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METAL AND NON-METAL PIPELINE LOCATOR WITH WATER LEAK DETECTION FUNCTION SUCCESS TPT-522 N

TECHNICAL DESCRIPTION
OPERATING INSTRUCTIONS

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Introduction

Metal and non-metal pipeline Locator with water leak detection function «Success TPT-522N»:

- non-metal pipeline location underground
- water leak detection from metal or non-metal pipelines underground up to 3 m depth
- water leak detection inside the house
- detection of cables underground up to 6 m depth
- detection of any metal pipelines underground up to 6 m depth
- survey the ground before the ground works (BB mode)
- distance of tracing from the place of transmitter connection is up to 3 km
- min and max method of tracing
- indirect measurement of the depth

Kit components are:

1 – Receiver AP-027
2 – Transmitter AG-144.1
3 – Acoustic sensor AD-227
4 – Electromagnetic sensor EMD-247
5 – Headphones
6 – Inductive antenna IEM - 301.3
7 – Impact device UM - 112

1 – Acoustic sensor AD-227
2 – Magnet for AD-227
3 – Contact rod for AD-227, (70 mm)
4 – Contact rod for AD-227, (150 mm)
5 – Carrying rod for AD-227
6 – Extention carrying rod for AD-227
7 – Allen key, 2 pcs
8 – Key (attached to cable)
9 – Handle

Operation conditions

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

1. Components and Operating Principle

Cable route and leak detector «***Success TPT-522N***» is a multi-purpose, integrated, multifunctional set. Functionally, the set joins three devices:

1. Route detector with the electromagnetic sensor;
2. Route detector with the acoustic sensor;
3. Leak detector with the acoustic sensor.

The set consists of the transmitter providing for electromagnetic field radiation and generation of impact (audio) pulses in the utility under examination (when using the impact device), and the receiver with electromagnetic and acoustic sensors.

Transmitter AG-144.1 is intended for electromagnetic and acoustic methods of underground utilities detection.

The maximum transmitter power in sinusoidal mode is 180 W.

Using the transmitter enables the following:

- Route location of utilities by electromagnetic (cables, metal pipelines) and acoustic methods (metal and NON-METAL pipelines).
- Conduct gas pipeline diagnostics and locate breaks in protective cable covering

The transmitter can be connected to the load either directly (with connecting wires) or with the use of the inductive antenna or inductive clamp providing for noncontact (inductive) connection of the utility under examination.

Use of the inductive antenna as a load is only possible at the 8192 Hz frequency (selected automatically at antenna connection).

The electromagnetic sensor connected to the receiver converts the electromagnetic signal into the electric one. The electric signal is delivered to the receiver where it is amplified and filtered. According to the signal in headphones and LCD-indicator, the operator determines the route location.

In the route location mode, the receiver is also able of receiving a signal from industrial frequency radiation sources (50/60 Hz) and cathode protection systems (100/120 Hz).

The leak detector consists of the acoustic pre-amplifying converter and receiver where the received signal is subject to amplification and filtering. Noise of a hole through the ground is perceived by the converter, amplified in the pre-amplifier and fed to the receiver. The receiver filters the hole noise of unwanted sounds, amplifies the signal and forwards it to headphones and indicator. According to the maximum signal or specific hole noise, the operator determines the leak location.

2. Receiver AP-027

2.1 Appearance and Controls

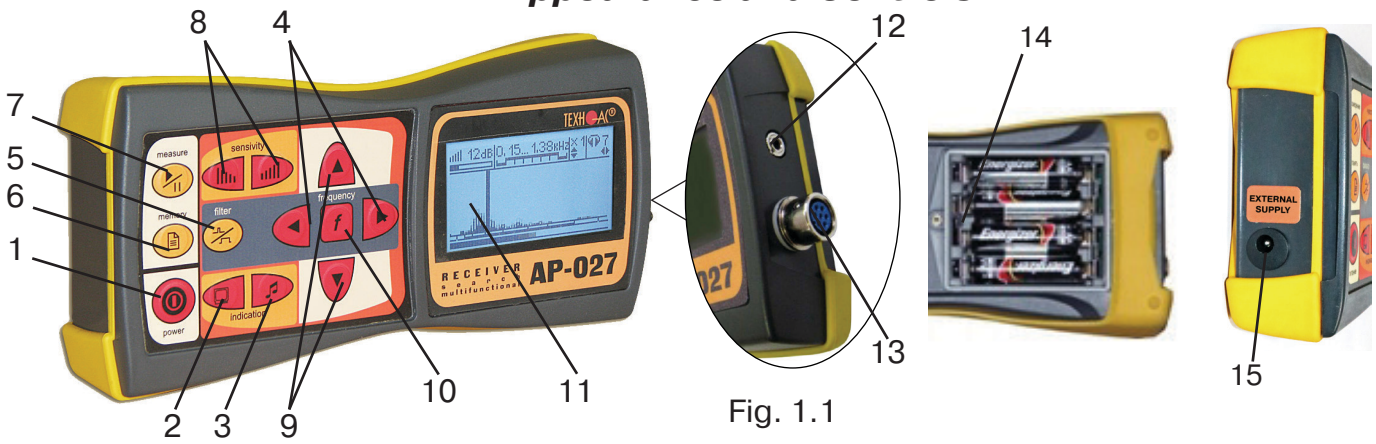


Fig. 1.1

1	⏻	power on/off button	9	▲/▼	selected parameter adjustment buttons (up/down)
2	▭	visual indication type button	10	*f*	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-027 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-027 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 cab 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-027 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

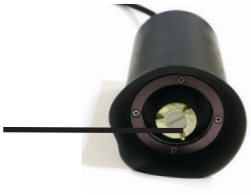
It is recommended to adjust the length of the neck strap for more comfort during operation.

3. Acoustic sensor AD-227

3.1. Set content of acoustic sensor

1 – Acoustic sensor AD-227
2 – Magnet for AD-227
3 – Contact rod for AD-227, (70 mm)
4 – Contact rod for AD-227, (150 mm)
5 – Carrying rod for AD-227
6 – Extention carrying rod for AD-227
7 – Allen key, 2 pcs
8 – Key (attached to cable)
9 – Handle

threaded hole plug



Acoustic sensor AD-227 is made with threaded holes for installation of removable rods (magnet pos.2, rods pos.3 and pos.4) and extension handle pos.5. The set of sensor includes plastic plug-screws (for protection of threaded holes from dust and water) and a key (pos.8).

While working with acoustic sensor without removable elements for handling, use the handle on sensor cable to position the sensor (pos.9) .

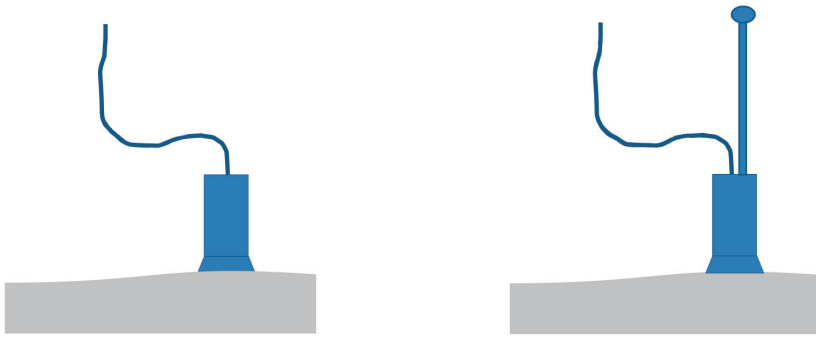
Using of magnet allows to attach the acoustic sensor to metal pipes and isolation valves. While preparing the sensor for the operation with removable handle and (or) rods, these plugs should be removed. After finishing the location the accessories should be removed and the plugs should be placed back.

3.2. Structural and operation features of acoustic sensor

Sensitive element of acoustic sensor is placed on steel sensing base (later on – base). The base is hanging at snap diaphragm made of sound-proof rubber and protected from external noise with safety cuff. Overall design of the sensor reduces the distortion of external noise and prevents mechanical damage of body.

Best protection from external noise is provided when cuff is placed fully on ground surface. (also when using rods).

When working with sensor, the cuff is placed fully against the surface, and the base of sensor should touch the ground surface.

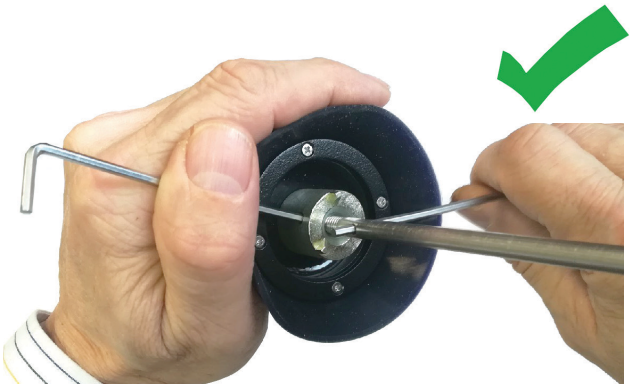


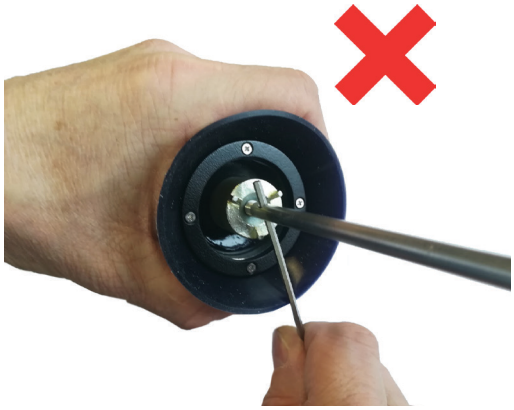
While working with sensor, please, make sure you are not pressing it too hard. The sensitive base may strike of vertical movement mechanical stopper. It may cause the unwanted noise in headphones and distorted signal. The distortion of signal may happen when sensitive base is placed incorrectly due to roughness of ground surface. When placing the sensor, choose as flat surface as possible.

When working on soft soil or in high grass or snow, use removable rods.

The rods are installed and removed manually. If necessary Allen keys (supplied) can be used to install and remove the rods. (one key is put into the hole of the rod, the second – into the hole in the base of sensor to prevent cranking of the base and damaging of the sensor)

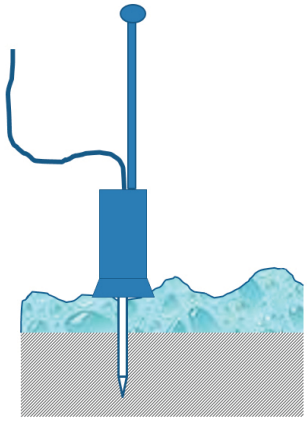
WARNING! Using one key to install the rod is prohibited!



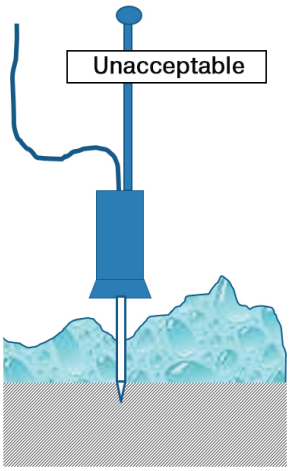


When using the rods, please, make sure that protective cuff fully touches the surface of the ground. This helps to exclude the influence of unwanted noise. (Pic. 3.1).

If it is impossible to place the cuff so it fully touched the ground, provide as much silence as possible. (Pic.3.2).



Pic. 3.1



Pic. 3.2

Indicated useful signal level fully depends on the position of the sensor. Comparison of signal levels can be done only when the sensor is placed in multiple points at similar conditions.. Moreover, the signal level in each point should be measured several times and average value should be considered as true.

Some elements of sensor are made of rubber, that is why it is restricted to clean the sensor with sharp tools. It is also restricted to bash the sensor over hard surfaces in order to clean it off the dirt. In order to clean the sensor rinse some water on it.

4. Operation sequence in liquids leak detection mode

Equipment used:

Receiver AP 027 | *Acoustic sensor AD-227* | *Headphones*

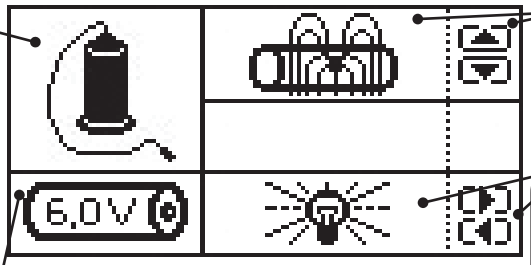
Fig. 4.1

4.1 Connection of sensors and check the receiver operability

1. Connect acoustic sensor and headphones to the corresponding receiver connections

2. Turn on the Receiver AP-027

3. In the start window on the receiver display:



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

Select the received signal type «leak» by any of ▲/▼buttons

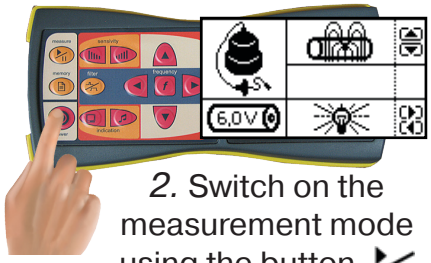
Set the necessary level of receiver display backlighting, using ◄/► buttons

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

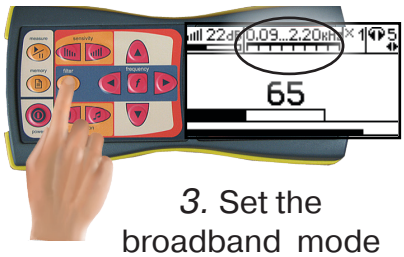
CAUTION!!
During leak detection works one should have a detailed diagram of underground utilities. If there is no diagram, a preliminary pipeline route location should be conducted. The level of valid signal and signal interference depends on the accuracy of acoustic sensor placement over the pipeline axis.

4.2 Preliminary route inspection

1. Place the acoustic sensor over the supposed pipeline location

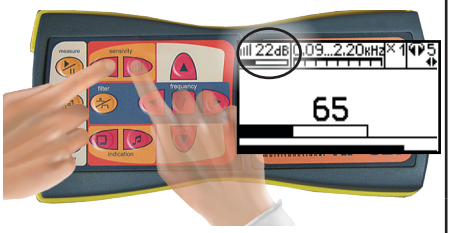


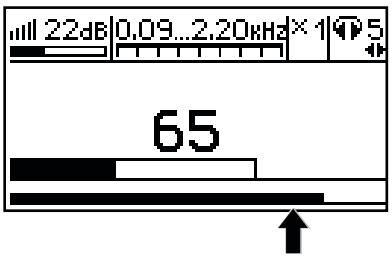
2. Switch on the measurement mode using the button



3. Set the broadband mode 0.09...2.20кНz, by pressing the filter button.

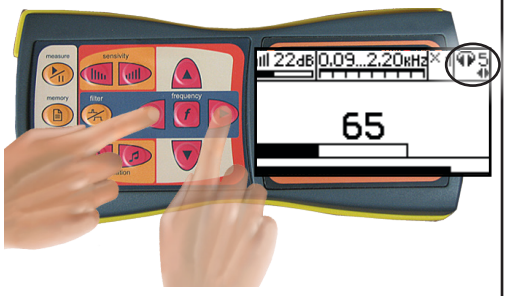
4. Set input signal level using sensitivity buttons и



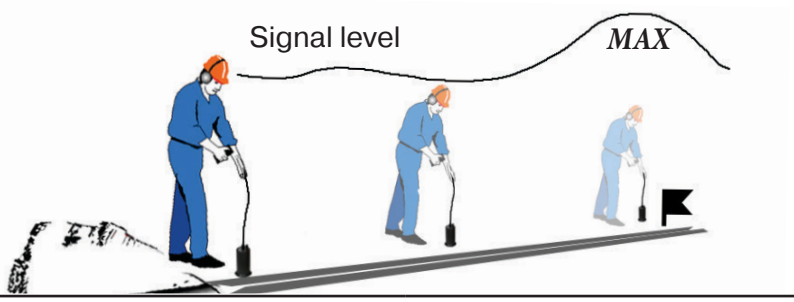


Narrow scale indicator readings should be preferably at 50...90% of maximum value

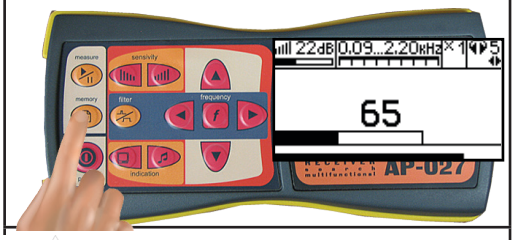
5. Set the headphones to required volume using buttons ◄/►



6. As you move along the route, move the acoustic sensor in increments of approx.1 m. and place markers in the spots where the signal level is the highest

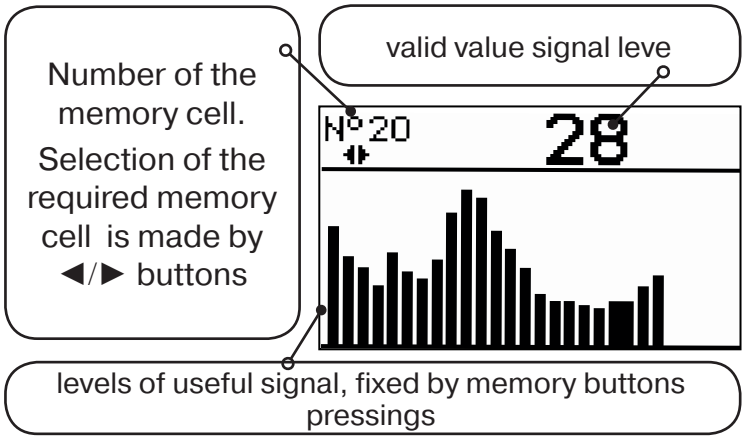


7. We recommend you to record the points where signal level is the highest into the memory of the device by pressing the memory button

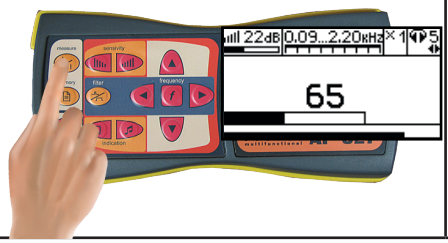
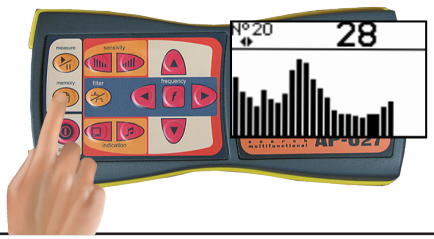
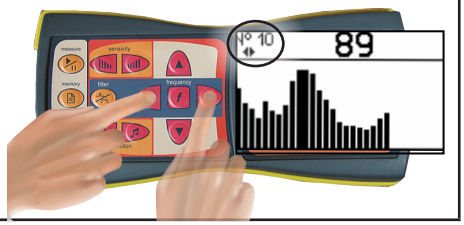


The receiver has an ability to record/view 30 saved signal levels Output signal level values are recorded every time by pressing the memory button

7.1. Browse the saved memory (Appendix B), select the areas with the highest signal and search for leaks in the marked spots If on the extraneous background sounds you can hear the distinctive sound of the leak, ***set the filter (p.4.3)***. If not - move the sensor to another proposed location



In order to enter the review mode:

1. Turn off measurement mode by pressing	***2.*** Press the memory button	***3.*** Review memorized fields using the ◄/► buttons
		

In order to leave memory mode press button - you enter the launch window, and then to return to the measurement mode press «start»

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

NOTES:

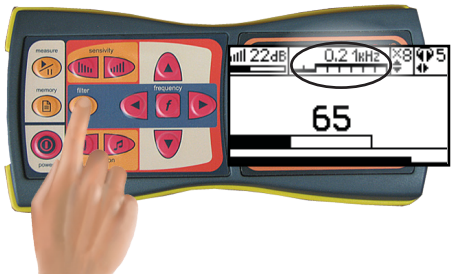
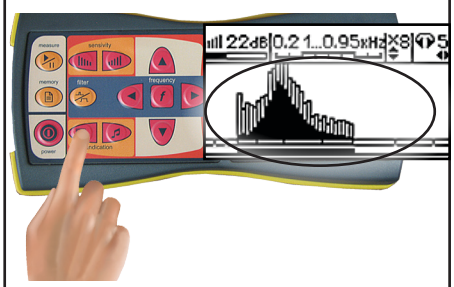
- It is recommended to turn off the measurement mode by pressing the button before moving the sensor, in order to save the receiver settings and eliminate unpleasant noise in the headphones.

- During leak detection it is not recommended to move the sensor and use the memory functionary earlier than 10 seconds after placing the sensor on the ground and turning on the measurement mode

- Do not change control settings as you move along the route, in order to save the relative value of signal level.

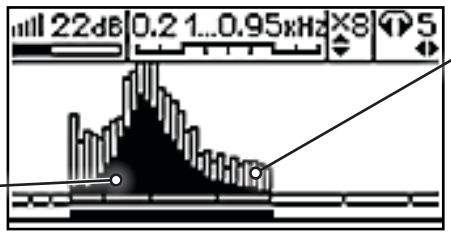
4.3 Conduct fine tuning of receiver filter

General principle of the filter setting is the gradual narrowing of band pass in order to isolate the sound of leakage and maximum suppression of all other sounds.

1. Place the acoustic sensor over the suspected leak point and commence filter setup.	*2.* On hearing a sound like the sound of fluid leakage turn on the band pass filter by the button	*3.* Switch to Spectrum window by pressing visual indication type button twice
 *Suspected leak point*		

4. Conduct an analysis of the generated spectrum

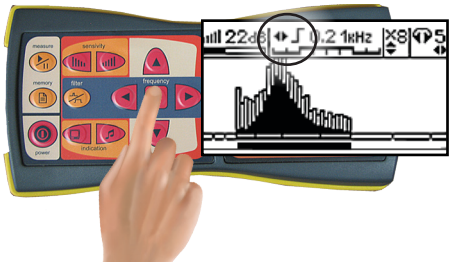
dark segments correspond to the frequency components of valid (continuous) signal



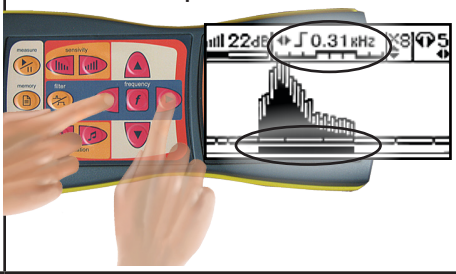
light to the frequency components of accidental interference

Frequencies where light segments prevail over the dark ones, are the most likely the interference frequencies that should be suppressed by pass band filter

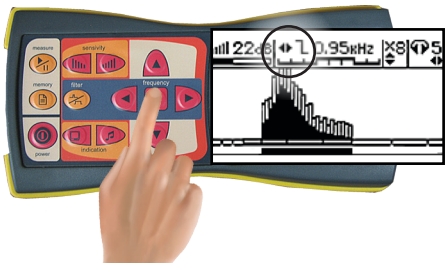
5. Turn on the filter by pressing the frequency button **f**. A symbol of low frequencies suppressing will appear on the display



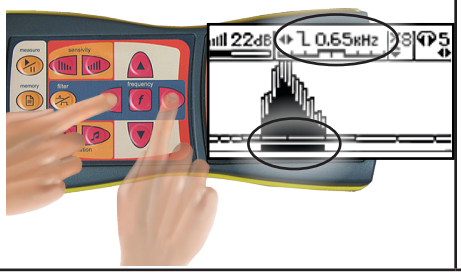
6. Using the buttons ◄/► increase the frequency of the lower «cut-off» 0.2 1kHz as long as it is not detrimental to the intelligibility of the sound in the headphones



7. Press the frequency button **f**. A symbol of higher frequencies will appear on the display

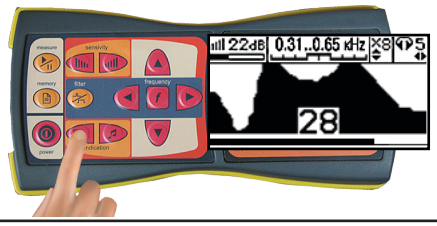


8. Using the buttons ◄/► decrease the frequency of the «cut-off» 0.95kHz as long as it is not detrimental to the intelligibility of the sound in the headphones.



9. Check the filtered signal quality shown in the Spectrum graph ***(see p. 4)***. Highest number of black stripes (valid signal) and lowest number of light stripes (interference) signifies correct choice of filter

10. Switch to Scale mode by pressing visual indication button . Without changing the settings, examine the suspected leak area ***as described above in sections 3.2 paragraphs 5-8***



Leak point usually corresponds to a point where valid signal level is the highest.(fig.4.2).

If the same intensity of the signal level is observed at a distance of 2 to 5 m, then the leak point is located in the middle of such a segment.

11. Mark the suspected leak location.

12. Turn off the device

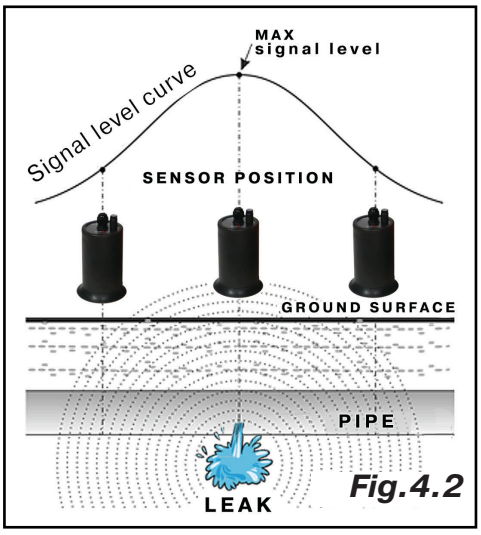


Fig.4.2

5. Operation sequence in passive cable route detection mode

Used equipment:

receiver AP-027 | *electromagnetic sensor EMD-247* | *headphones*

Fig. 5.1

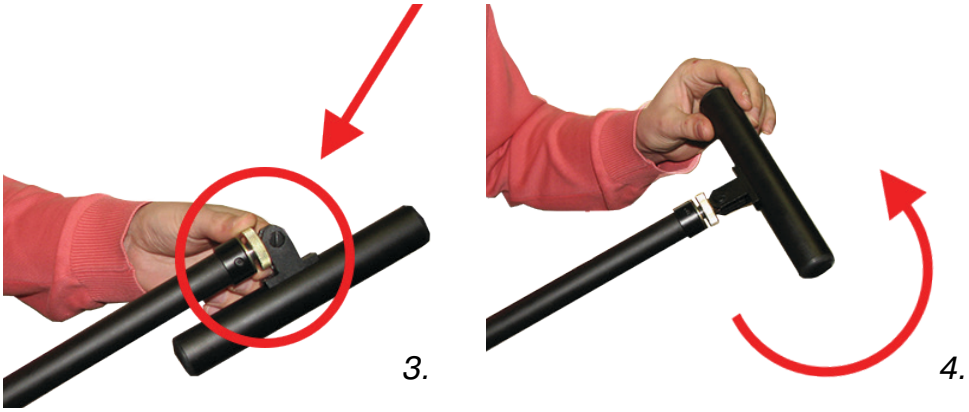
5.1 Connection of sensors and check of the receiver operability

1. Connect the electromagnetic sensor and headphones to the corresponding receiver connections headphones (if necessary)

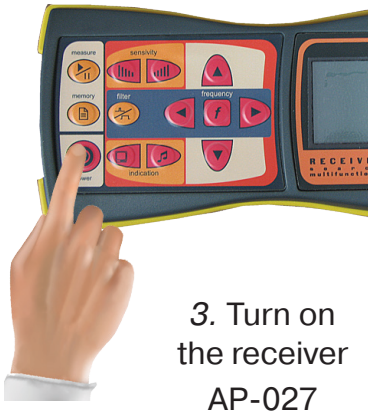
2.1 To set the electromagnetic sensor from transport to operating position. In order to do that: loosen the locking nut (1), extend the bar (2) to a required length and fix with the locking nut

1. *2.*

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



3. *4.*



3. Turn on the receiver AP-027

4. In the start window of the receiver display:

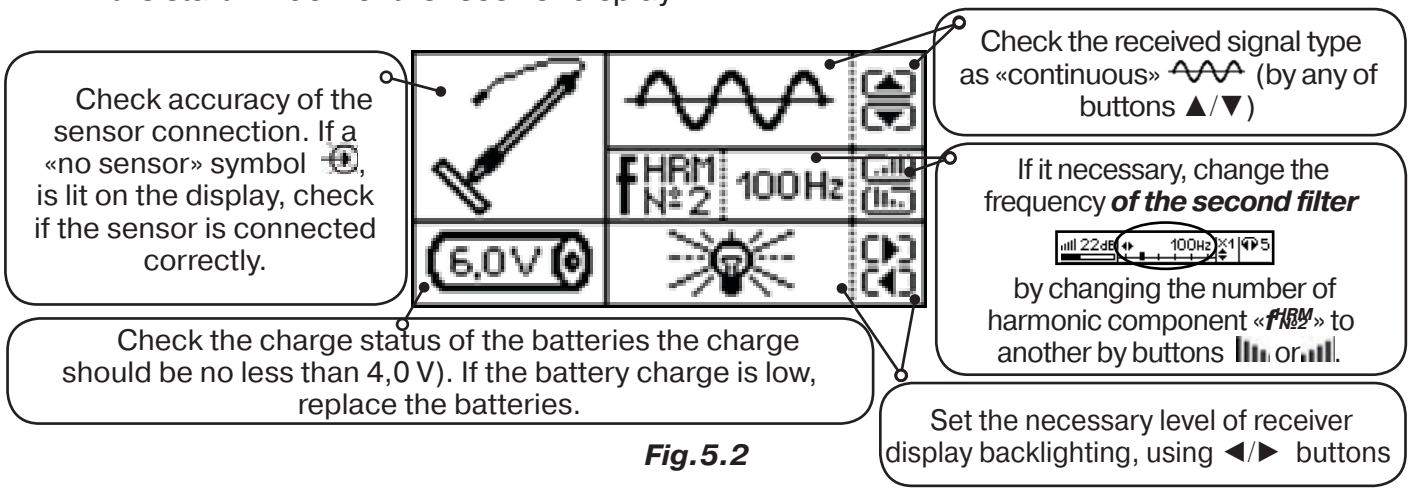
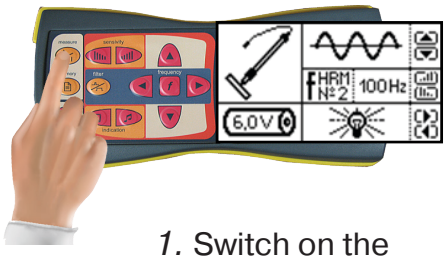
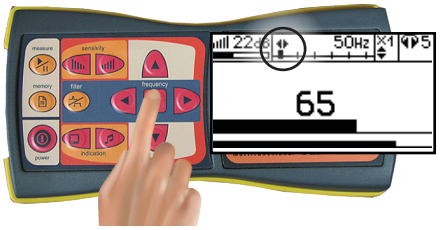


Fig.5.2

5.2 Conduct receiver setup

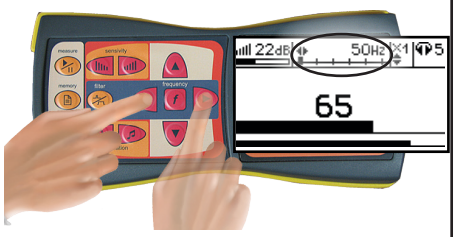


1. Switch on the measurement mode using the button

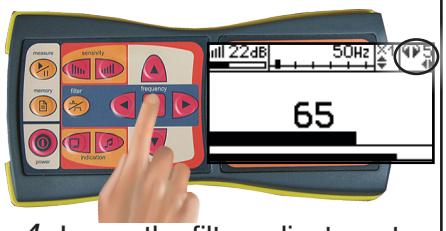


2. To select the necessary frequency press the frequency button **f**. symbol will appear ◆

For tracing of energized cables please set frequency 50 Hz.

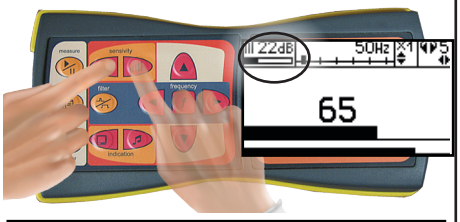


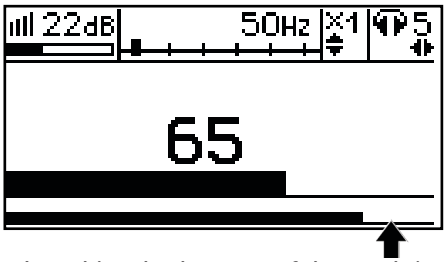
3. Using buttons ◄/►, set the desired frequency in the filtration zone for example, 50 Hz



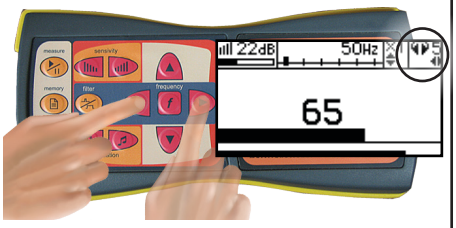
4. Leave the filter adjustment mode by pressing the frequency button **f**. Indicator ◆ will appear in the volume adjustment zone

5. Set input signal level using sensitivity buttons and



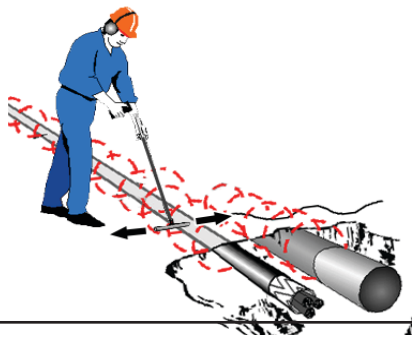


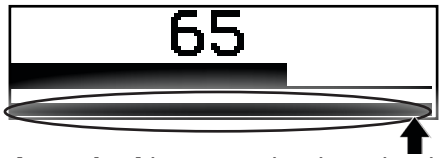
Level (at the bottom of the scale) must be within 50 ... 90% of the maximum



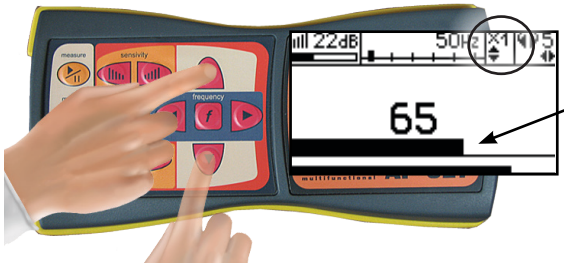
6. Set an acceptable volume level volume using ◄/► buttons

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.





Attention! *input overload can lead to the wrong interpretation of data*



8. Set the required gain factor of filtered signal to «×1/2/4/8», by pressing buttons ▲/▼

9. Commence detection or tracing according to the method set in ***p.4.3****, avoiding prolonged input/output overloads*

5.3 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.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.

The Maximum method

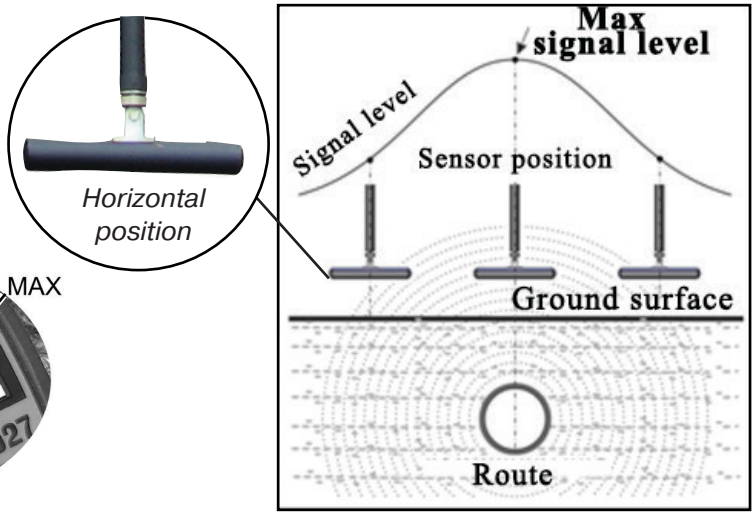
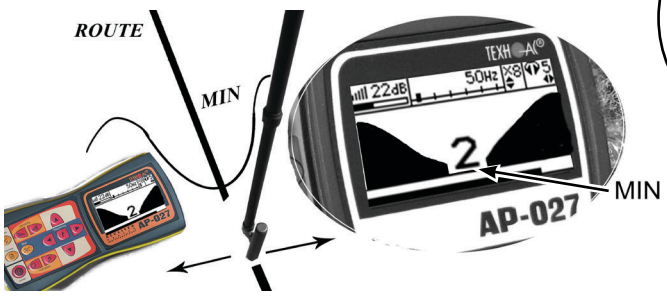


Fig. 5.3

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.



The Minimum method

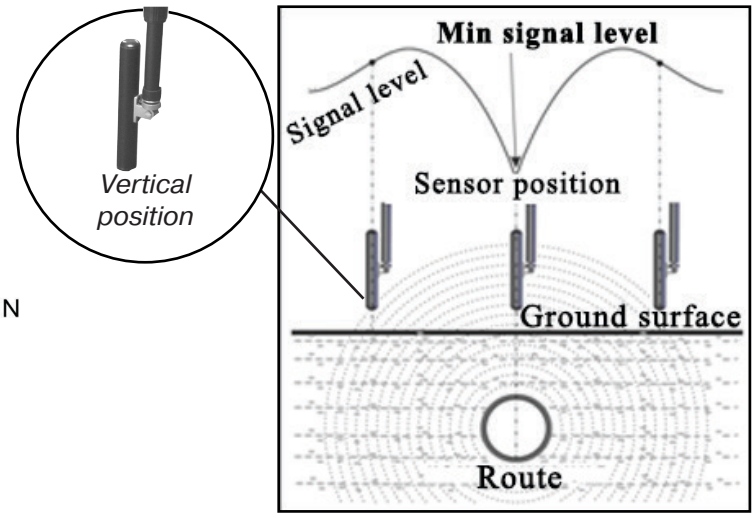


Fig. 5.4

6. Transmitter AG-144.1

6.1 Appearance. Controls

Fig. 6.1

1	Source (transmission, charging) switch
2	Internal source voltage selector switch
3	Selector switch of external source power delivery method
4	Selector switch of transmission modes «sin»
5	Selector switch of transmitted signal frequencies
6	Source status and charging process indicator
7	Output status indicator
8	«Dangerous» mode field
9	Plug sealing the external source connector (open)
10	External source connector
11	Output connector for connecting the utility, inductive antenna or clamp (the sealing plug is closed)

6.2 Transmitter Operating Procedure

Transmitter AG-144.1 transmits sinusoidal current for electromagnetic method of route location, either continuously or as short trains, for route location of cables and metal pipelines, or impact device control pulses for acoustic route detection.

High output current of the sine signal (up to 10 A) allows route location of extremely «low-resistance» utilities (for example, let the output current between «earthed» pipeline and earth loop bus). High output voltage (more than 330 V) and large power margin (up to 180 W) allow obtaining the sufficient route location current in long-distance «high-resistance» utilities.

Three sinusoidal transmission modes are provided:

- pulsed;
- continuous;
- three-frequency.

The selected power values are output automatically and are equal to the following values in autonomous mode: 7,5/15/30/60 W – CONTINUOUSLY, or 15/30/60/120 W - PULSES. Low power provides for energy saving and low «induction» towards adjacent objects, high power provides for long distance of signal translation and detection.

Resonant transmitting antenna (a shunt circuit) produces rather powerful radiation at relatively low energy consumption.

Several stages of protection against various impressible factors ensure high reliability.

«By default» increase of output voltage is limited **at the level safe for man** (24 V). When required (for cable route location), the limitation can be cancelled in on-line mode (temporarily till the session end), provided that relevant safety measures have been taken. Potentially «hazardous» unlimited mode of transmission is displayed as a special «warning» indicator « ⚠ ».

SAFETY REQUIREMENTS

There may be dangerous voltage (24 to 400 V) at the transmitter output (including terminals). The route location method is based on grounding one of the transmitter output terminals.

WARNING! Output port and leads of transmitter may carry dangerous voltage (more than 330V). The route detection procedure is based on the grounding of one of the transmitter output clamps.

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

Persons who have taken briefing and are physically qualified are allowed for handling the instrument.

Transmitter operation mode ensuring personnel safety at connection to the route:

-make sure that no works are carried out or planned along or near the utility being examined, which may cause intentional or unintentional touching the alive current-carrying part;

- make sure that the transmitter is off;
- earth the cable conductions which is opposite to the transmitter connection end and hang out the table «Earthed» («High voltage»);
- if the first three conditions are infeasible, use contactless connection by means of the inductive antenna or inductive clamp;
- make sure that the instrument cannot be unintentionally switched on by another person during connection of the output cable;
- connect the output cable terminal to the utility being examined (cable cord, pipeline, communication cable);
- connect the second output cable terminal to earth, cable armature, or to the grounded pin;
- connect the output cable terminal to the output jack of the de-energized transmitter;
- if there are other people near current-carrying parts, warn them about power supply saying «Power on».

Transmitter operation mode ensuring personnel safety at disconnection from the route:

-switch the transmitter off;

- disconnect the output cable from the transmitter, then close the connector with a rubber plug;

-repair works (digging the cable out, sleeve mounting, etc.) are allowed only AFTER the transmitter is off and disconnected from the utility.

6.3 Transmitter Connection

6.3.1 Contact method of transmitter connection

This method provides for interference-free signal transmission and allows using low frequencies.

Connection to utilities is carried out through attachment of the transmitter output connector to the utility and ground pin (Fig. 6.2).

Fig.6.2

Attachment is carried out at any appropriate place, the attachment point shall be cleaned from dirt with a file or abrasive paper till the metal can be seen. It provides for more reliable electrical contact of the terminal and utility.

Earth contact mounting:

- To obtain maximum route location distance at transmitter connection to the utility, place the earth contact at an angle approaching 90°and at **a maximum** distance from the route towards the supposed detection direction.

- Bury the earth pin to the height of not less than 2/3.

- To obtain the highest efficiency from grounding, do the following at the place of grounding pin mounting: strip contacts at the point of contact wire connection to the pin, ram the soil, moisten the soil using salt solution.

Methods of transmitter connection to the utility

Follow the below rules to ensure the proper detection of route location:

The longest range at route location is provided by direct connection of the transmitter to the load.

There are several methods for route location of an underground cable or a pipeline at direct connection to the utility:

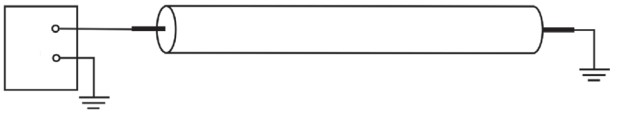


Fig.6.3

1) return conductor – ground (Fig. 5.3)

For this purpose connect the transmitter to one cable end and ground the other cable end.

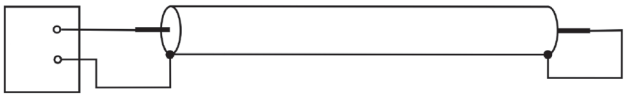


Fig.6.4

2) return conductor – cable armature (Fig. 5.4)

Using this method, connect the transmitter to cable ends, join other cable ends.

3) return conductor – cable cord (Fig. 5.5)

Using this route location method, connect the transmitter to two cords from one cable end and join cords from the other end.

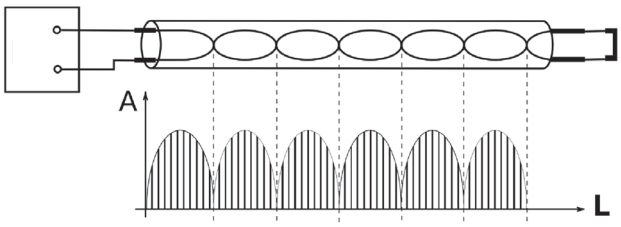


Fig.6.5

6.3.2 Contactless method with the use of - inductive antenna IEM-301.3

Fig.6.6

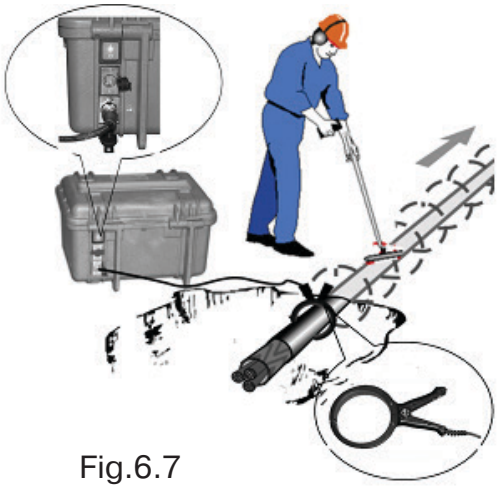


Fig.6.7

Connection to the utility is performed in inductive way. To this end, take the antenna from the package and insert the antenna active part into the base body. Connect the antenna to the transmitter output connector and install it above the place of supposed route location so that the antenna and the route are in the same plane (Fig. 6.6).

6.3.3 Contactless method with the use of inductive clamp.

This method allows route location of utilities, loaded and unloaded cables. Clamp must be closed around the conductor subject to route location (Fig. 6.7).

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.

6.4 Powering on the transmitter

Connect onnect the load to the socket on the transmitter back panel in accordance with the method of transmitter connection to the route (see section 1.3). The load may be the route being detected (pipeline, cable), induction antenna or inductive clamp.

In order to ensure safety, it is strongly recommended to complete all connection work before transmission is commenced.

Turn on the power supply by positioning the power on switch (Pt. 1 Fig 6.8) into one of the «I» positions, depending on selected power. If the «Power» indicator (Pt. 6 Fig 6.8) glows yellow, charge the internal batteries; if it glows green, you may commence the work.

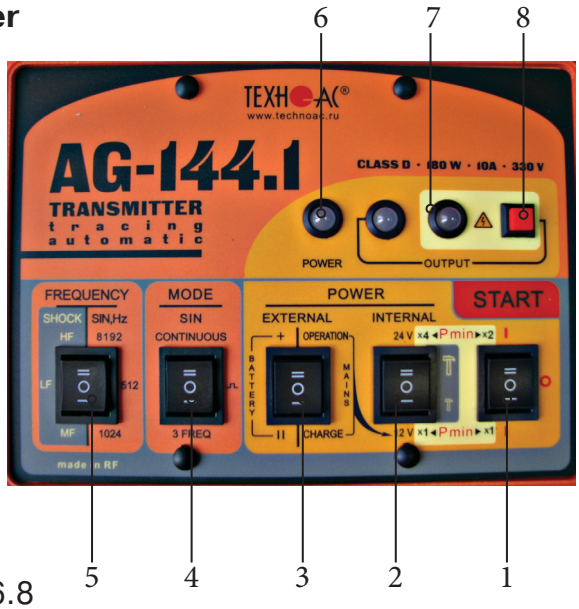


Fig.6.8

6.5 Transmitter parameter setting

6.5.1 Open the cover. Using selector switch «FREQ» (Pt. 5, Fig Fig 6.8), select the required frequency of sinusoidal transmission (512/1024/8192 Hz).

6.5.2 Using selector switch «MODE SIN» (Pt. 4, Fig 6.8), select the required type of sinusoidal transmission («CONT»/«⎍»/»3 FREQ»).

- continuous mode is required for most multi-sensor digital receiving systems;
- pulsed mode – highly economical mode with high legibility against the interference background for interface with analogue (mainly, one-sensor) receiving systems;
- three-frequency mode provides for selection of optimum frequency at the remote receiver without changing the transmitter frequency.

6.5.3 Using selector switches «SOURCE» («EXTERN»/»INTERN»), select the required operation mode.

Set the selector switch (Pt. 3, Fig 6.8) to position «OPER».

Using the internal source voltage selector switch (Pt. 2, Fig.6.8), set the first factor of the transmission power selection.

Power is selected based on the following principle: «minimum power which is sufficient for obtaining the output current producing the electromagnetic field allowable for route location».

Follow the below principles when selecting the transmission power and frequency:

- «lower power, lower frequency» – «repeated induction» towards adjacent objects are rarer, power supply life is longer
- «higher frequency» – receiver sensitivity is higher, lower power is enough, energy saving is possible, recommended for «high-resistance» utilities, but the degree of signal penetration into surrounding objects is higher, and due to greater attenuation the signal spreads to a shorter distance.
- «higher power, lower frequency» – transmission and route detection distance is longer but the power supply life is shorter.

6.5.4 Switch on power supply setting the power on-key (Pt. 1, Fig 6.8) to the position corresponding to the second factor of power selection.

6.5.5 Transmission and automatic matching will start with gradual output voltage increase. Watch the colour of indicator «OUT» (Pt. 7, Fig 6.8). If automatic matching ends with green light, the preset power has been reached. If automatic matching ends with yellow light, the load resistance is too high for the preset power while the output power is limited «by default» at the «safe» level of 24 V.

Here a decision shall be made whether the detection procedure is possible (for example, through trial route location). If the current in the line is obviously insufficient for producing an allowable level of the identification field, increase the output voltage higher than the 24 V «safe» level. After taking the respective safety precautions, the operator can start automatic matching in «unlimited mode» on his own responsibility.

To start «unlimited» mode, switch on power supply (using the selector switch «START»), with the red button «⚠ » pressed (pos 8, Fig 6.8) and held pressed till the red indicator «⚠»lights up. Blinking light of this indicator means possible «danger». Continuous light signals about actual presence of output voltage ≥24 V.

6.5.6 Operation in mode of shock pulses generation «SHOCK»

- Fasten the shock device on the facility (pipeline) under examination, using a chain fastener with a detent lever.
- Connect the shock device to the transmission output connector. When the energy is on, the instrument switches over to mode «SHOCK» (Pt. 5 Fig 6.8) automatically, where one of the three repetition rates of shock pulses (30-60-120 shocks per minute) can be selected, and the shock force is directly proportional to the supply voltage.
- Using the selector switch «SOURCE INTERN» (Pt. 2 Fig 6.8), select the shock force («12 V» – lower, «24 V» - higher).

NOTE.

Operation duration in shock mode when powered from the autonomous source only at the 12 V supply voltage is twice as long as at the 24 V voltage (with the shock repetition rate being the same). The external source prolongs the operation duration and/or increases the shock force.

*When working in the shock mode, just as when using any mechanical shock device, remember that **you are responsible for possible damages of pipes.** The material of pipes, thickness of walls, mechanism attachment point shall be taken into account. Do not attach the shock device directly in joints of pipes and increase the shock force unless necessary.*

6.6 Changing the Set Transmitter Parameters

6.6.1 Switch off the transmitter power supply by setting the power on-button (Pt. 1, Fig 6.8) to position «0».

6.6.2 Set other necessary parameters (see p. 6.5).

6.7 Operation with the Inductive Antenna

6.7.1 Preparation of contactless connection for loading.

To obtain maximum intensity of «induction», the utility line and the antenna frame shall be as close to each other as possible and **in the same plane (Fig. 6.6).**

6.7.2 If the antenna is connected to the output, upon energizing the instrument switches automatically to «antenna» mode with the 8192 Hz transmission frequency. Transmission type («⎍»/»CONT») is selected with selector switch «MODE SIN». Radiation intensity in autonomous mode depends on the selection made: either «<1Pmin>1» or «<4<Pmin>2». Power build up up to 36 V with the use of the external accumulator in this case will not give increase in radiation and therefore is not recommended. Build up of the power supply capacity (life) is possible with the use of the external accumulator.

During long operation of IEM-301.3 induction antenna on maximum output power of the transmitter a slight heat is possible (up to 60 degrees) In these conditions, please, use the stand to move the antenna. Do not hold the antenna with bare hands longer than 5 seconds or use protective gloves.

6.8 Operation with Inductive Clamp

When there are several close-spaced utilities, inductive clamp is recommended for inductive contactless «induction» of current to a single specific utility (Fig. 6.7). Consumption current of the clamp and, consequently, the field produced by the clamp, are inversely proportional to the signal frequency while the power remains unchanged.

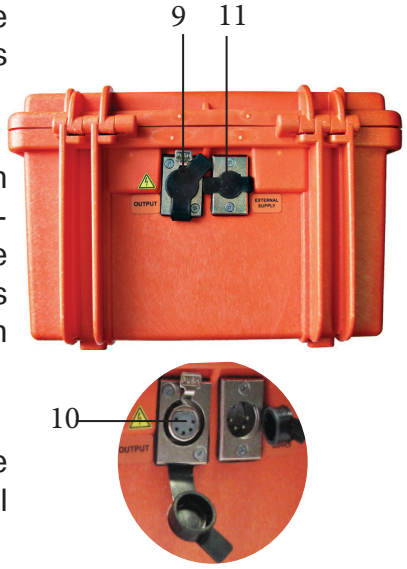


Fig. 6.1

6.9 Operation in Conditions of Atmospheric Precipitations

The moisture-proof instrument (IP54) allows operation in conditions of atmospheric precipitation, with its cover closed, if on-line measurements of parameters are not required. Before closing the cover, start transmission and make sure that the desired mode has settled. Free connectors on the rear panel shall be protected with hinged rubber plugs (Pt. 9, 11 Fig. 6.1).

6.10 Operation from the External Source

Either an additional accumulator (12/24 V) or the network source unit output (15V) can be connected to the connector on the rear panel (Pt. 10, Fig.6.1).

CAUTION!

The external source shall not have any galvanic coupling with whatever except for the transmitter input. Prior to connection, make sure that all the external source outputs are not grounded, grounded to neutral wire, or connected to the truck body.

Depending on the task, external source can be used either for life prolongation and/or power/impact force increase, or for charging.

Namely:

- External accumulator is used for power supply life prolongation, with the selector switch «SOURCE EXTERN ACC» set to position «II»;
- external accumulator is used for power supply life prolongation, with the selector switch «SOURCE EXTERN ACC» set to position «+» and net supply voltage (Σ) of 24 V;
- external accumulator is used for power supply life prolongation and/or power/impact strength increase (at Uextern acc=12V-powerx1.5, at Uextern acc=24V-powerx1.5 and lifex2), with the selector switch «SOURCE EXTERN ACC» set to position «+» and net supply voltage (Σ) of 36 V;
- network unit is used for operation with network power supply and «full» energy saving, with the selector switch «SOURCE EXTERN NET» set to position «OPER»;
- network unit is used for charging of internal accumulators, with the selector switch «SOURCE EXTERN NET» set to position «CHARG»;

NOTES.

1. With the network unit involved, the selector switch «SOURCE INTERN» shall be always in position «12 V». Otherwise, the network source will not be used.
2. Maximum permissible net voltage (Σ) of the combined source (internal=+external) in mode «SIN» is 40 V, in mode «IMPACT» – 52 V. When this voltage is exceeded, the red indicator «SOURCE» is blinking, and transmission is infeasible.
3. If the power supply mode is changed towards lower net power supply voltage (Σ), do not turn the transmission on earlier than in 5 s, otherwise incorrect operation mode may occur.

CAUTION! ENERGY SAVING!

All operations with the output power and impact frequency cause changes in energy consumption (and therefore source life). Prolong the source life using the external accumulator. At «SOURCE EXTERN II» – life prolongation depends on the external source capacity, at «SOURCE EXTERN +» – as much as 2 times at the same power SIN). When the 24 V external accumulator is connected in configuration «SOURCE EXTERN II» and «SOURCE INTERN 12 V» and when network powering is used («SOURCE EXTERN NET OPER»), energy of internal accumulators is used only for the control circuit («full» energy saving). To obtain energy saving, use the minimum sufficient power in the load and, when possible, use the mode of short-time pulsing. Note that power increase by as much as 2 times reduces the operation duration by 2.2 times, while the current (and, therefore, the field produced by the current) is increased by 1.4 times only. In its turn, capacity buildup by 2 times by means of the external accumulator leads to operation duration increase by 2.2 times. Operation breaks contribute to partial capacity recovery. Therefore, the «net» operation time with breaks is always longer than the continuous operation time, all other conditions being equal. Charge accumulators at the earliest opportunity. Avoid «automatic switching off due to low power supply» (indicator «SOURCE» is blinking yellow). Since 100% discharge reduces the capacity down to 60% irreversibly in 250 charge-discharge cycles and 30% discharge - in 1,200 cycles, frequent chargings to the full capacity are more preferable than full «emptying». Long-term storage of accumulators in discharged state leads to their full operability loss. Prior to long-term storage, charge accumulators and perform additional charging at least once per 6 months. Ambient temperature in storage shall be 20 to 25°C above zero.

Power supply sources with expired charge-discharge capacity can be replaced by the transmitter manufacturer.

6.11 Internal accumulators charge

Necessary instruments for charge is given on a figure 6.2:

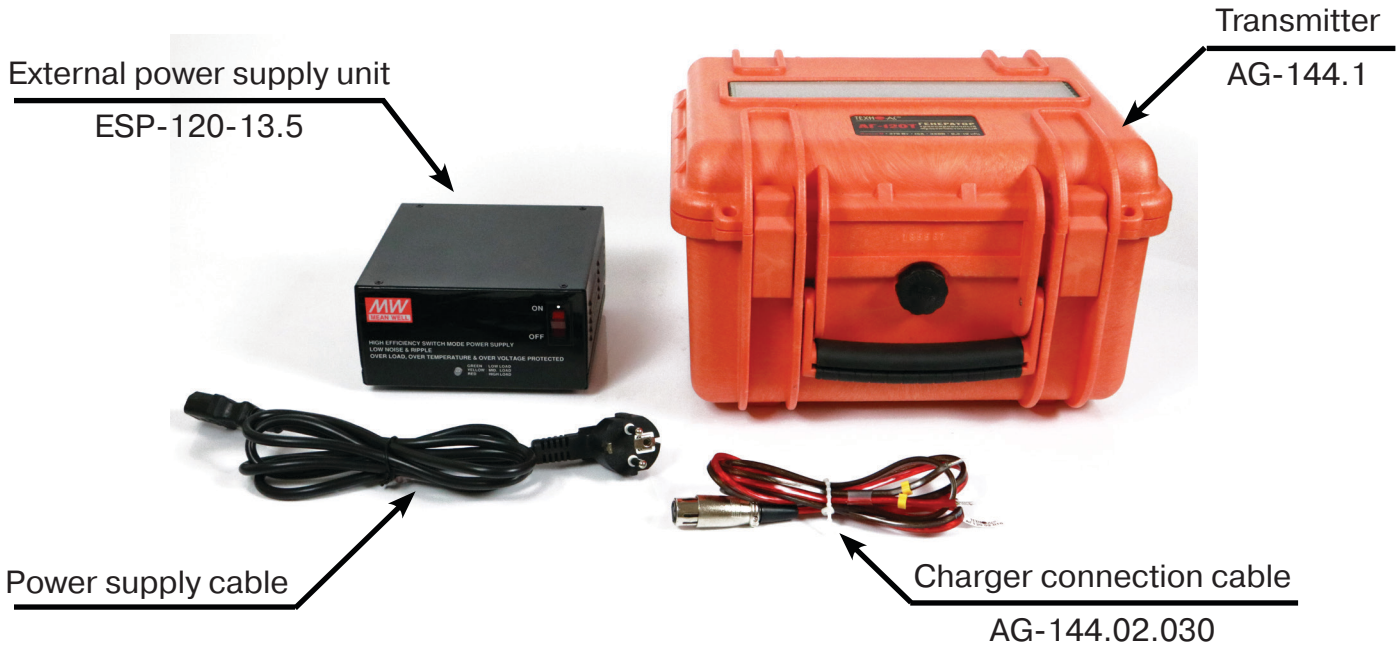


Fig. 6.2

Charger connection scheme is given on a figure 6.3:

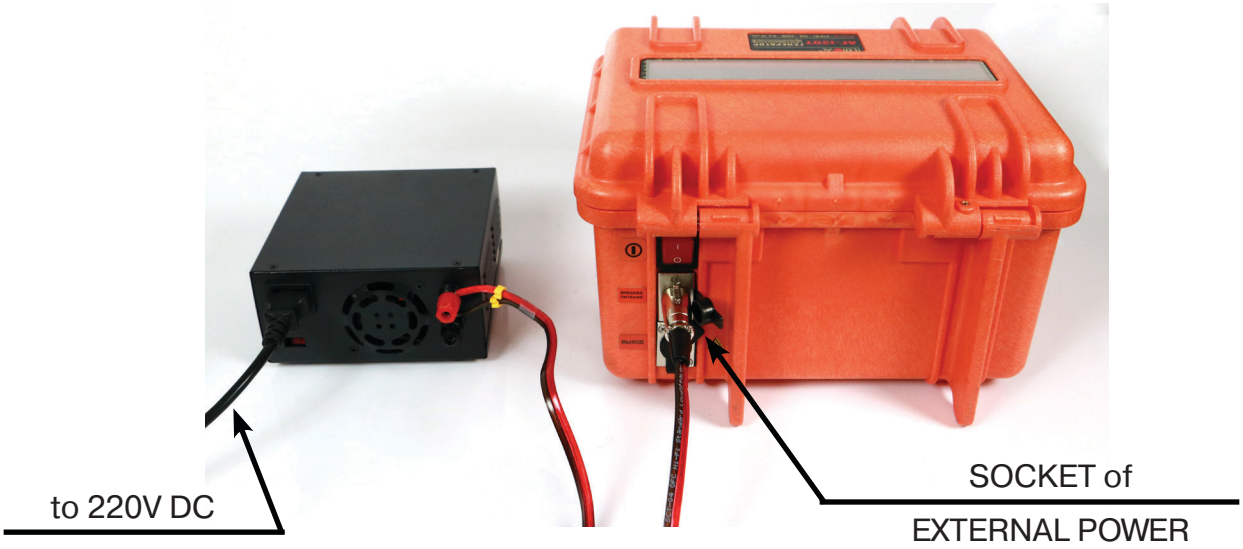


Fig. 6.3

ATTENTION!!
It is advised to charge the accumulators at the ambient temperature from -20 to +25 °C

In order to start the charge of accumulators, connect the charger and transmitter as given above:

1. With red-black cable (AG-144.02.030) connect transmitter on EXTERNAL POWER socket on one end and to the corresponding leads of ESP 120-13.5 on the other.

2. Connect power supply cable of ESP-120-13.5 t o220V DC power outlet. Set the switch to position “1“;

3. Set both “POWER” switches of transmitter to lower (“-”) position: “EXTERNAL” – «CHARGE» and «INTERNAL» – «12V» correspondingly;

4. Set «START» switch to lower (“-“) or upper (“=“) position.

NOTE: Blinking of charger indication LED (load indication) on face panel of ESP-120-13.5 indicates that charging is in process

Indicator «POWER» glows (with 5 sec delay) and consequently indicates the stage of charging with different color :

Yellow – 1st stage («stable current»)

Green – 2nd stage («stable voltage»)

Red – 3rd stage («charge finished / saving»)

Full cycle of charging (red glowing) guarantees 100-110% charge of capacity. If the charging process is stopped on the 2nd stage , at least 50% charge is guaranteed. Maximum period of 2nd stage is 2 hours. It is allowed to keep the device in 3rd stage of charging for any period. It is used for additional charge and storage.

If there is an error of charging “POWER” indicator may blink:

- Yellow blinking – external power supply is insufficient for charge (or probably 15V voltage does not pass from power supply unit)

- red blinking – power supply voltage is too high (or probably power supply switch is in position 24V instead of 12V)

- green blinking – Normal power supply, but charging is not in process (“External” switch of transmitter was set to “Operation” instead of “Charge”

If “charge error” (“Power” indicator blinking) happens, please, check clauses 1 – 3 and see what is wrong.

7 Active Route Detection

7.1 Incorporated equipment

1 – Receiver AP-027
2 – Transmitter AG-144.1
3 – Acoustic sensor AD-227
4 – Electromagnetic sensor EMD-247
5 – Headphones
6 – Inductive antenna IEM - 301.3
7 – Impact device UM - 112

At present the inductive (active) detection method has found the widest application in detection of underground utilities. The method is based on presence of the electromagnetic field around the current-carrying conductor.

The source of the test current with special frequency is a transmitter connected to one end of the utility being detected. The current flow requires a closed electroconductive loop, which one arm is a utility being detected and the other arm is an earth contact for current return through the earthing.

The maximum electromagnetic field strength measured above the earth surface corresponds to the axis of the utility being detected.

7.2 Operation sequence in active cable route detection mode

To handle the set properly, follow the below procedure:

7.2.1 Connect the transmitter to the route

Determine the transmitter connections types (contact/contactless) in accordance with the recommendations given above (see p. 7.3.).

7.2.2 Select and set transmitter parameters and operation mode

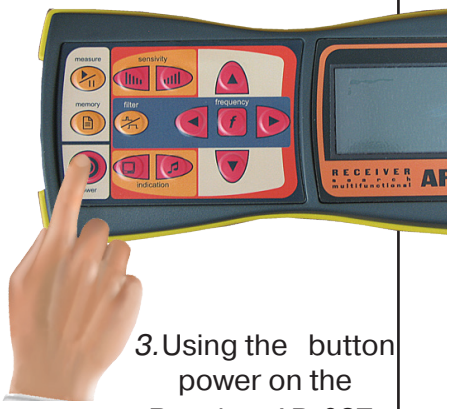
Set the following (see section 3.5):

- transmission frequency (512/1024/8192 Hz),
- signal type (continuous/pulsed/ 3-frequency);
- power connection mode (external/internal);
- transmission power selection factor.

7.2.3 Switch the transmitter on

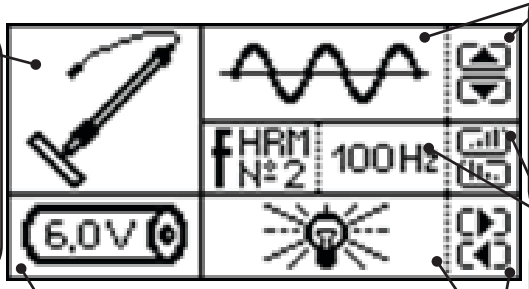
The process of transmission and automatic matching will start. «Output» indicator should glow green - set power is achieved.

Turn on the transmitter. Set the signal mode – continuous or pulse. Set transmitted frequency: 512 Hz / 1024 Hz / 8192 Hz



3. Using the button power on the Receiver AP-027.

4. In the «start» window of the receiver display check the following:



Accuracy of sensor connection. If a «no sensor» symbol , is lit on the display, check the integrity of sensor connection.

Select received signal type - «continuous , signal or «pulsed@ depending on the mode set on the transmitter (use either of ▲/▼ buttons)

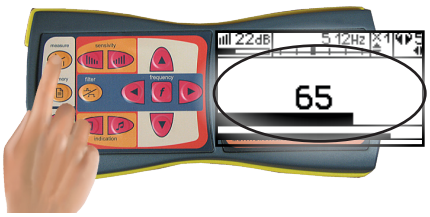
Receiver power sources charge level (no less than 4.0V). If the power supply sources are low, replace power supply sources.

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

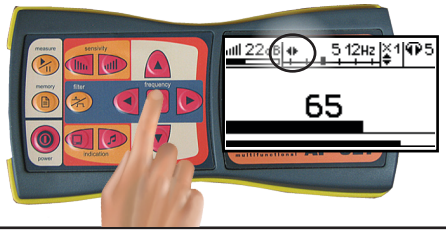
Set the second filter frequency (network frequency harmonics filter), by changing harmonics number f^{HRM}» with corresponding buttons or .

Fig. 7.2

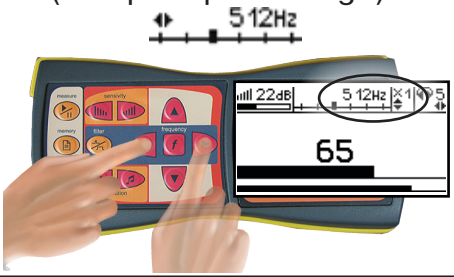
5. Start «measurement» mode, using the butt



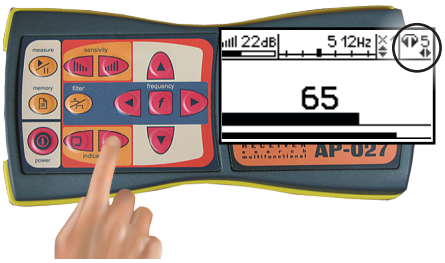
6. Press the «frequency» button . «Scale» window the central frequency of the filter will appear.



7. Select frequency set on the transmitter, using ◄/► buttons (See prompt message).



8. Exit filter adjustment mode by pressing the «frequency» button f ( ). In the window zone of the display, the prompt message will disappear and then reappear in a different zone

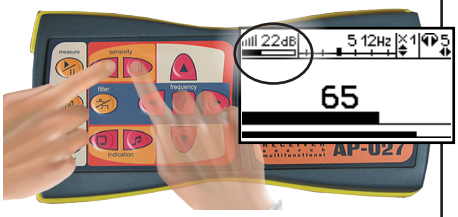


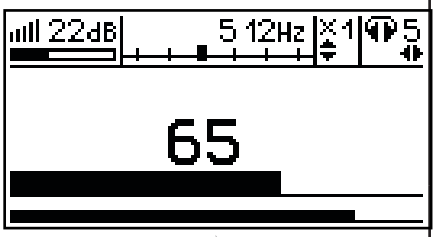
9. Set sound mode:

natural /

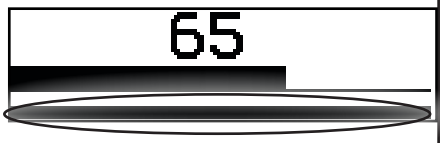
synthesized via headphones /synthesized via built-in speaker

10. Set input signal level using «sensitivity» buttons and

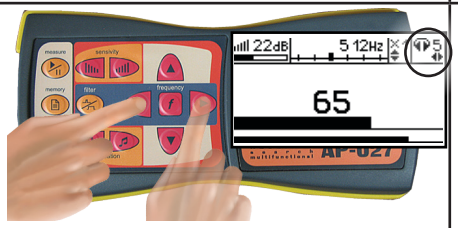




Lower scale indication should between 50...90% of maximum



Attention! Input overload may cause wrong interpretation of received data.



11. Set a comfortable volume level in the headphones by pressing the audio indication button and adjust the volume using ◄/► buttons

12. Set the necessary amplification factor «x1/2/4/8» by pressing the ▲/▼ buttons

13. Commence detection or tracing according to route detection method, avoiding prolonged input overloads.

7.3 Operation sequence in acoustic route detection mode

Incorporated equipment (Fig. 5.10):
Route locating transmitter AG-144.1
Inductive antenna IEM-301.2;
Receiver AP-027;
Acoustic sensor - AD-227;
Headphones;
Impact device UM-112.

Attention!

It is obligatory to fix firmly the impact device UM-112 on the pipe before switching it on. Don't switch it on without fixing on the pipe!

The mode is used for location of pipelines made of any materials (including DIELECTRIC ones!) by the acoustic method. The acoustic method, unlike the electromagnetic method, features the full absence of stray induction towards adjacent objects The acoustic method is effective in route location of metal pipelines in condition of high industrial interference, and essential for pipelines made of dielectric materials. The route location range depends on external factors such as ground kind and density, depth of burial, pipeline material and amount of content. The longest range is obtained at the maximum permissible supply voltage of the transmitter together with «buildup» by means of the additional external accumulator. The certain impact force depends on the supply voltage alone and is obtained through appropriate re-switching of autonomous and external accumulators. The optimal duration of impact pulses is set automatically, depending on the supply voltage (impact force).

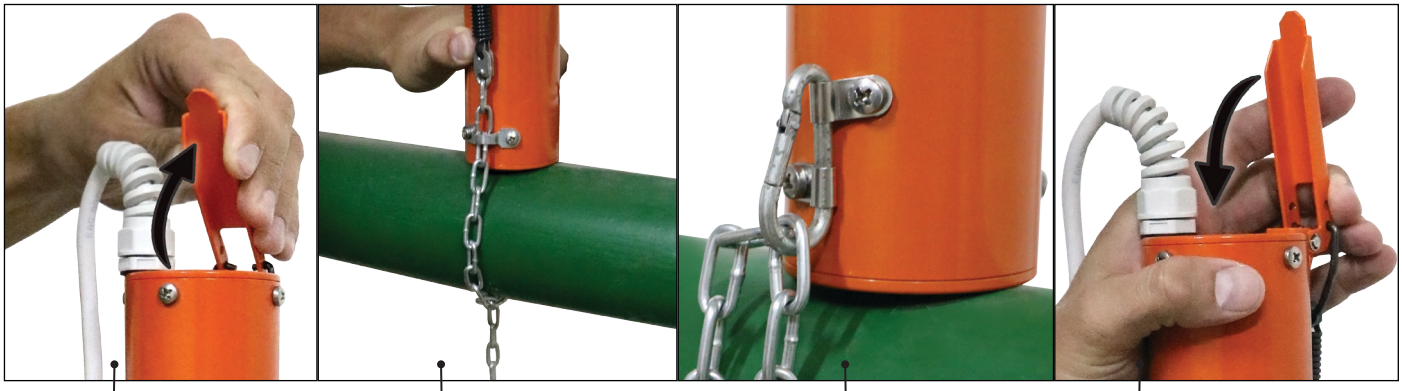
The transmitter load is the impact device UM-112 which is an electromechanical device for producing impacts against the facility (pipeline), to which it is fastened with a chain with a variable-length working part and a detent lever. The strongest impact is obtained when the mechanism is fastened vertically to a horizontal pipe and the supply voltage is the maximum possible.

The sound produced by the impact device is spread along the pipeline and, through the ground, is perceived by the acoustic sensor connected to the receiver. After being amplified and filtered in the receiver, the sensor signal is displayed on the indicator and forwarded to headphones. The operator detects the pipeline location according to the maximum signal level or specific clicking.

7.3.1 Fasten the impact device

- Fasten the impact device on the facility (pipeline) under examination, using a chain fastener with a detent lever (Fig. 7.13).

7.3.2 Connect the impact device to the transmission output connector



1)Throw the shock device tension lever aside before installing it on the pipeline.

2) Press the moving part (a die) of the shock device base to the pipe surface and wrap the pipe tight with a chain

3) Put the corresponding chain link on the chain fastening hook.

4) Lock the shock device on the pipe by releasing the tension lever.

7.3.3 Switch the transmitter on

When energized, the transmitter switches over to «IMPACT» mode (Pt.5, Fig. 7.8) automatically, where one of the three repetition rates of impact pulses (20-40-80 impacts per minute) can be selected, and the impact force is directly proportional to the supply voltage.

7.3.4 Using the selector switch «SOURCE INTERN» (Pos. 2, Fig. 7.8), select the impact force («12 V» – lower, «24 V» - higher).

Notes.

1. When using the set, like any other impact device, the material of pipes, thickness of walls, mechanism attachment point shall be taken into account (do not attach impact device UM-112 directly at pipeline joints). If there is a risk of pipe damage, the minimum possible impact force shall be used.

2. The operating impact device produces the magnetic field around itself, which may magnetize close objects.

7.3.5 Prepare the receiver for operation

Connect the acoustic sensor and headphones to the corresponding receiver connections.

7.3.6 Turn the receiver on and check its operability

1) Using the ⏻ button, power on the Receiver AP-027.

2) In the «start» window on the receiver display check the receiver power supply sources' charge (no less than 4.0V). If the power supply sources are low, replace power supply sources.

3) Accuracy of sensor connection. If a «no sensor» symbol is lit on the display, check the integrity of sensor connection.

4) In the start window, select the «impact» symbol, which corresponds to the operation in acoustic route location mode. The selection is made using any of the ▲/▼ buttons (See «prompt message»).

5) Set the necessary level of receiver display backlighting, using ◄/► buttons (see prompt message).

7.3.7 Conduct preliminary receiver setup

1) Position the acoustic sensor over assumed route. Start «measurement» mode, using the button.

2) Set the broadband mode «0.10...2.00кГц» (press filter button);

3) Set input signal level using «sensitivity» buttons and , based on «narrow scale» indicator readings (preferably at 50…70% of maximum value) Fig.7.14.

4) Set the headphones to required volume 5 using ◄/►buttons, (if the buttons are used to adjust the filter, turn the filter off (Pt.5 Fig. 7.11 and perform the setup).

5) By pressing the «indication » button (Pt.2, Fig. 7.11), switch to «Graph» indication mode and observe the uniform signals from the impact device with a frequency corresponding to the impact pulse interval frequency as set on the transmitter (20-40-80 impacts per minute) on the display (Fig. 7.15).

7.3.8 perform underground utility line route location.

Note ◄/► ▲/▼

As the distance from the point where the impact device is connected grows, the signal level will fade. In order to increase the level of received signal, use the «sensitivity» and «received signal level factor» buttons.

6.3.9 Mark the underground utility route .

6.3.10 Turn off the receiver.

6.3.11 Turn off the transmitter.

6.3.12 Disconnect the transmitter from the utility line.

8 In direct electromagnetic mode of measuring depth

Connect the electromagnetic sensor to the connectors ofthe Receiver AP-027.When determining the depth, one should take into account the terrain. In order to obtain precise results, select flat surface areas. Find the precise pipeline route location (preferably using the minimum method).Mark the spot.

Fix the sensor antenna at a 45° angle to the ground surface and hold it in a direction perpendicular to the pipeline route (Fig. 8). Moving away from the point above the pipeline, mark the spot where the signal is the lowest.Pipeline depth (h) will be equal to the length of the surface area between the point above the pipeline and the edge of the sensor antenna.

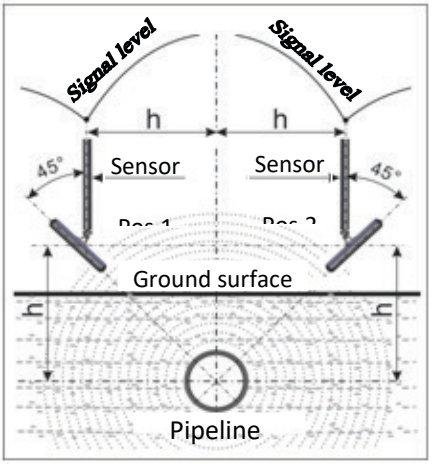


Fig. 8

9 Detecting the pipeline and utility lines intersection point (pipelines, power cables)

1) Perform preliminary pipeline route location.

2) Connect the electromagnetic sensor and the headphones to the Receiver AP-027 connectors.

3) Turn on the receiver and set it up (for broadband).

4) Position the electromagnetic sensor housing over the pipeline route parallel to the route (signal level displayed at the receiver indicator will be close to zero). Perform route location in accordance with the maximum method. When following the route, the intersection points with utility lines are identified based on the maximum signal.

10 Transportation and Storage

Packed instruments can be transported by enclosed transport means of any kind. When transported by air, instruments shall be placed in pressurized compartments.

Transportation conditions for packed instruments:

- temperature from -50°C to +60°C;
- relative humidity of up to 98% at the temperature of up to +35 °C;
- relative pressure from 84 to 106.7 kPa;
- maximum acceleration of pounding at transportation of 30 m/s2 at impact rate of 80 to 120 impacts per minute for 1 hour or 15,000 impacts at the same acceleration.

Transportation conditions for unpacked instruments:

- ambient temperature from -30°C to +60°C;
- relative humidity of up to 98% at the temperature of +25 °C;
- atmospheric pressure from 84 to 106.7 kPa;
- vibration amplitude not to exceed 0.1 mm within the frequency range from 5 to 25 Hz;

Arrangement and fastening of boxes with instruments in transport means shall prevent their displacement, impacts, shocks..

Boxes shall be positioned so that arrows of symbol «⇑» are looking upwards.

Packed and unpacked instruments shall be stored on racks in a dry room. Storage rooms shall be free from current-conducting dust, acid and alkali vapours, corrosive gases and gases damaging the insulation.

Instruments packed into transport package allow storage for six months, at that the transport package shall be free from leaks and dirt.

Appendix A
Receiver AP-027. 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 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
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	
	Headphones-synthesized sound. Frequency modulation	-
	Built-in emitter - synthesized sound. Frequency modulation	-
Supply	Voltage 4…7 V. - alkaline batteries AA type 1,5 V (4 pcs.).	
Time of continuous operation not less than	20 hours	
Automatic shutdown when the device is not active	After 30 minutes of inactivity	
Ambient temperature, C	minus 20C…to +50C	
Ingress protection rating	IP54	
Receiver AP-027 dimensions	220 × 102 × 42 (mm)	
Weight of the electronic unit, kg	0,46 kg	

Technical Characteristics of the Transmitter

Transmitted signal frequencies, Hz	
Frequencies SIN f1 / f2 / f3, ±0.1%	512 / 1024 / 8192
Shock repetition frequencies, low/medium/high frequency	0.5 / 1 / 2
Transmission modes	
«SIN» «contin»	Continuous sine transmission
SIN» «  »	Short-time pulsing of sine signal
pulse duration, ms	100
pulse repetition rate, Hz	1
«SIN» «3 freq»	Three-frequency – sine signal pulsing with repetition of frequencies f1, f2, f3
pulse duration, ms	100
pulse repetition rate, Hz	2
«SHOCK « pulse duration	Transmission of shock pulses. Set automatically.
Output parameters of sine transmission	
Maximum output voltage, V	
- at autonomous power supply	220
- with the 12/24 V external accumulator added	330
- at power supply from the network unit	140
Output power provided due to self-matching (fully-charged accumulators), ±20%	
- at autonomous power supply (12/24 V)	

Modes: - continuously - pulses 8192 Hz and 3 freq	**Pout, W**	7.5	15	30	60
	Rload, Ω	0.1...300	0.15...660	0.3...1.300	0.6...660
Modes: - pulses 512 and 1,024 Hz	**Pout, W**	15	30	60	120
	Rload, Ω	0.15...660	0.3...330	0.6...660	1.2...330
- with supply voltage built up to 36 V with the use of the 12/24 V external accumulator					
Modes: - continuously - pulses 8192 Hz and 3 freq	Pout, W	45		90	
	Rload, Ω	0.45...2.000		0.9...1.000	
Modes: - pulses 512 and 1,024 Hz	Pout, W	90		180	
	Rload, Ω	0.9...1.000		1.8...500	
- from the network power supply unit					
Modes: - continuously - pulses 8192 Hz and 3 freq	Pout, W	18		36	
	Rload, Ω	1.8...800		0.4...400	
Modes: - pulses 512 and 1,024 Hz	Pout, W	36		72	
	Rload, Ω	0.4...400		0.7...200	
Permissible load resistance		any (0...∞) Current limitation on «low-resistance» loads. Broken cable capacitance operation.			
Matching with load		Automatic, providing for the target power gaining in the load			
Power supply sources					
Built-in accumulator set		Two lead-acid sealed accumulators 12 V/7 Ah (AGM technology) with switch-over: 12V/14Ah or 24V/7Ah			

Network unit for accumulators operation or charging	Output voltage 15 V, output current up to 6.7 A
Source duration depending on power that was initially gained as a result of self-matching (ambient temperature 0°C), minimum	

continuous generation	Duration, hours	**1.7**	**3.7**
	Pout, W	60 autonomously/90 with add. acc.	30 autonomously/45 with add. acc.
one-frequency pulses	Duration, hours	**8**	**18**
	Pout, W	120 autonomously/180 with add. acc.	60W autonomously/90 with add. acc.
three-frequency pulses	Duration, hours	**8**	**18**
	Pout, W	60 autonomously/90 with add. acc.	30 autonomously/45 with add. acc.
transmission of shock pulses.	Duration, hours	**8**	**18**
	Pout, W	«hf» 2 Hz	«mf» 1 Hz
Maximum time of self-contained accumulators charging, hours		4	
Functional Specific Features			
Automatic functions		- self-matching **(target power gaining in the load)** -specific program for transmitting antenna control -built-in automatic charger -«autodetection» of transmitting antenna and shock device connection and disconnection	
Automatic disabling of transmission (charging)		- when accumulators are charged below the permitted rate (prevention of deep irreversible discharge) - when external source voltage does not correspond to the transmission / charging mode - when the network source mode is switched over during charging - when the output is short-circuited during matching - when the transmission mode does not correspond to the transmitting antenna or shock device presence / absence at the output	
Automatic repeated matching		- when the steady-state output power increases due to inadvertent drop in load resistance - when the frequency / transmission mode «SIN» is switched over - when certain source voltage changes occur	

Types of connected loads at transmission "SIN"	- direct connection to the facility with current «return» via the cable cord or armature - direct connection to the facility with current «return» via ground by means of a ground pin - loop connection with the use of the transmitting loop antenna at the 8192 Hz (selected automatically at antenna connection) - loop connection with the use of the loop clamp (selection of the cable from a bundle)
Design parameters	
Output power amplifier	pulsed, technology CLASS D(BD), Coefficient of efficiency > 80%
Indication	Light-emitting diodes: three-colour «source» and «out» - source voltage and status - output power and status red « » - possible or present «dangerous» output voltage (>24V)
Control	Push-button switches; three-position switches: - «FREQ» of the output signal «SIN, Hz» or «SHOCK « of pulse repetition - «MODE», «SIN» – sine transmission type - «START» of transmission / charging and selection of half / full power «SIN» available for this source two-position switches – «SOURCE» - «EXTERN» – capacity / power build-up with the use of the external accumulator or selection of operation / charging from the network unit - «INTERN» – selection of the 12V / 24 V internal source voltage for changing the specified power (by 4 times in autonomous mode) Button « » - loading in potentially «dangerous» mode with «unlimited» output voltage (Uout can be >24V)
Overall dimensions of the electronic unit (case), max., mm	**220x160x145**
Weight of the electronic unit, max., kg	**8.2**
Operation conditions	
Permissible ambient temperature range at operation	**minus 30…+60°C**
Climatic protection class	**IP54** (dust-water-shock-proof casing)

Appendix B
Control and indication of the generator AG-144.1

1 Source Status and Charging Process Indicator.

Continuous light colour:
- green –normal source or the 2nd charging stage (stable voltage);
- yellow –expiring source or the 1st charging stage (stable current);
- red – the 3rd charging stage (storage).

Flickering - «source or charging error» (automatic switching off of the transmission or charging has occurred):
- yellow–internal accumulators have been discharged or the external source is not enough for charging;
- red – the external source is too high for this mode;
- green – the source selector switch position «EXTERN» does not correspond to the current charging mode.

2 Output Status Indicator.

Faded – not transmission (pause, charging or automatic switching off due to improper source).

Colour:
- green – preset output power SIN has been achieved, or «impact» mode;
- yellow – preset output power SIN has not been achieved (load resistance is too high).

Blinking – intermittent transmission is in progress: matching, «sin pulse», «3 freq» or «impact».

Flickering – «output connection error» (automatic switching off of the transmission has occurred).
- green – the connected actuating device does not correspond to the current mode.
- red – closing of the output has occurred during matching.

3«Dangerous» Mode Field.

If the red button is held pressed immediately after source / transmission switching on (by means of the selector switch «START») till the indicator lights up, «unlimited» output voltage mode is enabled.

The indicator is faded – «safe» mode (Uout always <24V).

Blinking indicator ⚠ – potentially«dangerous» mode with unlimited output voltage (Uout may exceed 24 V).

Continuous indicator lighting – «danger» (Uout>24V).

8 Selector Switch of Transmitted Signal Frequencies

Repetition frequencies of *impact pulses «impact»:*
-«lf» («O») low frequency *(0.5 Hz);*
*-«mf»(«-»)*medium frequency (1 Hz);
- «hf» («=») high frequency (2 Hz).

Sine transmission frequencies «sin, Hz»:
-«512» («O»);
-«1024» («-»);
-«8192 («=»)

4 Source (Transmission, Charging) Switch.

«O»: source is off.
«I» («-»):
- at «sin» – switching-on of transmission with power equaling to the half of the available one for this source;
-in mode «impact» – switching-on of impact pulses transmission
-at charging – process start.

«I» («=» «Pminx2»):
- at «sin» – switching-on of transmission with full power available for this source;
- in mode «impact» – switching-on of impact pulses transmission;
- at charging – process start.

5 Internal Source Voltage Selector Switch

- «12V» («-» « Pminx1») – Uintern source=12V or «network power supply» or «charging of internal accumulators», power «sin» setting - Pminx1, at «impact» – the strength is lower;
- «24V» («=» « Pminx4») – Uintern source = 24V. The preset power in autonomous mode is 4 times as much as at «12V», at «impact» - the strength is higher

6 Selector Switch of External Source Power Delivery.

External «accumulator» is connected:
- «II» («-») - the external one is connected to internal ones with the «common negative side»;
- «+» («=») - the external one is connected to internal ones in series «negative side to positive side»; If total supply voltage is 36 V, the preset power is Pminx6 or Pminx12, depending on position of the selector switch «START» («-» or «=», respectively).

The network power supply unit «network» is connected
(the selector switch «intern» shall be set to position «12V» («-»)):
-«charg» («-») – charging of internal accumulators;
- «oper» («=») – transmission with network power supply only.

7 Selector Switch of Transmission Modes «sin».

- «sin pulse» - transmission of short-time sine signal trains («O»);
- «3 freq» («-») - transmission of short-time sine signal trains with frequency interleaving;
- «CONT» («=») – continuous sine signal transmission

9 «Charging of Internal Accumulators»

To start the mode, proceed as follows:
1) deliver the voltage from the network unit output to the external source input;
2) set the selector switch «SOURCE» to the lower («-») position «extern net» - «charge» and «intern» - «12 V»;
3) set «START» to the lower «I» («-») or upper «I» («=») position.

INDICATION

COLOR	PARAMETER VALUE	POWER		OUTPUT		BLINKING STOP – ERROR!	
		VOLTAGE	CHARGING	POWER	⚠ DANGER!	POWER	OUTPUT
●	low	low	1st phase (stable current)	power not achieved	—	supply is low	—
●	normal	normal	2nd phase (stable voltage)	power achieved	—	incorrect switching	
●	high	external high	3rd stage (storage) CHARGED!	—	blinking – high voltage probability illumination – high voltage exists	supply is high	SC when matching

Pmin for internal and external power

SIN MODE	SIN FREQUENCY, Hz	Pmin, Вт	
		INTERNAL	MAINS
3 frequency	—	7,5	18
continuous	512		
	1024		
	8928		
⎍	512	15	36
	1024		

POWER when supply is high

POWER SUPPLY, V			SIN MODE	SIN FREQUENCY, Hz	POWER, W	
EXTERNAL BTY +	INTERNAL	Σ			Pmin	Pmin►x2
12	24	36	3 freq	—	45	90
			continuous	any		
			⎍	8928		
24	12			512	90	180
				1024		
	24	48	shock only			

Appendix C
Receiver AP-027. Indication

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 AP-027 (fig.B.1) and the Start window (fig.B.2).

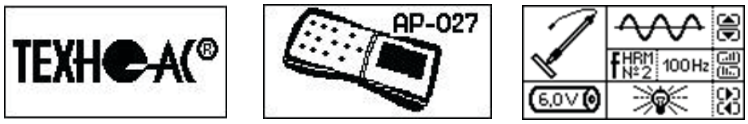


Fig. B.1

2. The start window

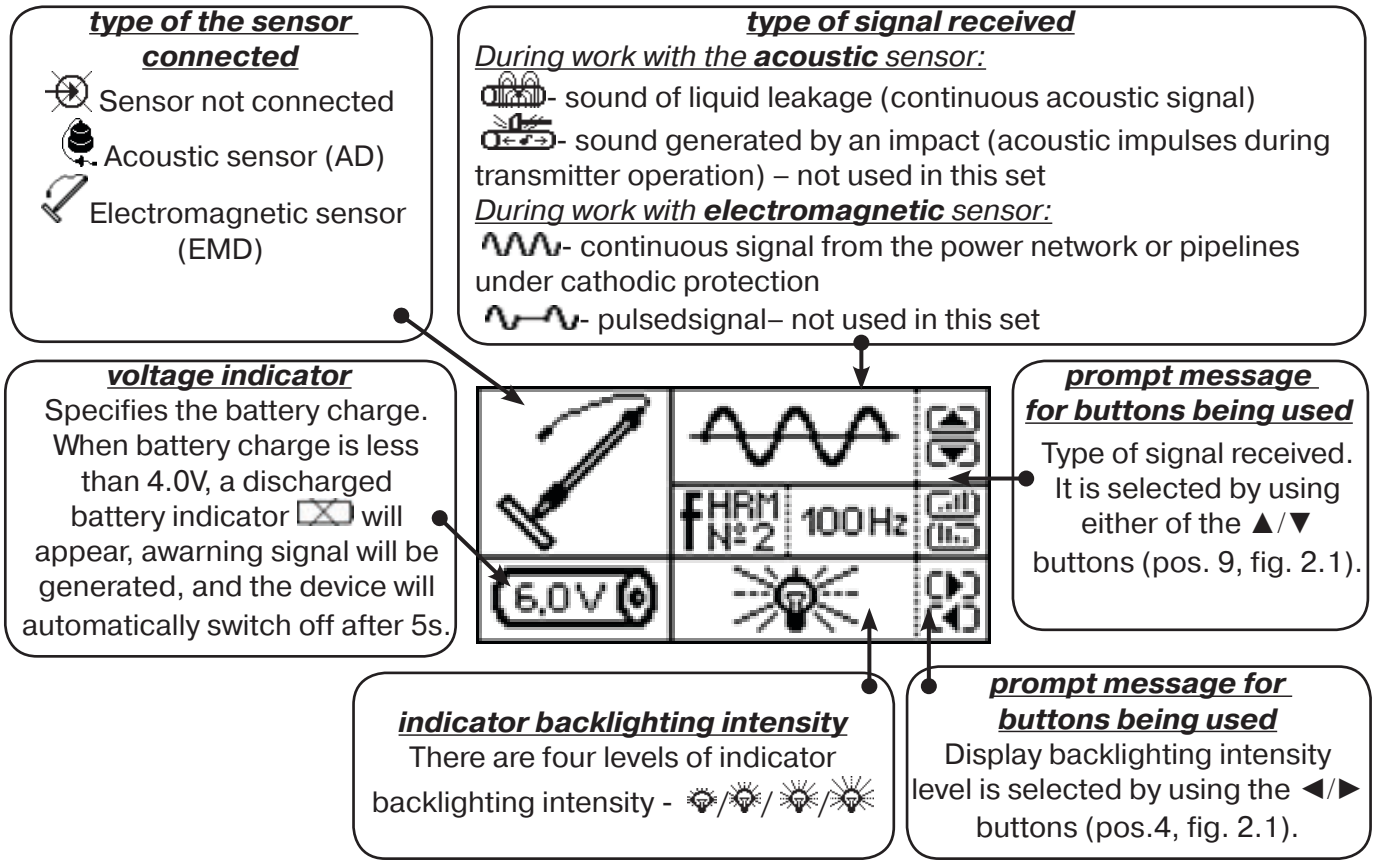


Fig. B.2

3. Scale window

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

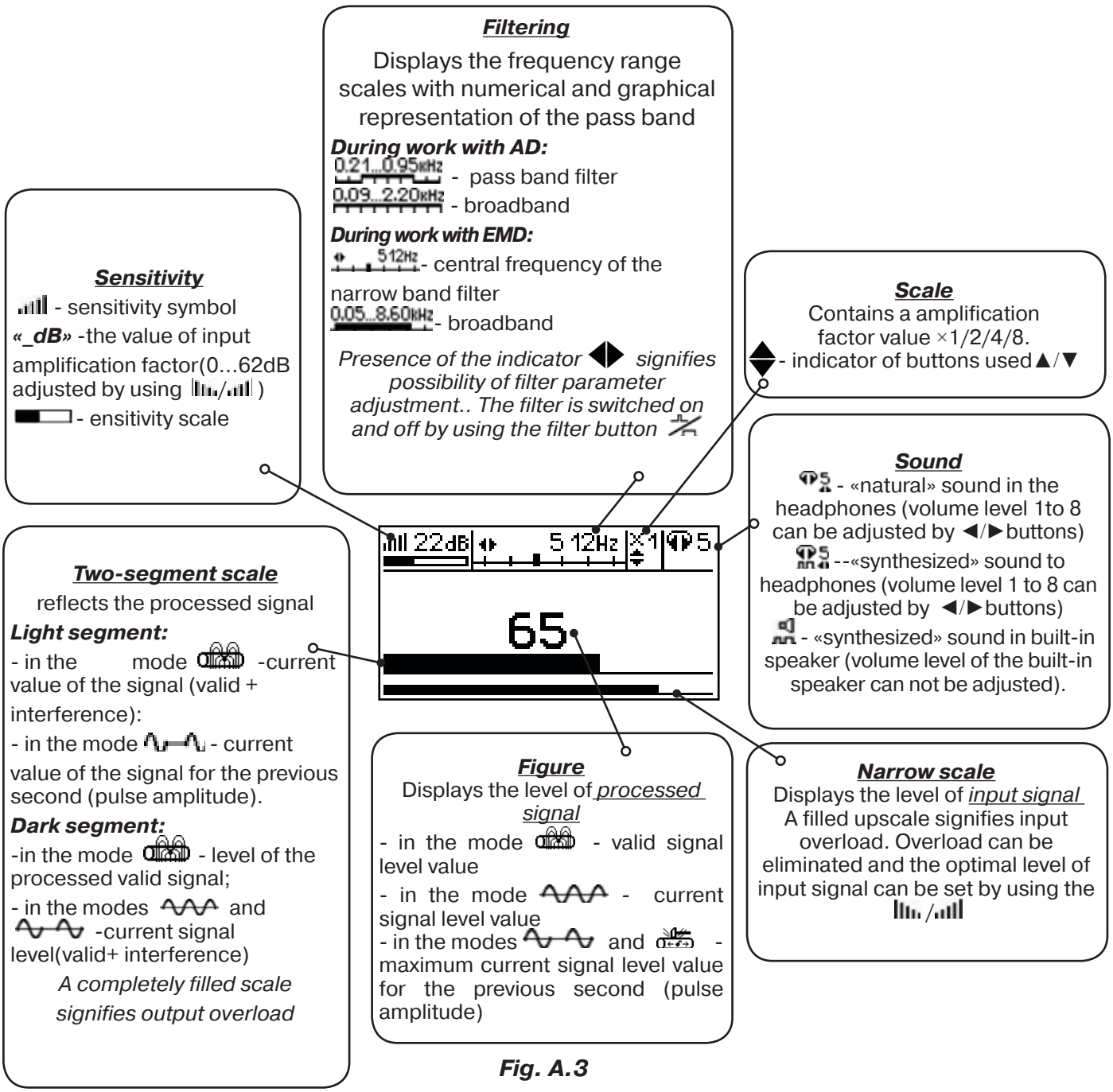


Fig. A.3

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 he optimal level of input signal can be set by using the /

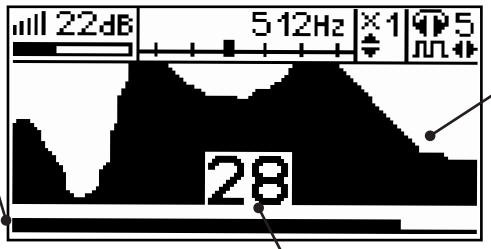


Fig. A.4

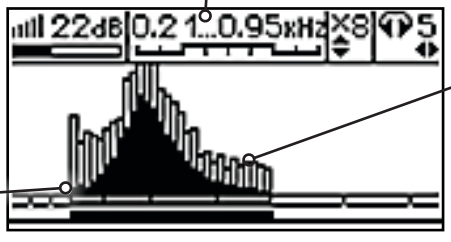
Figure
Displays the level of processed signal
- in the mode valid value of the signal
- in the mode - current value of the signal
- in the mode and maximum current value of the signal for the previous second (pulse amplitude)

5. Acoustic signal spectrum window

It displays the spectrum of the filtered signal.
When working with EMD switching the window can have the following view :

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 ▲/▼ and volume in headphones by◄/►. it is possible to switch over to adjusting the pass band and vise versa by means of (***f*** →◄/►→ ***f***).

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



light segments correspond to frequency components of accidental interference

Fig. A.5

The frequencies at which light segments significantly predominate over dark probably are the interference frequencies to be suppressed by the band pass filter.

6. Power range spectrum window

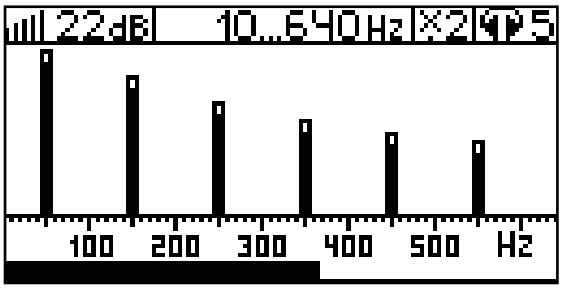


Fig. A.6

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

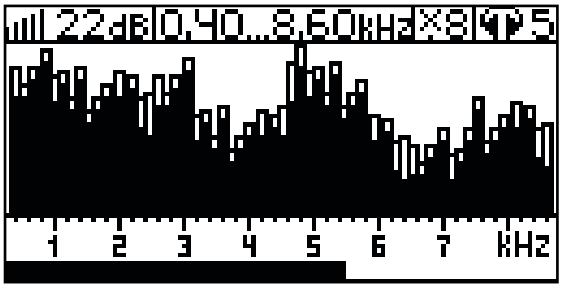


Fig. A.7

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

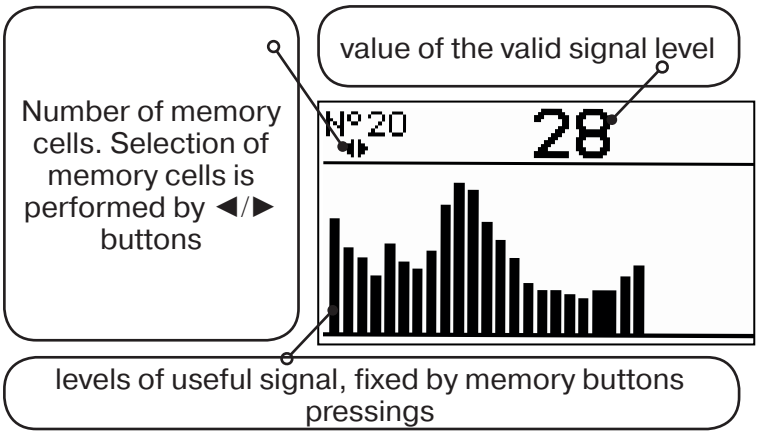


Fig. A.8

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 .

In order to do that: turn off measurement mode by pressing , the start/pause button , review memorized fields using ◄/► 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≥2».

The volume of the headphones is set by the operator using buttons ◄/►. 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.

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