



**TECHNICAL DESCRIPTION
OPERATION INSTRUCTIONS**

CABLE AND PIPE LOCATOR SUCCESS AG-319G

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Introduction

- Detection of cables and any metal pipelines underground up to 10 m;
- Direct digital measurement of the depth up to 10 m;
- Indication of the deviation from the utility axis in the mode "ROUTE";
- Direct digital measurement of the current;
- Survey the ground before the excavation works;
- Distance of tracing from the place of transmitter connection is up to 5 km.

Intended use

- Power
- Public utilities
- Oil and gas industry
- Geodesy
- Communication
- Construction
- Other industries

Operation conditions

- Ambient temperature, °Cfrom -20C to +60
- Relative humidity, %up to 85 at t=35 °C
- Pressure, kPa,.....84 to 106
- Device protection class..... IP 54

Receiver working principle

«Success AG-319G with integrated GPS/Glonass is used to locate cables and pipelines underground».

GPS/Glonass and usage logging allow to generate the data and transfer it to the PC via USB cable and special software program (V1.09 Beta User Manual). 2000 points can be stored.

The Cable and pipe locator «Succces AG-319G» consists of the electromagnetic radiation receiver and transmitter providing for the electromagnetic radiation of the route being detected.

According to the signal of the embedded speaker or headphones and using the graphic display indications the operator determines the route location.

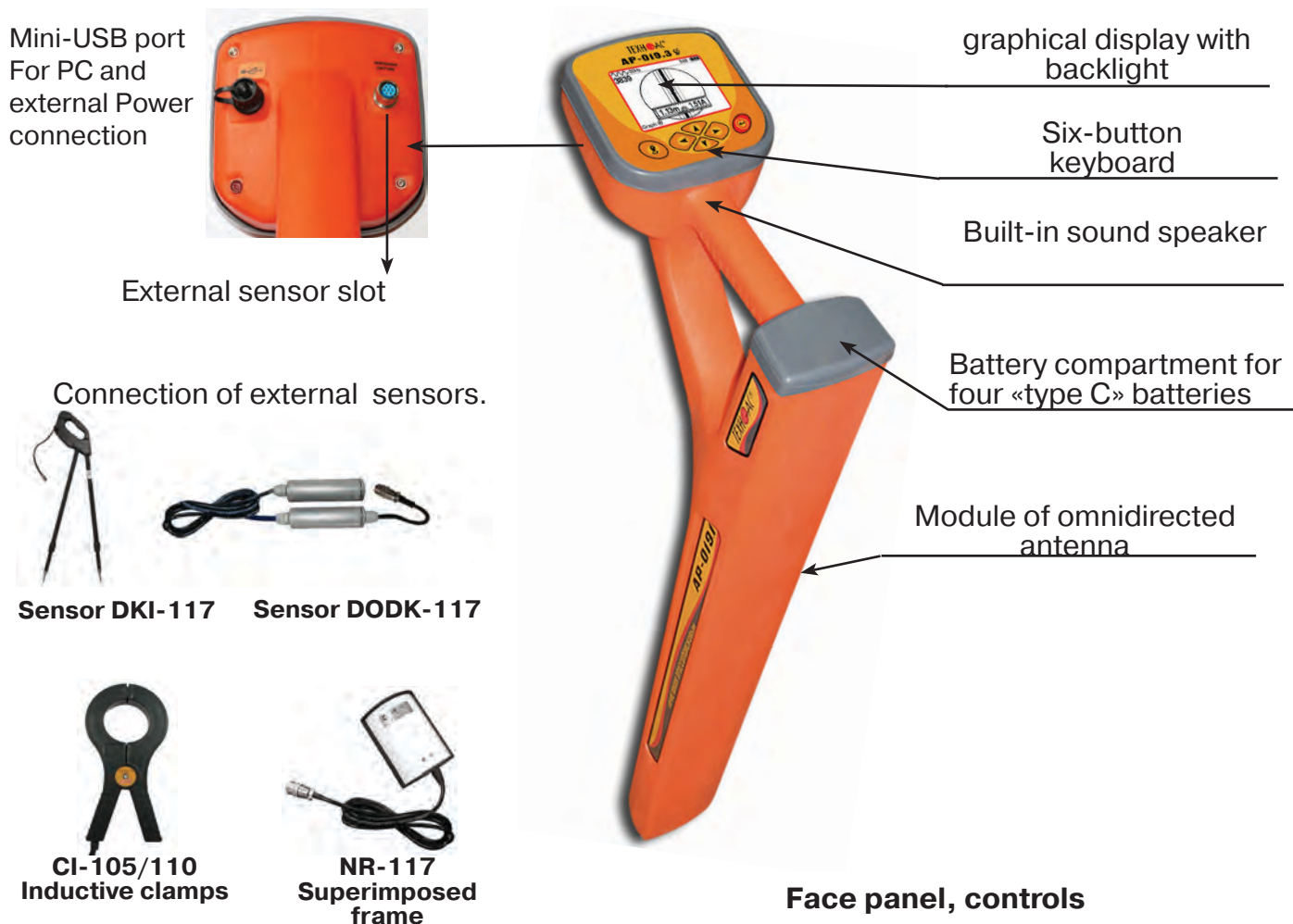
The receiver is capable of receiving a signal from industrial frequency radiation sources (50/60 Hz) and cathode protection systems (100/120 Hz). These modes are used for detecting the location of cable runs or routes carrying the voltage of the relevant frequency.

Cable or pipeline may be the load for generator. 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 contactless (inductive) connection of the utility under examination.

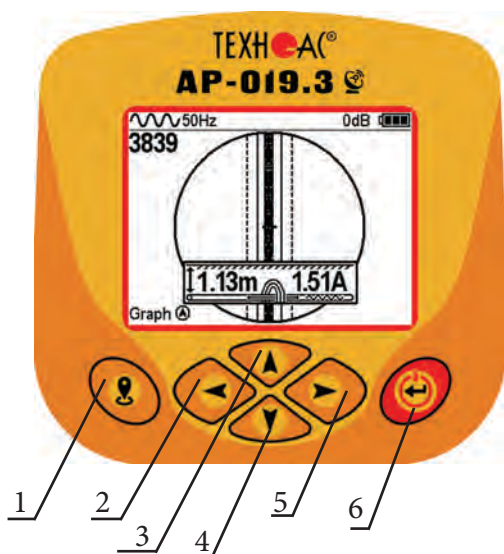
Use of the inductive antenna as a load is only possible at the 8,928 Hz frequency (selected automatically at antenna connection).




1. Appearance, receiver AP-019.3 controls

The receiver is made in a single block, solid cast IP54 rated body. Up to the battery compartment, the body provides an IP68 protection rating. Visually, the device can be split into three components: the face panel with controls and displays, the battery compartment and bottom which consists of the antenna block. On the rear side of the face panel, there are two slots for external connections.



Face panel, controls

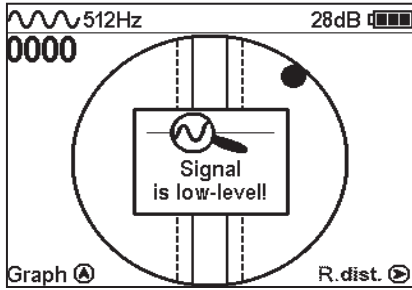


	<p>«Power»/«Enter» button (6) Switching on/off the receiver (to turn off the receiver, press and hold this button for 2 seconds) - open menu, - enter into the editing mode of the selected menu option, - exit for the editing mode saving selected parameters.</p>
	<p>Buttons «Up» (3), «Down» (4), «Right» (5), «Left» (2). - selection of the menu option (icon), - selection or changing the parameter inside the menu, - fast setting of the parameters</p>
	<p>«GPS» button(1) -Save coordinates and other available parameters of the point</p>

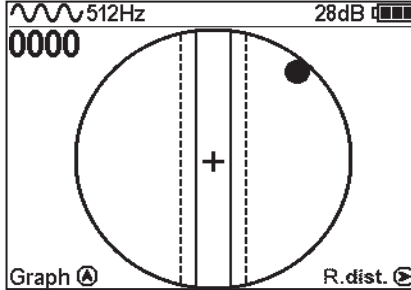
2. OPERATING MODES

2.1 "Route" mode

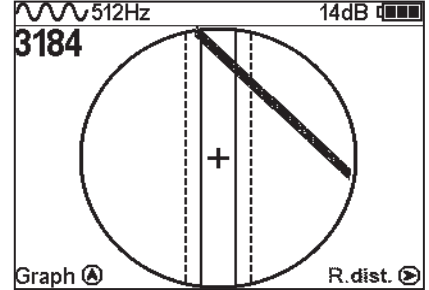
When turning on the receiver for the first time, the device will begin in route mode and the service information will appear. Route mode is the primary screen. Below, the indications are shown, which are dependent on the operator position near the located utility.



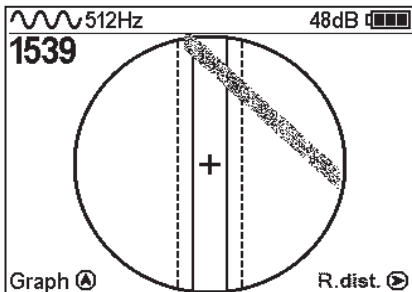
The receiver can't detect the utility.



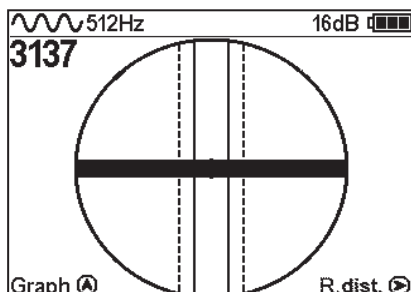
The ball on the screen shows the direction in which utility is located.



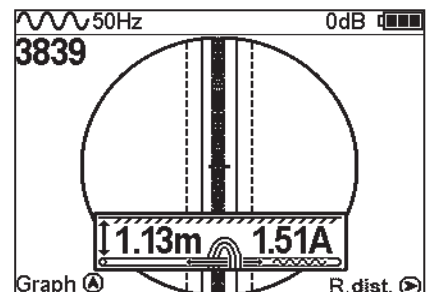
Position of utility axis shows, where the utility is situated.



When approaching the utility, a blurred line indicates its position.

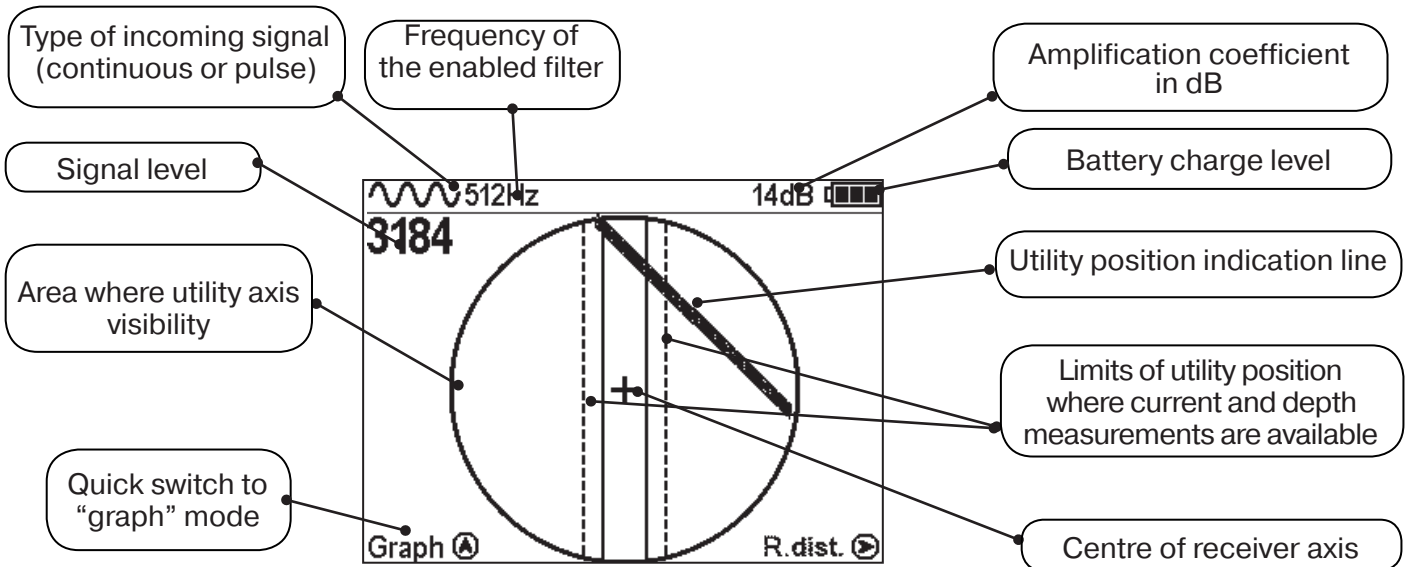


When above the utility, a solid line will appear which is perpendicular to the utility's direction.



Depth and current measurement enable automatically, If the utility indicating line is aligned with the axis of the receiver.

Route Mode Description

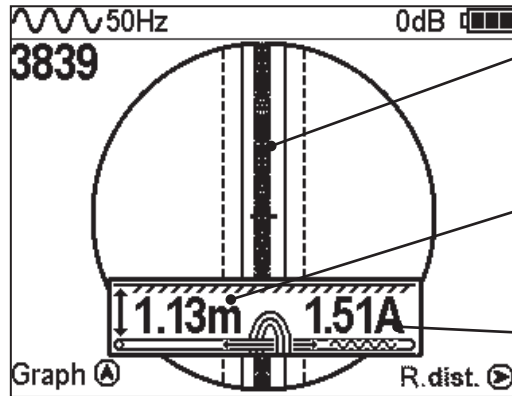


* The four-digit number "signal level" (0000 - 4100) represents the intensity of the electromagnetic field, which is dependent on the filter frequency. The numeric value of the "signal level" becomes greater when an operator approaches the source of electromagnetic signal of the chosen frequency. The signal gains its maximum level when the receiver is placed strictly above the utility. The first number of four-digit figure represents the order of the three-digit figure, generated by other figures: 0 - x1, 1 - x10, 2 - x100, 3 - x1000, 4 - x10000. Dynamic range of changing signal levels is 1,000,000 times (120 dB).

Route Mode and Depth Measurement

When the operator stands strictly above the utility and the line indicating the utility is positioned strictly in the centre field between the two dotted lines, an automatic depth and current measurement is performed.

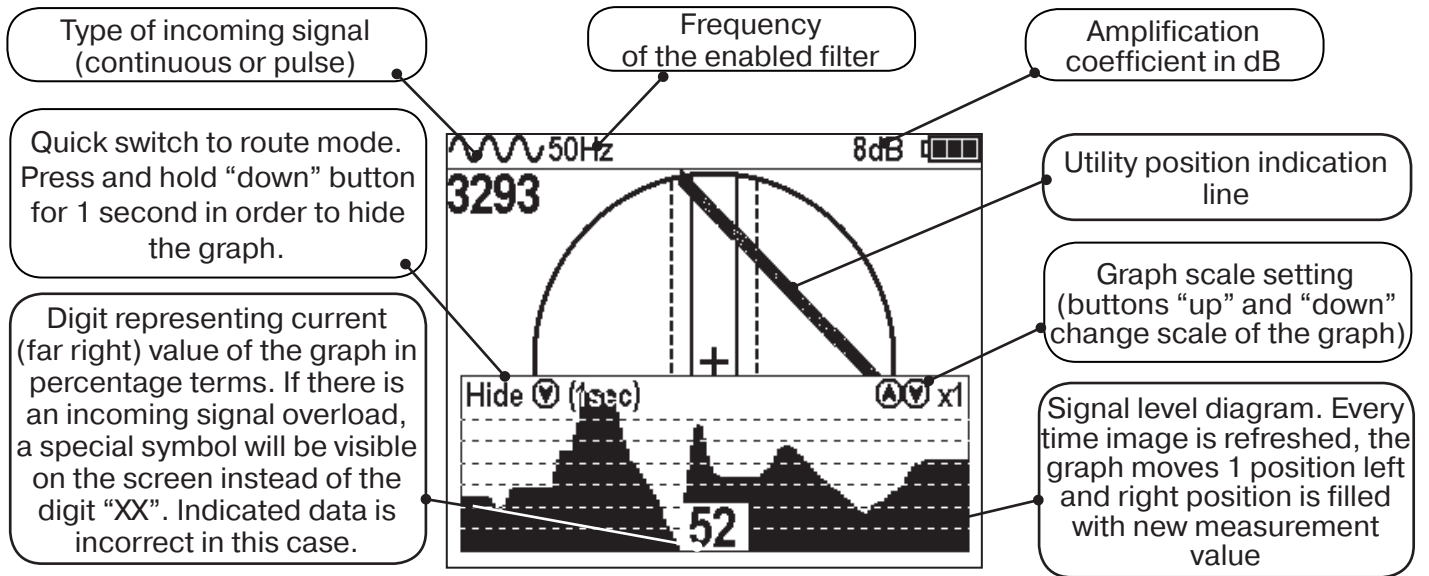
NOTE: When performing a depth measurement, the receiver antenna should be positioned perpendicularly to the utility.



- Receiver and utility axis are perfectly aligned
- Buried depth of the utility
- Current of the utility

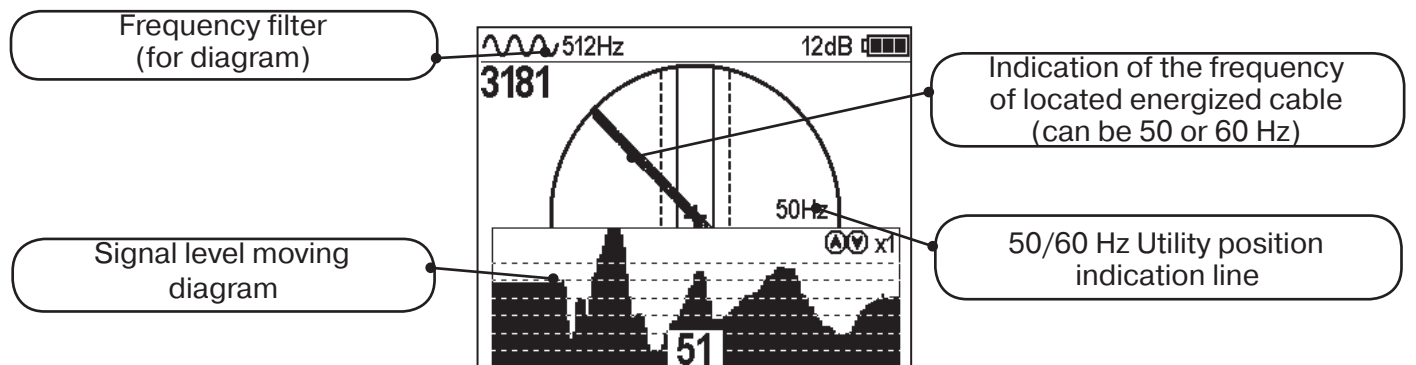
2.2 Graphic Mode

In graphic mode, the receiver screen is split into two segments. The upper segment indicates utility position in 2D, and the lower segment is a moving graph of signal level change in time according to a "maximum" method, where a maximum signal is reached when the receiver is positioned strictly above the utility and signal decreases when the receiver is moved further away from it. In this mode, current and depth measurement function is not available.



2.3 Graphic+ Mode

This mode is different from the ordinary graphic mode. The main difference is that the utility axis indication line represents only 50/60Hz utilities (power cables or utilities with induced signal) which can be accidentally met during the operation on active frequencies.

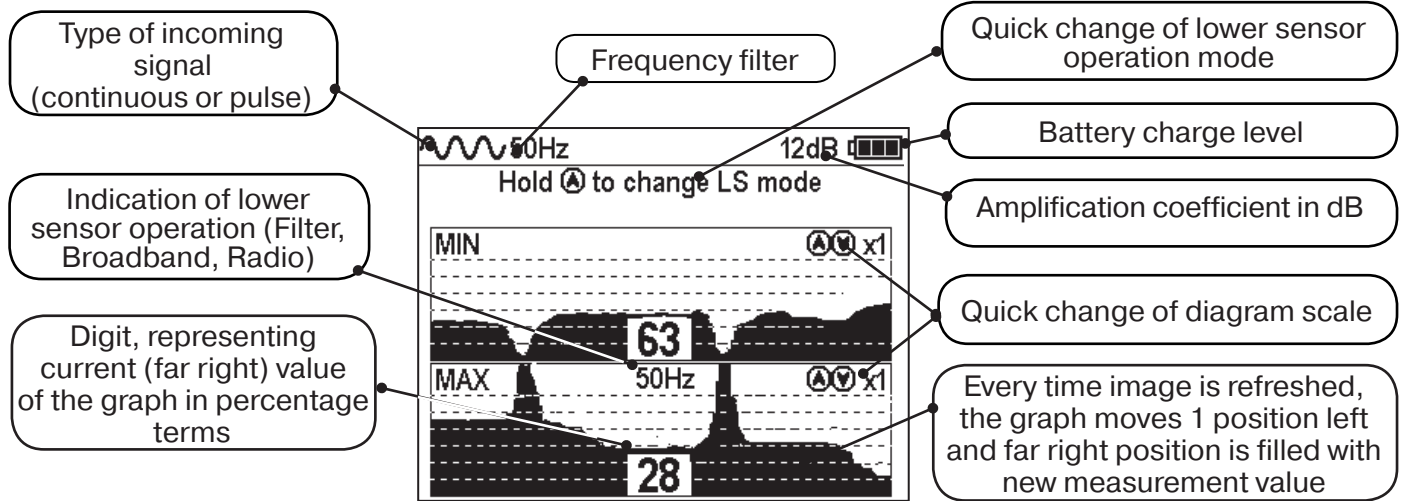


2.4 “Minimum maximum”

In “MIN & MAX” mode, the receiver screen is split into two segments. The upper segment is a moving diagram which represents signal level changes according to the “minimum” method – it means that the signal will be minimal when the receiver is positioned strictly over the utility. If the receiver is moved aside, the signal level will increase.

The lower segment represents the “maximum” method diagram – the signal will be maximal if the receiver is positioned strictly over the utility, and it will decrease if the device is moved further away.

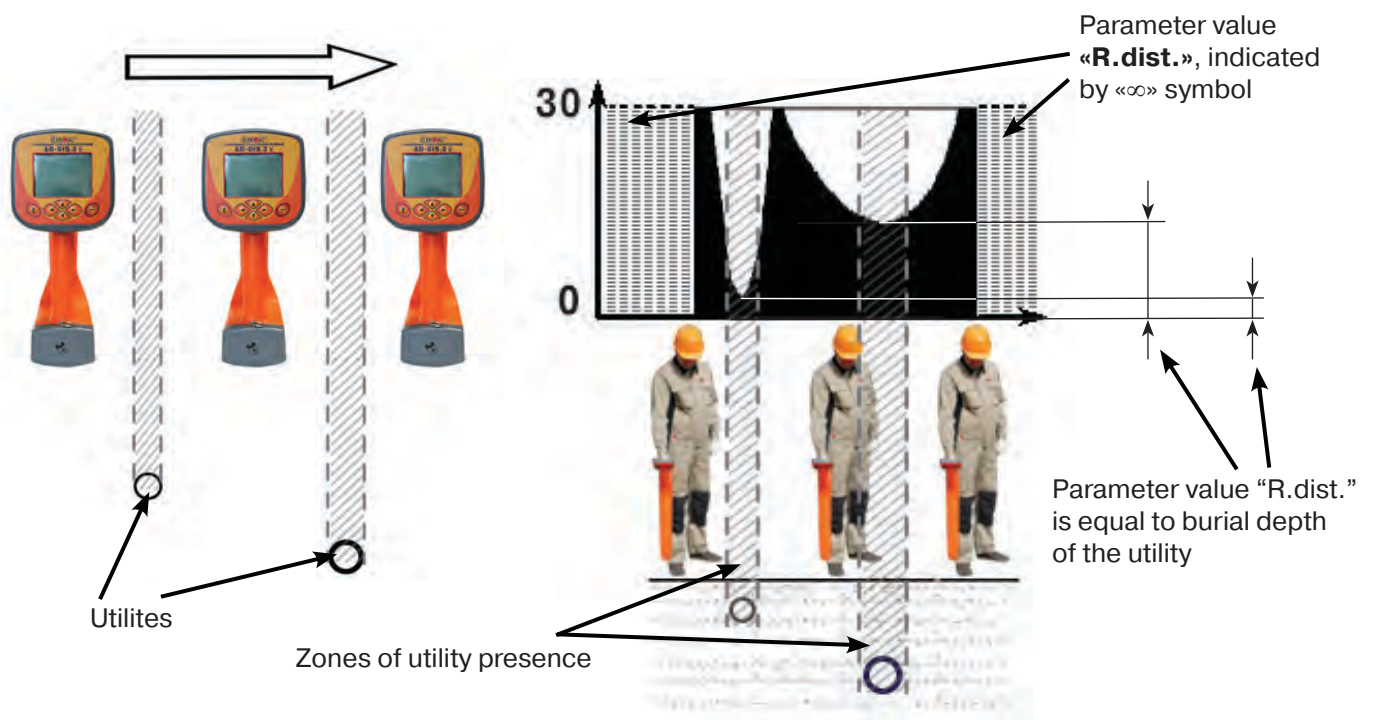
This mode does not allow depth and current measurements.



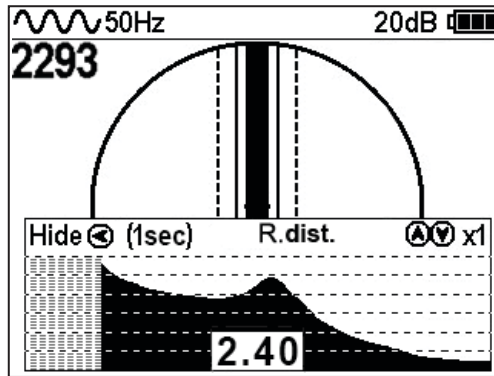
2.5 Modes with Graphic Representation of “Relative distance to the Utility” (R.dist.)

In cases given above, both utilities lay beside each other. However, in this case “MIN & MAX” mode does not allow the user to measure the depth of these cables. For this reason, it is better to use graphic modes with indication of the “relative distance to the utility”.

While approaching the utility, the value of “relative distance to the utility” changes in the way described on pictures, shown below:



When two utilities are buried close to each other while moving the receiver straight across the utility axis in “R dist” mode, an operator will be able to see the indication shown below:



Minimal values of “relative distance to the utility” indicate the presence of the utility with some fault because in the case of multiple utilities laying nearby, minimum signal point may move due to confluence of the signals.

You can enable the “**R.dis.Graph**” mode from “Route” mode by pressing the “>” button or by switching it in the “Modes” section of the receiver’s main menu.

2.5.2 “MIN & R.Dist” Mode

In this mode the screen is split in two parts. Upper part: Minimal signal graph, lower part: “relative distance to the utility” graph in real time.

Digit indicates the minimum signal level of far right point of the display

Hint – change of graph scale in 2, 4 and 8 times by pressing “up” and “down” arrows

Digit indicates relative distance value of far right part of the display

“R.dist” value indicated by “∞” icon

You can enable “MIN & R.Dist” mode only from “Modes” section of main menu.

2.6 “2 Frequencies” Mode Window

In the “2 frequencies” mode, the cable condition and pipeline protection diagnostic is performed using the external generator. When conducting works on cable route location, it is possible to select the communication located as “my own” and perform a route location on it.

Quick reset of readings and “reference” to the utility

Frequency components change of phase difference

Amplification coefficient in dB

Battery charge level

Signal direction (straight / reverse)

Frequency components amplitude modulation (A8/A1)

The sum of frequency components (A8+A1)

Signal level on 1024 and 8192 Hz

2.7 “Sonde” mode

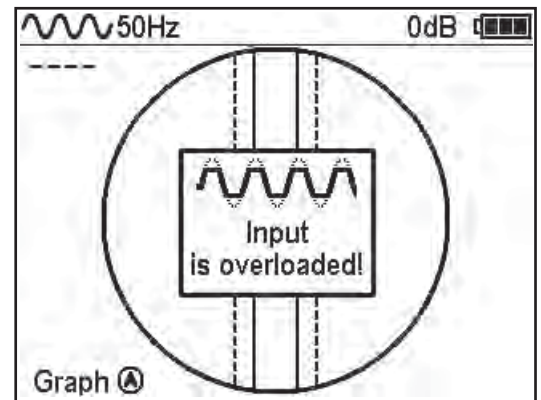
“Sonde” mode is used for tracing of non-metal pipelines by using a special pipe transmitter working on 512Hz frequency. (see paragraph 12)

IMPORTANT NOTE:

Modes are split in two sets: basic and extended. In basic set, only 3 modes are available: “Route”, “Graph” and “R.dis.graph”. All modes are available in extended set: “Route”, “Graph”, “Graph+”, “MIN & MAX”, “2 Frequency”, “Sonde”, “R.dis.graph” and “MIN&R.dist.”. You can switch between two sets in menu: Settings → Modes select.





Dynamic Overload Protection

There is protection in the receiver which prevents the influence of dynamic overload. When the receiver is operated in the area with tense electromagnetic fields, this function automatically reduces the incoming signal and prevents the electronics of the receiver from being damaged and notifies the user with a special message on the screen.

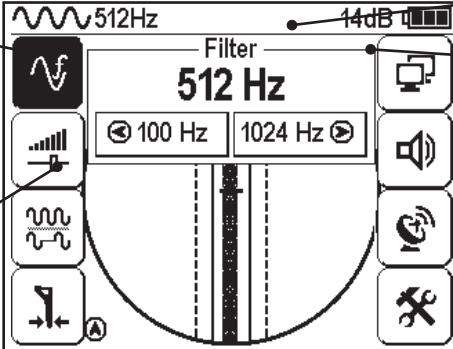


3. Menu description

3.1 Receiver switching on

<p>To switch on the receiver, press the "Power" button </p>		<p>Briefly Press "Enter" button to open the menu </p>	
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3.2 General View of the Menu Screen




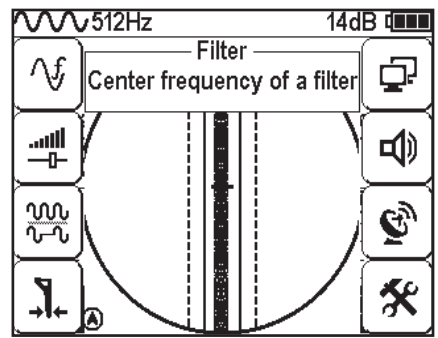

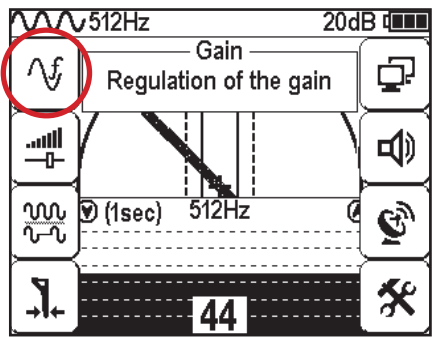

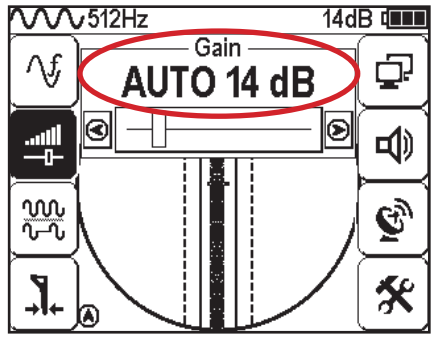


The selected menu option is highlighted with the dotted line, flashes with light/dark

Icons represent each menu option

Menu option name


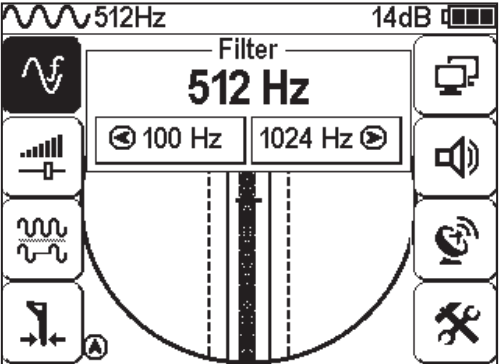

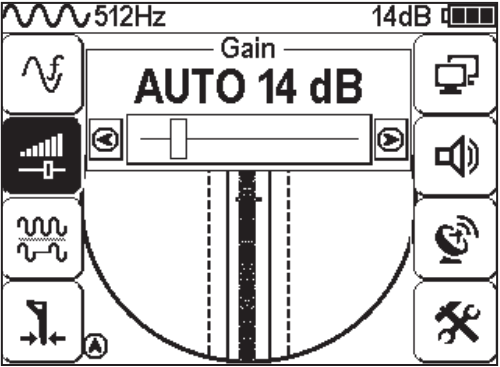

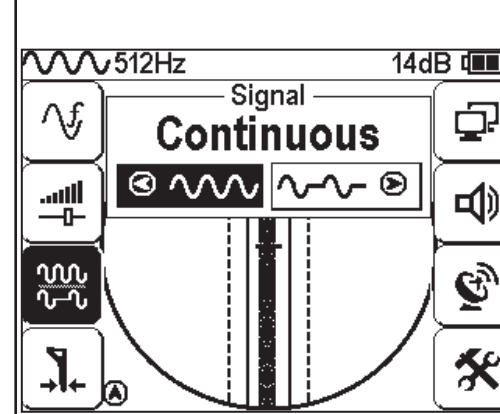

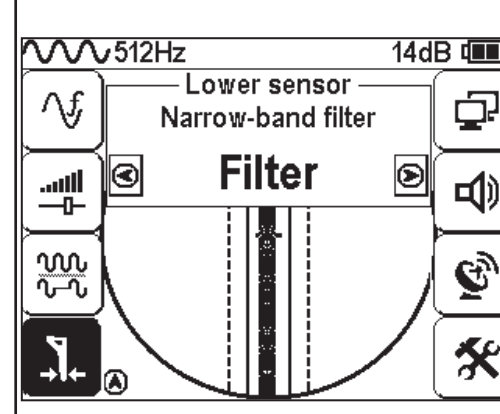
Brief menu option description


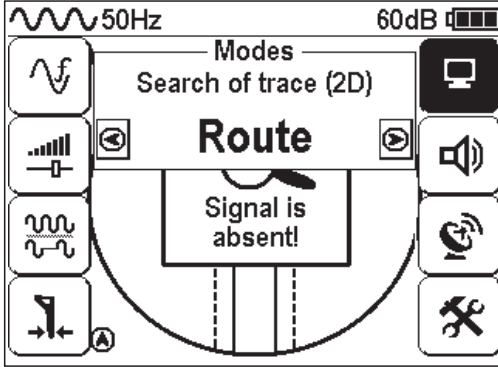

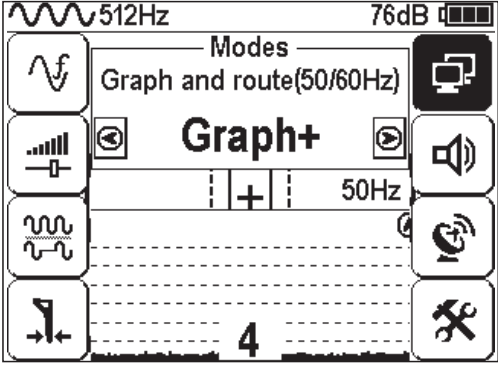

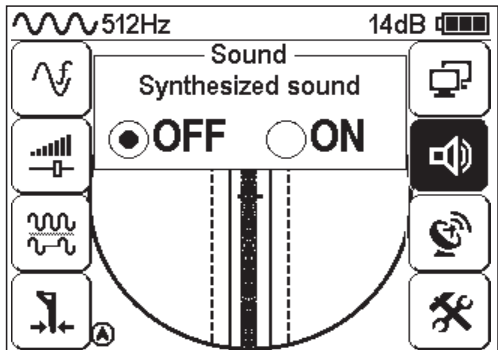

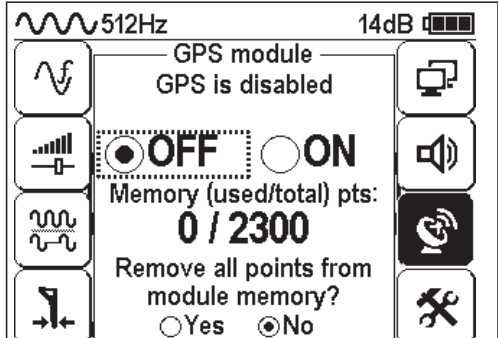
3.3 Menu Parameter Selection General Principle


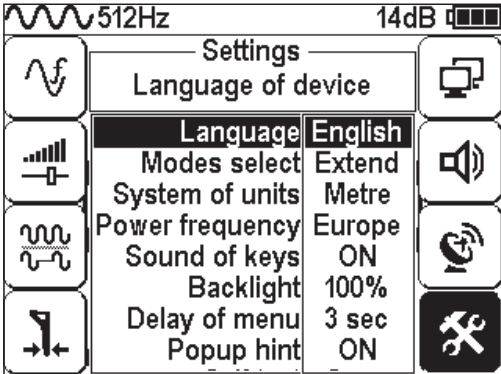
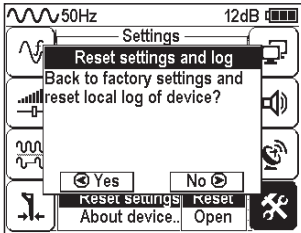
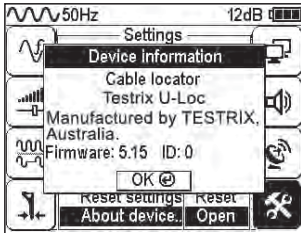
 <p>To open the menu, press "Enter".</p>	 <p>The menu will appear on the screen.</p>	 <p>Menu option selection is performed with buttons "Up", "Down", "Right" and "Left".</p>	 <p>Active "icon" is flashing and is highlighted by dotted line</p>
 <p>To change or view the menu item</p>	 <p>In the upper part of the indicator, the parameter editing panel will open.</p>	 <p>Values setting is performed with the buttons "Up", "Down", "Right" and "Left". The changed value is immediately applied.</p>	 <p>To exit into the main menu or switch to the set mode with the closing of the menu, press the "Enter" button. If you wait for several seconds, menu will disappear automatically.</p>


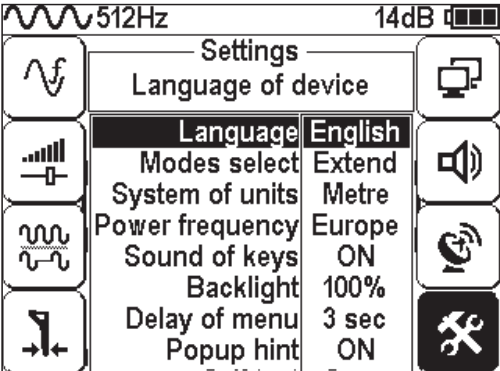
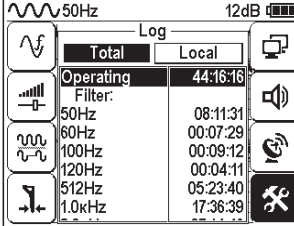
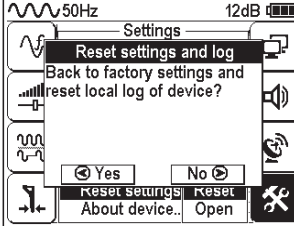
* If no buttons are pressed for a period of time, the menu will disappear automatically. The length of this period is set in the "settings" menu option.

8 items of menu contain parameters of setting, which are opened in the panel located in the upper part of the indicator. **Table 1**

№	Item of the menu	Display image	Parameter description
1	Filter 		The working frequency of the receiver corresponds to the main frequency of the applied filter. It is selected from the set: 50(60) Hz, 100(120) Hz, 512 Hz, 1024 Hz, 8192 Hz or 32768 Hz.
2	Gain 		The amplification coefficient of the scaling amplifier can be changed from 0 dB to 80 dB with 2 dB step. The optimum coefficient of amplification can be selected: - manually , - semi-automatically (by command), - automatically depending on the regime of the analysis and signal representation.
3	Signal 		The type of signal received can be “Continuous” or “Impulse” Continuous - operation on passive frequencies 50(60)Hz and 100(120)Hz, cathodic protection of pipeline. Impulse or Continuous - on active frequencies 512, 1024, 8192 and 32768 Hz in accordance with the transmitter.
4	Advanced Bottom Sensor Setting 		This option has several settings affecting the efficiency of the bottom sensor. • “Filter” (narrow-band filter) • “WB” (wide band, sensor receives all frequencies below 8kHz) • “Radio” (sensor receives all frequencies over 8kHz) “Filter” setting is used only in “Route mode”, other settings are used in “Graphic” mode

5	<p>Base Mode</p> 		<p>Basic set of modes:</p> <ul style="list-style-type: none"> - “Route” (2D display of the location of the utility); - “Graph” (visually represents the changes of signal level of surveyed cable as a diagram along with a 2D representation);
	<p>Advanced Mode</p> 		<p>Extended set of modes:</p> <ul style="list-style-type: none"> - “Graph+” (visually represents the changes of signal level of surveyed cable as diagram alongside with 2D representation of 50 (60) Hz cable; - “MIN&MAX” (graph representation of minimum and maximum signals) - “2 frequency” (amplitude and phase Non-destructive testing, detection of “friend” or “foe” signal on two frequencies).
6	<p>Sound</p> 		<p>Switching on / switching off of sound notifications created by the built-in speaker. Has two settings:</p> <ul style="list-style-type: none"> -OFF -ON
7	<p>GPS</p> 		<p>GPS Status bar can indicate the following information:</p> <ul style="list-style-type: none"> - GPS module is on. - GPS setting - GPS is switched off - Looking for GPS satellites - Coordinates of latitude and longitude

<p>8</p> <p>Settings</p> 		This menu is opened in the <u>main display</u>	
		Language	<Russian/English>
		Text messages language	
		Modes select	<Basic/Extend>
		Basic set of modes: “Route” and “Graph” Extended set of modes: “Route”, “Graph”, “Graph+”, “MIN&MA” and “2 frequency”	
		System of units	<Metre/Foot>
		Measurement system: metrical or imperial	
		Power frequency	<Europe/USA>
		The network frequency for passive search: Europe (50/100 Hz) / USA (60/120 Hz).	
		Sound of keys	<ON/OFF>
		Disables sound for button pressing	
		Backlight	It sets the brightness of the LED display
		It has following values: “0%”, “50%”, “100%”	
		Delay of menu	<1 sec/2 sec/ 3 sec/ 4 sec/5 sec>
		<u>Idle time before</u> closing the menu when no buttons are pressed.	
		• Popup hints	<ON/OFF>
		Disables pop-ups with useful hints.	
		• Self-test	<Reset>
		Self-test for errors of receiver’s components	
		 	

<p>Settings</p> 		<p>LOG</p> <p>The statistics of device usage including all applied settings</p> 
		<p>Reset settings</p> <p>Reset the device to factory default settings. After choosing this menu a dialogue window will appear:</p> 

4. Start of work

If alkaline batteries are used - Before start of work, you should install the batteries into the corresponding compartment of the receiver in the following sequence:



Unsnap Battery compartment. Pull out the ring on the receiver handle.



Install the batteries, observing the polarity

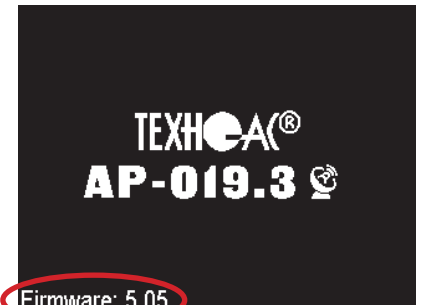


Install four new elements into the battery compartment of the device, minding polarity. Install the battery compartment into the body until it snaps.

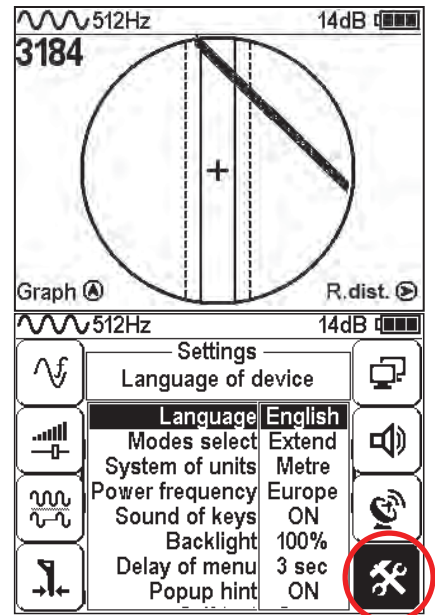
Receiver switching

To switch on the receiver, press the “Power” button 

The indication of the Firmware version, manufacturer logo and device name will appear on the screen.



Then, the receiver will automatically enter into “Route” mode in 5 seconds. When first switching, the factory settings are set by default . The filter frequency is 50 Hz.



Note

A description of factory settings can be found in the “settings” menu. You can go back to factory settings by selecting the “reset settings” option.

With factory settings enabled, you can perform the cable location with network frequency 50 Hz without the transmitter.

External Power

With the help of the mini-USB cable (included), the operator can connect to external power sources with 4-7V voltage. For example, a power bank (supplied separately).

The external power source can be placed under overclothes of the operator. It will allow an extension of the battery life in low temperature conditions. External power can be used with inserted batteries or without them.

NOTE: Power Bank should be placed as far as possible from the antenna block of the receiver in order to evade interference.

Basic Receiver Functions

- Location and tracing of underground utilities with depth measurement in “Route” mode.
- Location and tracing of utilities in “Graph”, “Graph+”, and “MIN & MAX” modes.
- Tracing of non-metal utilities in “Sonde” mode.
- Saving of coordinates and parameters of located points.
- Operation in “2 Frequency” mode (fault location and detection of signal direction).
- Selection of the cable from a bunch with inductive clamp.

5. Search of Utilities in “Route” mode



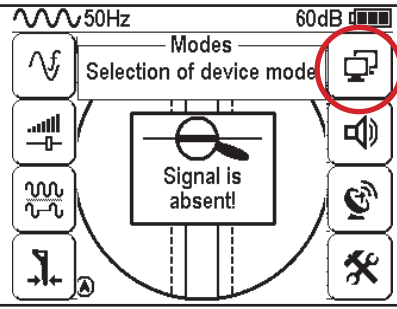


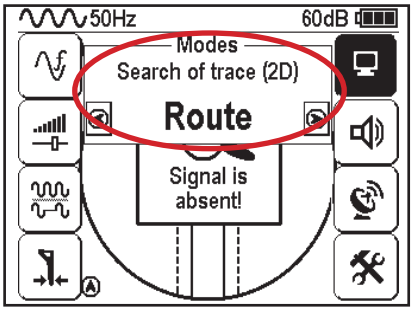



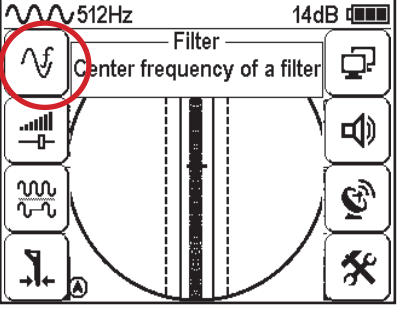


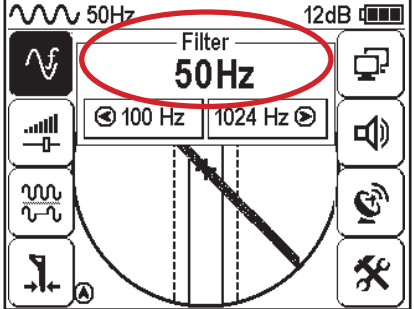

Route mode is the main mode for route location of various utilities (cables & pipelines) at all supported frequencies, both in “passive” cable route location and at the “active” (with the use of the route locating generator). In passive mode, the cable location is carried out at frequencies of 50(60) and 100Hz, while cable location in active mode is performed at frequencies of -512, 1024, 8192 and 33Hz.

5.1 Cable Location in Passive Mode

This mode is used to search and locate the route of power cables under voltage with a frequency of 50(60) Hz and other communications with the induced signal in frequency 50(60) Hz. The external generator is not used.

Receiver Setting for Operation in “Route” Mode

To enable “Route” mode, please, do the following:

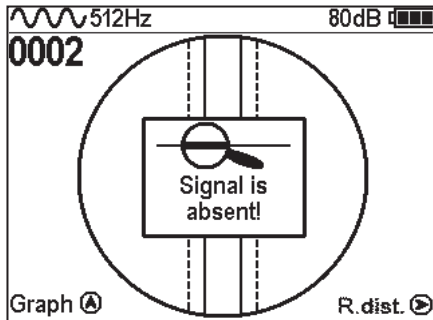
<p>Turn on the receiver</p> 	<p>Press “enter” button in order to open main menu</p> 	 <p>Choose “Modes” icon</p> 	<p>Press “enter” to enter the mode change menu</p> 	 <p>Choose “Route”</p> 
<p>Press “enter” button in order to open main menu</p> 	<p>Then go to “Filter” menu</p> 	 <p>buttons</p> 	<p>Press “enter” to enter the mode change menu</p> 	 <p>Select 50(60) Hz frequency</p> 

When filter 50(60)Hz is chosen, the type of incoming signal is automatically set to continuous.

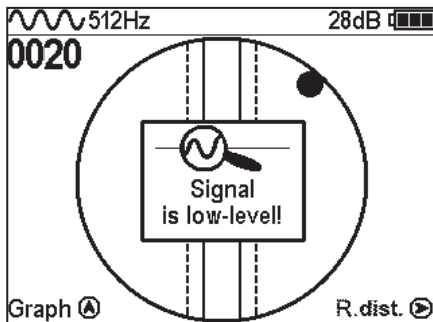
5.2 Search of a Communication and Measurement of its Burial Depth

1. Come to the supposed place of the utility under the voltage or induced voltage in frequency 50(60)Hz.

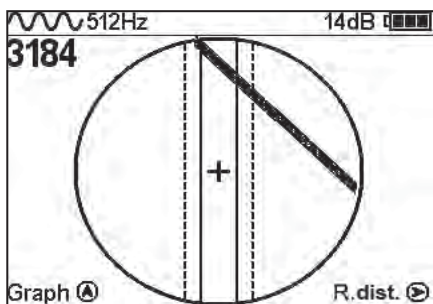
2. If the utility is far from the operator, you will see on the screen:



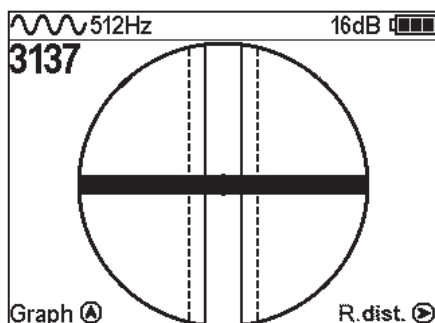
3. When moving towards the supposed place of the utility location, the “ball” will appear on the screen. It shows the presence of a utility and that it is a significant distance from the operator.



4. The “ball” position shows the direction of the utility relative to the operator.



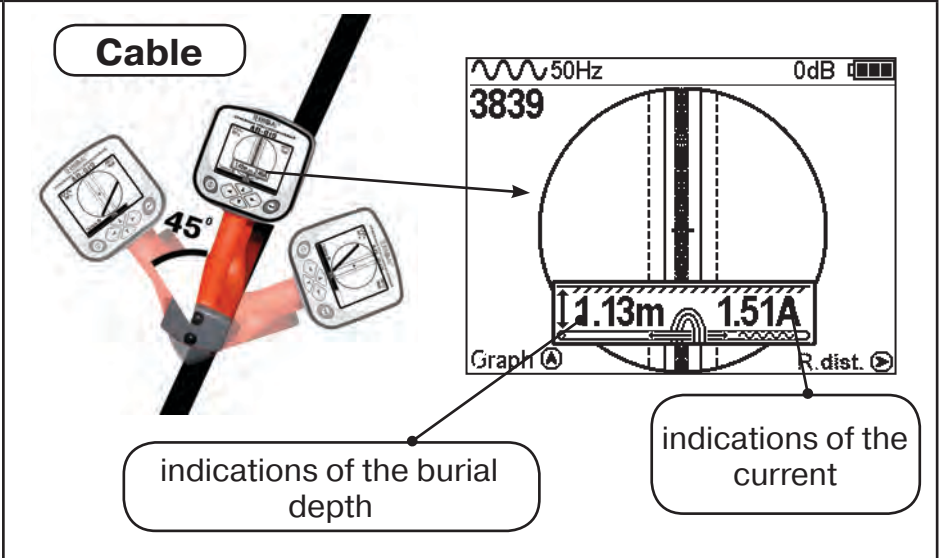
5. When the operator moves closer to the utility, the axis will move to the centre of the circle. This means that the operator is standing directly over the utility



The measurement of the burial depth of utility

7. Further you should rotate the device, until the utility axis is aligned along the receiver axis. In this position, given 'f' (the current in the cable) is sufficient, the window will appear displaying its burial depth and current. Now, the operator stands alongside the utility.

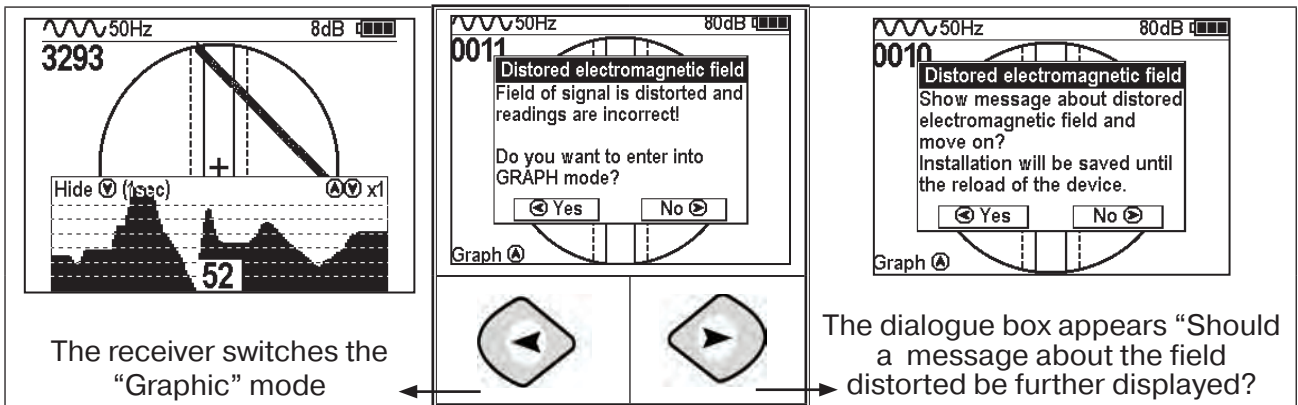
In this position, it is possible to move forward and trace a whole cable).



Note

Power cables most frequently lay at a depth of 60-80 cm, allowing to differ them from pipelines. It is possible that a cable lays in one channel with a pipeline, when the burial depth can significantly exceed 1 metre.

If the communication axis cannot be located exactly in the limited area, and the periodical jumps are happening from one border to the other, it indicates the presence of several cables under voltage with the 50 Hz frequency. You can specify number and position of the cables in "Graphic" mode.



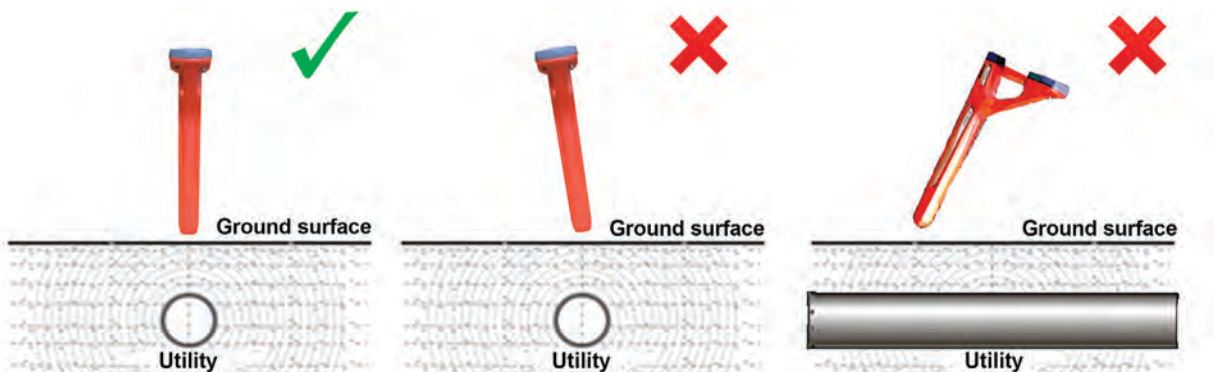
The receiver switches the "Graphic" mode

The dialogue box appears "Should a message about the field distorted be further displayed?"

In a case when the signal is significantly distorted, the receiver automatically shows the corresponding notification, offering the option of switching to "Graph" mode.

Attention:

Before measuring the depth of the utility, make sure that your device is positioned perpendicularly to the utility. Even a slight deviation from vertical position can influence the precision of the depth measurement.



5.3 Receiver's Built-in GPS Operation

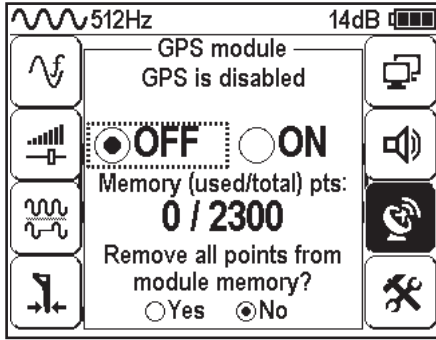


Fig.1

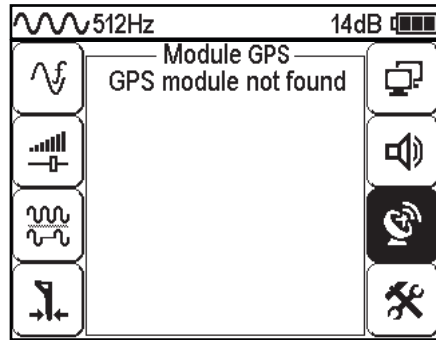


Fig.2

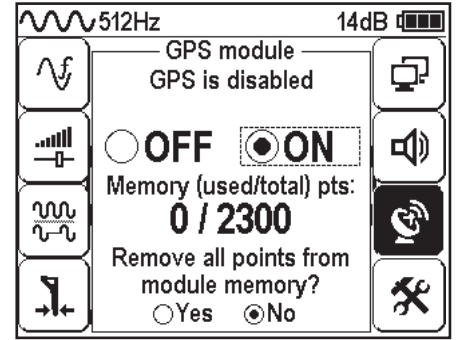



Fig.3

The GPS module works simultaneously with GPS and GLONASS signal. The internal memory and built-in module of the device allow the user to obtain the coordinates and save them together with several parameters: date, time, burial depth and current (if available) and operating frequency.

The GPS module is enabled from the main menu of the receiver.

When you open GPS  menu entry happens the following:


1. The receiver issues module connection command
2. If a response from the module is received, the receiver requests the number of available GPS points in module's memory and shows this information on the screen (see fig 1)
3. If the module doesn't respond, the receiver shows the message "GPS module not found" (see fig 2)

After turning on the GPS module, an icon starts to blink in a status bar of the receiver. It will blink while the receiver is trying to connect to the satellites. When the icon stops blinking, it means that the connection is established, and the coordinates may be obtained. Also, there is a small scale near GPS icon which represents GPS signal level. Time of satellite detection depends on the weather, availability of the satellite and can take up to 10 minutes.

The display of the receiver has the following indication:

- 1) GPS module status: a) GPS off, b) Looking for GPS satellites
- Current GPS coordinates (longitude and latitude in degrees in 5 digit precision)
- c) GPS module error
- 2) GPS ON/OFF button
- 3) GPS module memory status: shows the number of saved points in relation to available memory ("13/2300")
- 4) YES/NO buttons for module memory clearance: If you select "Yes", you will see the confirm dialogue window. Memory clearance is an irreversible action.

"POINT" is a form of entry in the device's or PC's memory. It holds current operating frequency of the receiver, burial depth of the located utility (if available), the current going through the utility (if available), current longitude and latitude of the receiver position (if available) and also current date and time (if available).

Saving of the point is performed by pressing the GPS button  on the receiver. If the GPS module is active, it finds the necessary number of satellites and indicates coordinates in the GPS menu. It means that the following data will be written in the memory: current coordinates, date and time. If the receiver indicates burial depth and/or current flowing through the utility while saving of the point is enabled, this data will also be saved in receiver's memory.

Operating mode of the receiver is saved every time because it is constantly available. When saving the data to receiver memory, you will see a corresponding message "Saving new point #X" (where X – is a serial number of the point). The receiver can store up to 2300 points. Uploading the data to a PC can be performed via USB cable and special software – Mapping Program.

5.3.1 GPS Module Accuracy

According to specifications:

GPS Quectel L86 nominal accuracy is < 2.5 sq m circular error probable (CEP). This means that in perfect conditions, every received point has 50% possibility to be located at a 2.5m radius near real position or 93% in 5m radius (see Fig 4).

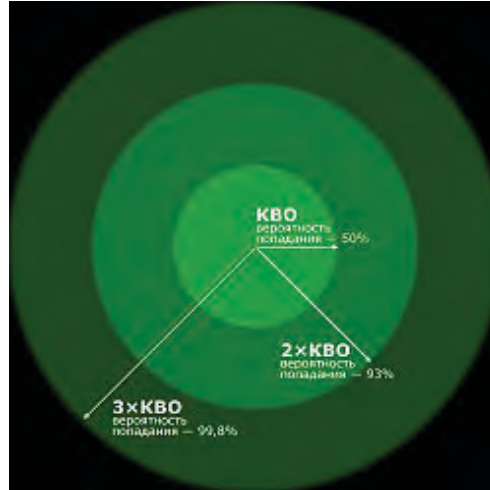


Fig. 4

Exact accuracy of the GPS device is an inconstant value and depends on many factors, such as physical obstacles, atmosphere conditions and GPS signal quality.

5.4 MapProgram

This software was developed for uploading saved GPS points from the receiver cable locator to a PC. It also indicates the points on Google maps, allows the user to edit the connections between points (track building) and also saves the data to a file (csv or kml format). All uploaded points are stored in the database. It is located in a folder with exe file. The database default name is "GPSdb"

Download MapProgram from the supplied disc. Install the software, following the instructions.

If you want to know how to use this software, please, see "Help" section in MapProgram

Download the latest version of MapProgram from website:

<http://technoac.com/mapprogram.html>

5.5 Cable Route Location in the Active Mode

This mode is used for the location and tracing of electro-conducting underground utilities (power cables, optic fibre cables with metal armouring and pipelines) by using the signal transmitter. Tracing is possible at the following frequencies: **512, 1024, 8192 and 32768 Hz.**

The filter on the receiver is set manually in accordance with the selected generator frequency.

When locating the cable route in the conditions of the large number of surrounding utilities, you should set the frequency **to 512 Hz.**

When it is impossible to ground the connection, you should select higher frequencies. To perform the cable location with damage detection, you should select a higher frequency.

Note

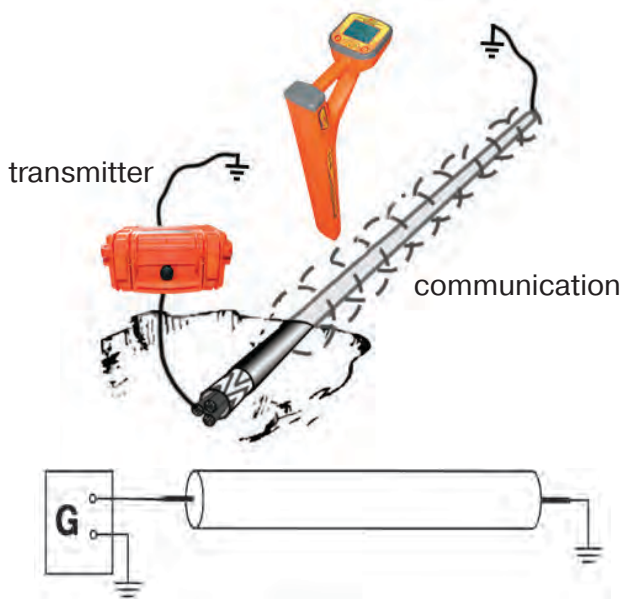
Transmitter Connection

Contact mode

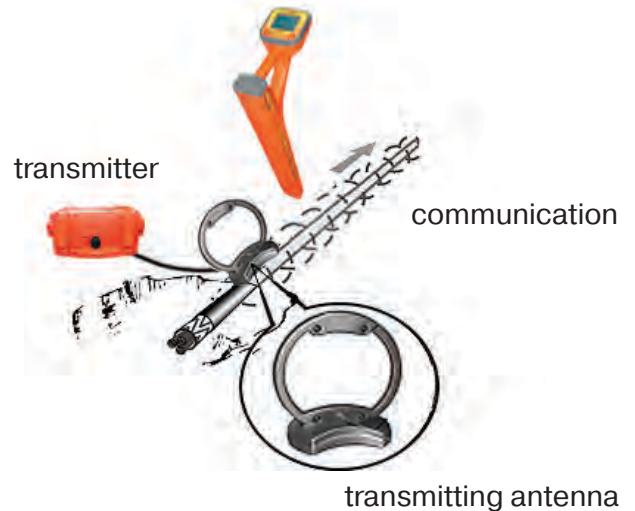
The generator output is connected directly to the communication

Contactless method

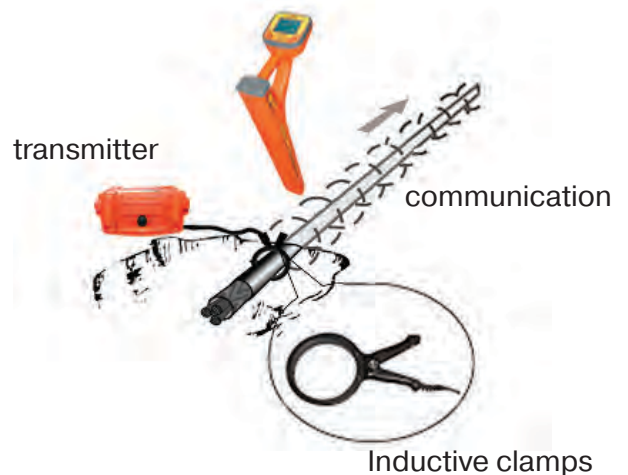
using the transmitting antenna



Contactless method
Connection with internal inductive antenna of the transmitter



Contactless method
using the induction clamps



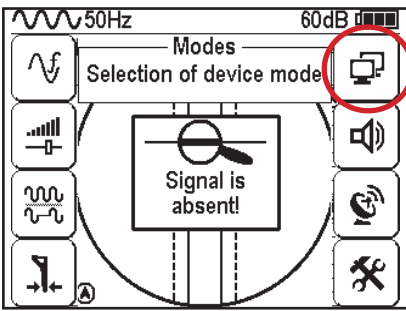


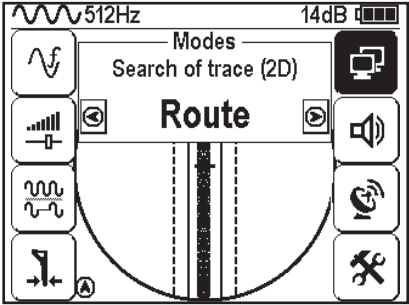


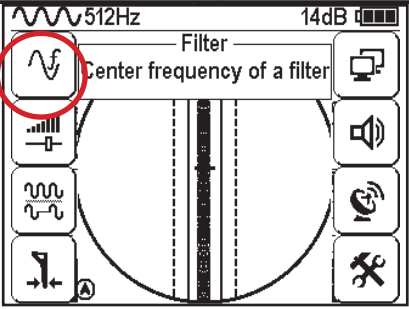


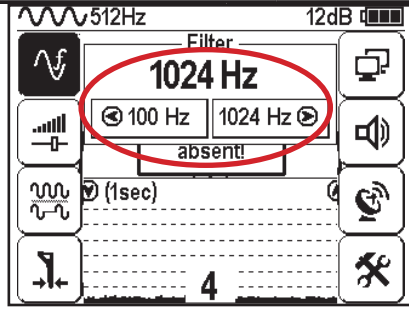




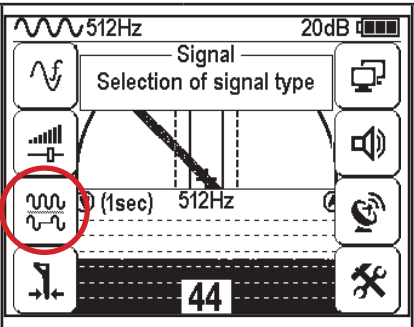


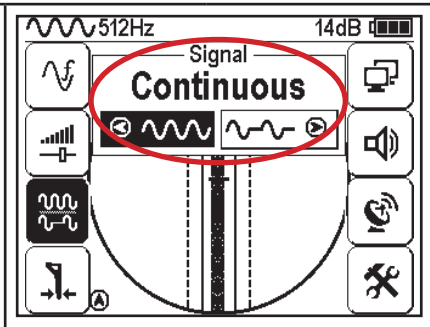


Note

Procedure for search of communication and conduction of cable route location

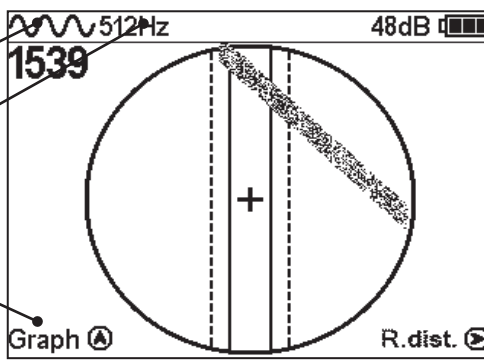

<p>1. Connect the transmitter to the utility by contact or contactless method.</p> <p>Note When possible, the preference should be given to the contact method of connection, which allows the user to perform the cable route location for more distantly.</p>	<p>2. Turn on the transmitter. Set the signal type - impulse "Co"/continuous "Pu" / pulse. The generation frequency on the transmitter - 512, 1024, 8192, 32768 Hz.</p> <p>Impulse mode (Pu) is used to increase the time of work of the transmitter.</p> <p>Continuous signal (Co) makes it possible to conduct simultaneously with the routing and the diagnostic of the faults of the power cable.</p>
<p>3. Start the generation, wait for the transmitter to power up.</p>	<p>4. Proceed with the setting of the receiver</p>

Setting of the receiver for the active search. "Route" mode

<p>Turn on the power</p> 	<p>Press "Enter" button to open the menu</p> 	 <p>Select the icon "Modes" in the menu</p> <p>buttons</p> 	<p>To confirm your selection press "Enter" button.</p> 	 <p>Select the "Route" mode</p> <p>buttons</p> 
<p>Press "Enter" again to return to main menu.</p> 	<p>Select "Filter" in the menu.</p>	 <p>buttons</p> 	<p>To confirm your selection press "Enter" button.</p> 	 <p>Set the filter frequency corresponding to the transmitter frequency, for example 1024 Hz</p> <p>buttons</p> 

 <p>Press "Enter" again to return to main menu</p>	 <p>Select "Signal" in the menu</p> <p>buttons</p> 	 <p>To confirm your selection press "Enter" button</p>	 <p>Select the type of signal</p> <p>buttons</p> 	 <p>Press "Enter" again to return to main menu</p>
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View of the Receiver Screen for Route Location in the Active Mode

<p>The input signal type set in the receiver (continuous)</p>	
<p>The set filter frequency - 512 Hz</p>	
<p>A hint for switching to the "Graphic" mode by the short pressing of the button </p>	

Having set up the receiver, you can start locating communication and determine its burial depth **similarly to p. 5.2.**



When working in the "Route" mode, the following can sometimes occur:



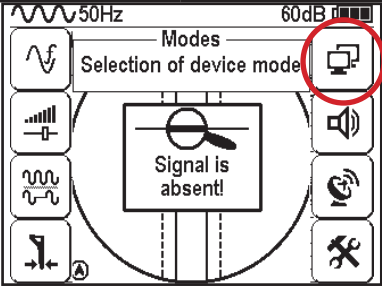

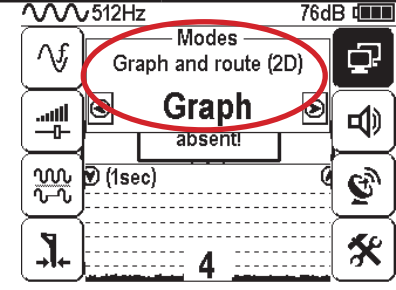

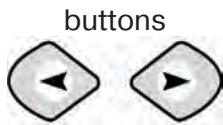

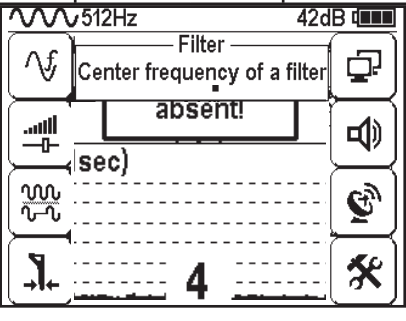

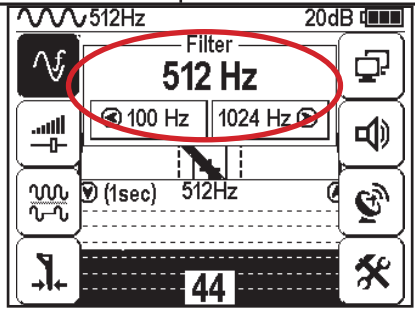


- the positioning of the utility axis into the centre is impossible
- the presence of several near located communications
- low signal in the cable

In these cases, you should switch to the "Graph" mode.

6. Search of Utilities in “Graph” Mode


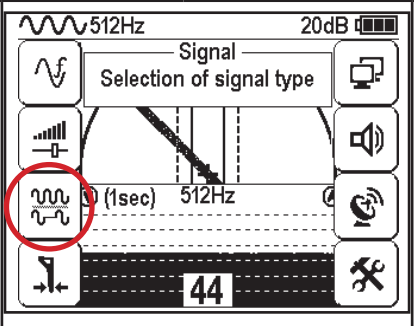

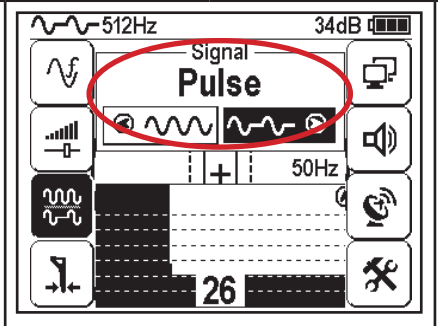



The “Graph” mode is the support mode and is able to locate various utilities (cables and pipelines), both in the passive and active modes with the route locating transmitter. In passive mode, the cable location is carried out at frequencies of **50(60) and 100(120)Hz** and in the active mode - **512, 1024, 8192 and 32768 Hz**. The “Graph” mode can be used to determine the number of the near located utilities. The “Graph” mode also allows the user to perform the route location in conditions of low signal on the utility, when the route location in the “Route” mode is impossible. The measurement of the burial depth and current is not available in this mode. In the “Graph” mode, the receiver screen displays the moving diagram of change in the signal level, depending on the time by the “maximum” method - when located over the utility, the signal is maximum, and when deviating from the axis, the signal decreases.

6.1 Setting of the Receiver for Work in the “Graph” Mode

<p>Turn on the power</p> 	<p>Press “Enter” button to open the menu</p> 		<p>To confirm your selection press “Enter” button</p> 	
<p>Select “Modes” in the menu</p>		<p>buttons</p> 	<p>Select the mode “Graph”</p> <p>buttons</p> 	
<p>Press “Enter” again to return to main menu</p> 		<p>To confirm your selection press “Enter” button</p> 		
<p>Select the “Filter” in the menu</p>		<p>buttons</p> 	<p>Set the filter frequency in accordance with the generator frequency, for example, 1024Hz</p> <p>buttons</p> 	


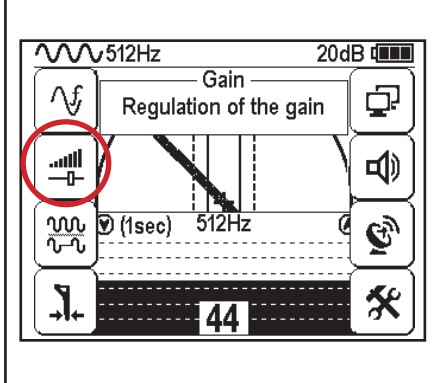

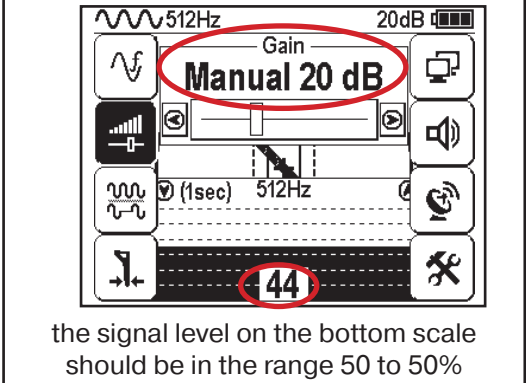



* At the active search, the signal should be transmitted on the route from the generator with the same frequency as on the receiver (p. 5.5).

In the **“Graph”** mode the work is performed in the **“Continuous”** or **“Impulse”** signal. The difference at the work with the **“Impulse”** signal is in that the digit in the center of the analogue scale shows not the current value of the signal, but the maximum value (amplitude) of the transmissions of the interruptible signal from the route locating transmitter. The pitch of the tone of the sound synthesized also corresponds to the maximum value of the signal for the period of the impulse transmitted.

 <p>Press “Enter” again to return to main menu.</p>	 <p>512Hz 20dB</p> <p>Signal Selection of signal type</p> <p>44</p>	 <p>To confirm your selection press “Enter” button.</p>	 <p>512Hz 34dB</p> <p>Signal Pulse</p> <p>50Hz</p> <p>26</p>	 <p>Press “Enter” again to return to main menu.</p>
	<p>Select “Signal” in the menu.</p>	<p>buttons</p> 	<p>Select the signal type, for example, impulse, and in accordance with the generator signal</p>	<p>buttons</p> 

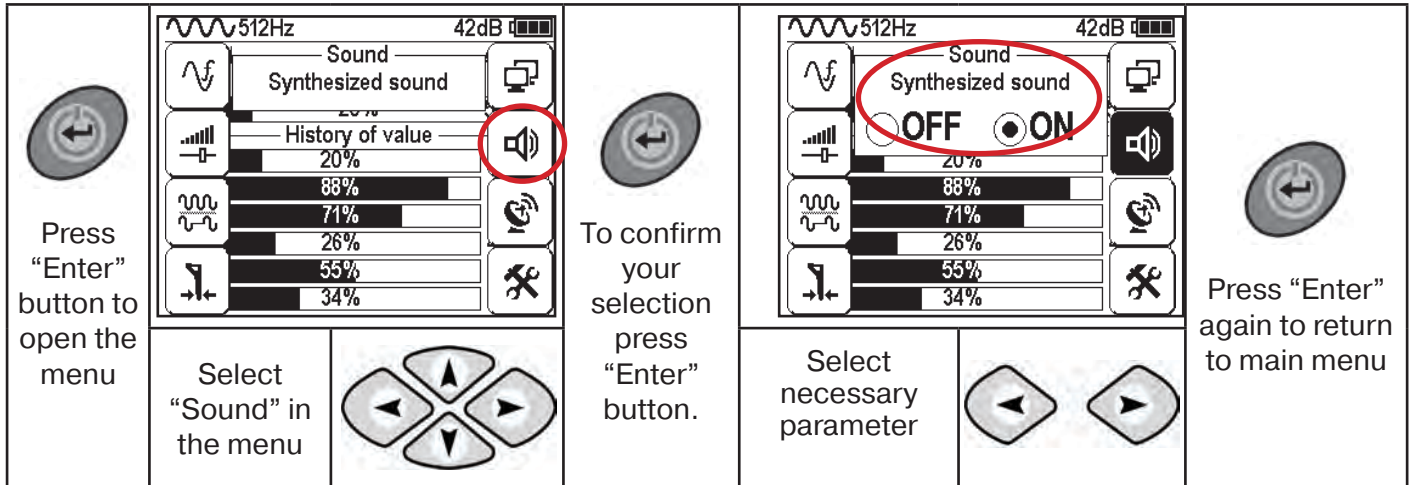
Note When working in the passive mode **50(60) Hz, 100(120) Hz** - you should always select the **continuous type of the signal**.
 When working with the generator (in the **active mode**) **512, 1024, 8192 Hz, 33 kHz** - the type of the signal on the receiver is **continuous or impulse**, in accordance with the signal set on the transmitter.

During the route location, you can manually set the input signal amplification.

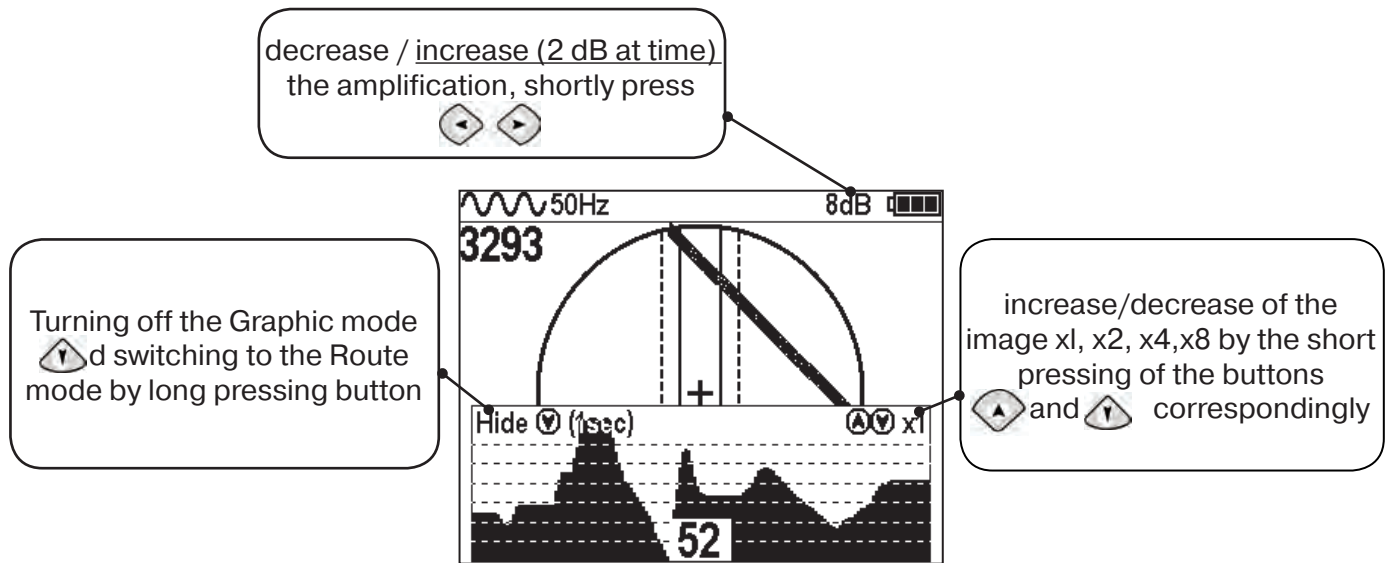
 <p>Press “Enter” button to open the menu</p>	 <p>512Hz 20dB</p> <p>Gain Regulation of the gain</p> <p>44</p>	 <p>To confirm your selection press “Enter” button..</p>	 <p>512Hz 20dB</p> <p>Gain Manual 20 dB</p> <p>44</p>	 <p>Press “Enter” again to return to main menu.</p>
	<p>Select “Amplification” in the menu.</p>	<p>buttons</p> 	<p>the signal level on the bottom scale should be in the range 50 to 50%</p> <p>Set the amplification coefficient, for example, 20 dB</p>	<p>buttons</p> 

The change of the input signal amplification coefficient should be performed manually by short pressing buttons   or semi-automatically by holding one of them pressed for 1 sec.




In the “Graphic” mode it is possible to listen synthesized sound through the built-in speaker, The sound tone pitch changes depending on the signal level.



6.2. “Hot” Keys for Work in the “Graph” Mode



Note If the signal occupies the whole graphic (the black string), it is necessary to perform the following actions:

1. Decrease the graphic scale to the value x1 by pressing button 
2. Decrease the signal amplification coefficient by pressing button  until the appearance of the decrease of the input signal level is less than 80%.
3. In case of low signal, increase the amplification coefficient by pressing the button and the scale by pressing this button 

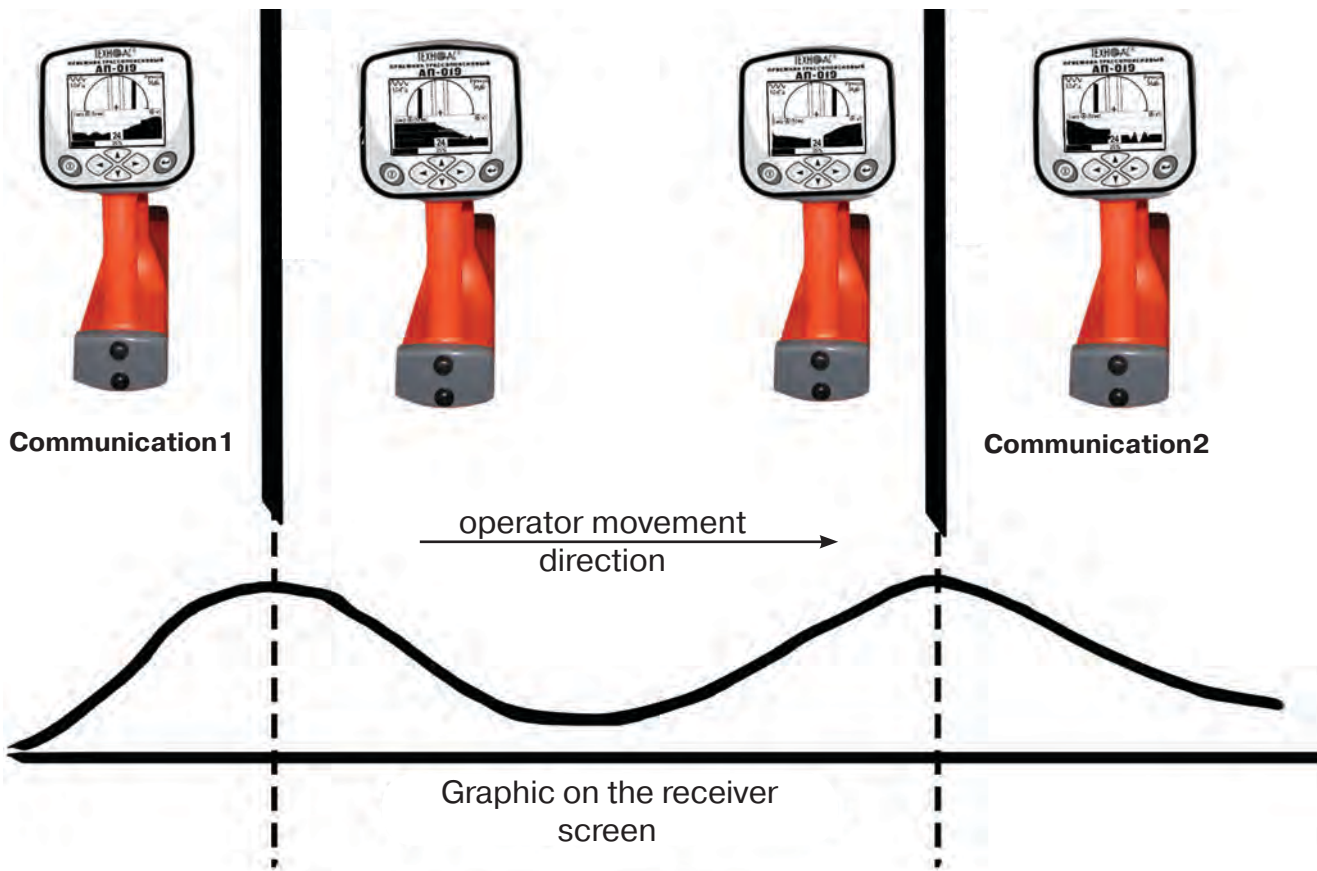
6.3. Search of Utilities in “Graph” Mode

1. Perform the receiver setting - select the Graphic mode
2. Locate the receiver in parallel to the supposed axis of the utility, slowly move in the direction, as shown in the figure below.
3. Slowly move the receiver towards the area where you previously experienced problems locating the utility.

You can see the example of operation on this picture:



In the presence of two utilities, the approximate view of the graphic on the receiver screen is shown in the figure.



4. You should locate the utility by the maximum signal level.

7. Search of Utilities in “Graph+” Mode

The “Graph+” mode is available in the advanced set of modes. “Graph+” is the auxiliary mode. This mode differs from the mode “Graph”, as it shows a “2D” image compatible with the graphic, not the relative position of the route, but automatically demonstrates the presence and provision of the near “power” cable under the voltage with the frequency 50(60) Hz.

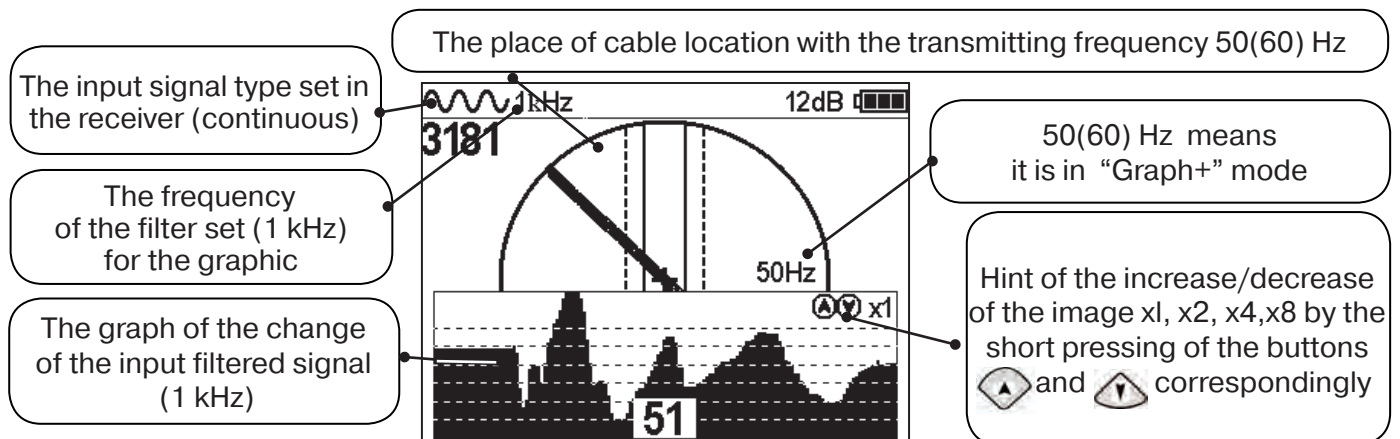
7.1 Setting of the Receiver for Work in the “Graph+” Mode

The setting of the receiver and use of the “hot keys” for work in the mode “Graph+” fully matches with the setting of the receiver for the “Graph” mode (see sections 7.1 and 7.2).

7.2 Search of Utilities in the “Graph+” Mode

<p>Note</p> <p>1. 1. Connect the transmitter to the communication by contact or contactless method.</p> <p>When possible, preference should be given to the contact method of connection, which allows the user to conduct the cable route location more distantly.</p>	<p>Note</p> <p>2. Turn on the transmitter . Set the signal type - impulse “Pu”/continuous “Co”. The generation frequency on the generator: - 512, 1024, 8192, 32768 Hz. Impulse mode is used to increase the working time of the generator. Continuous signal provides the option to perform simultaneously with the routing the diagnostic of the faults of the power cable.</p>
<p>3. Set up the receiver for work in the “Graph+” mode (section 7 1), set the frequency and type of the signal the same as on the transmitter</p>	<p>4. Start the generation, wait for the transmitter to power up.</p>

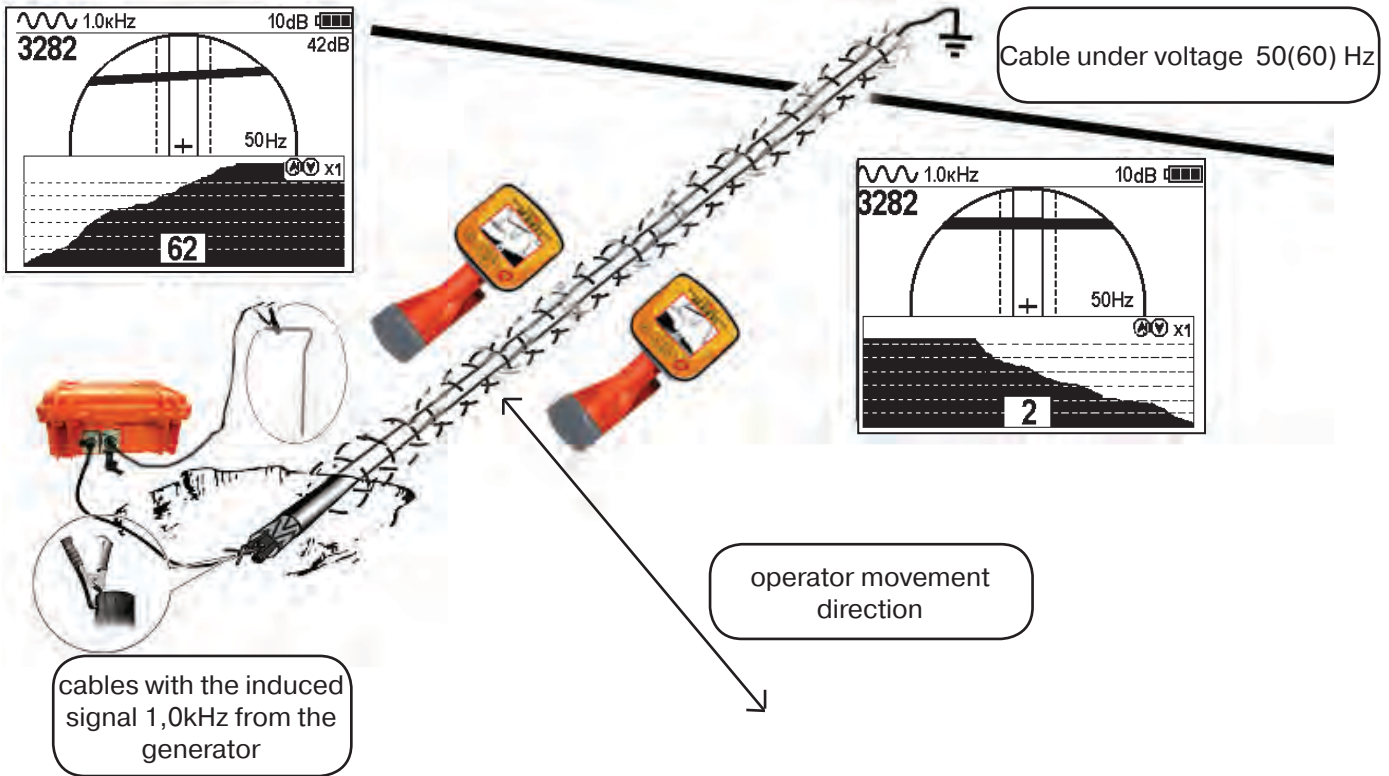
View of the Receiver Screen for Route Location in the Active Mode



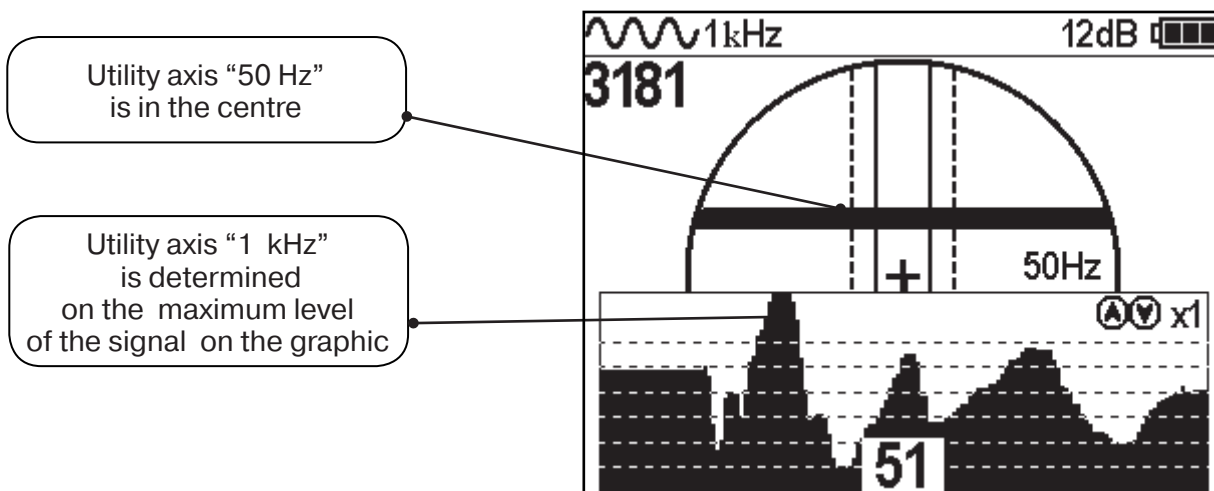
5. Approach the supposed place of cable route, on which the signal from the generator was transmitted. Locate the receiver axis in parallel to the utility axis.

The graph showing the change in the signal level will be displayed on the screen in frequency 1 kHz, on the 2D image of the route of the cable located near (if any) will be displayed under the voltage 50(60)Hz.

You should move the receiver as shown on the figure.



The place of the crossing of the cable corresponds to the setting of the pointer “50 Hz” onto the centre of the circle at maximum value of the indication on the “Graph” of the active frequency signal.

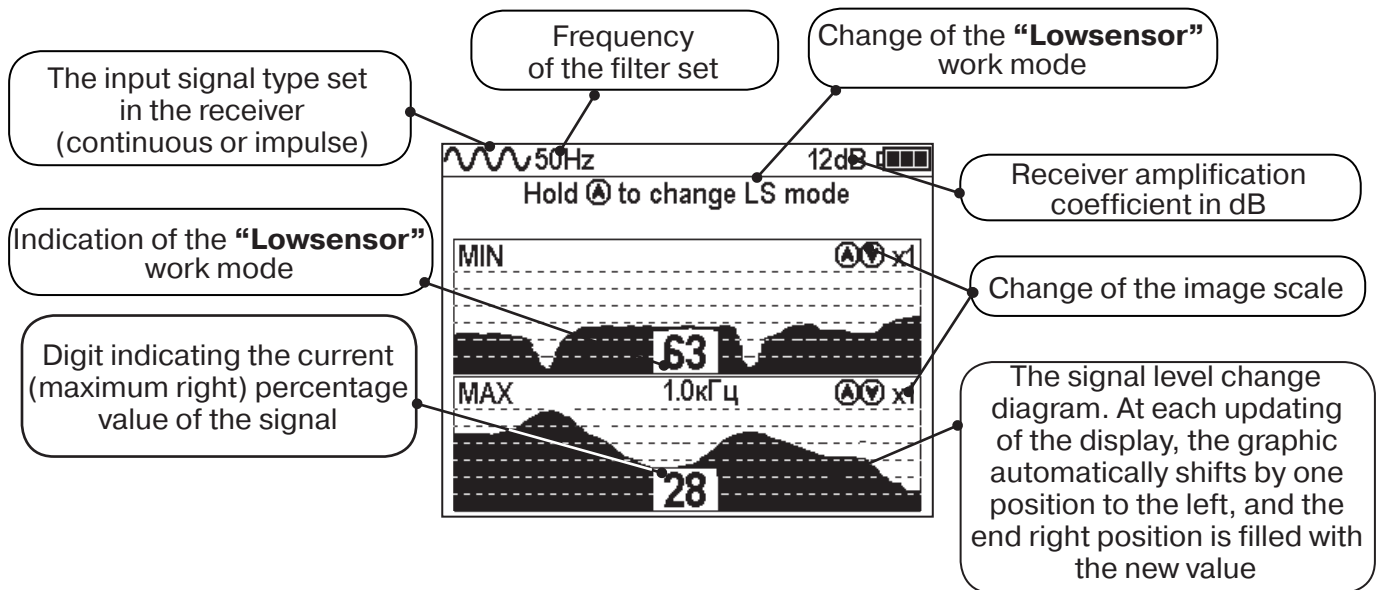


8. Performing a Cable Location in the Mode “MIN & MAX”

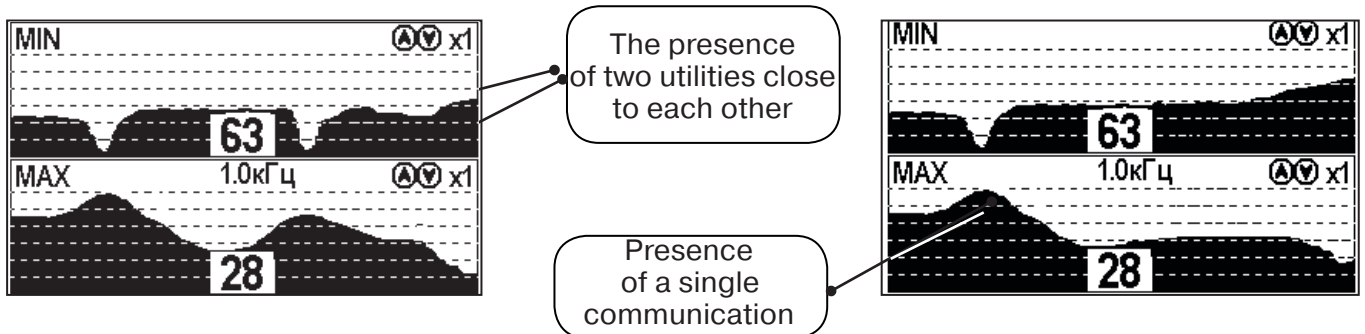
In the mode “**MIN & MAX**”, the device works simultaneously both on the method “maximum” and the method “minimum”. This mode is used in the conditions of distorted field, in the presence of nearby utilities and at the low induced signal. It allows the user to perform location and to determine the presence and location of utilities located nearby.

In the “**MIN & MAX**” mode, the receiver display is divided in two halves. The moving diagram of the signal level change is displayed in the upper part by the “**minimum**” method - when located over the cable, the signal is minimal, and when deviating from the axis, the signal increases. The bottom half of the screen shows the moving diagram of the signal level change depending on the time by the “**maximum**” method - when you stand over the cable, the signal is maximum, and when deviating from the axis, the signal decreases.

In this mode, the value of the depth and current in the utility are not displayed.



The cable route location is performed similarly to route location in the “Graph” mode, orienting on the maximum level of the signal on the lower scale of the graphic and the minimum level of the signal on the upper scale. To determine the number of the nearby utilities, you should step aside from the axis of the located cable and go straight across to the utility axis to visualise the amount and place of the route of utilities.



9. Performing Cable Route Location in “2 Frequencies” Mode

The mode “2 frequencies” was added so the user could determine the signal direction in cables.

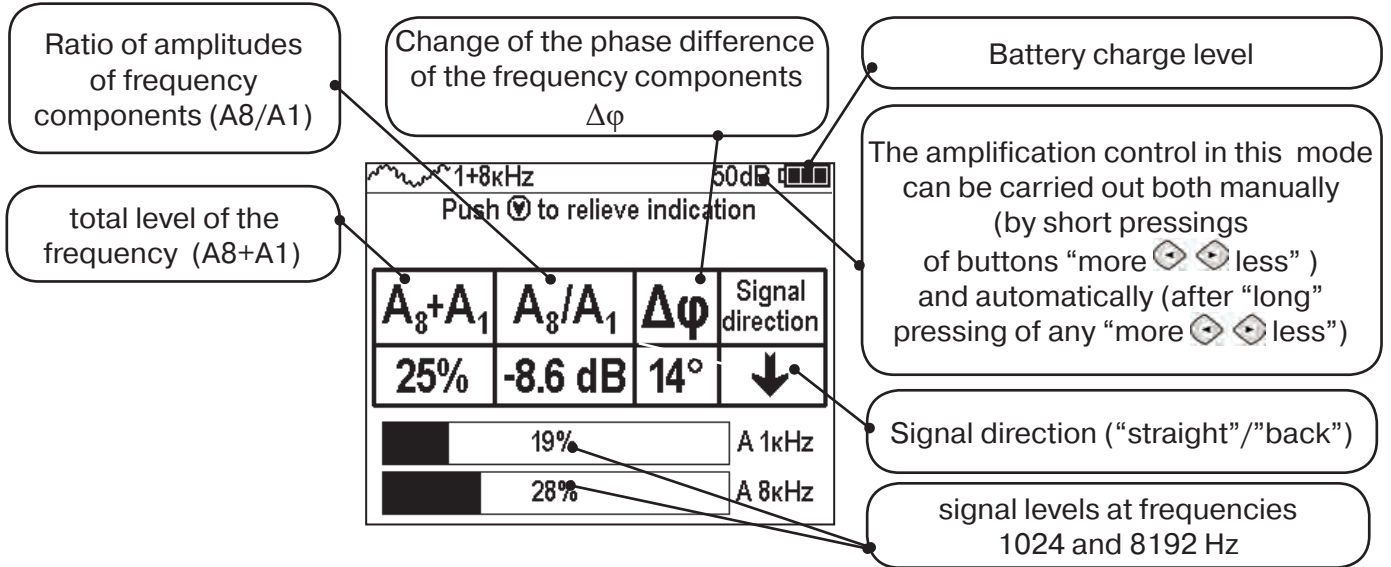
Additional possibilities of the mode are described in App. 2:

Append. 2 p.3 Amplitude “two-frequency” method “ ΔA ”;

Append. 2 p.4 Phase “two-frequency” “ $\Delta\phi$ ”



The mode “2 frequencies” is realised only with the contact method of connection of the transmitter.

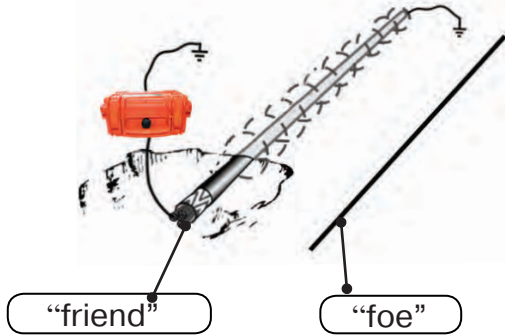


1. One output of the transmitter should be connected to the point of the utility that is more distant from the supposed place of the defect (start of the diagnostic site). The other output of the generator is grounded on the maximum possible distance from the utility from the other side (end of the diagnostics site). The buried service should be earthed (or grounded) as far away from it as possible.





2. The transmitter in the mode “2F” sends to the utility the signals of two frequencies (1024Hz and 8192Hz) simultaneously.

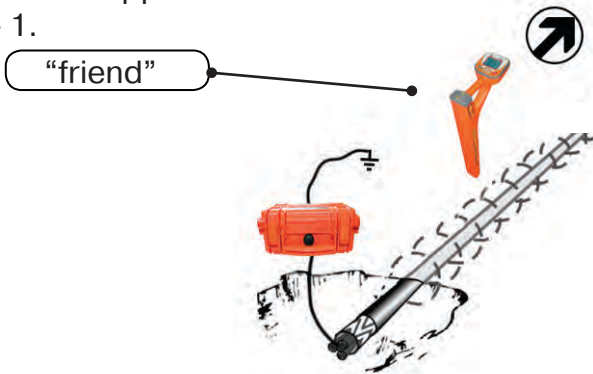
3. The signal from the utility, to which the route locating transmitter is directly connected, is conventionally named - "friend". The "parasitic" signal from the nearest utility, on which the generator signal is transferred, is conventionally named as "somebody else's".





4. Based on the direction of the "arrow", it is possible to distinct a "friend" signal from a "foe" one, since the current direction in "friend" utilities is opposite the "transferred" currents flowing through "foe" utilities.

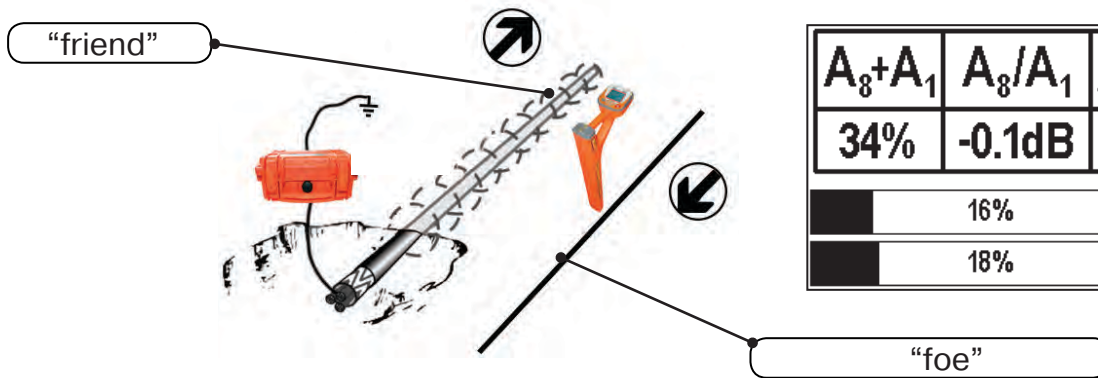
A_8+A_1	A_8/A_1	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↑
 16%	A 1kHz		
 18%	A 8kHz		



5. "Signal direction - forward" is the conventional concept and "assigned" by the operator, for this position of the sensor relative to the route. The "assignment" is performed by the pressing of the button "⏸"; when the sensor is located exactly over the "allocated" utility that is supposed to be a "friend". After that, the pointer of the signal direction takes the form - 1.



A_8+A_1	A_8/A_1	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↑
 16%	A 1kHz		
 18%	A 8kHz		

When switching to the "foe" communication with the other "signal direction" (or at the change of the sensor position to the "reverse"), the sound will be emitted (if switched on) and the arrow will show the "signal direction - back 1".

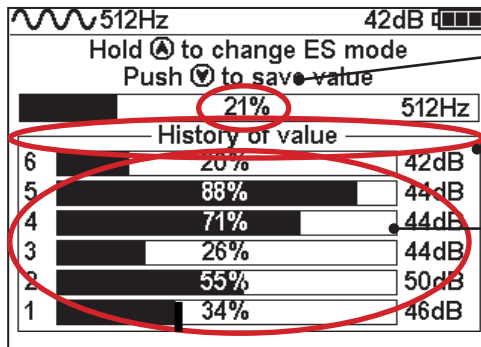


A_8+A_1	A_8/A_1	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↓
 16%	A 1kHz		
 18%	A 8kHz		

10. The work mode «Cable selection from a bunch»

The mode «Cable selection from a bunch» is switched on and off automatically with the connection and disconnection of the external sensor (**ES**) **CI-105/110** (inductive clamps) or **NP-117** superimposed frame).

The mode is intended for selection of the «allocated» cable from the bunch of cables on the basis of maximum signal emitted by this cable. The selection can be carried out at all the frequencies supported by the receiver.



The level of the filtered signal from the sensor CI-105/110 or NP-117 in percentage

The current level of the signal and the amplification coefficient for the moment of measurement

Six lines for signal level and amplification coefficient values stored by the user. At each storage the content of all lines moves by one position down

10.1. The work with the receiver in the mode «Selection of the cable from a bunch»

Attention! In order to select the allocated cable from a bundle, you should provide the flowing of the current of the current on the set frequency and form through it. To do this, it is necessary send into the searchable cable the signal from the route locating generator by the contact or contactless method and provide the «current return» to the generator (for example, through the ground). All output ends of cables of the bunch should be connected to the «return» circuit.



Fig. 10.1


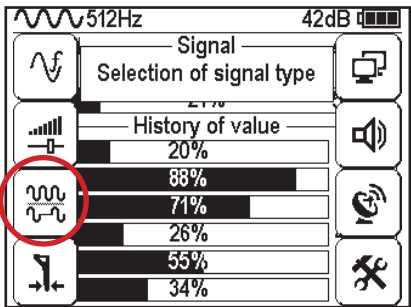

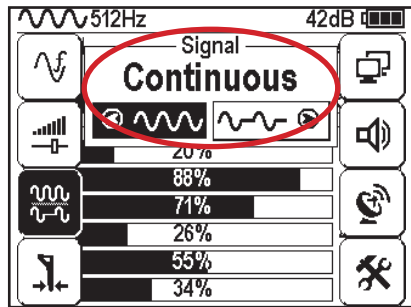





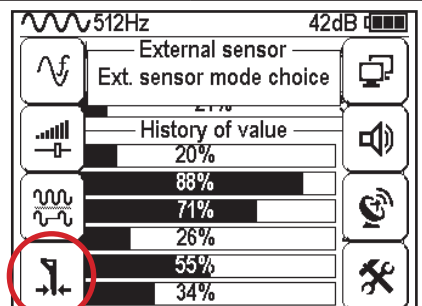

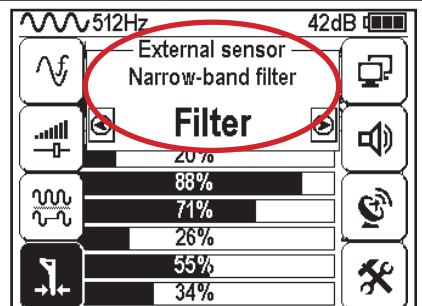



Fig 10.2

Connect inductive «clamps» CI-105/110 using the cable-adapter for «clamps» to the receiver (**fig. 10.1**) or NP-117 (**fig. 10.2**).

 Turn on the power	 Press 'Enter' button to open the menu	 Select «Filter» in the menu.	 To enter the change mode
		Set the working frequency, for example, 512 Hz (*)	

(*) at that the signal should be sent into the cable from the transmitter with the same frequency 512Hz

 <p>Press 'Enter' again to return to main menu.</p>		 <p>To confirm your selection press 'Enter' button.</p>		 <p>Press 'Enter' again to return to main menu.</p>
	<p>Select «Signal» in the menu.</p> 		<p>Select the signal type corresponding to the signal type from the transmitter, for example, continuous.</p> 	

	 <p>To enter the selection</p>		 <p>To exit from the menu you should press the button «Enter». If you will wait for several seconds, menu icons will disappear.</p>
<p>Select the icon «Mode of the lower sensor» in the window.</p> 		<p>Select the mode of the bottom sensor «Filter»</p> 	

Install on «induction clamps» CI-105/110/110 (fig. 10.3) or apply NP-117 (fig. 10.4) onto the one of cables.



Fig. 10.3

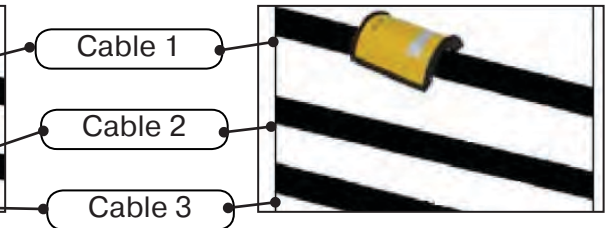

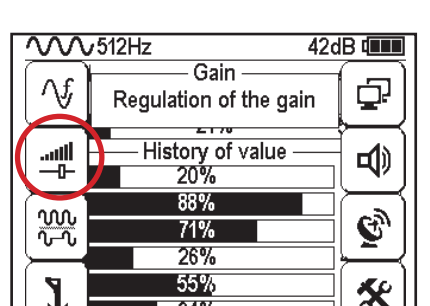

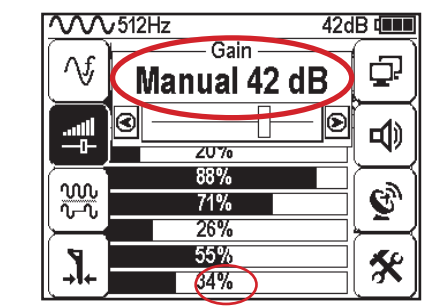



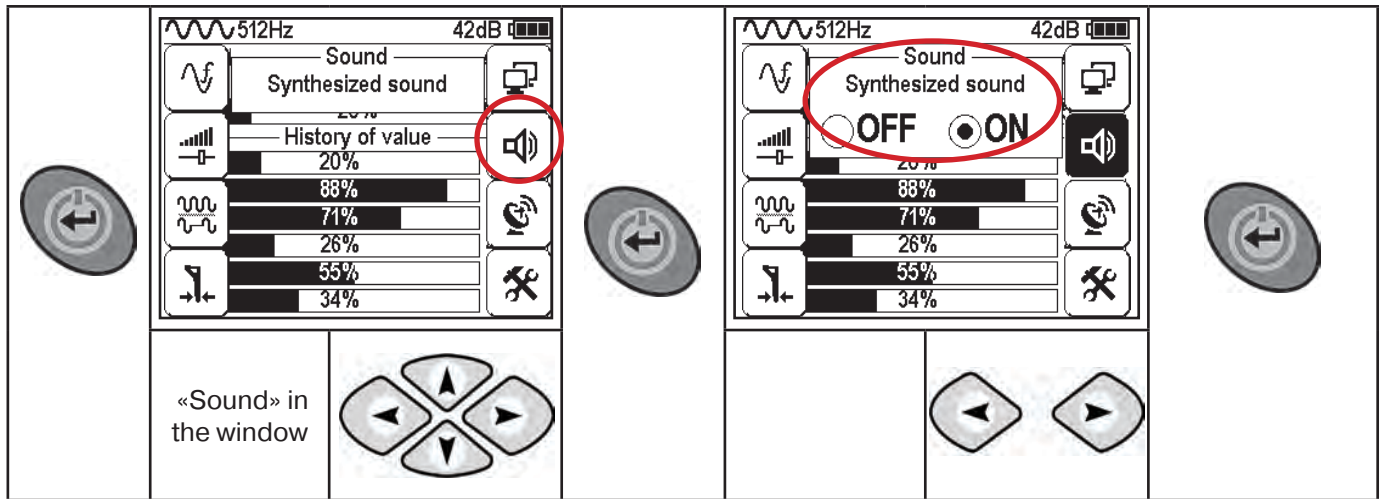


Fig. 10.4

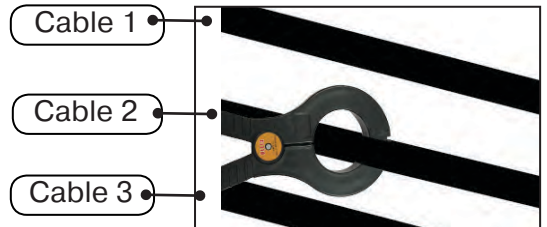
 <p>Press 'Enter' again to return to main menu.</p>		 <p>To confirm your selection press 'Enter' button.</p>	 <p>the signal level on the bottom scale should be in the range 50 to 80%</p>	 <p>Press 'Enter' again to return to main menu</p>
	<p>Select «Amplification» in the menu.</p> 		<p>Set the amplification coefficient, for example, 40 dB</p> 	



Save parameters of measurement into the memory by pressing the button

Alternately putting on «Inductive clamps» or applying a attachable frame to the cables bundle, find «isolated» cable by the higher level of the signal (Fig. 10.5).

The tone pitch of the synthesised sound correspond to the signal value (including and «impulse» amplitude)



Note

To compare the signals, you should perform measurements at the equal amplification coefficient.

In the example (fig. 10.5) it is possible to compare values only with the amplification 42 dB. The maximum of them is the value under the number 5.

The maximum signal 80% (42 dB) corresponds to the cable No.2

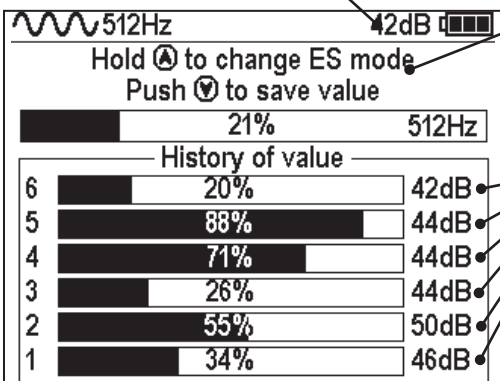
	32%	512Hz
History of value		
6	38%	42dB
5	61%	42dB
4	48%	42dB
3	10%	32dB
2	27%	36dB
1	14%	36dB

Fig. 10.5

10.2. «Hot» keys for the work in the mode «Selection of the cable from the bunch»

step-by-step (by 2dB) decrease / increase coefficient of the amplification, sequential pressings

switching between modes of work of the external sensor (ES) is carried out by the holding of the button more than 1 sec. «WB» - range of frequencies 0.04..8 kHz «Radio» - range of frequencies 8, 40 kHz at absence of the value corresponds to the frequency of the set filter (here - 1,0 kHz)



The storage of the parameters of measurement (signal level from the sensor connected and amplification coefficient) into the memory using the button (the memory keeps last six measurements)

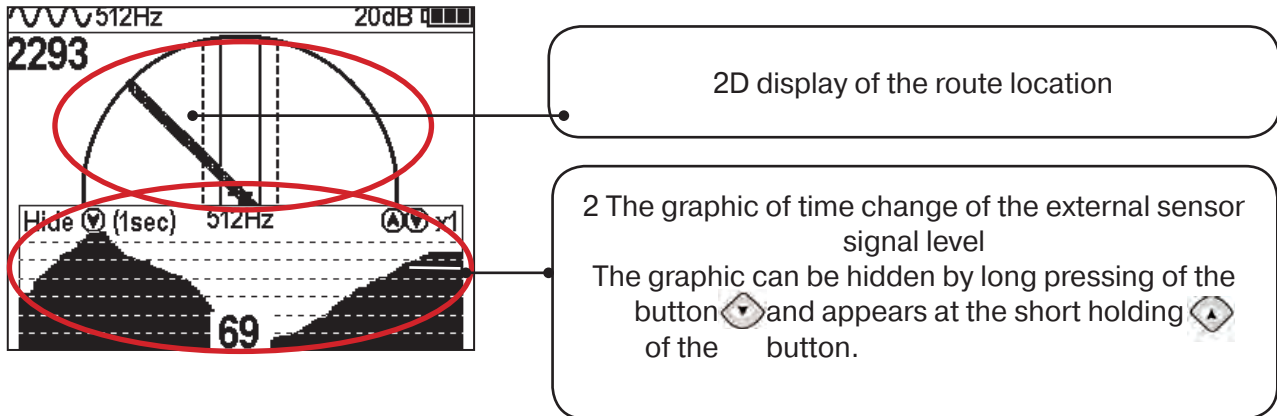
Note

In the mode «Cable selection from a bunch» using the external sensor, the work with the continues and impulse signal is supported (menu option «signal», table 1 p.3). The difference at the work with the «Impulse» signal is in that the digit in the center of the analogous scale shows not the current value of the signal, but the maximum value (amplitude) of the transmissions of the interruptible signal from the route locating transmitter made by TECHNO-AC.

11. Mode «Search of defects» using external sensors

The mode 'Search of defects' is switched on and off automatically, when connecting and disconnecting external sensors DKI-117, DOLK-117. The mode «Search for defects» with external sensors DKI-117/DODK-117 was added for search of insulation defects.

The search of defects of cable defects can be carried out at all frequencies both in an active, and passive modes.



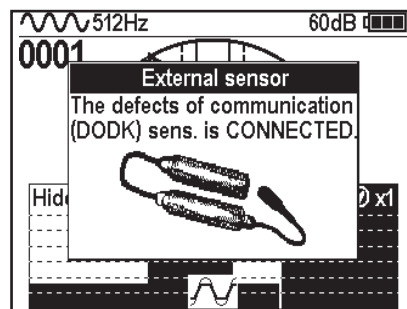
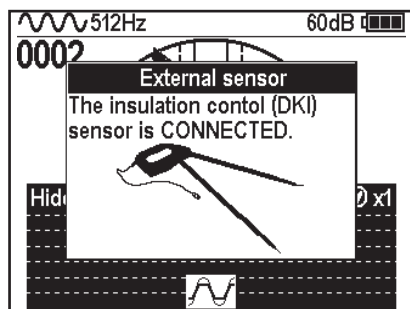
11.1. The work with the receiver in the mode «Search for defects»



Fig. 11.1



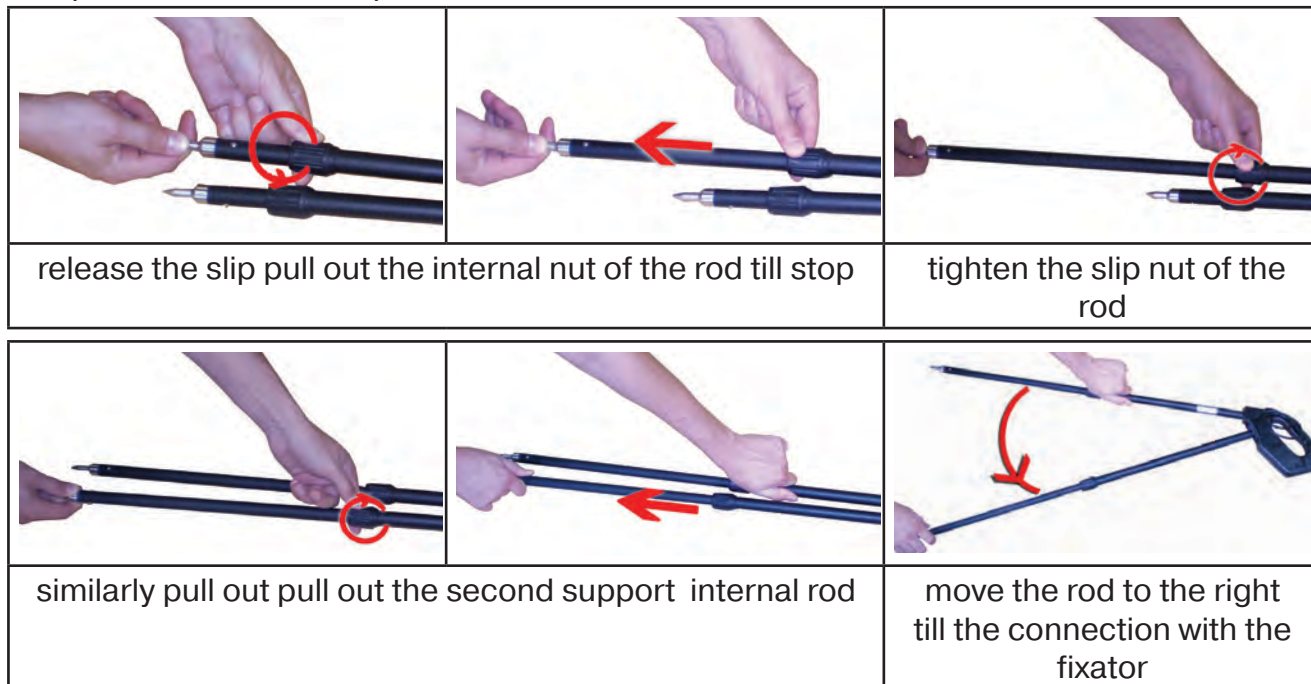
Fig. 11.2



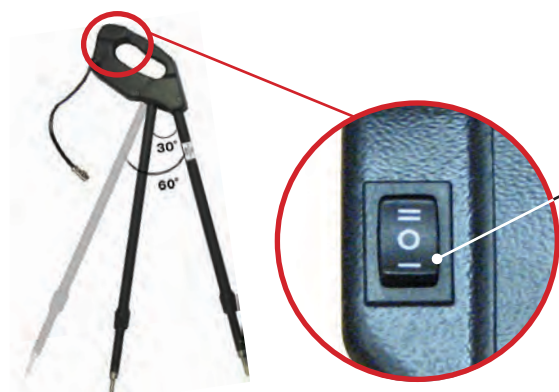
- Connect to the sensor to the receiver of the insulation control DKI-117 (fig. 11.1) or DODK-117 (fig. 11.2).

Preparation of the sensors for work DKI-117

Prepare the sensor for operation.



The average position of the fixator corresponds to the angle 30, end - angle 60 (fig. 11.3). Maximum distance between electrodes corresponds to the maximum sensibility.



- 3-position switch of the weakening
- in the position «O» - signal 100%
 - in the position «I» - the signal is weakened in 5 times
 - in the position «II» - the signal is weakened in 25 times

Fig. 11. 3.

Before starting the operation you should set the switch into the position «O». If during the search process, with the amplification coefficient 0 dB, the input signal level is greater than 70%, you should switch the sensor regulator to «I» position and with a further increase of the signal to the position «II», and then perform the adjustment of the coefficient of amplification of the receiver to the level of the input signal 50 to 80%. (Fig. 11.4)

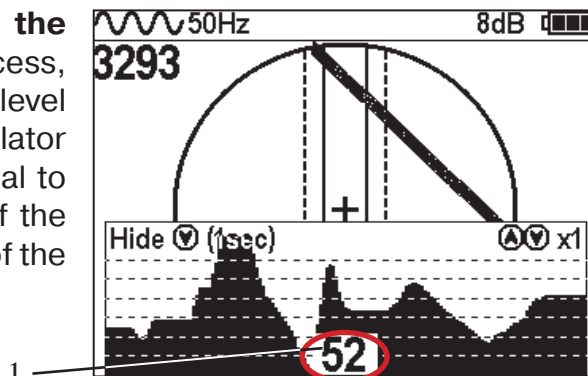


Fig. 11.4

DODK-117

The survey shall be performed by two operators, the one operator has the measuring electrode, and the second one has the measuring electrode and receiver (fig. 11.5). Based on the receiver indications, you can locate the damaged cable (by methods described in the application 2 p. 1-2).

NOTICE!

When working with the sensor DODK, the electrodes should be used without gloves, providing the contact of the sensor with a skin (fig. 11.6)




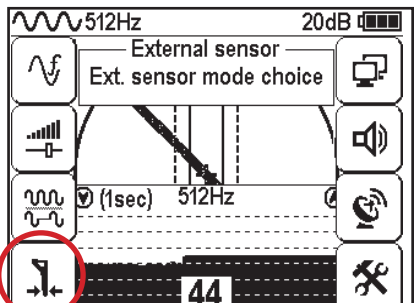


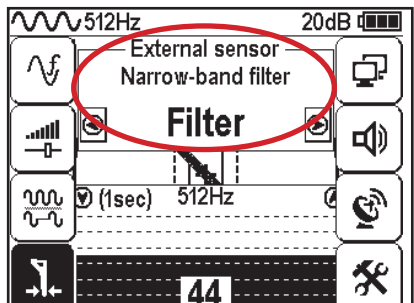


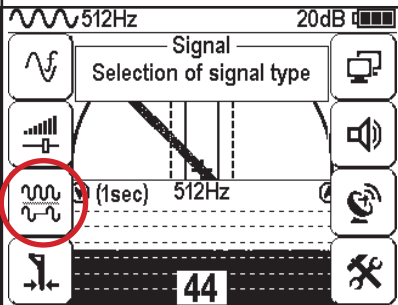


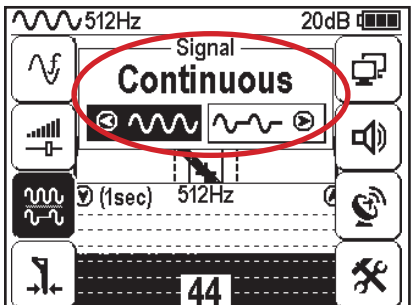

Fig. 11.5



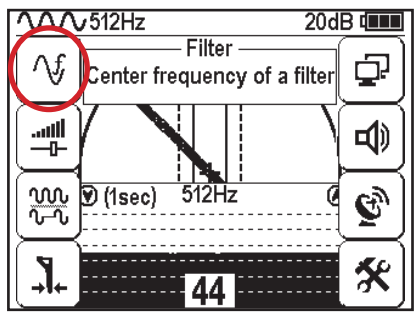


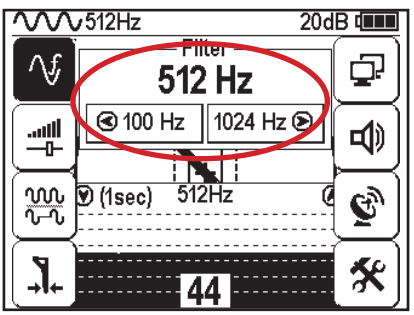



Fig. 11.6

Receiver setting

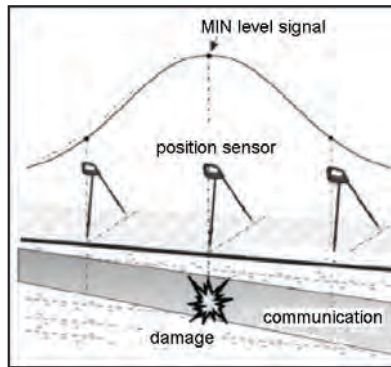
1. Turn on the receiver
2. Set the work mode of the lower sensor to the value «Filter»
3. Set the working frequency and type of the signal:

 <p>To call out of the menu press the button «Enter»</p>	 <p>Select the icon «Mode of the lower sensor» in the window.</p> 	 <p>To change of the parameter selected, press the «Enter» button.</p>	 <p>Set the value signal «Filter»</p> 
 <p>To exit the change mode</p>	 <p>Select the icon «Signal» in the window.</p> 	 <p>To enter the change the parameter selected, press the «Enter» button.</p>	 <p>To exit the setting of the parameter, press the «Enter» button.</p> 

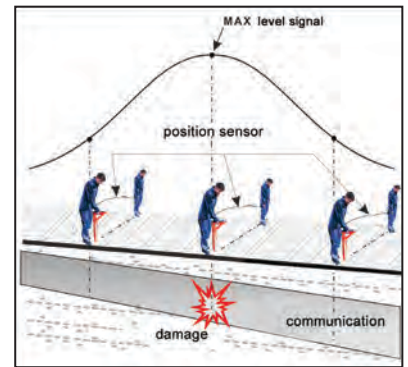
 <p>To call out of the menu press the button «Enter»</p>	 <p>Filter Center frequency of a filter</p>	 <p>512Hz 20dB</p> <p>Select the icon «Filter» in the window.</p> 	 <p>To change the parameter selected, press the Enter button.</p>	 <p>512Hz 20dB</p> <p>512 Hz</p> <p>100 Hz 1024 Hz</p> <p>512Hz</p> <p>44</p> <p>Set the working frequency, for example, 512 Hz (*)</p> 
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Wait for several seconds till menu icons disappear

The search of insulation damage should be started by the method «MAX» (fig. 11.7, 11.8) (see. appendix 2). Move along the cable axis, mark the place cable signal (start of the signal rise, place of the maximum detection).



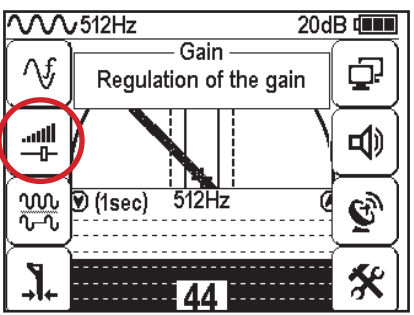


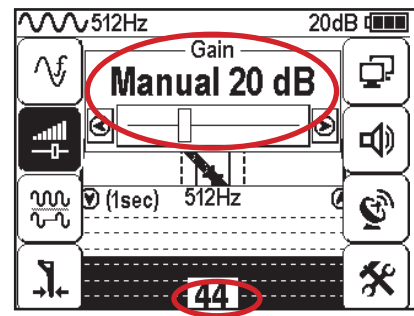




(fig. 11.7.)

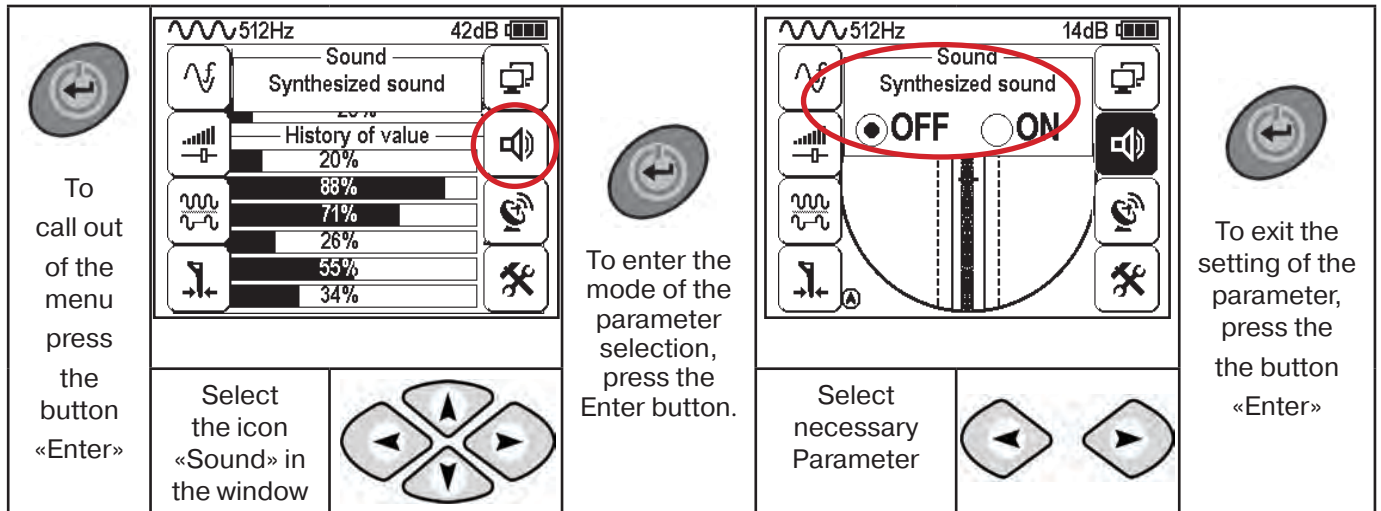


(fig. 11.8.)



When working with sensors you should regulate the receiver amplification coefficient so that the signal level was in the rang 50 to 90 %.


 <p>To call out of the menu press the button «Enter»</p>	 <p>Gain Regulation of the gain</p>	 <p>512Hz 20dB</p> <p>Select the icon «Amplification» in the window.</p> 	 <p>To enter the mode of the arameter selection, press the «Enter» button.</p>	 <p>512Hz 20dB</p> <p>Gain Manual 20 dB</p> <p>44</p> <p>the signal level on the bottom scale should be in the range 50 to 70%</p>	 <p>To exit the setting of the parameter, press the «Enter» button.</p>
		<p>Set the amplification coefficient, for example, 14 dB</p> 			

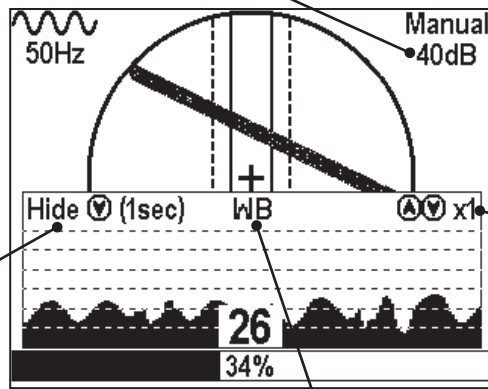
The user can listen synthesized sound through the built-in sound speaker. The sound tone pitch changes depending on the signal level. The synthesized sound can be switched on in the menu «**Sound**».






11.2 «Hot» keys for work in the «Graph» mode with DODK and DKI

step-by-step (by 2dB) decrease / increase coefficient of the amplification: semi-automatic of suitable gain by pressing "down" button for 1 second  

switching off the «Graph» mode and switching to the Route mode by holding the button for more than 1 sec 



increase/decrease of the image x1, x2, x4, x8 by the short pressing of the buttons:  

This part of the screen shows the advanced bottom sensor mode:
WB - Wide Band (F up to 8kHz)
Radio - F more than 8 kHz
To switch the mode, press the button: 

User can hear synthesized sound via built-in speaker. Sound pitch will change in accordance with signal level. You can enable this feature in "Sound" menu.

NOTE

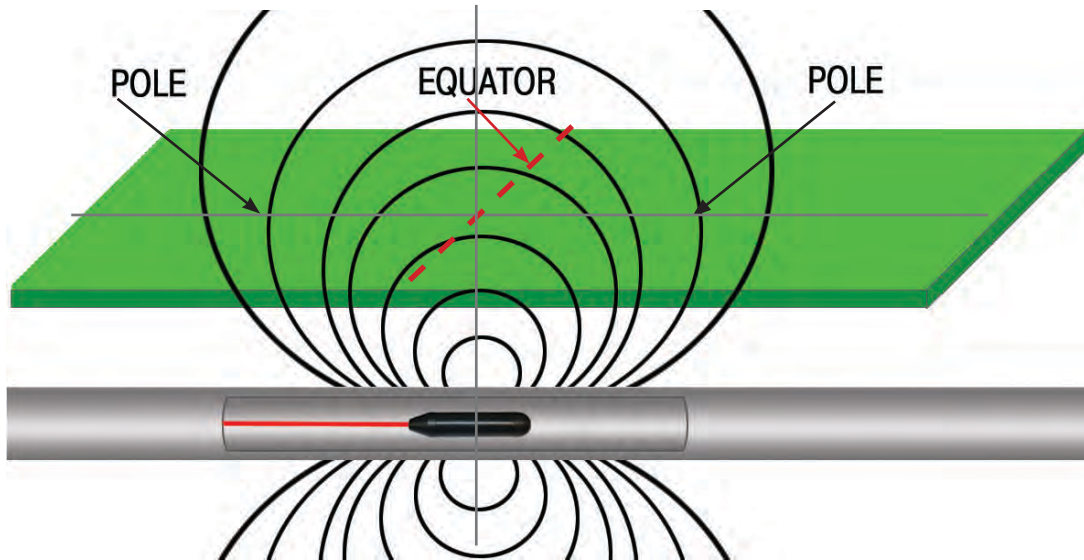
In the mode «Search of defects» using the external sensor, the work with the continues and impulse signal is supported. The difference is in that the digit in the center of the analogue scale shows not the current value of the signal, but the maximum value (amplitude) of the transmissions of the interruptible signal from the transmitter. Without changing the gain coefficient (gain coefficient should be the same as in the place of maximum signal) you should change to initial point and survey the area of maximum signal again. Try to find local maximums (places where the signal grows then decreases and grows again). Locate the main maximum.

The presence of local maximums indicates that there are several places with damaged insulation which are placed closely to each other. It is advised to wright down the signal level of the places with 'normal' signal level and the places where the signal reached its maximum. The range of signal increase usually correlates to the scale of damage.

12. Sonde Mode

Sonde Operating Principle

Sondes (also known as beacons or pipe transmitters) have a built-in emitting coil which generates an alternating magnetic field with two poles and an equator on ground surface:



If Earth's axis can be positioned horizontally, then the form of its magnetic field will be similar to the form of sonde's magnetic field in a pipe.

Three key characteristics of magnetic field are taken into consideration: two POLES and the EQUATOR.

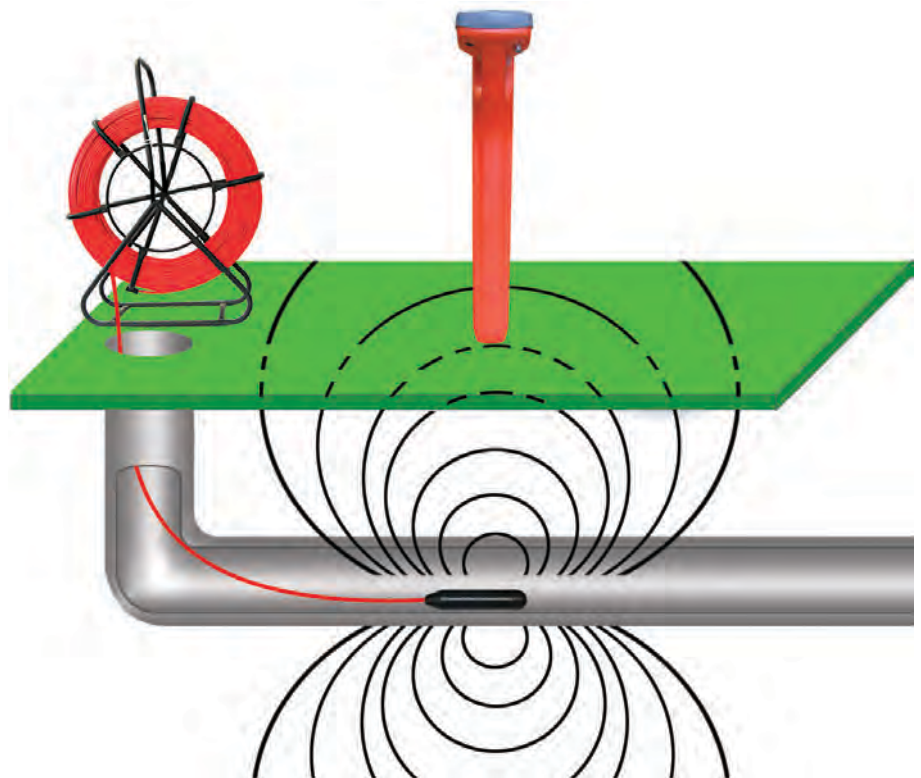
In poles, the angle of magnetic field is equal 90 degrees (lines are drawn vertically). In equator, this angle of magnetic field is equal 0 degrees (horizontal lines). Poles are constant characteristics of magnetic field. This is why they can be used as markers for precise location of the sonde.

The sonde is inserted into the pipeline with a push wire.

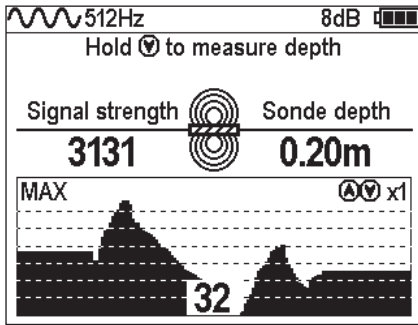
The locator scans the signal from the sonde and detects its position and burial depth.

To get maximum signal level is a key goal of locating sonde's position. Burial depth of the sonde is indicated correctly only when the receiver is positioned strictly above the sonde (above the centre of equator) and the sonde is positioned horizontally.

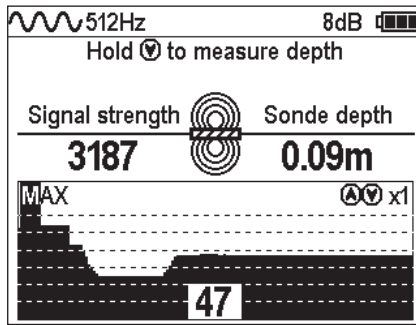
"Main peak" ("general maximum") of signal level is located at the centre of Sonde's emitting coil (Equator's centre) and two "false peaks" (two local maximums) are situated outside of two "local minimums" (POLES). "local minimums" (POLES)



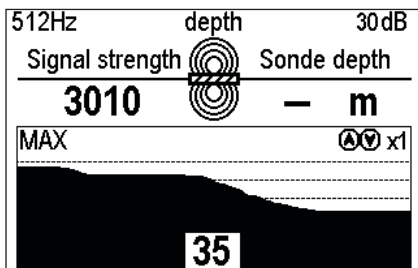
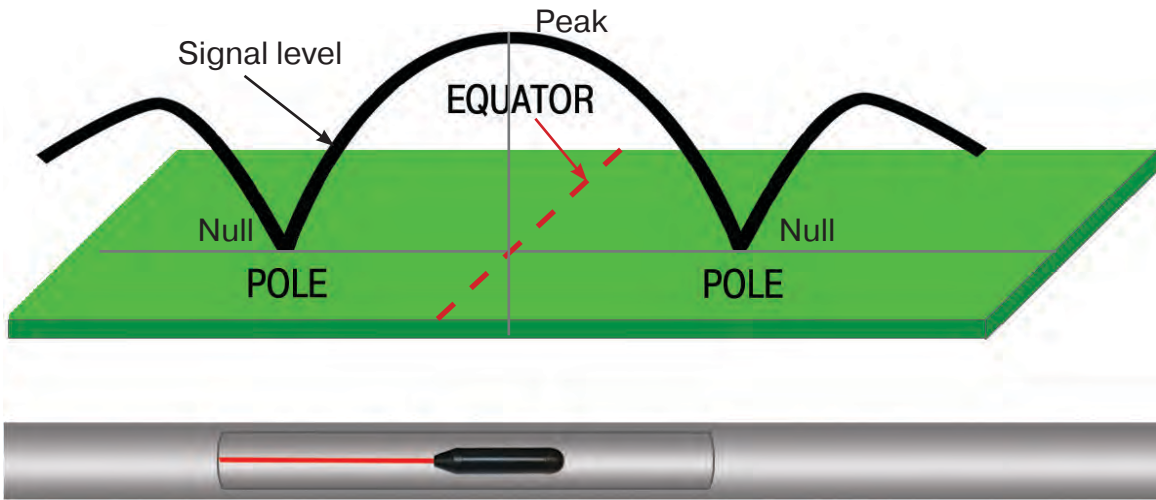
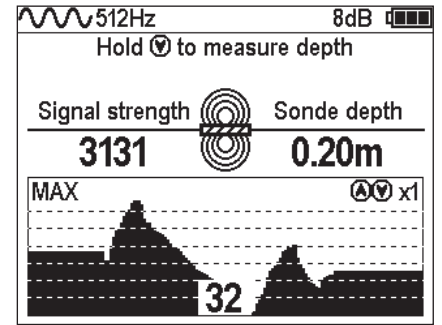
Deviation left from equator



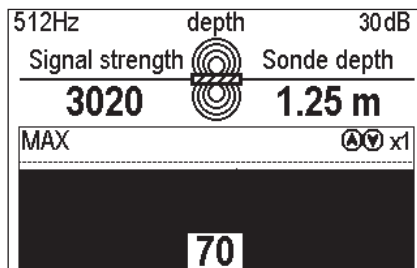
Above center of equator



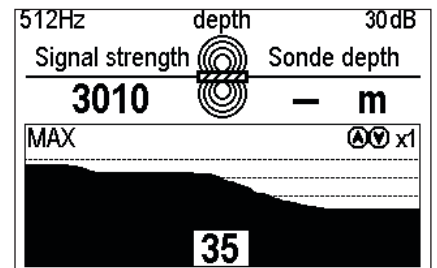
Deviation right from equator



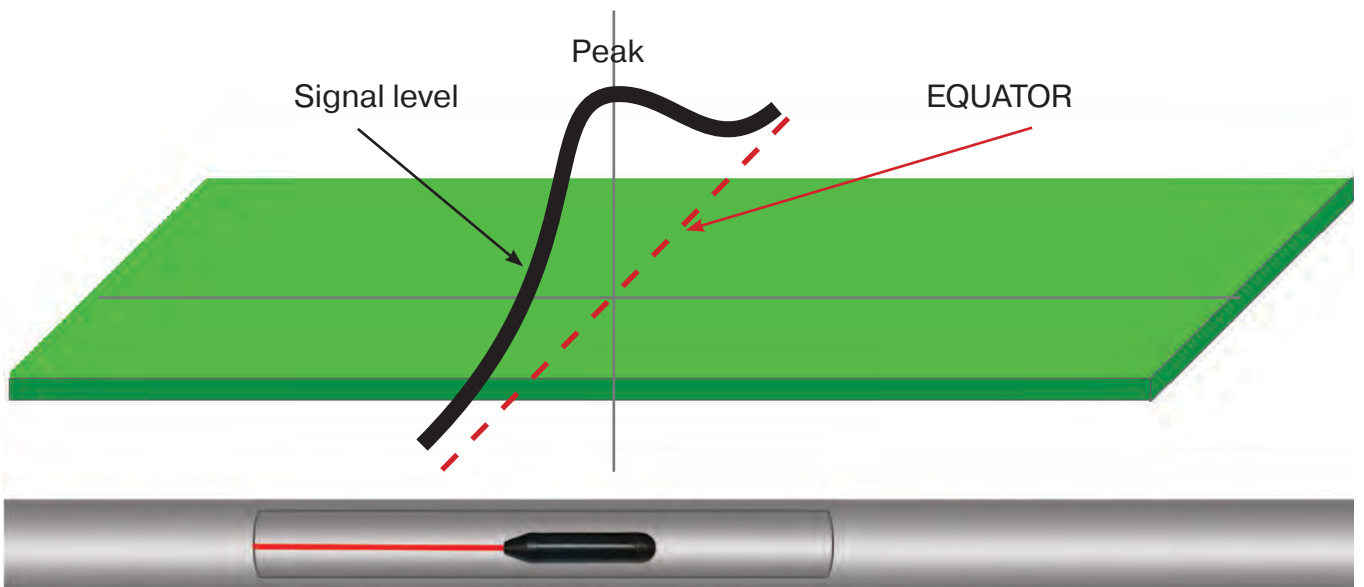
Deviation forward from equator



Above center of equator



Deviation backward from equator



Signal of horizontally positioned sonde as it is seen by EM sensor of the receiver. “Main peak” (general maximum) is situated above the centre of sonde’s emitting coil (equator’s centre), and two “false peaks” (local maximums) are situated before two “nulls” (minimums or poles).

12.1. Sonde Detection and Location of the Utility

1. Select “Sonde” mode in menu.
2. Before installation of the sonde into the utility, make sure that sonde is fully operational, and the receiver can obtain a strong and stable signal.
3. Mount the sonde on the push wire using 3.5 mm hex head (not included in supply). You have to match the hole on the wire with the mounting hole on the sonde.
4. Push the sonde into the pipe. In order to start location, you have to push it no less than 3m from the operator .

You must stay within the field, generated by the sonde in order to locate it Field range depends on the type of sonde, pipe material, depth and soil type.

To locate the Sonde, find the area with the maximum signal level.

5. To locate the approximate direction of the sonde, point the locator to the utility to search the area for signal, slowly moving the locator perpendicular to the ground around the spot.

By looking at maximum value of four-digit number on receiver display, you can see the signal level.

Signal level reaches its maximum, when the lower antenna is positioned as close as it is possible to the sonde. Sound indication of the receiver will help to locate the spot of the maximum signal.

The signal will be at its maximum when the locator’s axis is perpendicular to the sonde’s axis (utility axis) and the locator is pointing at the sonde.

When approaching the sonde, the signal level will rise (together with the tone of sound indication).

6. When the approximate direction of the sonde is located, position the device strictly perpendicularly to the utility axis and walk in the sonde’s direction.

At the point of maximal signal, the locator, pointed strictly perpendicularly to the utility should be moved along the equator line, until it reaches its maximum signal point.

7. When the receiver is positioned, try to move it left, then right, in order to locate false peaks. Each peak consists of two signal values: one with critical signal level rising and the second with some signal level rising. If these local false peaks are presented in the area and the sonde has horizontal orientation, it means that the locator is positioned strictly over the sonde and the utility has been located.

NOTE

The place with maximum signal, generated by the declined sonde, can be positioned off the equator line (see “Declined sonde” for more information).

ATTENTION!

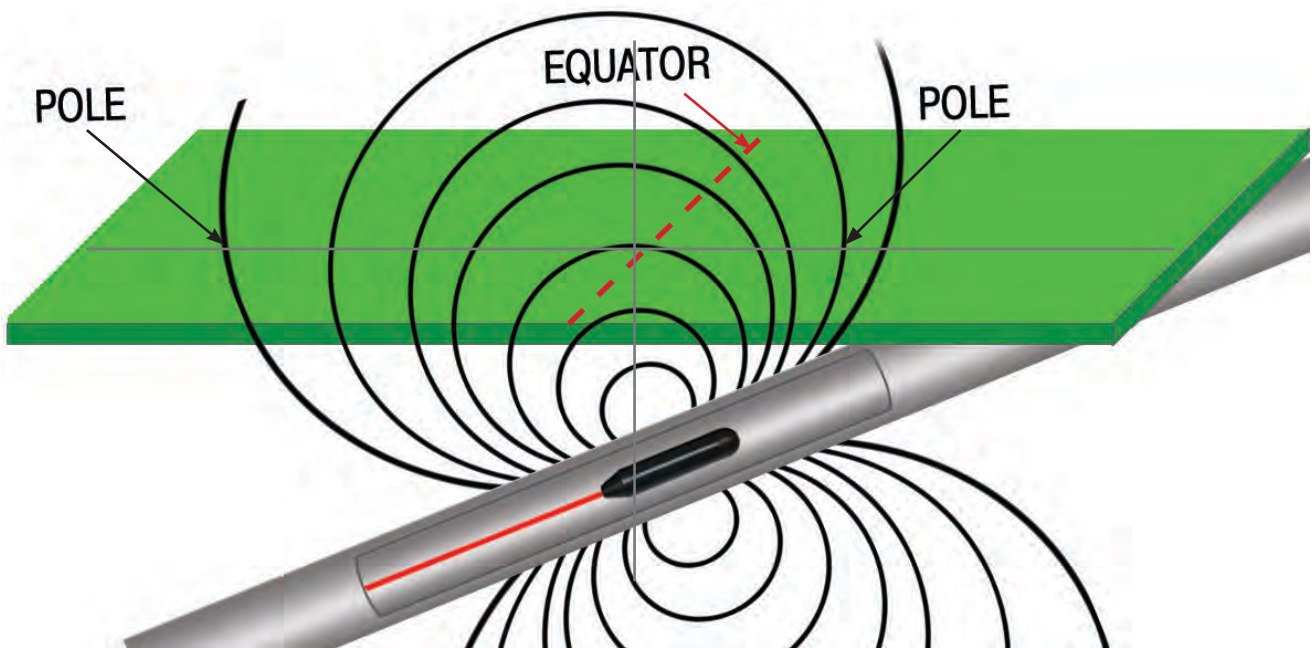
Standing on the equator doesn’t mean that you are standing over the sonde; Remember, that the key goal of locating the sonde is to locate the spot with a maximum signal. You must be at the point of the strongest signal in order to locate the sonde.

12.2. Declined Sonde

The sonde is considered to be declined when its position is not parallel to the horizontal ground surface. It most commonly occurs when the utility changes its vertical direction. Finding the poles of equator can help figuring out if the sonde is declined or not.

When the sonde is declined, the equator will not be positioned in the middle between two poles. When the sonde is significantly declined, the equator can be positioned off sonde's centre and the maximum signal point can be positioned near one of the poles.

Sometimes, when the sonde is positioned strictly vertically (perpendicular to ground surface), one of the poles will be positioned strictly together with the max signal point. The second pole will not be visible at all. In any case, in order to locate the position of the sonde, find the spot with the maximum signal level.



12.3. Measuring the Depth of the Sonde

ATTENTION! The receiver must be switched to Sonde mode because electromagnetic field, generated by the sonde has complex 2-line quasi toric form.

1. In order to measure the depth, you have to position the locator perpendicular to the ground, strictly over the sonde. You have to slowly move the device around, in order to get the best signal and best depth reading.

2. Press and hold “down” button on the locator for 1 second. It will enable the depth measurement. Measured depth will appear on the screen.

In order to confirm the readings of the depth, you have to do the following:):

1. Remember the depth value you've just received
2. Raise the locator to 150mm above ground surface
3. Look at the depth change. The depth should increase by 150mm.

If the depth value remains the same or increased more than it was intended, it can mean the following: signal field is distorted, the signal is too low (for example, the batteries of the sonde are dying) or wrong location of sonde's signal equator (the original depth was measured at wrong place).

NOTE

The value of depth, measured as described above, is true for undistorted signal. If the signal is distorted, depth readings can be distorted. Use the depth value only as approximate reference. Before ground works, try to measure burial depth of located utility with any available method .

Appendix 1 Receiver AP-019.3 Specifications

Parameter	Value
Receiver Quasi resonant filter centre frequency	50(60)/ 100(120)/ 512/ 1024/ 8192 / 32768 Hz
“Wide band” frequency band	0.04...8 kHz
Frequency range "Radio"	8...40 kHz
Sonde frequency	512 Hz
Dynamic range of incoming signal	120 dB
Number of embedded sensors	4
Max. Sensitivity (in “Graph” mode: F0 = incoherent distortion +10dB is 31...35 kHz)	5 mA at 1m distance
Data log capacity	2300 “points”
Connected external sensor	CI-110
Sensitivity control	Auto-for 2D display “Route” Semi-automatic or manual (optional) - for the “Graphic”, “Graphic+”, MIN&MAX, and “Sonde”. Automatic or manual (optional)-for the “2F” mode.
Determination the burial depth of the route	Automatically in “Route” mode 0...9.99 m By pressing a button in “Sonde “ mode
Burial depth identification accuracy	±5%
Identification of the effective current in the route	Automatically in “Route” mode 0.001...49.99 A
Accuracy of current measurement of received signal	±5%
Support of energy saving (intermittent) modes of the route locating generators	At combined work with the route locating generators made by "»NPO TECHNO-AC» LLC" ("Pulse" mode)
Visual indication	Graphic display LCD display, 320x240 pix., with LED backlight
Induced parameters	- 2D visualization of the route location relative to the device -Graphics of the signal level from sensors -Route burial depth -Signal current -Signal strength - Settings and control parameters
Audio indication	Built-in speaker: -natural filtered sound - buttons sound indication
Power source	4...7 V (4 type C batteries) External Power Bank – optional
Time of continuous operation from the single battery set	Not less than 20 hours
Automatic shutdown when the device is not active	After 30 minutes of inactivity
Operating /storage temperature range	-20...60 / -30...60°C
Dust and water protection degree	IP54
Dimensions	330x140x700 mm
Weight (excluding batteries)	2,4 kg

Appendix 2 Searching methods by AP-019.3

1. MAX method when searching the place of insulation damage with sensors DKI-117 and DODK-117

When searching for insulation damage by «MAX» method, the one of the input terminals (contact pins of DKI or electrodes of DODK) should be placed over the route, and the second one - at a maximum distance from the route, in the direction straight across its axis.

While moving along the route, the operator dips the contact pins in of DKI sensor in the ground. The measurements will be correct while the contact pins are firmly dipped into the soil.

DODK electrodes are transported by two operators located from each other at the distance equal to the length of the connecting wire. In this case, measurements can be made continuously in motion.

The signal gradually increases when approaching the spot of damage, reaches its maximum when one of the contact electrodes is above the damage spot and then gradually decreases (fig.A.1).

The MAX method can reliably detect the existence of damage, however, has a low accuracy of localization of the exact place due to the blurred indication of signal curve maximum.

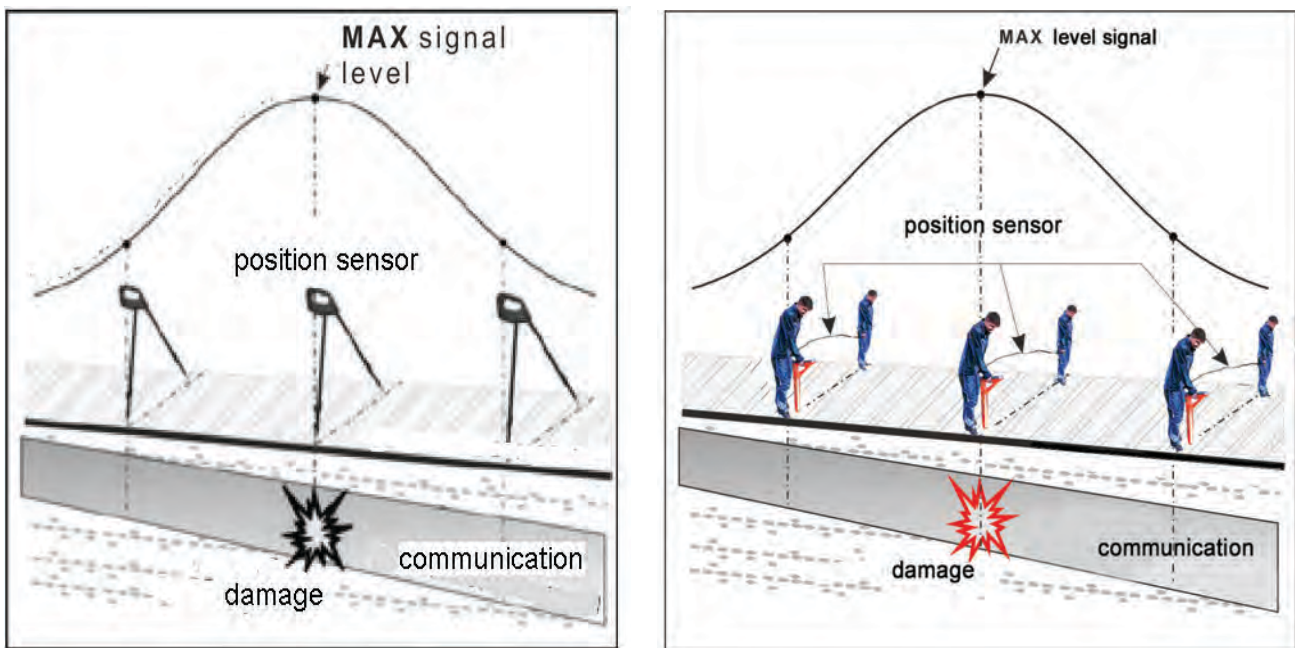


Fig. A.1

2. Method MIN when searching the place of damage location using sensors DKI-117 or DODK-117

When searching for insulation damages by «MIN» method, the contact pins of DKI-117 or DODK-117 electrodes should be placed over the route, along the axis of the route. When you use the MIN method, the signal increases smoothly at first, then rapidly decreases to a certain minimum value, then as the distance from the damage place increases, it rises sharply again and then gradually decreases.

The place of damage will be located midway between the electrodes, at a time when the signal reaches the minimum value (**fig. A.2**).

The sensor DODK-117 provides a «fast» method of damage location, which is especially important for the extensive communications, and the sensor DKI-117 provides a higher sensitivity and accuracy of damage location and needs only one operator for work with it.

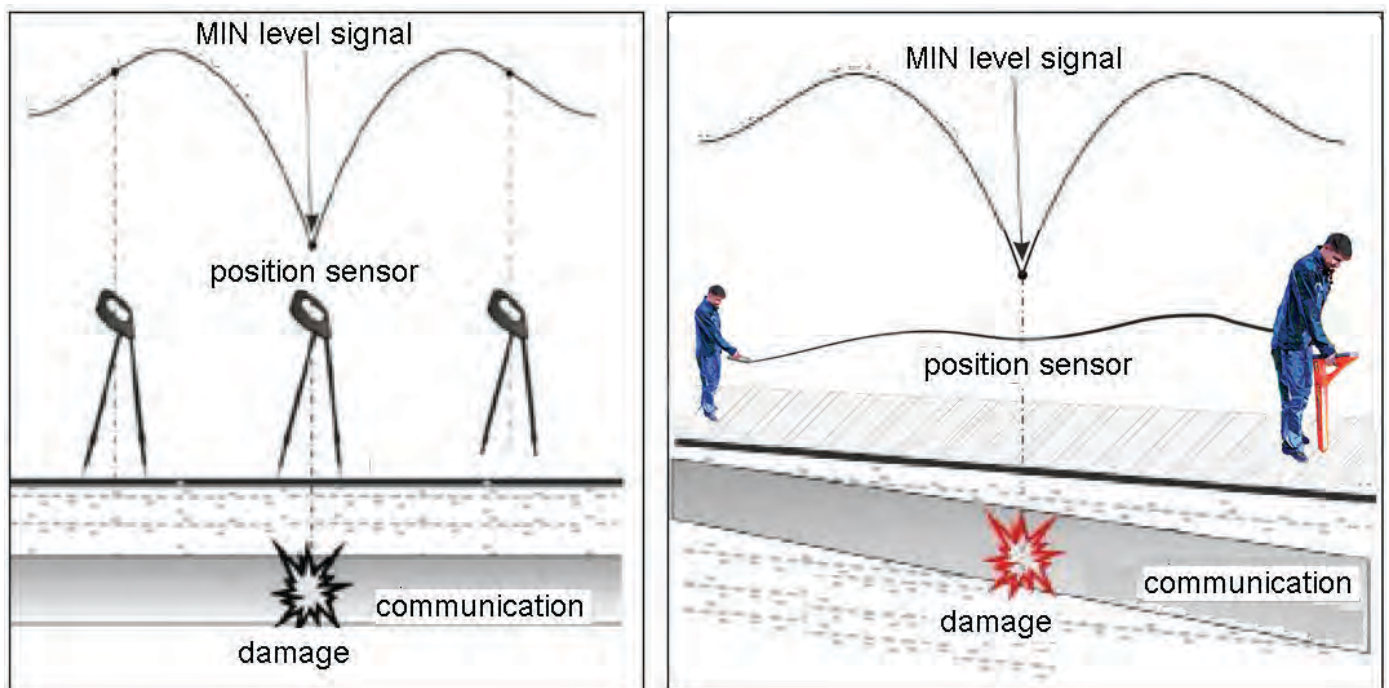


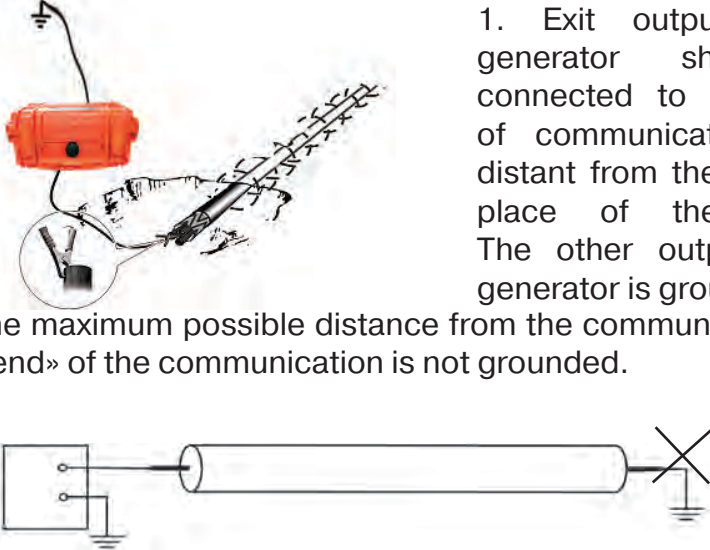
Fig. A.2

3. Amplitude «two-frequency» method «ΔA»

This method was added for contactless search of insulation defects of city cables with resistance less than 5 kOhm. The smaller the distance to the end of the cable, the higher the sensitivity of the method on this site.


The method decription: the two-frequency signal is transmitted from the generator. The ratio of two-frequency signal amplitudes remains stable, if there is no damages in cable. At presence of damage, the ratio of amplitudes in the place of damage is changed.

Table 8




1. Exit output of the generator should be connected to the «start» of communication (more distant from the supposed place of the defect). The other output of the generator is grounded on the maximum possible distance from the communication. The «end» of the communication is not grounded.

2. The transmitter in the mode «2F» sends to the communication the signals of two frequencies (1024Hz and 8192Hz) simultaneously.



3. The defect localisation is performed in direction «from generator».



4. The value «A8/A1» is sharply changes, when operator passes the place of leakage of the signal current into the ground.

A_8+A_1	A_8/A_1	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↑
16%		A 1kHz	
18%		A 8kHz	

Note
A8/A1 indication can have negative value. In such cases it recommended to reset indication periodically, using the button

A_8+A_1	A_8/A_1	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↑
16%		A 1kHz	
18%		A 8kHz	

5. The «double» scale shows levels (amplitudes) of the frequency components of the signal. At bottom - «A8kHz», at top - «A1kHz». When levels of the frequency components are insufficient for determination « $\Delta\varphi$ », the inscriptions «A8kHz» and «A1kHz» are correspondingly «darkening», and the value «X.XdB» disappears.

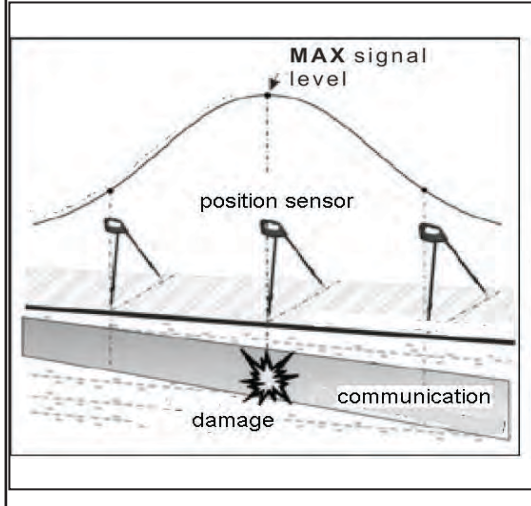
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, A8/A1 did not changed, it means that there are no damages on the surveyed site.

7. The sharp positive overfall of the « $\Delta\phi$ » value by 3dB and more indicates the possibility of defect existence (the resistance is less than 5 kOhm). The sensor should be located straight across the communication.

A_8+A_1	A_8/A_1	$\Delta\phi$	Signal direction
34%	4.4dB	-2°	↑
<input type="checkbox"/> 16%		A 1kHz	
<input type="checkbox"/> 18%		A 8kHz	

If you go through the same site in the opposite direction (towards the generator), holding the receiver the same as before with reset of the indication (using the button « ∇ »), negative value of the reading (more than minus 3dB) will mean that there is damage in the cable.

8. To validate the existence of the damage, use 2 contact method, using. (the methodology in app. 2 of p.1.2)



4. Phase «two-frequency» method « $\Delta\phi$ »

The contactless method of search for insulation defects of city cables with resistance less than 10 kOhm. The smaller the distance till the end of the cable, the higher the sensitivity of the method on this site. This method cannot be used in city because of high distortion of the signal.

Steps 1-3 are similar to those in p.3.

A_8+A_1	A_8/A_1	$\Delta\phi$	Signal direction
34%	4.4dB	14°	↑
<input type="checkbox"/> 16%		A 1kHz	
<input type="checkbox"/> 18%		A 8kHz	

4. « $\Delta\phi$ » shows - the change of the phase difference « $\phi_{1024} - \phi_{8192}$ », after the resetting (in degrees reduced to the frequency 1024 Hz). The value « $\Delta\phi$ » is sharply changes, when operator passes the place of leakage of the signaling current into the ground.

Note

$\Delta\phi$ indication can be negative, «running» in the process of increase of distance from the generator. It is recommended to periodically reset such indications (exactly over the route), using the button « ∇ ».

A_8+A_1	A_8/A_1	$\Delta\phi$	Signal direction
34%	-0.1dB	-2°	↑
<input type="checkbox"/> 16%		A 1kHz	
<input type="checkbox"/> 18%		A 8kHz	

5. The «doubled» scale shows levels (amplitudes) of the frequency components of the signal. At bottom - A8kHz, at top - A1kHz. When levels of the frequency components are insufficient for determination $\Delta\phi$, the inscriptions A8kHz and A1kHz are correspondingly «darkening», and the value «X⁰» disappears.

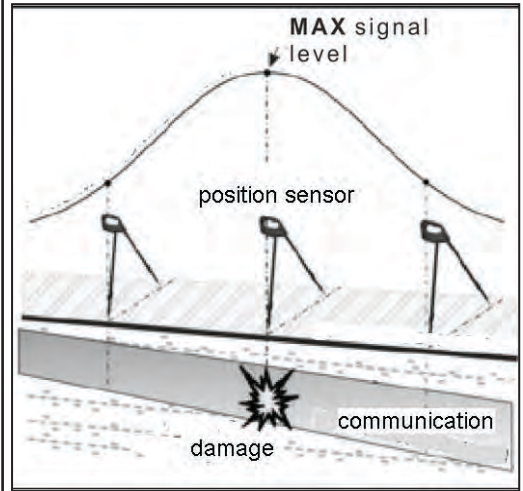
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, « $\Delta\phi$ » did not changed, it means that there are no damages on the surveyed site.

The sharp positive overfall of the « $\Delta\varphi$ » value by 5° and more indicates the possibility of defect existence (the resistance is less than 10 kOhm). The sensor should be located straight across the communication.

A_8+A_1	A_8/A_1	$\Delta\varphi$	Signal direction
34%	4.4dB	14°	↑
	16%		A 1kHz
	18%		A 8kHz

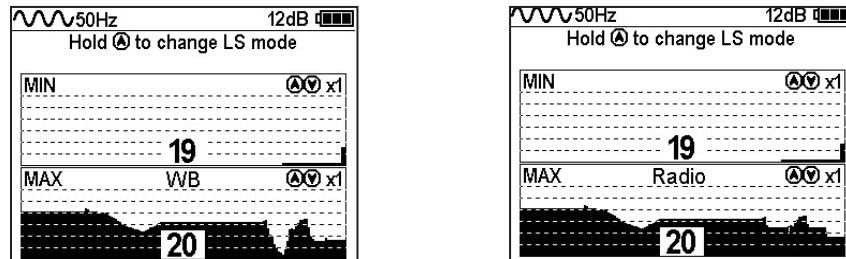
If you go through the same site in the opposite direction (towards the generator), holding the receiver the same as before with reset of the indication (using the button « \odot »), negative value of the reading (more than minus 5°) will mean that there is damage in the cable.

To validate the existence of the damage, use contact method, using. Append. 2 p.1,2)



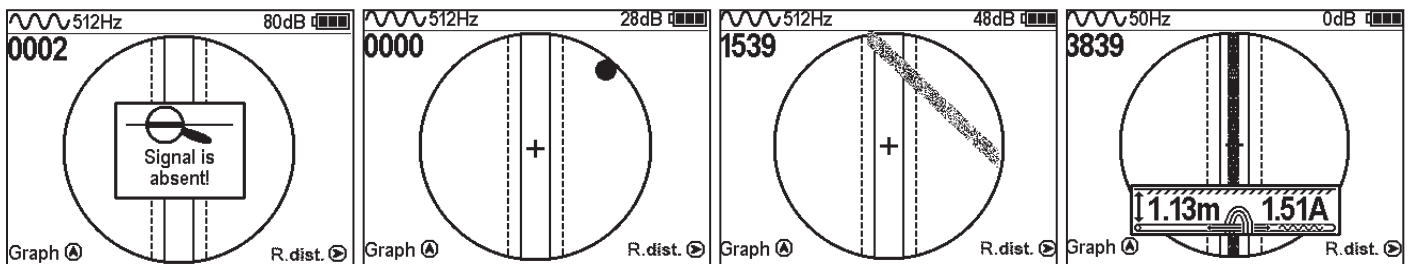
Appendix 3 Area survey before excavation works

First of all the area should be surveyed with the receiver in passive mode, in order to locate the signal from energized power cables, pipes with cathodic protection or any other current providing utility. To do that, use the following frequencies consequently: 50 Hz, 100 Hz, Radio and Broadband mode. Area survey in broad band frequencies should be performed in “MIN&MAX” mode: In lower sensor mode WB (0-8kHz) and Radio (over 8kHz).

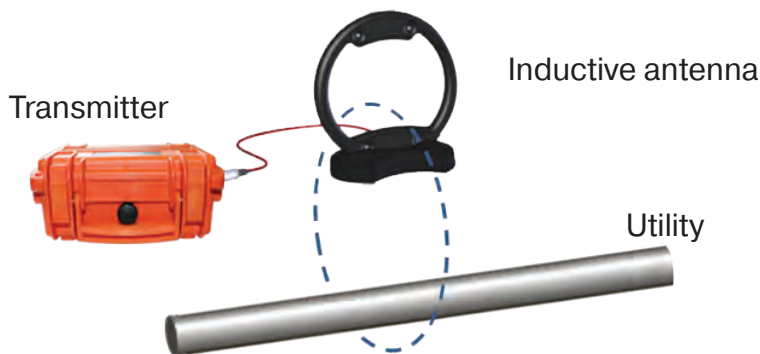


In this case the operator should rely on “MAX” scale.

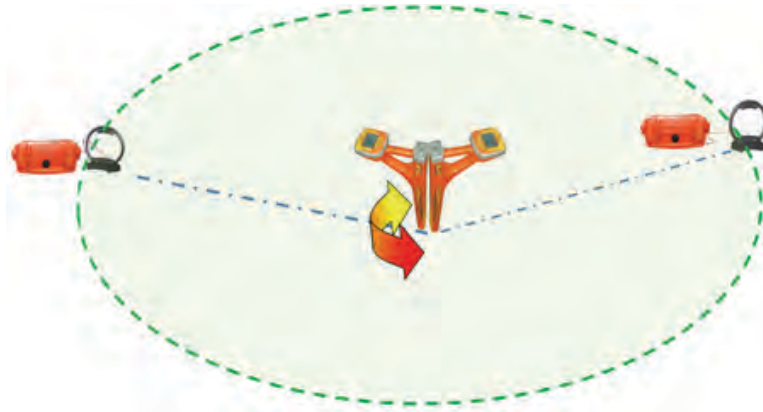
At 50 a 100Hz frequencies in Route mode the signal strength will increase as you are moving to the utility. Following indication should appear on the screen while performing these actions:



Active mode survey is performed with transmitter and external inductive Antenna IEM-301.5. Inductive antenna induce better signal when it is positioned in the same flatness as the utility.



First make sure that there is no utility in the center of surveyed area. To do that, first operator with receiver stands above the tested point and second operator moves the transmitter with antenna around the first one. The radius should be 10-20m and the first operator should point the head of receiver towards the 2nd operator with antenna.

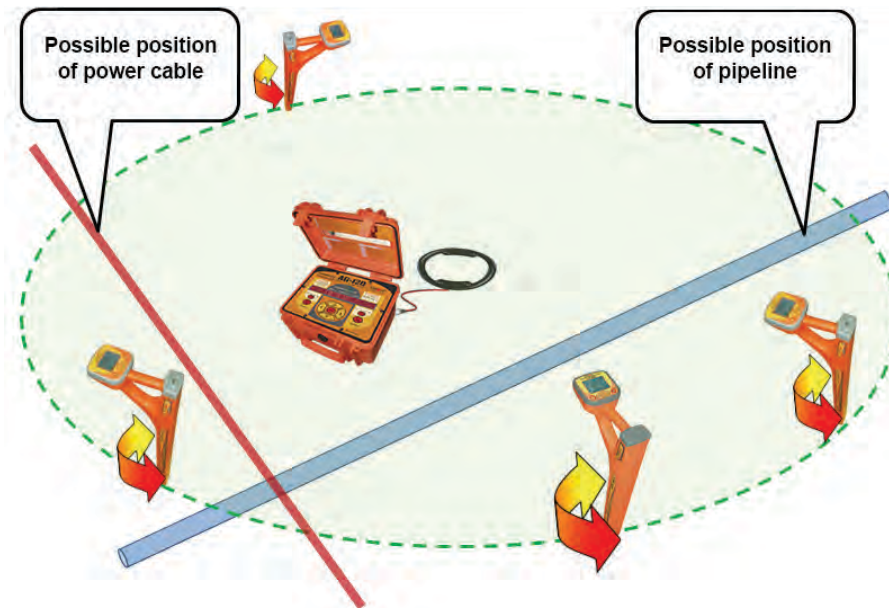


If there is no utility in center point of the area, then start the general location routine described below.

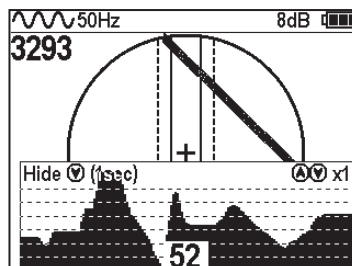
When surveying the area in active mode, it is necessary to place IEM antenna horizontally in the center of the plot (you can remove the antenna from its stand). In this position the antenna will be in the flatness parallel to all surrounding utilities in the area.

After that it is necessary to connect the antenna to the transmitter and start the induction. Power of the transmitter should be set according to the size of the surveyed area (the smaller the area – the smaller the power).

Area survey in active mode should be carried out in “Graph” mode of receiver at the same frequency as had been set on the transmitter. Operator should move around the transmitter and perform to measurements at each point in two mutually perpendicular positions.



The presence of the utility will be indicated by the “signal strength” value (upper left part of display) or the graph in bottom part of the screen.



Appendix 4 Operational features of the set

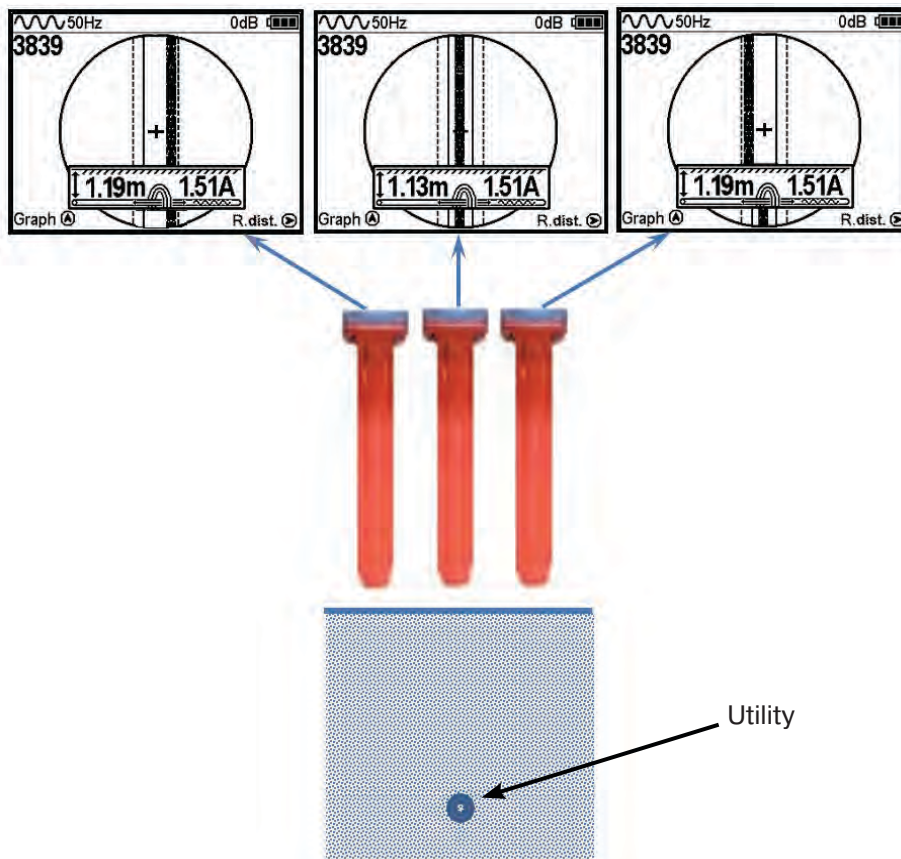
External influence during receiver operation

Receiver's display readings can be incorrect while operating in distorted electromagnetic field. The cause of that may be in closely (approx. 3m radius) positioned metal objects (cars, metal fences, manholes and other utilities) and mobile phones.

If an important measurement is going to take place, please, try to exclude the influence of surrounding distortion.

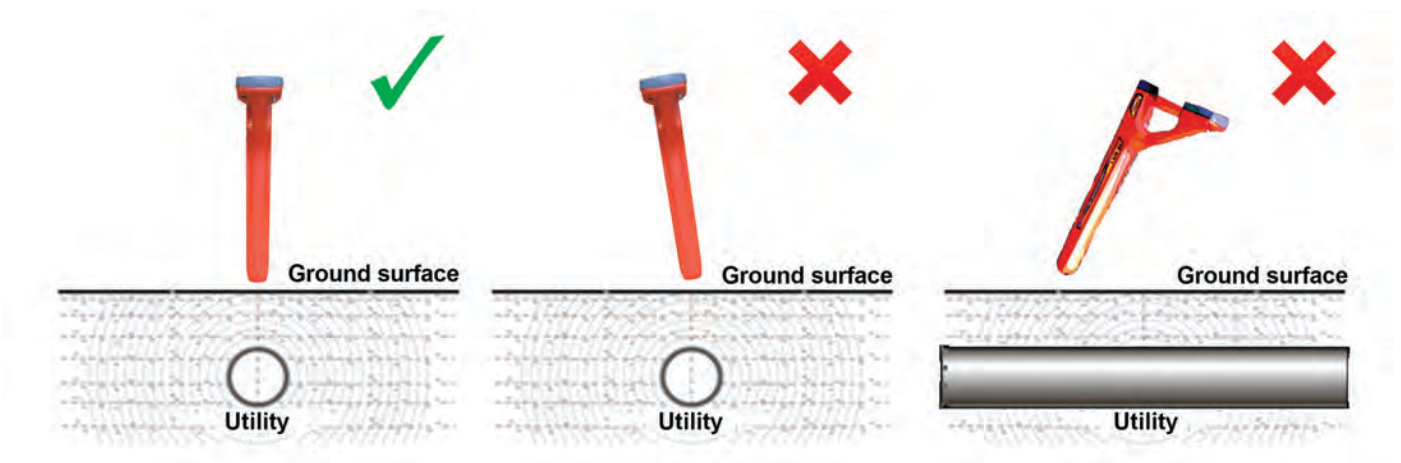
Specialties of utility depth measurements

During depth measurement process (if the utility axis indication is in the area of receiver screen, including its aligning with the axis of receiver) if the receiver is slightly moved aside the value of depth is increasing. That is why, true depth will be indicated by minimum value of depth indication.



Receiver position during depth measurement

Before measuring the depth of the utility, make sure that your device is positioned perpendicular to the utility. Even slight deviation from vertical position can influence the precision of depth measurement.



Operation via external power supply

When operation is performed via external power supply, all internal power sources should be removed.

Specialties of utility location at 50Hz

50Hz signal is used almost in every electric supply system in Russia and in most European countries. Energized cables create electromagnetic fields, which are induced to other conducting utilities (pipelines, dead cables)

From one side, this allows operator to locate both pipelines and cables in “Route” mode. Operator can define power cable and pipelines according to the depth (as a rule, average depth for cables is 0.6-1.0m; for pipelines 1.5m and more)

From other side, electromagnetic fields, created by current, induced on pipelines make tracing harder, especially in the areas with a lot of utilities in one spot. The receiver evaluates the position of the utility according to the resultant signal in a given spot.

When operating in passive mode on 50Hz frequency, in case of multiple utilities, the receiver can't tell which emits the signal. In this situation the values of depth can be incorrect.

It is important to understand that separate cables under voltage can create very weak electromagnetic fields and as a result almost absent resultant signal. It may be impossible to locate them in “Route” mode. Please, use “Graph” mode to identify the position of such cable.

13. The transmitter AG-120 13.1. Appearance. Controls

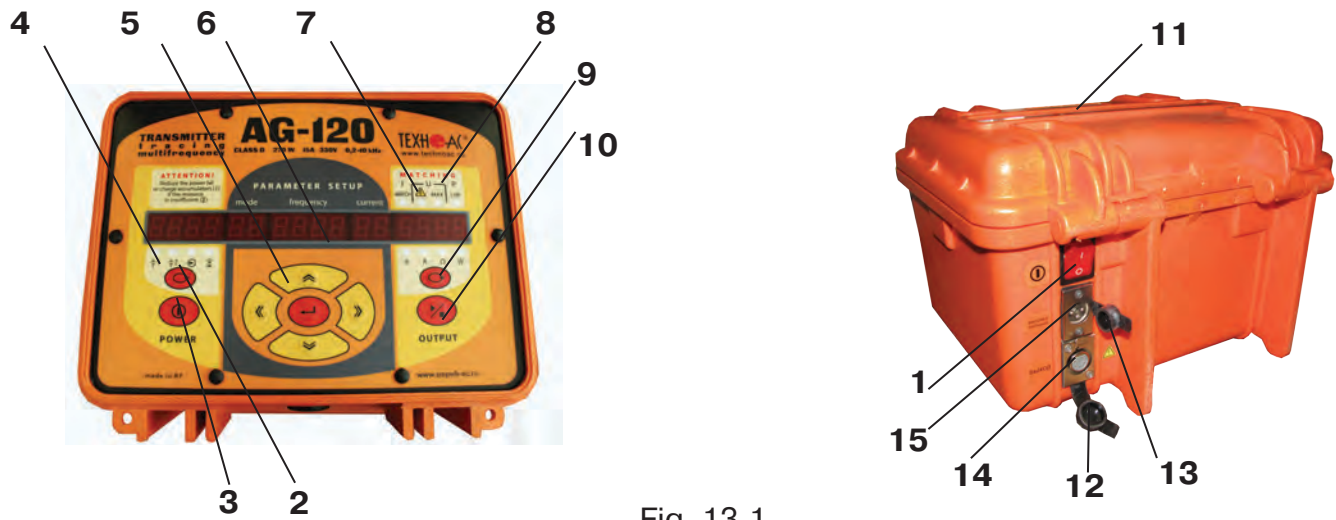


Fig. 13.1

1	External power switch (mechanical waterproof) with generation indicator
2	Button « I » control of internal electronic power switch
3	Button of power supply parameter indication
4	Indicated power supply parameter: voltage acc.1/acc.2/ext. power. (V), life time (hour) or charging time (hour, min)
5	Menu control buttons « ◀◀ » - selection of parameter to be set in the left direction by the indicator « ▲ » - increase of value or «up» in the list « ▼ » - reduction of value or «down» in the list « ▶▶ » - selection of parameter to be set in the right direction by the indicator « ↵ »: in the «stop» condition – entering to the parameter setting / exit from parameter setting with saving of settings - in the «generation» condition – input of current value of output current as setup value
6	Indicator of power supply parameters (V, hours), work mode, generation frequency (Hz), set current (A), output parameters (V/A/Ω/W)
7	«MATCHING» (results): set current is achieved «Imatch», mode of unlimited voltage «U ⚡ », maximum voltage «Umax», power limited at the optimal level «P lim»
8	Parameter indicated by «output multimeter»: U «V», I «A», R «Ω», P«W»
9	Button of selection of parameter indicated by «output multimeter»
10	Button « ▶■ » «START/STOP» of generation, matching or charging
11	Transparent window for indication reading with closed cover
12	Plug sealing the output connector (opened)
13	Plug sealing the external power supply connector (closed)
14	Output connector to connect the buried utility, transmitting antenna or clamp
15	Input connector to connect external accumulator or mains power supply adapter (operation/charging)

13.2. Procedure of work with the transmitter

SAFETY REQUIREMENTS

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.

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

Personnel safe procedure for work with the transmitter when connecting to the route:

- make sure on the monitored buried utility and near it no activities are conducted or planned which can result in deliberate or accidental touching of the current-conducting part under voltage;
- make sure the generator is switched off;
- ground the cable conductor opposite to the transmitter connection point and put the table «Grounded» («High voltage»);
- make sure the instrument can not be activated accidentally by another person during connection of the output cable;
- connect the output cable clamp to the monitored buried utility (cable wire, pipeline, link cable);
- connect the second clamp of the output cable to the grounding, cable armor or to the grounded rod;
- connect the output cable connector to the output socket of the deactivated transmitter;
- if there are other persons near current conductive parts alert them about voltage supply by saying «Applying voltage ».

ATTENTION!

When connecting the transmitter the latter itself shall be TURNED OFF!

Personnel safe procedure for work with the transmitter when disconnecting from the route:

- turn off the transmitter power;
- disconnect the output cable from the transmitter and close the connector with rubber plug;
- conduct the troubleshooting activities only AFTER the transmitter is turned off and disconnected from the buried utility.

When working on pipelines, use only “safe” mode!

13.3. Transmitter connection

1) Contact mode of transmitter connection

This mode guarantees transmission of signal without interference and allows use of low frequencies.

The connection to buried utility is done by mating of the output connector of the transmitter to the buried utility and grounding rod **figure 13.2**.

The grounding is carried out in any convenient place, which should be cleaned from the dirt with file or sand paper to the metal. This ensures more reliable contact of the clamp and buried utility.

Rules for grounding:

- To achieve the maximum tracing distance when the transmitter is connected to the buried utility the grounding shall be arranged at an angle close to 90° and **as far as possible** from the route in the assumed search direction.

- The grounding rod shall be inserted for at least 2/3 of its height.
- To achieve better grounding effect the following methods shall be used in the place of grounding rod installation: cleaning of contact in the place of contact wire connection to the ground rod, pressing of the ground, moistening of the ground using salt solution.



Fig. 13.2

Methods of transmitter connection to the route

To achieve quality in route position detection the following rules should be observed:

The direct connection of the transmitter to the load provides the longest tracing distance.

Several ways can be used to define the underground cable (or pipeline) route when directly connected to the buried utility. They are as follows:

1) The ground is a return conductor

Connect the transmitter to one end of the cable, ground the other end of the cable.



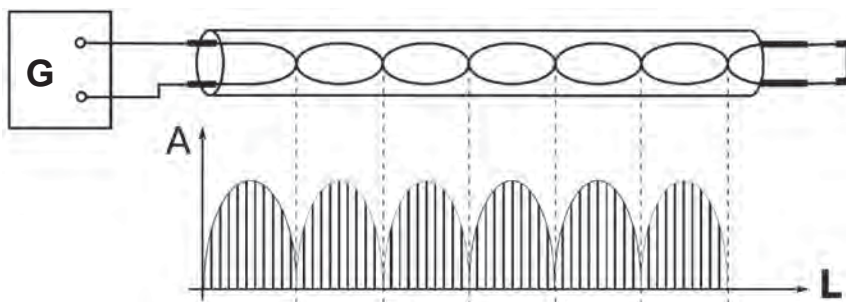
2) The cable armor is a return conductor

Connect the transmitter to ends of the cable; join the other ends of the cable.



3) The cable cord is a return conductor

Connect the transmitter to two cords from one end of the cable, join the cords from the opposite side.



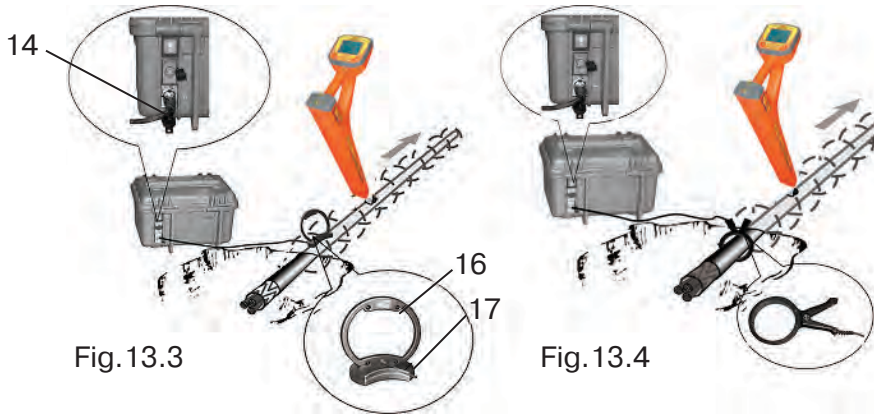
2) **Contact free mode** using the **inductive** antenna – IEM

Connecting to the utility is carried out by induction method.

To do this: remove the antenna from its package and insert active part of the antenna in the foundation body. Connect the antenna to the transmitter output connector (**pos. 14 figure 13.3**) and install over assumed place of route. The antenna and route must lay in the same plane.

3) **Contact-free mode** using the **transmitting** clamp.

Allows tracing of the selected buried utilities, energized and de-energized cables. The clamp shall be put around the conductor to be traced **figure 13.4**.



NEVER! Touch the clamps of connecting cables and parts of monitored buried utility while the transmitter is working.

NEVER! Mate and disconnect the connecting cables while the transmitter is working.

13.4. Turning on the transmitter power

Connect the load to the lowest connector on the transmitter rear panel in accordance with the tracing procedure (pos.14 **figure 13.5**). The examined route (pipeline, cable), inductive antenna or transmitting clamp can be used as a load.

To ensure safety it is strongly recommended to complete all connection works before the generation is started.

Turn on the power with external mechanical switch «I/O» on the rear panel by setting it into the «I» position pos. 1. Open the cover. Turn on the power with the button **pos.2 figure 13.6**. The indicators on fields «POWER» and «PARAMETER SETUP» will start indicating.



Fig.13.5



Fig.13.6

13.5. Parameter setup

The field «PARAMETER SETUP» **figure 13.7** is used for selection of one of three generation frequencies f1, f2, f3, one of three modes of sine generation (continuous «CO», one frequency transmission «PU», two frequencies transmission «2F» or charging mode «CH») and of four current loads. If necessary the “banks” of currents and frequencies can be modified quickly. The use of the transmitting antenna as a load is possible only if a generation frequency of 8192 Hz which is set automatically when the antenna is connected to the output.



Fig.13.7

1) To enter the setup mode depress the button of entering into parameters setup « ↵ » pos.5 while staying in the “stop” mode (no generation, yellow LEDs on the “OUTPUT” field **figure 13.7**. are not on). Will begin to blink field of the indicator «MODE».

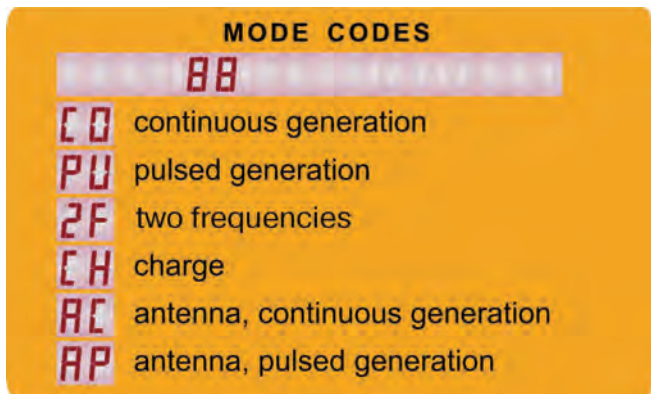


Fig.12.8

2) Depending on the task, to set the mode the buttons « ^ » or « v » (cycle) pos.5 **figure 13.7** are used to select on the field “MODE” the symbol depicting the required generation mode or mode of internal accumulators charging. The mode codes are shown on figure 4.8. If the transmitting antenna is connected to the output, the signal «AC» is indicated (mode «antenna, continuous»). The selection in this case is possible only between modes «AC» and «AP» (mode «antenna, pulsed») directly by the buttons « v » or « ^ ».

3) To set the operation frequency or current, use the button « >> » until the indicator «FREQUENCY» or «CURRENT» appears on the indicator screen. In the modes «CO» and «PU» the blinking value (figure) can be modified.

To input another value of frequency instead of the blinking one press the button « ← » so that only first digit of the figure would be blinking (the highest digit). To select another digit use the buttons « >> » or « << ». The blinking figure can be modified with buttons « ^ » or « v » (0...9). To save the new value in the «bank» of frequencies (instead of the previous one), press the button « ↵ ».

It is possible to work with the specified frequency temporarily before power is switched off, if the generation (automatic matching) is activated immediately with the button « ⚡ » pos.10 **figure 13.9**.




4) The setting of the specified current is conducted similarly to the work frequency specification. The range of specified current is 0,1...9,9 A with a step of 0,1 A. "Bank" of factory set current values has 10 following values (A): «0.1», «0.2», «0.3», «0.5», «1.0», «2.0», «3.0», «5.0», «7.0», «9.9». If necessary, the current of pulsed transmission ("PU") in the stable mode of transmission can be increased up to 15A (if there is enough power). The values of current exceeding 9,9A may not be saved in the "bank" of currents.

The high output current (up to 15 A) allows tracing of buried utility with extremely low resistance (for example, to pass the output current between grounded pipeline and grounding circuit bus). In this case the small, but still sufficient, part of the output current is branched into the remote areas of buried utility. The serviceability is maintained till full short-circuit of the output clamps.

When selecting the load current (or power) and frequency of the transmission the following guidelines are to be followed:

- the lower is the power – the higher is power supply life
- the lower is the current, the lower is the frequency – the lower «induction» on the neighboring elements
- the higher is the frequency – the higher is sensitivity of receiver, the less current (power) is enough, energy saving is possible, recommended for high-resistance buried utilities, on the other hand, the higher level of signal penetration into the neighboring objects and, as a result of higher attenuation, the signal is spread at the less distance.
- the higher is the current, the lower is the frequency – the range of transmission and route detection is higher, but the power required is higher.

13.6. Modification of the set parameters

To modify the set parameters, stop the generation with the button «» pos.10 **figure 13.9** at the field «OUTPUT» by one or two depressions and proceed to the parameters setup. The first depression of the button «» pos.10 results in stop of the automatic matching process at the achieved level (the indicator readings are "frozen", no generation, yellow LEDs on the field «OUTPUT» are not on), second depression on the button «» results in the stop of generation (the indicator is off).












To enter the parameters modification mode depress the parameters setup button «» pos.5 while staying in the «stop» mode. The indicator field «MODE» will start blinking, to change the mode use the buttons «» or «» (by cycle) pos.5 to select the required generation mode symbol and go to modification of other parameter (frequency, current) with buttons «» or «». The blinking value of parameters from the databank can be selected with buttons «» or «» (0...9). To modify the parameter value when the required value is not in the databank (the selected parameter blinks) depress the parameter setup button «», after that the blinking figure can be modified with buttons «» or «» (0...9). To save the new value in the data "bank" (instead of the previous one) depress the button «».



Fig.13.9

13.7. Indication of parameters

1) Indication on the field «POWER» figure 13.10.

One of the digital indicator readings is selected by the corresponding button pos.3 by the green LEDs.

⚡1- voltage on the “base” internal accumulator №1
⚡2 -voltage on the «superstructure» internal accumulator №2

⊕ -voltage on the external power supply input
⌚ - in the generation mode – estimated power supply life meaning: «for this level of energy consumption it will work for N hours» (on base the family of discrete discharge curves for new accumulator for $t = 0^{\circ}\text{C}$). The reading «20» means «very high life time which is difficult to estimate». The reading «0,1» means: «the instrument may switch off at any moment».



Fig.13.10

- in the «charging» mode - time of charging by the stable current (counting up) and time of charging by the stable voltage (counting down), hours/ min

If two or three first LEDs are illuminated at the same time, that means that the digital field «POWER» indicates the resulting voltage, supplying the terminal power amplifier. In this the first (left) seven-segment indicator on the field «POWER» symbolically depicts the configuration of mutual connection of the power supplies. The list of possible power supply configurations and codes is given on the transmitter cover (figure 13.11).

POWER SUPPLY CONFIGURATION CODES	
⊞	internal in parallel (12V)
⊞	internal serial (24V)
⊞	internal in parallel, external serial (24V)
⊞	internal and external in parallel (12V)
⊞	internal and external serial (36V)
⊞	only external (accumul 24V or network power 15V)

Fig.13.11

2) Indication on the field «PARAMETER SETUP»

Indication on the field «PARAMETER SETUP» is described in the sections parameters setup and parameters modifications.

3) Indication on the field «OUTPUT»

When the **power is applied** to the transmitter two situations are possible:

- If the LEDs on the field «OUTPUT» **are not illuminated**– the transmitter is in the standby mode («stop»). The parameter setup can be conducted or the generation (automatic matching) may be initiated immediately by depressing of the button pos.10. The mode «stop» will last for 1 minute. If no button is depressed the internal electronic power switch will switch the power off automatically.

- If one of yellow LEDs **is illuminated** on the field «OUTPUT» (and the external switch pos.1 is highlighted), the power has been turned off during generation and the same mode with the previous settings is restored. The automatics tries to recover the situation through the automatic matching. If it is necessary to change the set parameters, stop the generation with the button « » pos.10 on the field «OUTPUT» («turn off» the yellow LED and illumination of the external switch with one or two pressing) and proceed to the parameters setup.

During the generation the estimated values of output parameters are indicated on the digital field «OUTPUT»: load voltage «V», load current «A», load resistance «Ω», load power «W». The accuracy of measurement ($\pm 5\%$ for «V» and «A» and $\pm 10\%$ for «Ω» and «W») is sufficient for situation evaluation and decision making. The indicated parameter is selected by the button « $\frac{1}{2}$ » pos.9 the LED corresponding to the selected parameter is illuminated pos.8 figure 13.10.

The power is selected automatically according to the principle: «sufficient (or maximum possible) for achieving of the specified output current (or closest possible value)». When the automatic matching is finished (or interrupted with button “START/STOP ”) manual control of voltage (current, power) with buttons « \wedge » and « \vee » is possible. During this the indicator « ⌚ » always indicates the remaining life of the internal power supply (hours) depending on the accumulator discharge level and current energy consumption.

The high output voltage (above 330 V with the use of additional accumulator 12 V) and high reserve of power (up to 270 W with additional 12V accumulator) provide sufficient tracing current for long buried utilities with high resistance.

After complete attempt of automatic matching (not aborted) the field «MATCHING» pos.7 figure 12.10 reveals the result:

- «Imatch» - completed successfully, specified current achieved. After generation is turned off from this condition the set parameters of generation and selected parameters of indication becomes default values, that means loaded after power interruption.
- «Umax» - the voltage is not enough to achieve the specified current for this load (the load resistance is too high or the contact between output clamps with the load is broken).
- «P lim» - not enough power to achieve the specified current for this load.

The potentially «dangerous» unlimited mode of generation is depicted with a special «alert» indicator « ⚠ ». The «default» increase of the output voltage is limited by level safe for a human (24V). If necessary (for tracing the cables) it is possible to operatively remove the limitation (temporarily) if the appropriate precautions are taken.

Here the decision should be made about necessity to correct the parameters of output current. For this purpose the test tracing is recommended.

13.8. Start and stop of generation

If after power is turned on the button « ⏏ » pos.10 is depressed shortly in the standby mode («stop»), the generation and automatic matching – step-by-step increase of voltage at the output until the specified current is reached shall be started. It is recommended to monitor the power life indicator (« ⌚ ») on the field «POWER».



Fig.13.12

Direct connection to buried utility
 24.9 – supply voltage (2 acc in series), V
 CO - continue generation
 1024 – frequency, Hz
 4,0 – current, A
 58 – power, W

is recommended to monitor the power life indicator (« ⌚ ») on the field «POWER». If the output voltage («V») exceeds «24.0» the automatic matching shall stop anyway. If the specified current is not reached, the indicator “Umax” shall be on in the field «MATCHING». This is a **safe**

mode set by default when the power is on.

If higher output voltage is required to achieve the necessary current during tracing of the cables (AND APPROPRIATE SAFETY MEASURES ARE TAKEN!), the automatic matching can be started in the «unlimited» mode. For this purpose press the button « ⏏ » in the standby mode (“stop”) and keep it **depressed** until the “alerting” indicator « ⚠ » is on. That means the potentially dangerous “unlimited” mode is activated, the output voltage may exceed 200 V with internal power supply and 300 V with added 12V external power supply. The «unlimited» mode shall exist until the power is off.

The current in load is selected or input from the keyboard in the indicator field «CURRENT». In the course of automatic matching the voltage on the load is increased step by step till the current in the load exceeds the value stated in the setter («CURRENT»).

In this case the voltage increase is stopped and the “Imatch” sign appears in the field «MATCHING». If the load resistance is changed in the stable mode of generation, the power selection program shall maintain the specified current within $\pm 2\text{dB}$ by repeated automatic matching with appropriate adjustment of power.

The incomplete automatic matching procedure can be stopped at any point by depressing of the button « $\frac{1}{2}$ ». The first pressing in the course of automatic matching – «stop» of matching, second – «stop» of generation. Depression in the stable mode of generation results in «stop» of generation.

ATTENTION! ENERGY SAVING!

All manipulations with output current (power) lead to energy consumption (power supply life time) change. Observe the life time indicator « ⌚ » on the filed «POWER» to make sure there is enough time to complete the tracing. To save the energy, work with the minimum sufficient power in the load. Use the mode of short-time transmission if possible. The breaks in operation help in partial replenishment of capacity. Charge the accumulators if the situation allows. Do not bring to automatic switch off through insufficient power.

Long-term storage of accumulators in discharged condition results in complete loss of their serviceability. Before long term storage charge the accumulators and recharge them at least every 6 months. The temperature during storage shall be $+20\dots 25^{\circ}\text{C}$.

13.9. Operation with inductive antenna

To achieve the maximum intensity of the «induction», the buried utility line and antenna frame must be located as close as possible to each other and in **a single plane**. Prior to connection of the frame to the output turn off the power in the “stop” mode with power button pos.2 « $\frac{1}{2}$ » figure 4.13 or with external mechanical switch. If the antenna is connected to the output when the power is on, the instrument switches to “antenna” mode characterized by permanent parameters setup. The following is indicated: mode «AC», frequency «8192», current «0,2».



Fig. 13.13

Inductive connection to buried utility with antenna
20 – time, h
AP - pulsed generation
8192 – frequency, Hz
2,0 – current, A
29,5 – power, W

After transmission is activated with the button « $\frac{1}{2}$ » pos.10 the automatic matching results in automatic setting with optimum specified parameters. After that if necessary the output voltage can be reduced or increased with the buttons « $\frac{1}{2}$ » and « $\frac{1}{2}$ ». To continue transmission after power interruption restart with the button « $\frac{1}{2}$ » is required.

WARNING! During long time operation of loop antenna IEM-301.3 in continuous mode, its body may heat up to 60°C



Fig. 13.14

Inductive connection to buried utility with clamp
10.5 – time, h
PU - pulsed generation
512 – frequency, Hz
4,0 – current, A
20,0 – power, W

13.10. Operation with the transmitting clamp

If there are several closely located buried utilities it is recommended to use the transmitting clamp figure 12.14 to induce the current specifically in one of them contact-free. The power consumed by the clamp is reverse proportional to the signal frequency if the voltage is constant. It is not

recommended to apply the power more than 60W in the continuous generation mode (CO).

It is not allowed to transmit more than 20W in continuous (CO) mode and more than 200W in pulse (PU) mode on CI-110 clamp.

13.11. Operations under precipitations

The waterproof instrument (**IP54**) allows operation under precipitations when the cover is closed providing the online adjustment of parameters is not required. The power is turned on/off with external waterproof power switch «I/O» pos. 1 figure 13.15. The readings are monitored through the transparent window in the cover pos. 11 figure 13.15. Make sure the required mode is selected and start the transmission before closing the cover. Every time the power is turned on with the closed cover the system shall restart this mode (except for «AC» and «AP») with automatic matching. The transmission is indicated by highlighting of the external switch. The free connectors on the rear panel are protected by rubber plugs.



13.12. External power connection

The additional accumulator (12/24V) or power adapter output (15 V) can be connected to the upper connector of the rear panel pos.15 figure 13.15.

ATTENTION!

The external source output may have no galvanic link except for with the transmitter output. Prior to connection make sure there is no grounding, zeroing or link to the vehicle body for any of the external source outputs.

Depending on the task the instrument uses the external power for increase of the life time or increase of power or for charging.

13.13. Internal accumulators charge

Necessary instruments for charge is given on a figure:

Transmitter
AG-120TM



Charger
AG120.02.100



Charger connection scheme is given on a figure:







EXTERNAL POWER
SOCKET

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 shown on the pictures above:

1. Connect power cable to the charger AG120.02.100;
2. Connect the charger to «EXTERNAL POWER» socket of the transmitter and connect it to 220v power supply;
3. Select «CH» mode in transmitter menu:
 - in «STANDBY» (yellow indicators are not glowing, transmission is off), press «» (ENTER) button. Indicator "MODE" will start to block;
 - using arrow keys «» / «» («MORE» / «LESS» select «CH» mode;
4. Press «» (START/ STOP).

When charge is in process you will see animation of remaining charge time on transmitter screen. The charge is performed in two stages – express cycle and full cycle. Express cycle can charge the transmitter up to 80%/ Full cycle takes 6 hours more and charges the transmitter up to 100-110%.

14. The joint operation of transmitter and receiver during active route detection

The inductive (active) search method is now most widespread for detection of underground buried utilities. The basis of the method is the fact that there is an electromagnetic field around the conductor with current.

The transmitter connected to one end of the monitored buried utility serves as a source of test current of special frequency. For flowing of the current it is necessary to have a special electric conductive circuit with monitored buried utility as one branch and grounding as another branch for return of current through the ground.

The maximum strength of the electromagnetic field measured above the ground surface corresponds to the axis of searched buried utility.

To properly operate the kit the following rules are to be observed:

- Transmitter grounding selection (refer to p.12.3);
- Definition of transmitter connection type (refer to p.12.3);
- Setting of transmitter parameters (refer to p.12.5);
- Adjustment of receiver

After performing the above items you can start buried utility tracing.



Thank you for choosing Techno-AC equipment!

- If you have any suggestions for device's operation improvement in accordance with your needs, or
- you have proposals for improvement of technical documentation or
- you have questions regarding device operation please email us to: info@technoac.com or call: +7 (496) 615-16-90 (ext. 113)

We will solve your problem in no time.

Appendix 5 Specifications of AG-120

Frequency of generated signal	
Frequency of generated signal Frequencies f1, f2, f3 (three frequencies fixed in memory), Hz	Range 200...9999 (selected in the range with a resolution of 1 Hz and accuracy of $\pm 0,05\%$ Hz and input in the power-independent memory)
Frequency f4 (one «temporary»), Hz	Range 200...9999 (selected instead of one of the «fixed», not input to the memory, exists while the power is on)
Output parameters	
Output current	
Maximum in manual mode: - continuous and two frequencies generation, A - pulse generation, A	10 15
Maximum output voltage	
- when working in safe mode, V - under internal power supply, V - with added external accumulator 12V, V - when supplied from power adapter, V	24 220 (170 when «2F») 330 (260 when «2F») 140 (110 when «2F»)
Maximum output power when accumulators are fully charged	
- under internal power supply or from external accumulator 24V, W	120 continuous at a load of 1,2...300 Ohm / 180 pulsed at a load of 0,8...200 Ohm
- with added external accumulator 12V, W	180 continuous at a load of 1,8...450 Ohm / 270 pulsed at a load of 1,2...300 Ohm
- from power adapter, W	70 at a load of 0,7...200 Ohm
NOTE. When incompletely charged or (and) frequencies above the “logarithmic middle point” of the range (1,4kHz) the reduction of the maximum power with an increase of frequency and load resistance is possible at no more than 3dB.	
Resistance range for matched loads, broader than	
For minimum specified current (0,1A) - for internal power, Ohm -with external accumulator 12V added, Ohm	4...2200 (4...1700 when «2F») 4...3300 (4...2600 when «2F»)
For maximum continuous current (10A) - for internal power, Ohm -with external accumulator 12V added, Ohm	0...1,2 0...1,8
For maximum pulsed current (15A) - for internal power, Ohm -with external accumulator 12V added, Ohm	0...0,8 0...1,2
Matching with the load	
	- automatic, providing achieving of the specified current in the load - manual (buttons « » or « »)

Design parameters	
Output power amplifier	Pulsed, technology CLASS D(BD), Efficiency factor > 80%
LED-based superbright digital indicators of high temperature range	- all supply voltages - modes and settings - power resource - «OUTPUT MULTIMETER»: «output voltage», «current in load», «load resistance», «power in load»
Control	Nine-button keyboard and external power switch with generation indicator providing work under rain with closed cover (due to parameter setup “memorizing”). Intuitive interface
Dimensions of electronic block (case), maximum, mm	305x270x194
Weight of electronic block, maximum, kg	12
Operating temperature range, °C	-30 ...+50

Appendix 6

Symbols displaying the power supply configuration of the AG-120 transmitter



accumulator No2 is connected in parallel with the base accumulator No1 (12V)



accumulator No2 is connected in series with the base accumulator No1 (24V)



the external accumulator (12V) is connected in series to the internal accumulators No1 and No2 connected in parallel (24V).



the external accumulator (12V) is connected in parallel to the internal accumulators No1 and No2 connected in parallel (24V) .







the external accumulator (12V) is connected in series to the internal accumulators No1 and No2 connected in series (36V)









the power amplifier is supplied only from external source with an elevated voltage (external accumulator 24B or power adapter 15V). The internal (accumulators No1 and No2) supply the rest of the circuit.

The horizontal segments designate the power supplies with «-» output connected to the common wire of the circuit. The base internal accumulator No1 is always connected to the common ground and is designated by the lowest horizontal segment (if participates in the power amplifier supply). The vertical segments designate the power supplies with «-» output connected to the «+» of the other sources («superstructure sources»).

External supply type	Power source connection configuration			
				
	External only	All in parallel	External in series with mutually parallel internal ones	All in series
Accumulator 12 V / ≥ 24 Ah	-	Increase depends from external accumulator capacity	Life time x2	Either life time or Pmax x1,5
Accumulator 24 V / 15 A	The life time is fully defined by the external accumulator capacity	—		
Power adapter 15 V / 15 A	The life time is fully defined by 220 V AC mains availability.	—		

Symbolic depiction of the AG-120 multifrequency transmitter operation modes

	continuous generation
	pulsed generation (short transmissions)
	two frequencies (frequencies sent in turn)
	charging of internal accumulators
	transmitting antenna connected, continuous generation
	transmitting antenna connected, pulsed generation

Indication of emergency situations during the AG-120 multifrequency transmitter operation

Indication	Reason	Implication
Er 10	Signal reached minimum	Incorrect actions of the operators when the level of output signal is changed manually with the buttons « » or « ». The transmission is not stopped
Er 11	Signal reached maximum	
Er 12	Power reached maximum	
Er 14	Current in load reached maximum	
Er 20	Encountered external power voltage not allowed for charging	Indication of emergency situations resulting in automatic switching the transmission off
Er 21	External power voltage during generation has been too low	
Er 22	Voltage of one of internal accumulators has been too low	
Er 23	Voltage of external power has been too high	
Er 30	Current mode did not match to “presence/absence” of transmitting antenna due to incorrect connection	
Er 40	Highest allowed current in output cascade has been exceeded	
Er 41	Highest allowed consumption current has been exceeded	