



**TECHNICAL DESCRIPTION
OPERATING INSTRUCTIONS**

CABLE AND PIPE LOCATOR SUCCESS-438.15N

1. Design and principle of operation

Cable and pipe locator «**Success AG 438.15N**» is designed for:

- detection of cables up to 6 m depth
- detection of metal pipelines up to 6 m depth
- survey the ground before the ground works
(“Broadband” mode with frequency range between 0.05 and 2.0 kHz)
- distance of tracing from the place of transmitter connection is up to 3 km.
- indirect measurement of the depth

Kit components are:



- 1 – Receiver AP-027M
- 2 – Electromagnetic sensor EMD-247
- 3 – Headphones
- 4 – Transmitter AG-105

Fig. 1.1

Operation conditions

- Ambient temperature, °C -20 to +50
- Relative humidity, %.....up to 90

2. Receiver AP-027M

2.1 Appearance and Controls

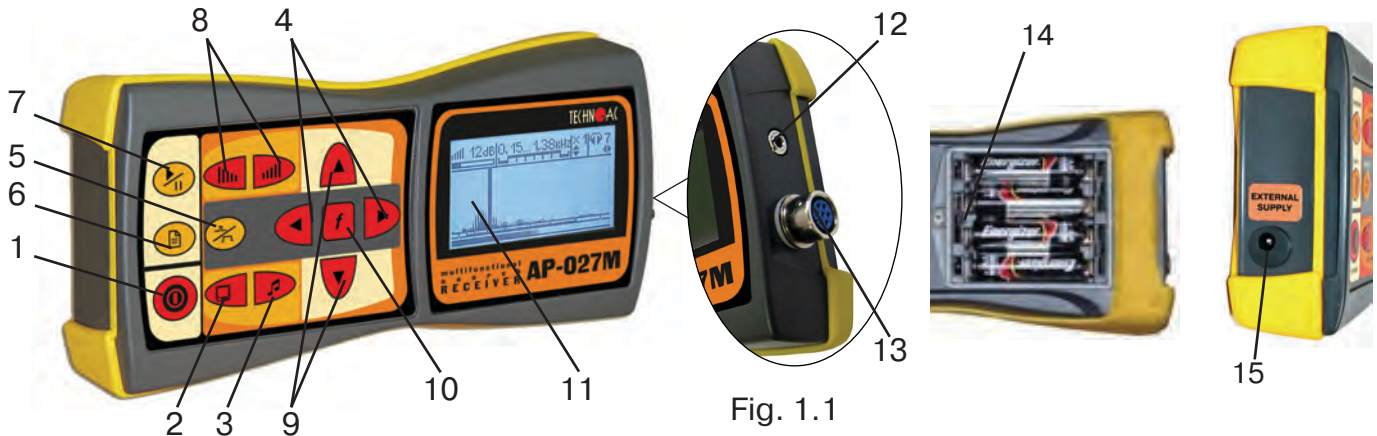


Fig. 1.1

1		power on/off button	9		selected parameter adjustment buttons (up/down)
2		visual indication type button	10		frequency button (filter frequency adjustment on/off)
3		sound indication type button	11	LCD screen	
4		parameter selection buttons (left/right)	12	headphones jack *	
5		filter button (broadband on/off)	13	sensors connector	
6		memory button	14	protective insert	
7		start/pause button (measurement mode)	15	external power supply socket	
8		sensitivity buttons (higher/lower)			

* AP-027M receiver uses 3,5mm port for headphones connection. It allows to use in-ear and on-ear headphones without microphone, with 3,5mm stereo (TRS) mini-jack.

Technical specifications of the Receiver are listed in Appendix A.

Screen controls are listed in Appendix B.

2.2 Preparing Receiver AP-027M for operation

1. Insert 4 AA elements in battery compartment of the receiver, observing the polarity. Fig 1.1 p. 14 If accumulators are used, they should be fully charged with charger, supplied separately.

Receiver can also work from external PowerBank, supplied separately*.



*Set of external PowerBank (for example, Xiaomi Mi Power Bank 20000 mAh with protective case and power adaptor питания SAMSUNG ART-U90EWE 5.0 V/2.0 A)

NOTE

AP-027M automatically switches to external power supply, when connected to PowerBank. Some models of PowerBanks should be activated by pressing separate button on their body. When working at negative temperatures (to -20°C) place PowerBank under clothes.

2. Set the receiver on the holder

a) Place the receiver and holder as shown on the picture below:

b) Put one end of the holder below protective rubber of the receiver

c) Put other end of the holder below the second rubber



3. Put the strap of the holder around your neck. Connect required sensor to the receiver. Now it is ready for operation.

NOTE

It is recommended to adjust the length of the neck strap for more comfort during operation.




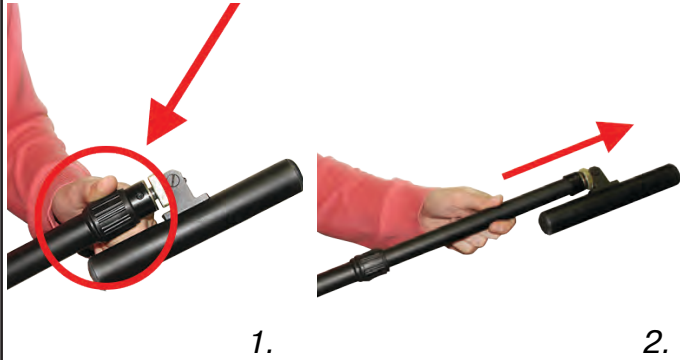


3. Operation sequence in passive cable route detection mode

Used equipment:




Fig. 3.1




3.1 Connection of sensors and check of the receiver operability



<p>1. Connect the electromagnetic sensor and headphones to the corresponding receiver connections headphones (if necessary)</p> 	<p>2.1 To set the electromagnetic sensor from transport to operating position. In order to do that: loosen the locking nut (1), extend the bar (2) to a required length and fix with the locking nut</p> 
<p>2.2 Loosen the locking nut (3) and install the electromagnetic sensor (4) in a position used in route detection. Fix the position with the locking nut. Horizontal position – is used for route detection by maximum method, and transport position for route detection by minimum method</p> 	<p>3. Turn on the receiver AP-027M</p> 

4. In the start window of the receiver display:

Check accuracy of the sensor connection. If a «no sensor» symbol , is lit on the display, check if the sensor is connected correctly.

Check the charge status of the batteries the charge should be no less than 4,0 V). If the battery charge is low, replace the batteries.

Check the received signal type as «continuous»  (by any of buttons /)

If it necessary, change the frequency of the second filter by changing the number of harmonic component «*f_{HRM}*» to another by buttons  or .






















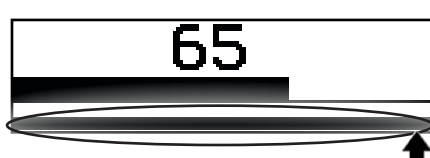
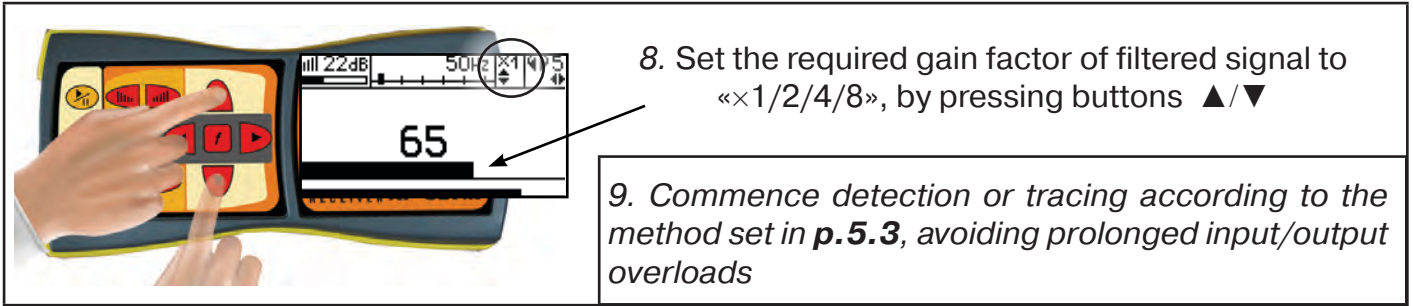
Set the necessary level of receiver display backlighting, using / buttons

Fig. 3.2

3.2 Conduct receiver setup

 <p>1. Switch on the measurement mode using the button </p>	 <p>2. To select the necessary frequency press the frequency button . symbol will appear </p>	<p>For tracing of energized cables please set frequency 50 Hz.</p>
 <p>3. Using buttons , set the desired frequency in the filtration zone for example, 50 Hz</p>	 <p>4. Leave the filter adjustment mode by pressing the frequency button . Indicator  will appear in the volume adjustment zone</p>	<p>5. Set input signal level using sensitivity buttons  and </p> 
 <p>6. Set an acceptable volume level volume  using ,  buttons</p>	<p>7. Moving along the route, it is necessary to move the electromagnetic sensor across the route in one and the other side to maintain a maximal level of the signal.</p> 	 <p>Level (at the bottom of the scale) must be within 50 ... 90% of the maximum</p>  <p>Attention! input overload can lead to the wrong interpretation of data</p>



3.3 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.5.3). 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.



The Maximum method

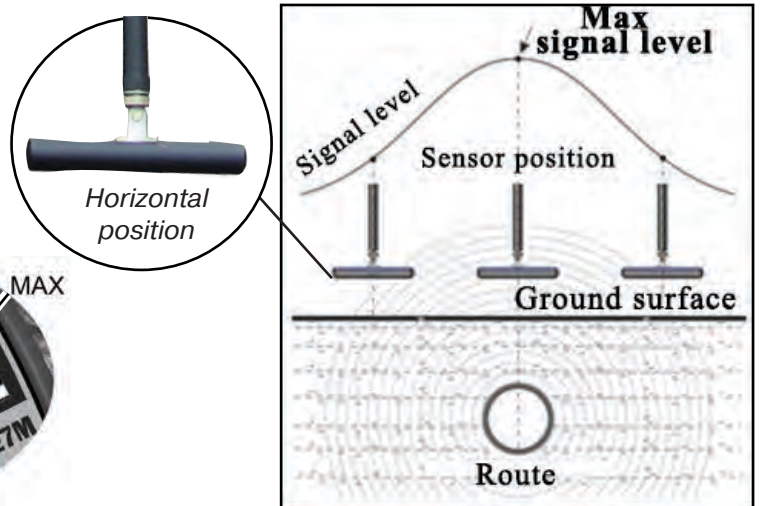


Fig. 3.3

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. 5.4. 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).



The Minimum method

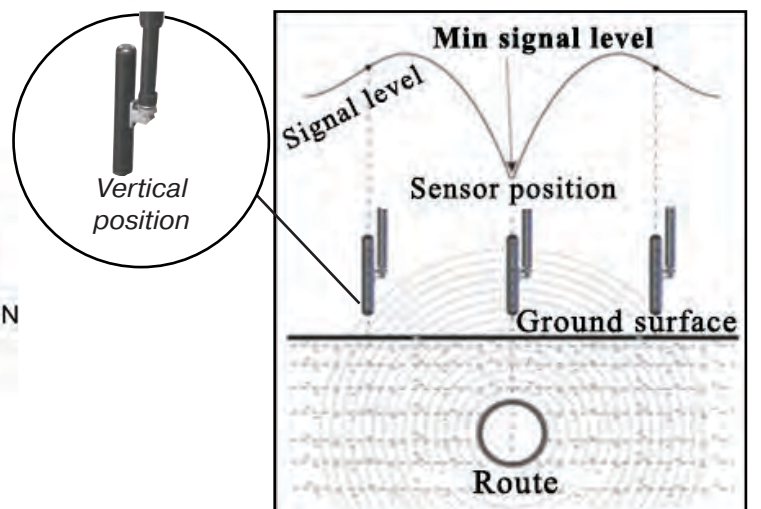


Fig. 3.4

3.4. Additional features

3.3.1 Task: Indirect electromagnetic mode of depth measuring

Equipment used: receiver AP-027M, 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. 3.5**)

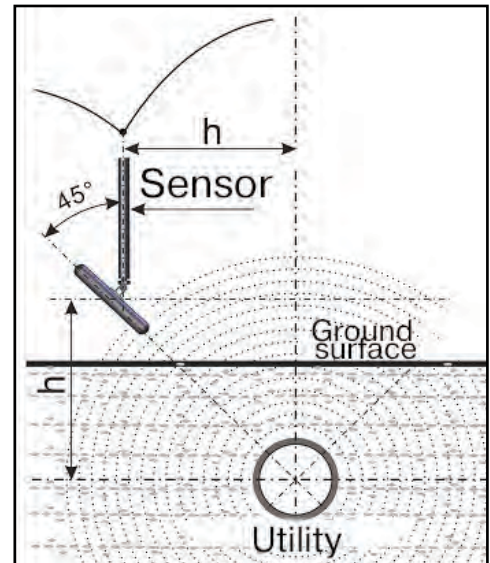


Fig.3.5

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

Equipment used: receiver AP-027M, 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. 3.6**). 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.

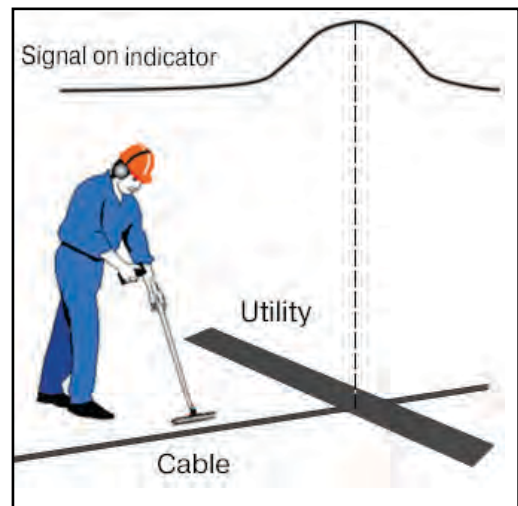


Fig.3.6

4. Transmitter AG-105

AUTONOMOUS • POWERFUL • PORTABLE • MEASURING

Device introductory information

4.1. Purpose of Use and Physical Configuration

The transmitter 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 **20 W**. 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 **7 W** in the continuous oscillation mode, the "life cycle" is approximately 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 a "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 are **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.

Transmitter AG-105 is the best-in-class of the "portable communication 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) location 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 **5 A**) 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 an intense electromagnetic field under relatively low energy consumption. There is the possibility of connecting the **external induction transmitting antenna** which produces intense emissions and provides immediate access to the “buried” utilities. An add-on **transmitting induction clamp** lets the induction of a current effectively into the specifically “chosen” utility from others nearby (inclusive of the one under voltage).

The transmitter AG-105 contains 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 and power supply voltage.**

In the case of a decrease in “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 the battery’s “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 «NPO TECHNO-AC» LLC.

The ingress protection rating of the casing is **IP65** which completely precludes any ingress of the dust or water jets when enclosed. 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)

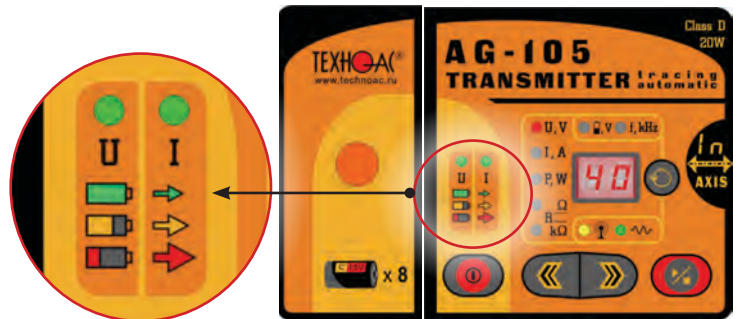
“**Electrical power supply field**” always displays rough estimates of the power supply. Source condition in the current mode operation using three coloured light emitting indicators.

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,V” 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”

(In accordance with the operator choice) shows the numerical values of the following parameters in the “Digital field”.

- 1) POWER SUPPLY VOLTAGE in volts “**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 “I”.

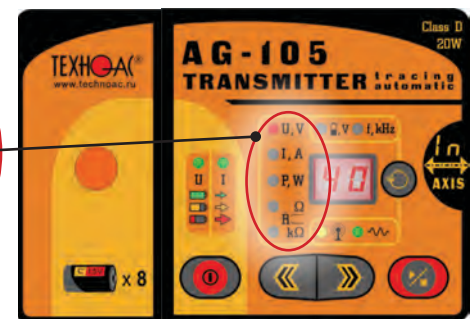
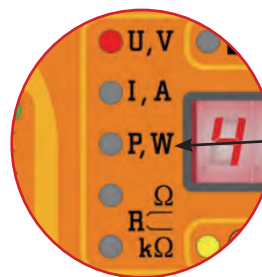
- 2) FREQUENCY of the generated signal in kilohertz “**f, kHz**”:

- 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” mode “In” 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).

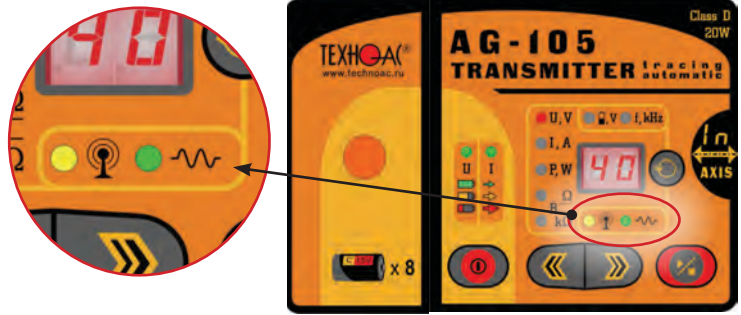
- **green** glow – no equipment is connected to the output, internal transmitting inductor is only operable “In”.

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:

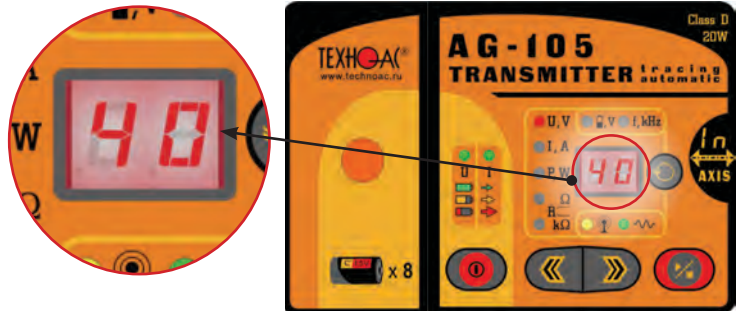
“In” - internal transmitting inducto.

“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.



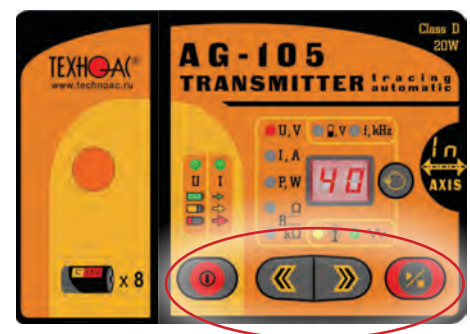
4.2.6 Control Buttons

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 external factors.

Five-pin connector “OUTPUT”

For output cable connection with clips, transmitting antenna or induction clamp.
As illustrated, the rubber cover is removed for making external sources possible.



4.4. Accessories



**Output cable
 («clips»)**

is designed for «contact» connection of the transmitter outlet to the communication 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 communication 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 communication under examination.



**Extra accessories, optional*

Transmitting induction “clamp”

CI-105 is designed for highly efficient induction of the trace current to particularly “allotted” communication or for “non-contact” connection to the communication 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

There are many features that help any untrained operator master the device within a short period of time: convenient and user-friendly control and indication units with explanations, the elementary control algorithm backed by automation (“intuitive interface”) and several protection levels from emergency modes.

The automatic adjustment allows the generation of 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, for example, the 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 provides the highest degree of efficiency among all the known circuit design concepts for the power amplifiers. Thanks to the aforementioned, 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 this, automatic adjustment load voltage incrementally increases 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 and power) is available via buttons LESS/ MORE “”.

Under power supply voltage decrease during oscillation, for example, batteries self-discharge, the signal output voltage is lowering proportionally (and consequently absorbed power) as the supply source “energy potential” reduces. This program system extends the battery’s “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 «NPO TECHNO-AC» LLC.

WARNING! ENERGY SAVING!

All operations with output voltage (current and 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 there is enough time to perform utility location. 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, given all other conditions remain 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.

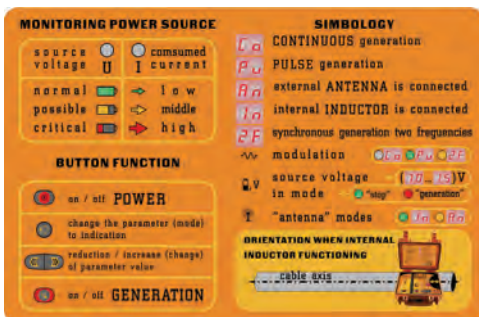
NOTE

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 ensure 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 the same condition.

If the batteries kit has undergone a 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 5 W).

4.6. Illustrative Use information about “Power Supply Monitoring”, “Buttons Functionality” and “Symbols”



On the inner side of the cover, there is information on the principles of the following information types, namely POWER SUPPLY MONITORING, BUTTONS FUNCTIONALITY AND SYMBOLS of the “Digital field” and the front side of the panel.

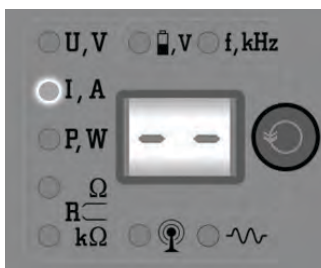
4.7. “Multimeter” of the Output Parameters

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 “**I, A**”. Minimum measured and indicated value – 0.05A “.05”, current is indicated in Amperes (A).

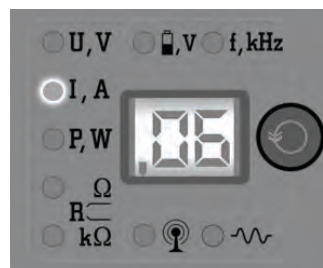
Examples:

>than 0 and <50mA



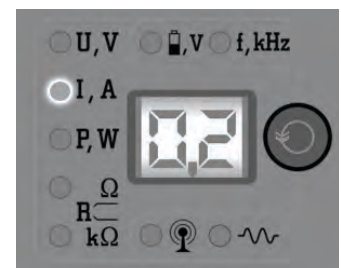
$I < 50 \text{ mA}$

than 50mA and less than 99mA



$I = 60 \text{ mA}$

more 99mA





$I = 0,2 \text{ A}$


- load power in watts “**P, W**”;
- load resistance in ohms or kilohms “**R, ($\Omega / k\Omega$)**”. 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 800 Ω . The parameter which value should be indicated in the “Digital field” is set by the “CHOICE” button “**CHOICE**” 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 activated by the device switching on via pressing POWER “” 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 “” 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.


WARNING! Do not touch terminals of output connection cables and elements of the utility being examined while the transmitter is on.






WARNING! Do not connect and disconnect connection cables while the transmitter is on.

WARNING! Do not connect and disconnect connection cables while the transmitter is on.

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.



5.1.3 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);

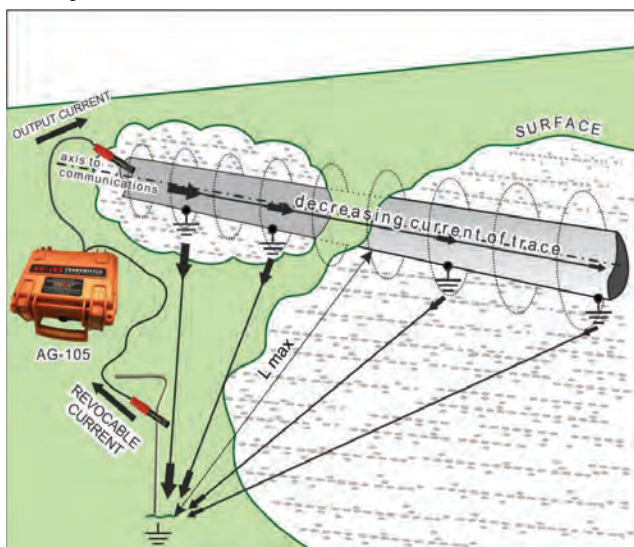
8.1.4 Connect the output of the device to the utility under examination via contact or non-contact (induction) method (in accordance with the chosen utility locating method). The contact method is more efficient for utility location but not always convenient and absolutely unsuitable for the location of cables 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, for example, 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. If the transmitter is connected directly to the utility, and current is not indicated (you see “- -” on the screen), make sure that there is current in the utility by checking it with receiver.

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.

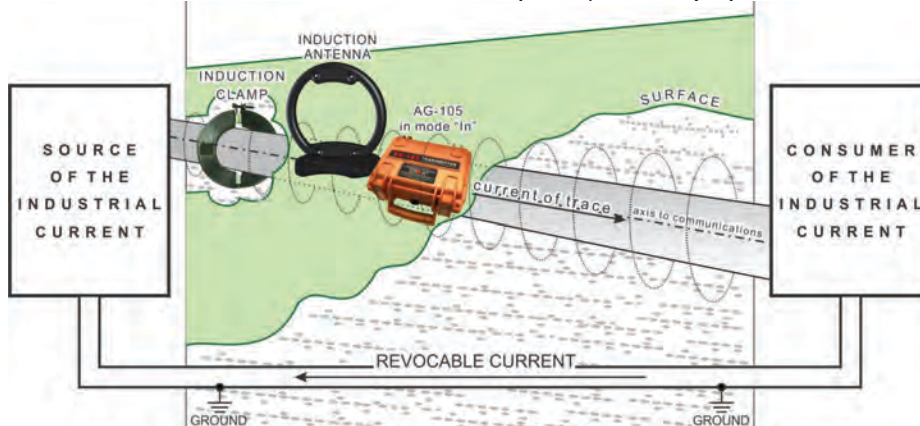
In this case, the resistance between the connection to the pipe and earthing point (rod or other standard earthing bus) is extremely low.

“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 5 A at the load less than 0.8Ω), it offers high

probability of the successful utility location at a considerable distance from the connection point.

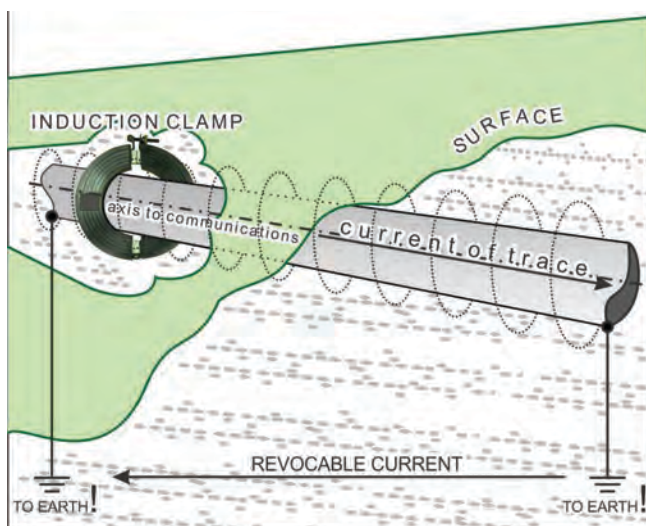
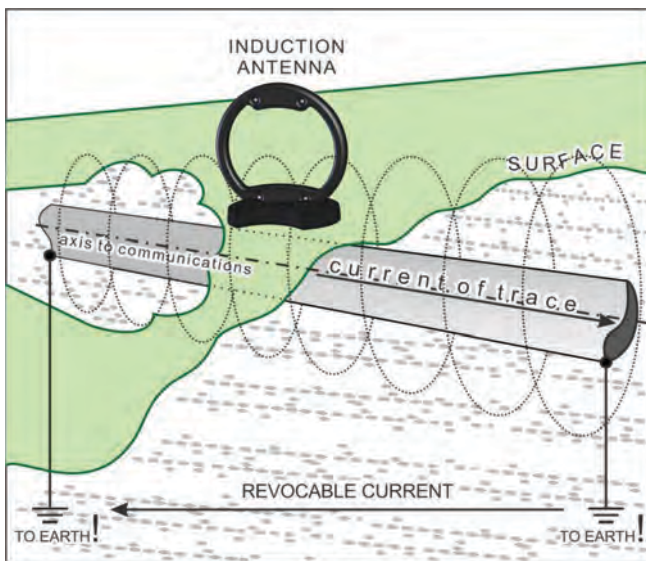
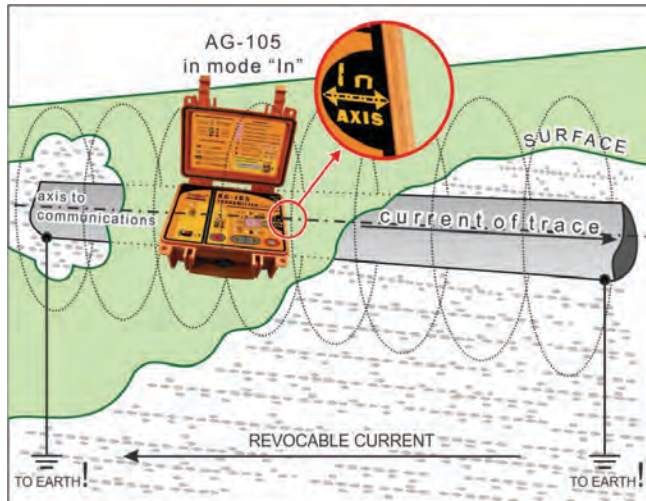
The diminishing of the signal at the distant pipeline sections is offset by the considerable “reserve” for the manual or automatic adjustment of the sensitivity of receivers made by NPO TECHNO-AC.

NOTE for “non-contact” connection methods (“In” / “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 location of a utility 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 location of the utility 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 communication and oriented parallel to its direction). The utility locator shouldn’t be used near to 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 communication and coplanar with it. The communication locator shouldn’t be used nearby the transmitting antenna in order to avoid the immediate induction connection (apart from the communication).

If the communication 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 communication 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” mode “In”.

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 “**0.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 “**O**” 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) “**0.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) “**~**” - active / non-active “MODULATION” and the type of the special signal form (should be chosen in the “Digital field” by MORE/ LESS “**◀▶**” 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 “**◀▶**” 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 location 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 communication 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, put 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 “**▶**” is initiated the automatic adjustment process with the “occasional” resistance load. Along with this, the output signal voltage incrementally increases up to the moment when the specific load current value is reached (or exceeded) (0.2 A at frequencies 512Hz “0.5” / 1024Hz “1.0” / “2F” or 0.1 A 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” \geq “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 power sources

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

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



In the case of the availability of two power sources at the same time – external and internal

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



5.6. 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 user should act accordingly.

NOTE

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

5.7. Ingress Protection Rating

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

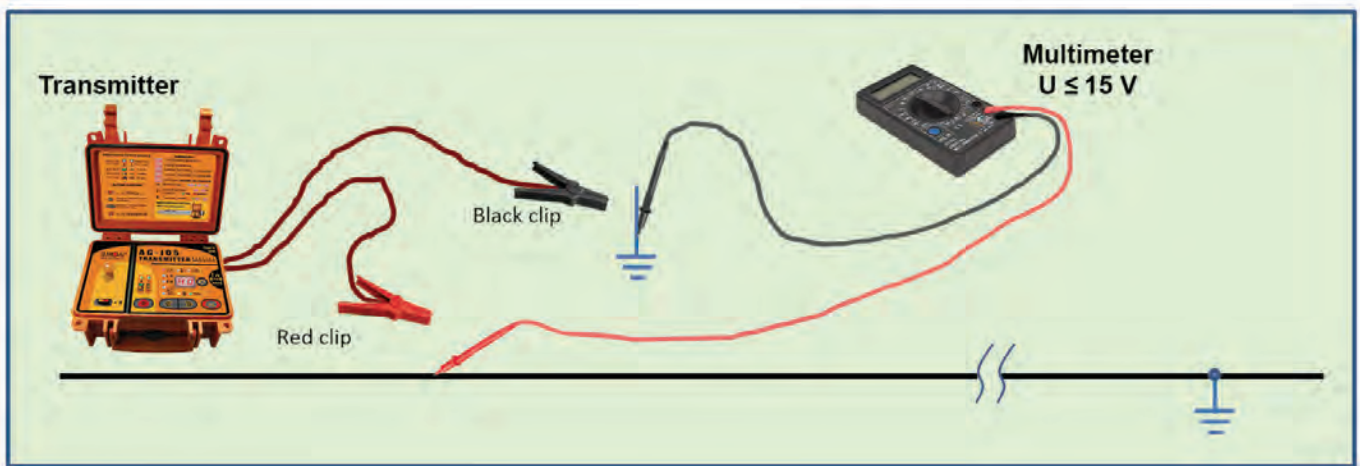
6. Transmitter Direct Connection to Utility

The direct connection of transmitter to the utility is used to create tracing current in de-energised conducting utilities.

Transmitter operation during direct connection requires additional safety precautions. Before connecting the transmitter directly to the utility do the following:

- 1) **Make sure that surveyed utility doesn't carry any voltage in relation to protective grounding or grounding rod, pushed into the ground.**
- 2) **Make sure that there is no high voltage source connected to the utility.**
- 3) **Make sure that there is no 15V voltage between transmitter cable connection points.**

Use the multimeter to check the voltage presence between connection points.



Attention!

Voltage between two points of transmitter cable connection can damage the transmitter!

Connection of the transmitter to utility under voltage, breaks the operation conditions and cancels manufacturer warranty!

If it is necessary to survey the cable under voltage, please, use inductive antenna or clamps for the transmitter in order to create tracing signal.

Appendix 1



Receiver AP-027M Technical specifications

Parameter	Tracing	Leak detection
Type of accepted signal	Uninterrupted /pulse	Uninterrupted signal
Frequencies of the receiver's filter	Central frequency of quasi-resonant filter 50..60 Hz, 100....450 Hz through 50 Hz, 120...540 Hz through 60 Hz, 512 Hz / 1024 Hz / 8192 Hz/ 33kHz	Range limitation "below" 0,1/0,15/0,21/0,31/0,45/0,65/0,95/1,38 kHz
	two-frequency mode 1024 Гц + 2048 Гц, 1024 Гц + 8192 Гц	Range limitation "above" 2,00/1,38/0,95/0,65/0,45/0,31/0,21/0,15kHz
«Broadband», (operating mode)	0,05 ...8,6 kHz	0,09...2,20 kHz / 0,03...0,50 kHz
Gain factor	100 dB	
Visual indication	Liquid-crystal display- symbols and meaning of the chosen modes and parameters. -animated (moving) scale of the output signal level - digital value and animated (moving) scale of the output signal level -graphic (moving diagram) of the output signal level - frequency content of the output signal level -digital and graphic display of output signal levels kept in the "memory".	
Sound indication	Headphones natural broadband or filtered signal	
	<u>Headphones-synthesized sound.</u> <u>Frequency modulation</u>	-
	<u>Built-in emitter - synthesized sound.</u> <u>Frequency modulation</u>	-
Supply	Voltage 4...7 V. - alkaline batteries AA type 1,5 V (4 pcs.).	
Time of continuous operation not less than	20 hours	
Ambient temperature, C	minus 20C...to +50C	
Ingress protection rating	IP54	
Receiver AP-027M dimensions	220 × 102 × 42 (mm)	
Weight of the electronic unit, kg	0,46 kg	

Appendix 2

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” mode	Internal transmitting inductor “In”.
“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	
<u>Output current, A</u>	
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”
<u>Maximum output voltage, V</u>	
Depending on “modulation”, ≥	32 – in the dual-frequency modulation mode “2F”
	40 – in other modes
<u>Maximum output power, W</u>	
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 “Bt”, <9 V “Ac”
	Maximum allowed voltage for operation – 15V .
	Automatic shutdown voltage in the “oscillation” mode: < 4,2V “Bt”, <7,9 V “Ac”
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” and “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 “Bt”, <8.8V “Ac”
	At power supply voltage in the “oscillation” mode < 4,2V “Bt”, <7.9V “Ac”
	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	Automatic , up to the reaching of the specific consumption rate or attainment of the load current: - ≥ 0,2A at frequencies 512Hz “0.5” / 1024Hz “1.0” / “2F”; - ≥ 0,1A at frequencies 8192Hz “8.2” and 32768Hz “33”.
	Manual (via buttons LESS / MORE “   ”) after the automatic adjustment.
Connection options to the communication under examination	“Contact” connection with “earth return”.
	“Non-contact” connection with application of 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 /k Ω).
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 3 Switching-on the receiver

1. Switching-on the receiver

When the receiver is switched on, the display shows the following sequence: manufacturer's trademark (logo) «TECHNO-AC», Business card of the Receiver with the Software version number and the Start window (fig.A.1).

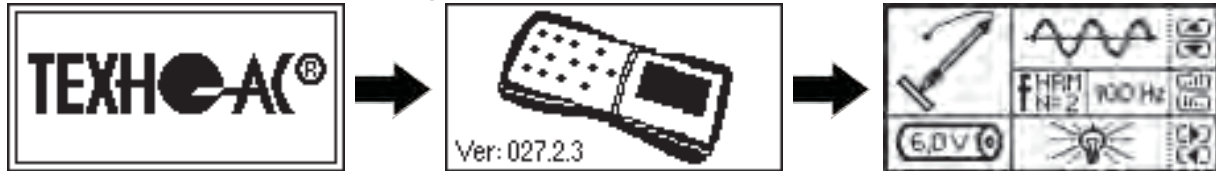


Fig. A.1

When switching the receiver with the button **f** while holding button **f**, after Business card Window of network frequency selection will appear. Frequency of 50 Hz or 60 Hz is selected by any of button **◀/▶**, and



«input» with transfer to Start window is performed by pressing the button again **f**.

2. The start window

The start window displays the following information:

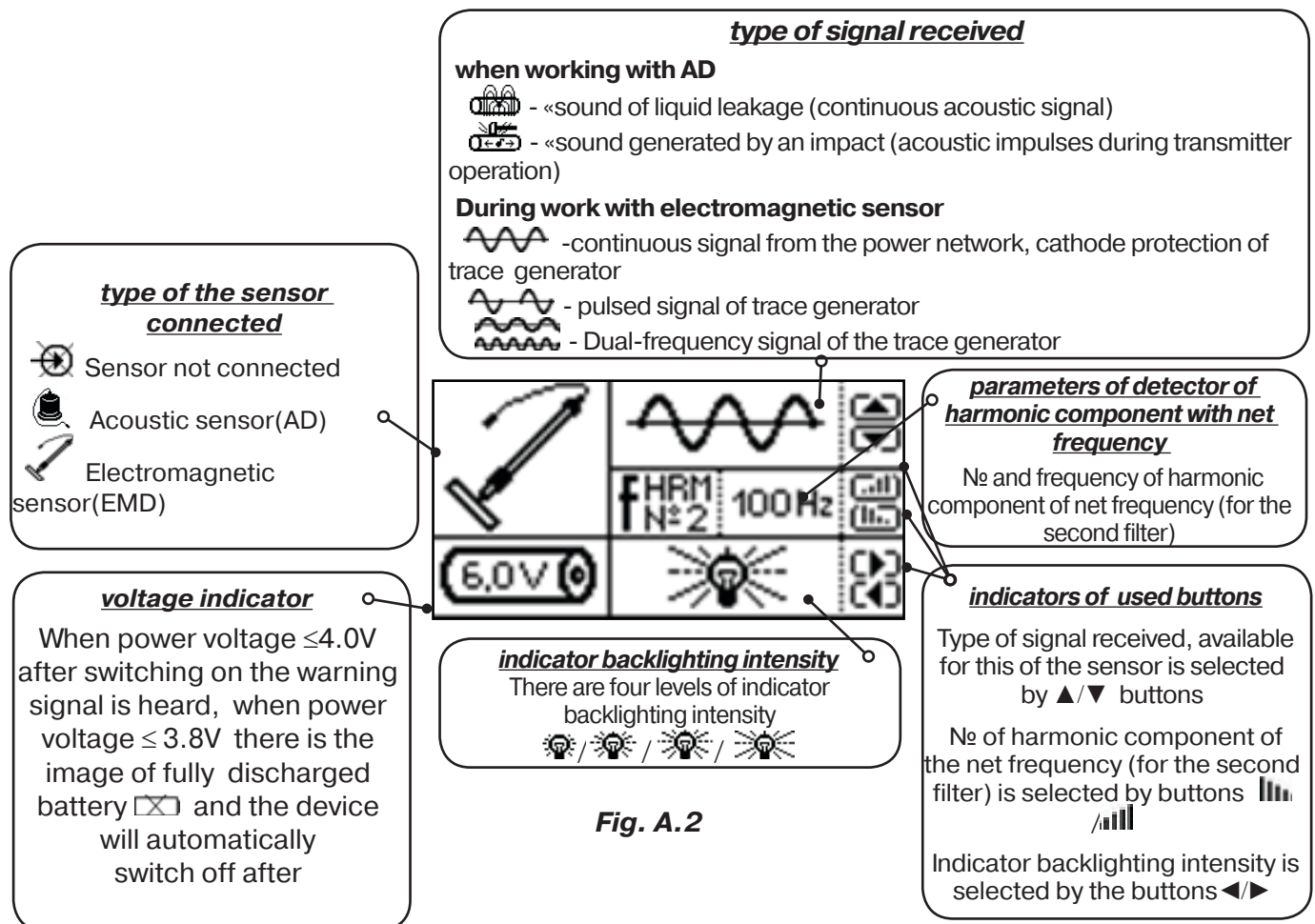


Fig. A.2

Return to the Start Window from measurement mode is performed by pressing **⏸** ((pause mode) and **f** .

3. Scale window

When measurement mode is selected (except the two-frequency), Scale working window appears first fig.A.3.

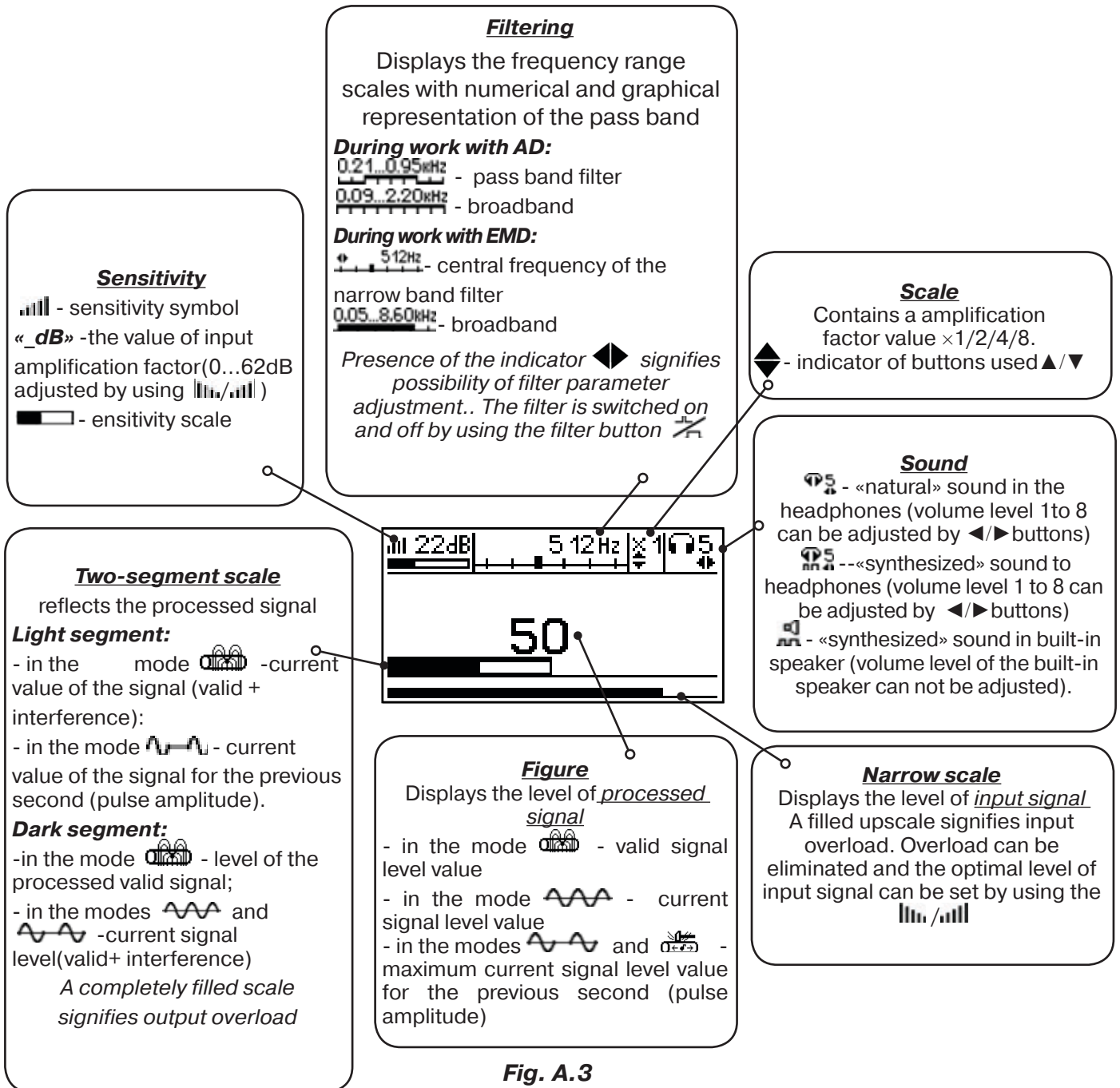






Fig. A.3

Visual indication button can lead to the indication modes of Graph (fig.A.4) and Acoustic signal spectrum(fig.A.5) or Power range spectrum (fig.A.6) and Broadband electromagnetic range (fig.A.7).


4. Graph window

The graph displays the changes in processed signal levels over time and moves at constant speed from right to left.

The graph
shows processed signal

- in mode  - change in the level of processed valid signal over time
- in modes ,  and  - change in the level of current signal value over time

Narrow scale

Displays the level of input signal. A filled upscale signifies input overload. Overload can be eliminated and the optimal level of input signal can be set by using the 

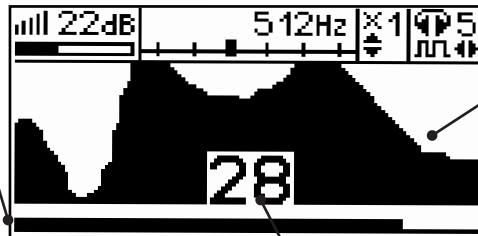






Fig. A.4

Figure
Displays the level of processed signal

- in the mode  valid value of the signal
- in the mode  - current value of the signal
- in the mode  and  maximum current value of the signal for the previous second (pulse amplitude)

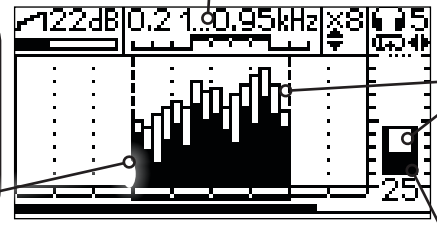
5. Acoustic signal spectrum window

«Spectrum Analyzer» is an auxiliary tool for signal visualization. It does not replace audio analysis and subjective evaluation by the operator. The mode is used when adjusting the band pass filter. The spectrum of the filtered signal is displayed on the screen. In broadband mode, the entire range of this mode is displayed. To adjust the filter, you need to exit the «broadband» mode.

At the same time, the window may look like this (axelerometer leakage, 0.21...0.95kHz):

Band pass of the filter on the figure - 0,21...0,95kHz. It is possible to switch over to adjusting the image scale at vertical by means of $\blacktriangle/\blacktriangledown$ and volume in headphones by $\blacktriangleleft/\blacktriangleright$. it is possible to switch over to adjusting the pass band and vice versa by means of $(f \rightarrow \blacktriangleleft/\blacktriangleright \rightarrow f)$.

dark segments correspond to the frequency components of valid («continuous») signal



light segments correspond to frequency components of accidental interference

Two-segment scale corresponds to the processed signal

Fig. A.5

«Bright segments» of the columns in the analyzer represent the maximum level of the signal in a certain frequency range for a certain period of time.

In leak detection mode, this is the level of brief! signal variations (“irrelevant” background noise).

In impact mode, this is the maximum level of the signal for 2 seconds! («useful» impact or “spark discharge”).




«Dark segments» of the columns in the analyzer display:

- the level of continuous «useful» component of the signal in leak detection mode;
- animation of changes in real time in impact mode.

Thus, bright segments are essential in impact mode and supplementary in leak detection mode, while dark segments are vice versa, essential in leak detection mode and supplementary in impact mode.

In the leak detection mode «» ():

Frequencies with the highest dark segments are likely to be «useful». Other frequencies (especially those with the highest bright segments) are recommended to be suppressed by a band pass filter. The final decision here is made by the operator based on subjective experience in recognizing various sounds of leaks.

By repeatedly pressing the button «**f**» (not in the «broadband» mode!), you change the mode to the lower range limitation mode of the band pass filter «» or upper range limitation mode «» or headphones volume regulation. Adjustments are made using the buttons «/».

In the acoustic pipe location mode (or cable spark discharge sound location) «» ():

Frequencies with the highest bright segments are likely to be spectral components of the sound of impacts (spark discharges). The rest (especially those with high but barely moving dark segments) are recommended to be suppressed. The final decision here is made by the operator based on subjective experience in recognizing various «impact» sounds.

6. Power range spectrum window

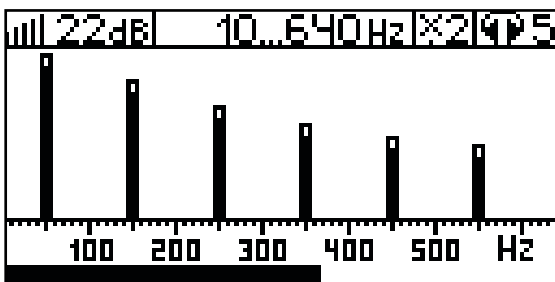



Fig. A.6

The window is available in the electromagnetic mode of broadband 0.05...8.60kHz and can be called for by the additional touch of a button . The display shows the industrial frequency spectrum of «10 ... 640 Hz». Maximum of emission spectrum of the power cable falls to 50/60 Hz.

Two-segment columns show the current and minimum values of the frequency components of the signal. Typically, the spectrum contains harmonic components

which are dependent on the form of voltage and current in the load. There can be often present strong odd harmonic components at frequencies of 150/180, 250/300 (Hz), etc.

7. Broadband electromagnetic spectrum window

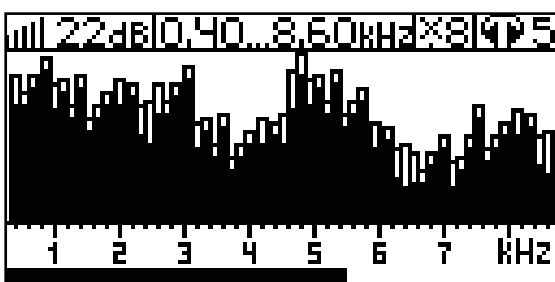

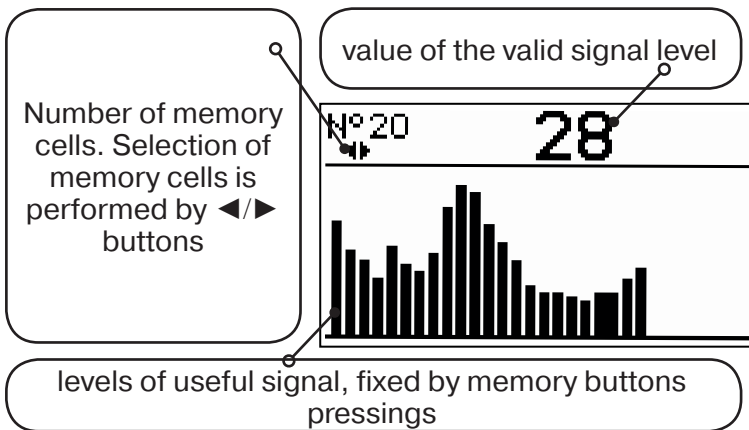



Fig. A.7

The window is available in the electromagnetic mode of broadband 0.05...8.60kHz and can be called for by pressing the button . The display shows the industrial frequency spectrum of «0.50...8.60 kHz».

Two-segment columns display the current and minimum values of the frequency components of the signal.

8. Memory window



The receiver has an ability to record/view 30 saved signal levels (fig.A.8). Output signal level values are recorded every time the memory button  pos. 6.fig.2.1 is pressed in the measurement mode.

The memory of the receiver provides 30 cells for filling, any subsequent record is the last one.






The review mode is called up by the memory button  .

Fig. A.8

In order to do that: turn off measurement mode by pressing  , the start/pause button , review memorized fields using $\blacktriangleleft/\blacktriangleright$ buttons.

Leaving Memory window for the previous measurement mode occurs by sequentially pressing memory button  and measurement  buttons.

When the receiver is powered off, the recorded data is not saved.

9. Audio indication


The sound is output to the headphones or the built-in sound transmitter. Three categories of sound are used:

- «Natural» without filtering (broadband) to the phones;
- «Natural» filtered (narrowband) to the phones;
- «Synthetic» (modulation of sound frequency by the level of the filtered signal) to the phones or to the built-in transmitter.

When working with AD only «natural» sound is used.

When working with EMD in the mode «natural sound to the phones» the adopted «high active» frequency 8192Hz and 33kHz, before playing, are converted into a well-acceptable «low» frequencies of 838Hz and 1574Hz respectively.

«Synthesized» sound is created by a principle: «Frequency of the audible sound signal (pitch) is directly proportional to the signal level,» and the volume does not depend on the level of the received signal. «Synthesized» sound is played while values «figure \geq 2».

The volume of the headphones  is set by the operator using buttons $\blacktriangleleft/\blacktriangleright$. Two pressings correspond to the one change of figure on the display «8 ... 1/1...8».

Volume of the «synthesized» sound on the built-in transmitter can not be regulated.

Appendix 4 Transmitter Indication

Battery holder
with the handle in the centre 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 utility 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" "In" and "MODULATION" "Pu" modes. If "earrings" or "clamp" are connected to the output, the indicator "In" not glowing. In "Antenna" mode, the indicator "In" is always glowing: **green** in case of internal antenna. In case of "regular" (not modulated) signal the indicator "Pu" is not glowing. In case of "MODULATION" (special form signal) the indicator "Pu" 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 EXAMPLE				
"nominal" power supply voltage	"low" absorbed current	pulse modulation mode "Pu"	"oscillation" operation mode	output voltage 40V
"U" green	"I" green	"Pu" green	red glowing "U, V"	"U, V" → "40"