is in use then the casing of the device should be located right above the utility under examination (to set the reference point “In_axis” on the front panel above the axis of the utility and oriented parallel to its direction). The utility locator shouldn’t be used nearby the transmitter location in order to avoid the immediate induction connection (apart from the utility).

If the utility is not a part of the complete electrical circuit then both its ends should be earthed for creating a path for earth current “return” of the signal.

3) If the external induction transmitting antenna is in use “An” then it should be located as close as possible to the examined utility and coplanar with it. The utility locator shouldn’t be used nearby the transmitting antenna in order to avoid the immediate induction connection (apart from the utility).

If the utility is not a part of the complete electrical circuit then both its ends should be earthed for creating a path for earth current “return” of the signal.

The earthing should be done at a possible distance from the utility to reduce mutual cancellation of the “tracing” and “revocable\return” signal current.

4) If the induction transmitting “clamp” is in use then the utility should be wrapped by them in any available point. The utility locator shouldn’t be used near the “clamp” location in order to avoid the immediate induction connection (apart from the utility) despite the fact that in this case this connection is not as evident as in the “antenna” modes “In” and “An”.

If the utility is not a part of the complete electrical circuit then both its ends should be earthed (for creating a path for earth “return” of the “revocable” current signal. The earthing should be done at a possible distance from the utility to reduce mutual cancellation of the “tracing” and “revocable\return” signal current.

5.2. Settings

5.2.1 Open the cover. Turn on the device by pushing POWER «**I**» button.

5.2.2 After switching on of the device “on default” the indicator POWER SUPPLY VOLTAGE «**V**» glows green. The device is in the “stop” mode. The pre-set of the modes and parameters values should be done.

5.2.3 If it is necessary to change the indicated mode or parameter it can be done by sequenced presses of the CHOICE «**C**» button.

In this case (“along the loop” and “counterclockwise”) in the “Internal parameters field” and “Modes field” one can choose reference and variable values of the modes and parameters indicated in the “Digital field”. The chosen mode and parameter marked by the flash of the relevant indicator.

The sequence of the indications in the functional fields.

1) «**V**» - POWER SUPPLY VOLTAGE in volts (reference value, **green** glow);

2) «**A**» - active «ANTENNA» mode and the type of connected transmitted antenna (depends on which accessory is connected to the «OUTPUT» connector:

3) «**M**» - active / non-active «MODULATION» and the type of the special signal form (should be chosen in the “Digital field” by MORE/ LESS «**L**» buttons):

- lack of glow – no modulation (continuous signal «**Co**» «of standard» sin form);

- **green** glow – pulse modulation mode «**Pu**»;

- **yellow** glow – dual-frequency modulation mode «**2F**».

4) «**f, kHz**» - frequency of the generated signal in kilohertz (**green** glow) is chosen in the “Digital field by LESS/ MORE «**L**» buttons:

- for loads “clips” or “clamp” - 512Hz «0.5» / 1024Hz «1.0» / 8192Hz «8.2» / 32768Hz «33»

- for «antenna» modes «In» or «An» - 8192Hz «8.2» / 32768Hz «33».

The generation frequency is set if possible lower but according to recommendations of the chosen “utility locating method” and proceed from the premise that the lower the frequency:

- the less re-inducing to the nearby facilities, the less the leakage of the “revocable” current, the more transmission distance.

- the lower sensitivity of the utility locators (more revocable current required and consequently power of transmitter) the more difficult to overcome the utility conductivity flaws.

5.3 Clips

(standard accessory for the “contact” connection)

5.3.1 If “clips”\ earrings are connected to the “OUTPUT” the device is ready for “contact” load connection. The internal transmitting inductor “In” is not connected (“ANTENNA” mode indicator «**A**» does not glow).

5.3.2 To connect one clip to the input of the examined utility and the second one to the earthing rod (or relevant earthing) at maximum distance from the utility. The opposite end of the examined utility should be earthed.

5.3.3 By pressing the button START/STOP «**S**» is initiated the automatic adjustment process with

the I “occasional” resistance load. And along with this the output signal voltage incrementally increases up to the moment when the specific load current value is reached (or exceeded) (0.2A at frequencies 512Hz “0.5” / 1024Hz “1.0” / “2F” or 0.1A at frequencies 8192Hz “8.2” / 32768Hz “33”). If the load resistance is too high for reaching these values of the output current then the maximum possible output signal voltage is produced.



5.3.4 After that manual alterations (by LESS / MORE « » buttons) of the output signal voltage are possible in the range of provided by the automation.

5.4. Internal transmitting inductor «In»

5.4.1 The internal transmitting inductor is connected to the output automatically if there are no other accessories connected to the “OUTPUT” connector. «Antenna” mode “In” is indicating («» - **green**).

5.4.2 For maximum intensity of “inducing” the reference point of the emitting inductor (“In axis” on the front panel) should be placed above the utility axis and in its direction.

5.4.3 In the “ANTENNA” mode “In” (via buttons LESS / MORE « ») the FREQUENCY of the generated signal can be chosen «f,kHz»: 8192Hz «8.2» / 32768Hz «33».

5.4.4 In the “ANTENNA” mode “In” besides of the “regular” continuous oscillation mode «Co» (by pressing LESS / MORE « » buttons) pulse “MODULATION” «Pu» is available for choosing.

5.4.5 The oscillation is activated by START / STOP «» button. Upon completion of the automatic adjustment the highest value of signal voltage is reached on the output «U,V» ≥ «40».

5.4.6 After that manual decrease and inverse increase of the signal voltage (by LESS / MORE « » buttons) in the range envisaged by the automation.

5.5. External induction transmitting antenna (extra accessory for “non-contact” connection

5.5.1 The appliance of the external transmitting antenna IEM-301.5 allow to provide the higher emission intensity and more convenient access immediately to the utility in comparison to the use of internal transmitting antenna “In”.

5.5.2 If the external induction transmitting antenna is connected to the “OUTPUT” connector the device is in “ANTENNA” mode «AH» («» - **yellow**, and in the “Digital field” when choosing symbol «An» is indicated).

5.5.3 For maximum “inducing” intensity the utility line and antenna frame should be positioned as close to one another as possible and coplanar with each other.

5.5.4 In the “ANTENNA” mode «An» (by LESS / MORE « » buttons) it is possible to choose generated signal FREQUENCY «f,kHz»: 8192Hz «8.2» or 32768Hz «33». The switch of the resonant frequency which is located in the casing of the transmitting antenna should be positioned «8.2» or «33».

5.5.5 In the “ANTENNA” mode «An» apart from «regular» mode of continuous oscillation «Co» the pulse «MODULATION» mode «Pu» is available.

5.5.6 The oscillation is initiated by START / STOP «» button. Upon completion of the automatic adjustment process the highest signal voltage value is reached on the output «U,V» ≥ «40» (if antenna is not overload by nearby massive metallic objects).

5.5.7 After that manual decrease and inverse increase of the output signal voltage (by LESS / MORE « » buttons) in the range provided by the automation.



NOTE for subparagraph 7.4 and 7.5

In the «Output parameters field» in the «ANTENNA» modes «In» and «An» “output signal voltage” is available «U,V», applied to the antenna.

The current «I,A», power «P,W» in the utility and its resistance «R,Ω / kΩ» in this instance are not measured and not displayed (because of the lack of galvanic coupling).

5.6. Transmitting induction “clamp” (extra accessory for “non-contact” connection)

5.6.1 In case of several nearby utilities for specially efficient current inducing specifically into one of them or for “non-contact” connection to the utility under voltage it is recommended to use transmitting induction “clamp” CI-110.

5.6.2 In case if “clamp” is connected to the “OUTPUT” connector the device is ready for operation at this load type. The internal transmitting inductor «In» is disconnected (the indicator of «ANTENNA» mode «» does not glow.

5.6.2 The device operation with transmitting “clamp” is similar to operation with “clips” (“output cable” with “alligator” connectors). As a result signal voltage across the “clamp” is indicated «U,V» / along with signal current in the “clamp” (not in the utility) «I,A» / capacity absorbed by the “clamp” «P,W» / impedance of the “clamp” (not the utility) at present frequency «R,Ω/kΩ». The current absorbed by the “clamp” is inversely related to the signal frequency at its constant voltage.

5.6.3 If the identification of the “chosen” utility in the “bunch” is required it is necessary to earth all output ends of the “bunch”.

5.6.4 Then the “chosen” utility should be wrapped around with a “clamp”.

5.6.5 The press of the START / STOP «» button is initiating the automatic adjustment. Upon the completion (or interruption by pressing START / STOP «» button) of the automatic adjustment process the manual control over the voltage in the “clamp” is possible (as well as over current, power) by pushing LESS / MORE «» buttons.

5.6.6 After that the utility locating of the “singled out” utility is possible and its identification in the “bunch” with the use of any proper receiver equipped with electromagnetic sensor (for locating) or receiving “clamp” (for identification by “sequential search” of the output ends of the bunch based on the maximum level of the received signal).

5.6.7 The pulse mode «Pu» provides the high intelligibility in spite of industrial interferences and therefore is recommended to be used with transmitting “clamp”.



5.7. External power sources

To the EXTERNAL SUPPLY connector on the back panel can be connected an “appropriate” power source currently possessed by the customer.





2) Mains power supply adapter AG114M.02.020 (based on GS60A15-P1J «MEAN WELL») energizes from the mains with the voltage of 220V and supply a direct-current voltage of $15V \pm 3\%$ with value of the current 4A. Offered as extra accessory.

In case of availability of two power sources at the same time – external and internal (battery) – the device consumes supply current from the source which has larger value of output voltage. Therefore in case of external power it is recommended to remove the battery (at least one) in order to avoid their possible useless charge consumption.

5.8. Electromagnetic compatibility

The present device is subsumed under “information technology equipment” (ITE) class A according to Russian Stage Standard (GOST) 51318.22-2006. Such equipment should not have any sale restrictions. When used in private households this equipment could disturb the smooth running of other technical equipment because of the industrial interferences. In this case the customer should act accordingly.

NOTE

Private household is a space where the radio and TV sets can be placed at a distance less than 10m from ITE.

5.9. Ingress protection rating

The ingress protection rating of the casing IP65 which is completely eliminates the possibility of the ingress of the dust and water jets inside when the device is lidded. Open slots on the back panel which are protected by the rubber covers.

Transmitter AG-105 Technical specifications

The frequencies of the continuous «Co» or pulse «Pu» signal, Hz ± 0,1% - «kHz»	
Load «clips» or «clamp»	512 - «0.5» / 1024 - «1.0» / 8192 - «8.2» / 32768 - «33»
«Antenna» modes	8192 - «8.2» / 32768 - «33»
Operating modes	
«Antenna» modes	Internal transmitting inductor «In».
	External induction transmitting antenna «An».
«Modulation» modes (special form signal)	Pulse «Pu» (short-term transmissions of the sine signals). Transmission duration 0,12sec. Transmissions repetition frequency 1Hz.
	Dual-frequency «2F» (simultaneous frequency generation 1024Hz, 8192Hz). Amplitudes ratio 4/1 (respectively).
Output parameters under power supply voltage 12... 15V	
<i>Output current, A</i>	
Restricted by the program under manual increment , ≥	5 – at frequency 512Hz «0.5» / 1024Hz «1.0» / 8192Hz «8.2» / «2F»
	3 - at frequency 32768Hz «33»
Set by the program for automatic adjustment with the external load of «clips» or «clamp», ≥	0,2 – at frequency 512Hz «0.5» / 1024Hz «1.0» / «2F»
	0,1 – at frequency 8192Hz «8.2» / 32768Hz «33»
<i>Maximum output voltage, V</i>	
Depending on «modulation», ≥	32 – in the dual-frequency modulation mode «2F»
	40 – in other modes
<i>Maximum output power, W</i>	
Restricted by the program, ≥	20 - In the continuous «Co» and pulse «Pu» modes at frequencies 512Hz «0.5» / 1024Hz «1.0» / 8192Hz «8.2» at load resistance up to 80Ω In dual-frequency mode «2F» at load resistance up to 50Ω.
	6 - At frequency 32768Hz «33» at load resistance up to 260Ω.
Power supply sources	
Operating range of the supply voltages	Minimally acceptable voltage for oscillation start-up - 7V .
	Maximum allowed voltage for operation – 15V .
	Automatic shutdown voltage in the “oscillation” mode < 4,2V .
Battery set	8 «alkaline» cells 1,5V «type C» Recommended – «Duracell® ULTRA».
External power supply sources (optional)	Battery «12V» (e.g. automotive) Output voltage 11...14V, maximum current not less than 4A.
	Mains power supply adapter AG114M.02.020 (extra accessory based on GS60A15-P1J «MEAN WELL») Output voltage 15V, power 60W.
Operating time («life cycle»)	While in operation of the battery set «type Cx8» is defined by the quality (capacity and «load capability») of the applied alkaline cells and can be equal to from 4 to 6 hours in the «Co» и «2F» modes or from 20 to 30 hours in the «Pu» mode at initial output voltage 7W in «continuous» modes «Co» / «2F» or at initial output voltage 15W in pulse modulation mode «Pu».
	Under the external power supply is fully conditioned by this external energy source characteristics therefore under mains supply operating time is unlimited .

Operational characteristics	
An automatic control over the output voltage during oscillation process	Proportional control over the output power depending on the “energy potential” of the power supply source.
Automatic shutdowns of the device	At power supply voltage in the “stop” mode < 6,5V.
	At power supply voltage in the “oscillation” mode < 4,2V.
	At power supply voltage > 15,5V.
	In case of exceeding of the admissible absorbed current value (the exact figure depends on the actual mode).
	In case of short circuit of the output during the adjustment process (actuation of the hardware safety system of the terminal amplifier).
	In case of non-compliance of the oscillation mode settings depending on whether the external antenna is installed in the output or not (the switch to the “stop” mode).
	In case of “long” (≈ 100sec) downtime in the “stop” mode (if the buttons are not pushed).
Adjustment with load	<p>Automatic, up to the reaching of the specific consumption rate or attainment of the load current:</p> <ul style="list-style-type: none"> - ≥ 0,2A at frequencies 512Hz «0.5» / 1024Hz «1.0» / «2F»; - ≥ 0,1A at frequencies 8192Hz «8.2» и 32768Hz «33». <p>Manual (via buttons LESS / MORE « ») after the automatic adjustment.</p>
Connection options to the utility under examination	«Contact» connection with “earth return”.
	«Non-contact» connection with application of the internal transmitting antenna «In».
	«Non-contact» connection with the use of external induction transmitting antenna «An» (the emission intensity is higher and easier access to the utility in comparison with the internal transmitting antenna «In»).
	«Non-contact» connection using the transmitting induction “clamp” (selection of the cable from the bunch as possible).
Electromagnetic compatibility	
Classification in accordance with the Russian State Standard (GOST) 51318.22-2006	Class A
Structural parameters	
Power output amplifier	The technology — updated CLASS D Efficiency to 85%.
LED indicators	Separate light-emitting diodes indicating parameters and modes.
	Digital indicator displaying the modes and parameters values and also showing output parameters of the « MULTIMETER » measurements, e.g.: output voltage (V), load current (A), load power (W) and load resistance (Ω /kΩ).
Overall dimensions of the electronic unit (case), not more than, mm.	216x180x105mm
The weight of the electronic unit, not more than, kg	2
The admissible environment temperatures range when in operation	- 30...+60°C With “battery” power supply it is not recommended to use the device under sub-zero environmental temperatures.
Ingress protection rating	IP65 (when the enclosure-case is shut).

Appendix Transmitter AG-105 Indication

Battery holder
with the handle in the center for removing. Contains 8 alkaline cells 1,5V «type C».

Electrical power supply field
One of the three categories of power source VOLTAGE «U» and ABSORBED CURRENT «I» is always displayed by the glow of one of the three-coloured indicators.

Output parameters field
VOLTAGE «U, V», CURRENT «I, A» and load POWER «P,W» and also its RESISTANCE «R, Ω / k Ω».
The only possible **red** glow of indicators of this field means «oscillation» is in progress.

Internal parameters field
POWER SUPPLY VOLTAGE «U.V» and FREQUENCY of the generated continuous «Co» or pulse «Pu» signals «f, kHz».
Green glow of POWER SUPPLY VOLTAGE indicator «U.V» can be seen in the «stop» mode, **red** – in «oscillation» mode.

Internal induction transmitting antenna field «In»
In «antenna» mode «In» the orientation mark «In axis» should be positioned precisely above communication axis and oriented parallel to its direction.

CHOICE button
By sequenced presses MODE or PARAMETER indication can be chosen to be shown on the «Digital display».

START/STOP button
The sequenced presses are switching the device from «STOP» mode to «OSCILLATION» and back.

Digital display
shows NUMERICAL value of the parameter («U.V» / «f,kHz» / «U,V» / «I,A» / «P,W» / «R, Ω / k Ω») and SYMBOLIC notation of the mode («In» - internal transmitting inductor / «An» - external induction transmitting antenna / «Co» - continuous oscillation mode / «Pu» - pulse modulation mode. Type of the displaying value is defined by the CHOICE button.

Modes field
has indicators of «ANTENNA» «» and «MODULATION» «» modes. If «earrings» or «clamp» are connected to the output, the indicator «» not glowing. In «Antenna» mode, the indicator «» is always glowing: **green** in case of internal antenna or **yellow** in case of external. In case of «regular» (not modulated) signal the indicator «» is not glowing. In case of «MODULATION» (special form signal) the indicator «» always glows: **green** in pulse mode «Pu».
Therefore, current operating mode is always displayed in the «modes field».

POWER button
on /off switching of the electric power supply

LESS/MORE buttons
Decrement / increment (adjustment) of the chosen (mode) or parameter value.

INDICATION EXAMPLES					
«nominal» power supply voltage	«low» absorbed current	external antenna «An» is connected	pulse modulation mode «Pu»	«oscillation» operation mode	output voltage 40V
«U» green	«I» green	«  » yellow	«  » green	red glowing «U,V»	«U,V» → «40»

6. Search the route in passive mode

The source of the electromagnetic field in this case are frequency currents 50 Hz in cables under mains voltage and 100 Hz in pipelines with cathodic protection mode, the route search is performed without using the trace generator. Equipment used: Receiver «AP-014», Electromagnetic sensor «EMD-247», headphones.

6.1 Route location methods

1. The Maximum method

This method consists of positioning the electromagnetic sensor in the direction of the magnetic field created by the utility radiation (fig.4.3). EMD antenna must be positioned horizontally and the sensor placed in a plane perpendicular to the cable route. In this case the maximum signal level is observed when the sensor antenna passes directly above the utility line. The maximum method is intended for a quick route location. Flat peaks of the signal level curve do not allow for high location accuracy, but enables a quick route location.

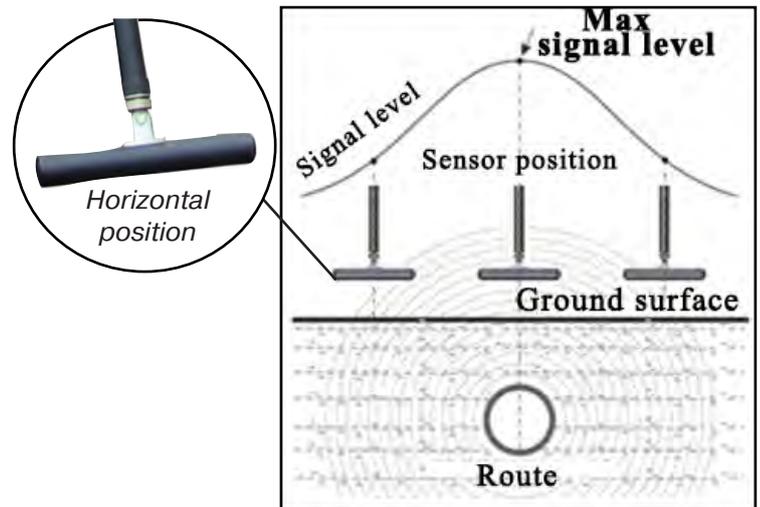


Fig. 6.3

2. The Minimum method

When the EMD antenna in a vertical (transport) position is placed directly above the route the signal is at its lowest level fig. 4.4. As the distance from the point directly above the pipeline increases, the signal level first rises sharply then slowly decreases. This is the minimum method, which is used to determine a more precise route location (after quick route tracing using maximum method).

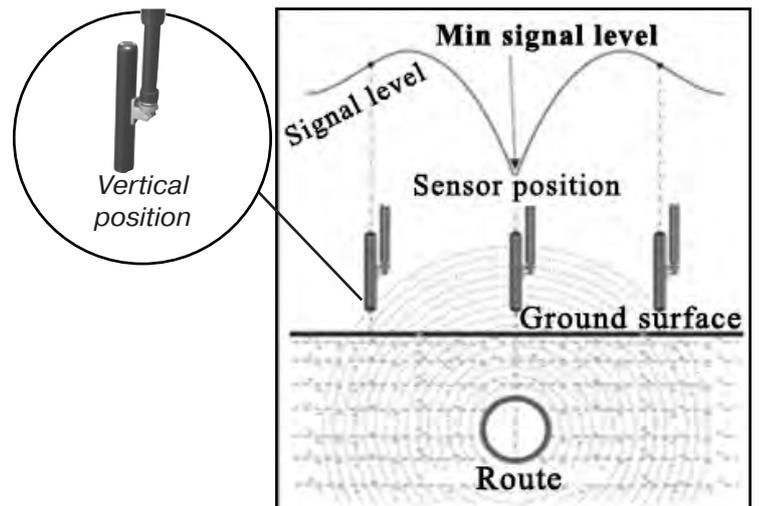


Fig. 6.4

6.2. Route search in a passive mode

In passive mode, the route search is performed without use of the trace generator. The source of the electromagnetic field in this case are the current frequency of 50 Hz in the cables under mains voltage and 100 Hz in pipelines with cathode protection.

Equipment used: Receiver «AP-014», an electromagnetic sensor «EMD-247», headphones.



The sequence of an operator's of actions:

1. Insert the two batteries into the battery compartment of the receiver «AP-014», observing polarity.
2. Connect electromagnetic sensor, headphones to the appropriate receiver sockets.
3. Turn on the power of the receiver. 



When switching on, the device reverts to the settings used in a previous work - the level of input gain, volume levels and frequency filtering.

4. Select the work «passive» frequency (50 Hz to trace cables under voltage 100 Hz or to trace the pipeline with cathode protection). 

5. Position electromagnetic transducer «EMD-247» precisely over the route so that it was at the point of maximum signal strength. To do this, place the the sensor perpendicular to the desired route on the distance from it, where is supposed to search;

6. Press the «Change receiver sensitivity» buttons to adjust the input level, so its level filled LED scale as much as possible, but to the last LED flashes. 



If while working the whole scale of the LED is full, and the last LED flashes (input overload occurs), one should reduce sensitivity of the receiver.
If the maximum of the sensitivity scale isn't filled, and the first LED flashes, it means that the device cannot recognize the signal at the selected frequency, because its level is too low or there is no signal.

7. Establish a comfortable headphone volume level using «Headphone Volume Changes» buttons. 

8. Go along the route by moving the electromagnet sensor across the route in one or the other way to determine points of maximum signal level. Points of maximum signal level correspond to the position of communication axis.

6.3 Search of the route in the active mode

For the current flow an electrically conductive closed loop is needed, one of its branches is the desired communication, ground for the return of the current through the ground is used as the other branch.

When searching for a route to active frequencies of the corresponding frequency generator, is the source of the tracer current, connected to the required utilities.

Locator « Success AG-511 » allows you to search for communications at the active frequencies of 512 Hz, 1024 Hz, 8192 Hz and 32768 Hz.

Equipment used: receiver AP-014» generator «AG-105» electromagnetic sensor «EMD-247», headphones.

The sequence of operator's actions:

1. Insert the two batteries into the battery compartment of the receiver «AP-014», observing polarity.
2. Prepare the electromagnetic sensor to work. (See Section 3)
3. Connect the receiver to the corresponding electromagnetic sensor connectors and headphones.
4. Determine the type of connecting the generator to the communication (contact / contactless) in accordance with recommendations described in section 4. 2. and connect the generator to communications
5. Turn on the generator. Set the signal form (discontinuous «PR» / continuous «NP»), the generation frequency of the generator to 512 Hz - «0.5» / 1024 Hz - «1.0» / 8192 Hz «8.2» / 32768 Hz - «33».
6. Turn on the power of the receiver.
7. Select the filter frequency in a receiver similar to settled on the generator.
8. Position electromagnetic transducer «EMD-247» precisely over the route so that it was at the point of maximum signal strength. For this you need to have the sensor perpendicular to the desired track at that distance from it, where you want to search;
9. Press the «Change receiver sensitivity» buttons to adjust the input level, so its level filled LED scale as much as possible, but to the last LED flashes.
10. Establish a comfort level of the headphone volume using the «Headphone volume Changes» buttons.
11. Go along the route, moving electromagnetic sensor across the route in one and other way to determine points with the maximum signal level. Points with maximum signal level correspond to the position of communication axis

7. Additional features

7.1 Task: Indirect electromagnetic mode of depth measuring

Equipment used: receiver AP-014, electromagnetic sensor EMD

Tip: When determining the depth, one should take into account the terrain. In order to obtain precise results, select flat surface areas.

Method: 1. Find the precise pipeline route location (preferably using the minimum method). Mark the spot.
2. Fix the sensor antenna at a 45 angle to the ground surface, minimum of the signal is observed at a distance from the point «above the route», equal to the depth of the utilities, when the antenna axis intersects the axis of the route. This is the indirect method of measuring the depth of utility (**fig. 7.1**)

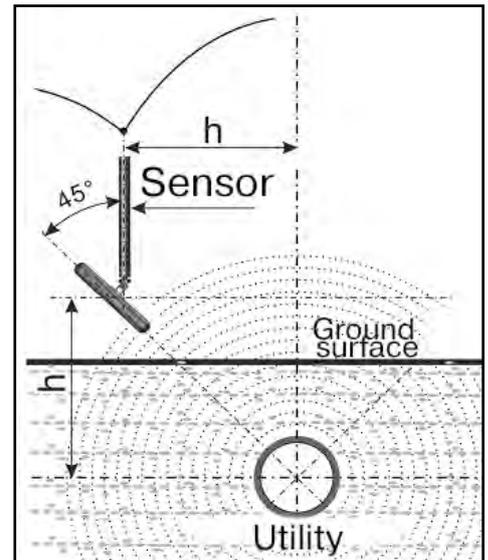


Fig. 7.1

7.2 Task: Detecting the pipeline and utility lines intersection point.

Equipment used: receiver AP-014, electromagnetic sensor EMD, headphones.

Method: 1. Perform preliminary pipeline route location.
2. Turn on the receiver and set it up for broadband.
3. Position the electromagnetic antenna over the pipeline, parallel to the pipeline route (signal level displayed on the receiver screen will be close to zero) (**fig. 7.2**). Perform route location in accordance with the maximum method. When following the route, the intersection points with utility lines can be identified by the maximum signal.

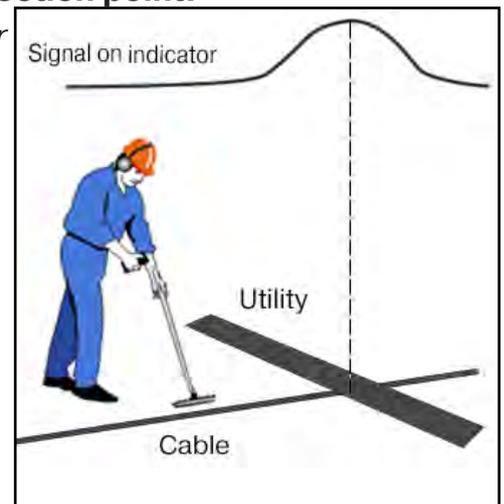


Fig. 7.2