



# **CABLE LOCATOR SUCCESS CBI-309G**

**TECHNICAL DESCRIPTION  
OPERATING INSTRUCTIONS**



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## Introduction

This Operation manual contains description of the cable route locator AP-019.3, its working modes, and information necessary for its proper use. AP-019.3 (hereinafter «the receiver» or «the device») can be used and a individually, and in the composition of the locating sets. The receiver works at the networks frequencies 50(60) Hz, 100(120) Hz, and with route locating transmitters at frequencies 512Hz, 1024 Hz, 8192 Hz, 32768 Hz («33 kHz») and at 512Hz in “Sonde” mode.

### **Cable locator «Receiver AP-019.3» is used for:**

- Detection of energized cables underground in two modes: “ROUTE” and “CHART” ;
- Direct digital measurement of the depth up to 10 m of the cable;
- Indication of the deviation from the utility axis in the mode “ROUTE” on LCD display;
- Measurement of the current in the utility on the operating frequency;

### **Intended use**

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

### **Operation conditions**

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

### **Cable locator «Receiver AP-019.3» working principle**

The working principle is based on the analysis of the electromagnetic field, created by the alternative current flowing through communications. The electrical signals induced in the receiver sensors are amplified, filtered, processed by the processor and displayed on the graphical display in the form of the communication position line, linear scale, and the graphic of the signal level change, digital value of the signal level amplification coefficient, distance to the communication axis, the value of the current flowing through it, and other parameters.

## 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.

Mini-USB port  
For PC and  
external Power  
connection



External sensor slot

Connection of external sensors.



Sensor DKI-117



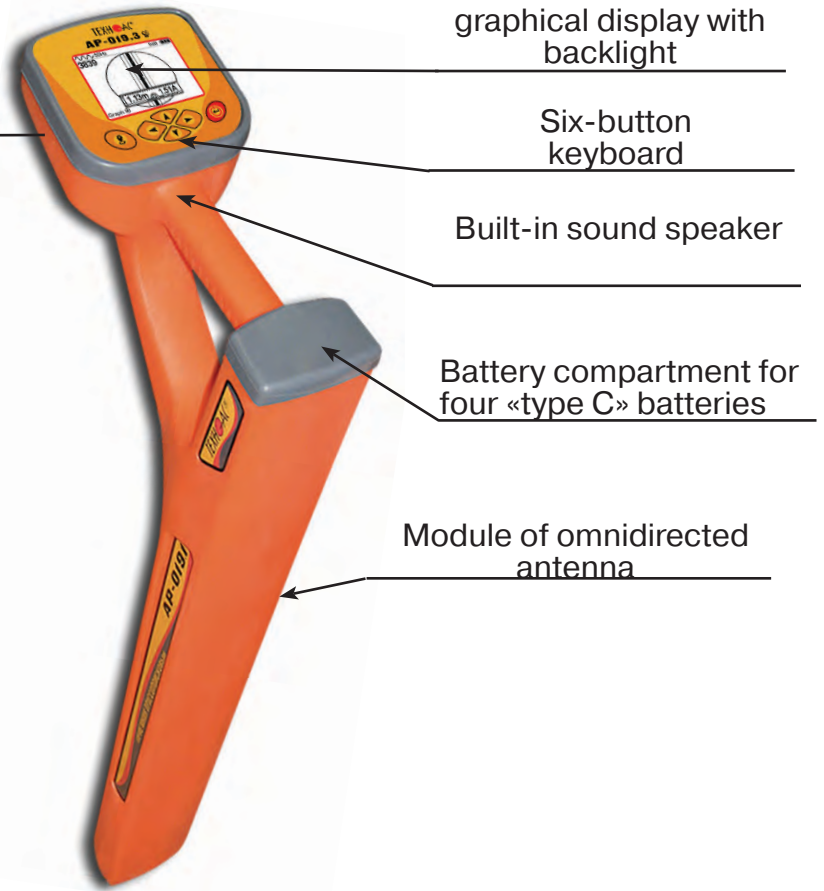
Sensor DODK-117



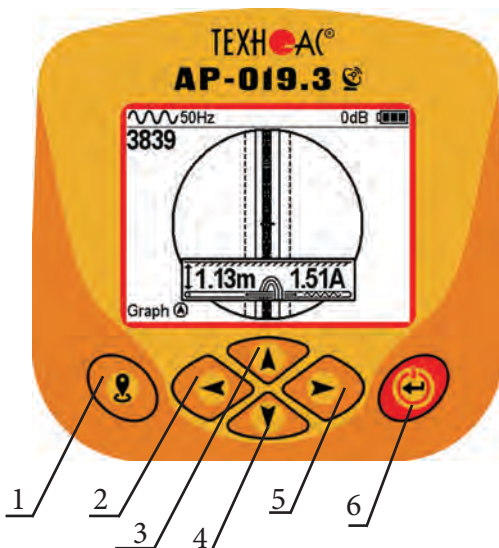
CI-105/110  
Inductive clamps






NR-117  
Superimposed  
frame



### Face panel, controls

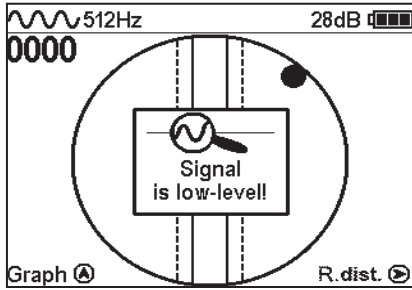


	<p>«Power»/«Enter» button (6) Switching on/off the receiver (to turn off the receiver, press and hold this button for 2 seconds) - open menu, - enter into the editing mode of the selected menu option, - exit for the editing mode saving selected parameters.</p>
	<p>Buttons «Up» (3), «Down» (4), «Right» (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>

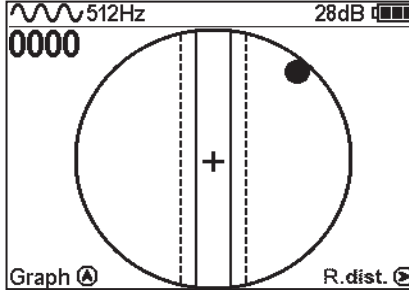
## 2. OPERATING MODES

### 2.1 "Route" mode

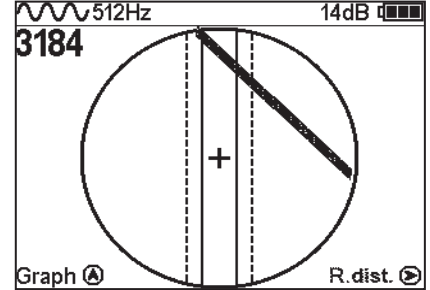
When turning on the receiver for the first time, the device will begin in route mode and the service information will appear. Route mode is the primary screen. Below, the indications are shown, which are dependent on the operator position near the located utility.



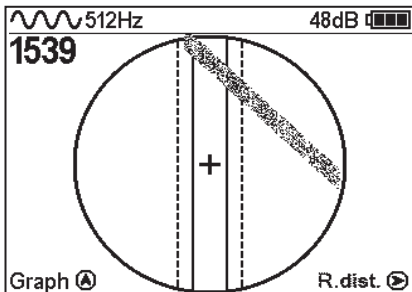
The receiver can't detect the utility.



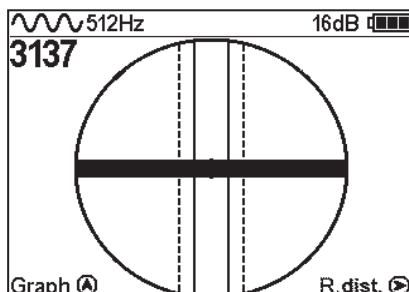
The ball on the screen shows the direction in which utility is located.



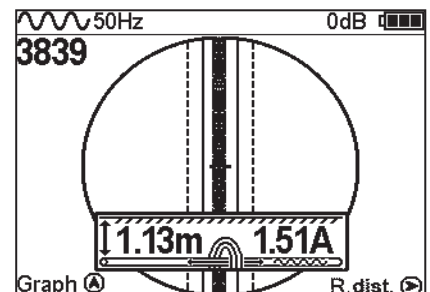
Position of utility axis shows, where the utility is situated.



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

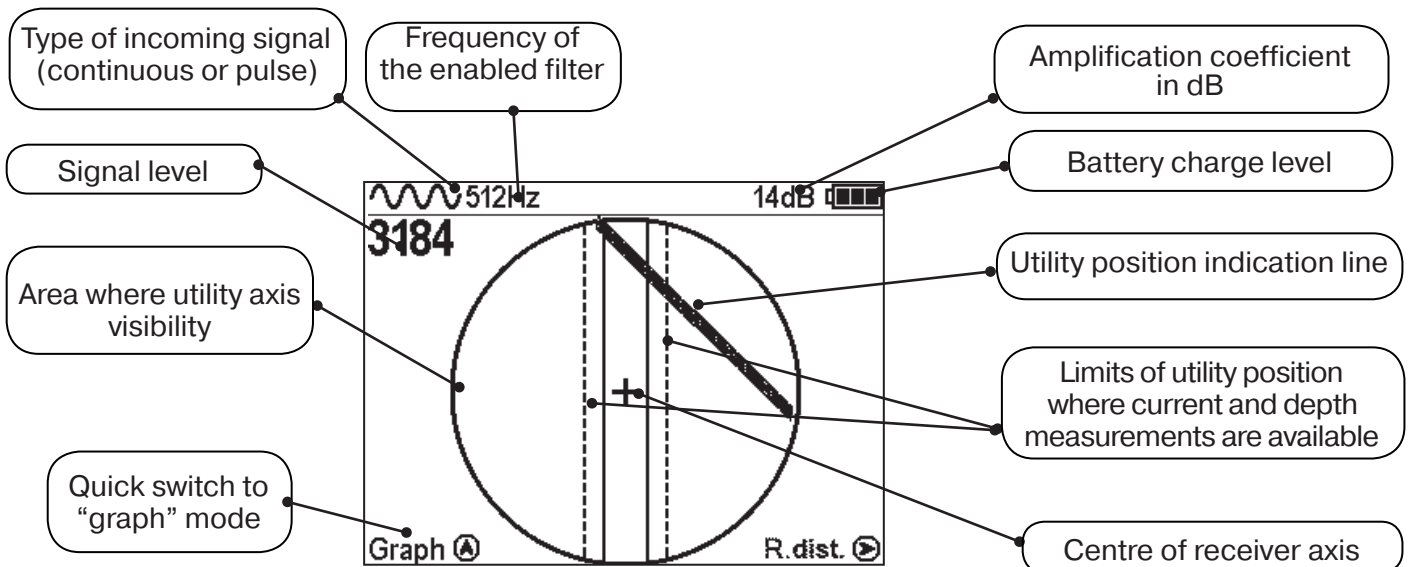


When above the utility, a solid line will appear which is perpendicular to the utility's direction.



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

### Route Mode Description

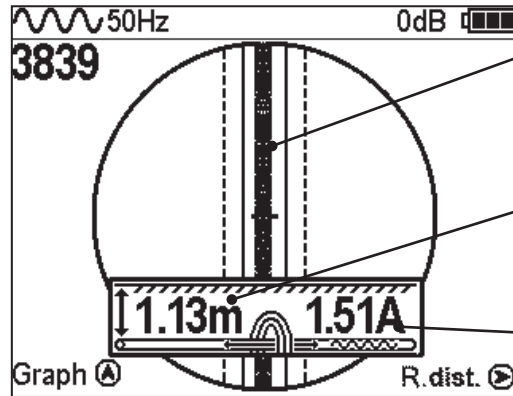


\* The four-digit number "signal level" (0000 - 4100) represents the intensity of the electromagnetic field, which is dependent on the filter frequency. The numeric value of the "signal level" becomes greater when an operator approaches the source of electromagnetic signal of the chosen frequency. The 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.



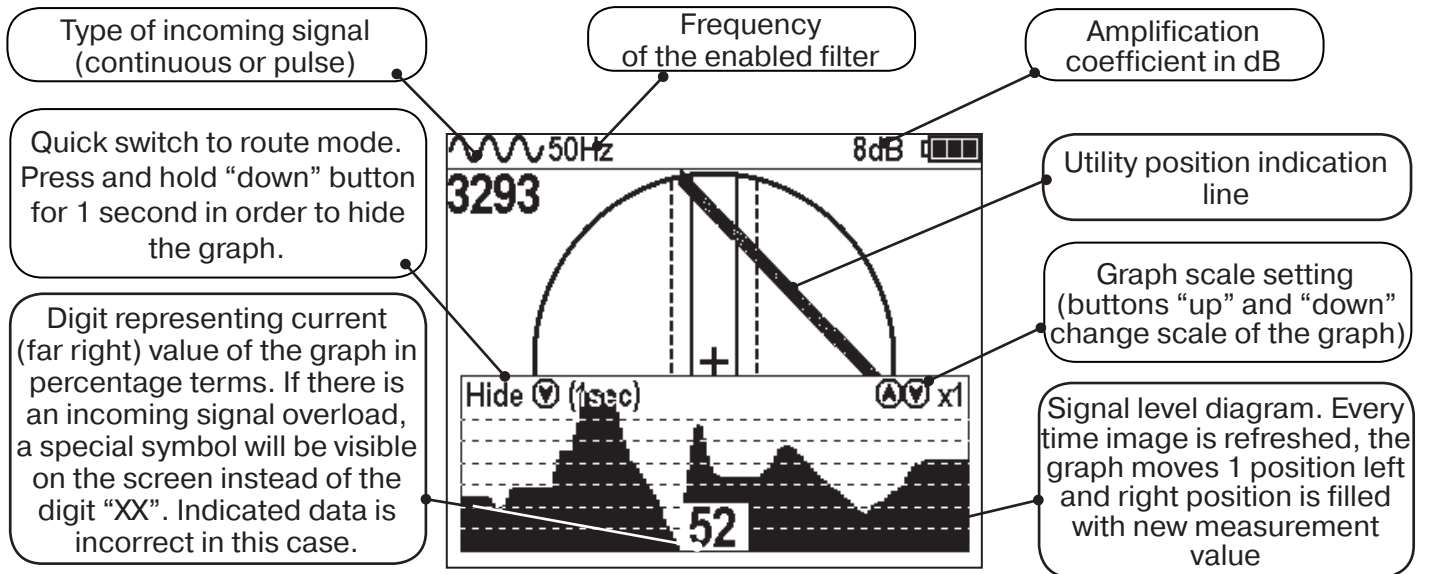
Receiver and utility axis are perfectly aligned

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.



Type of incoming signal (continuous or pulse)

Quick switch to route mode. Press and hold "down" button for 1 second in order to hide the graph.

Digit representing current (far right) value of the graph in percentage terms. If there is an incoming signal overload, a special symbol will be visible on the screen instead of the digit "XX". Indicated data is incorrect in this case.

Frequency of the enabled filter

Amplification coefficient in dB

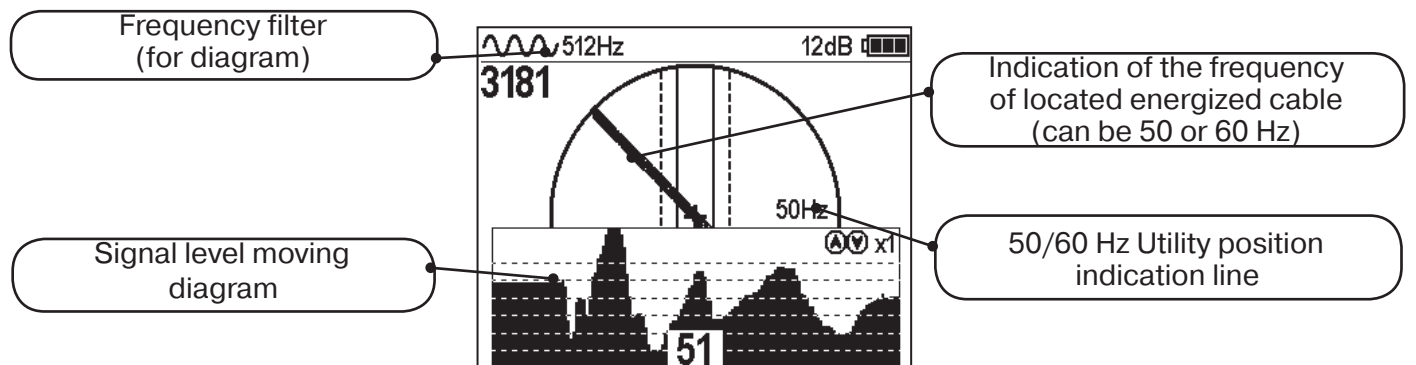
Utility position indication line

Graph scale setting (buttons "up" and "down" change scale of the graph)

Signal level diagram. Every time image is refreshed, the graph moves 1 position left and right position is filled with new measurement value

## 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.



Frequency filter (for diagram)

Signal level moving diagram

Indication of the frequency of located energized cable (can be 50 or 60 Hz)

50/60 Hz Utility position indication line

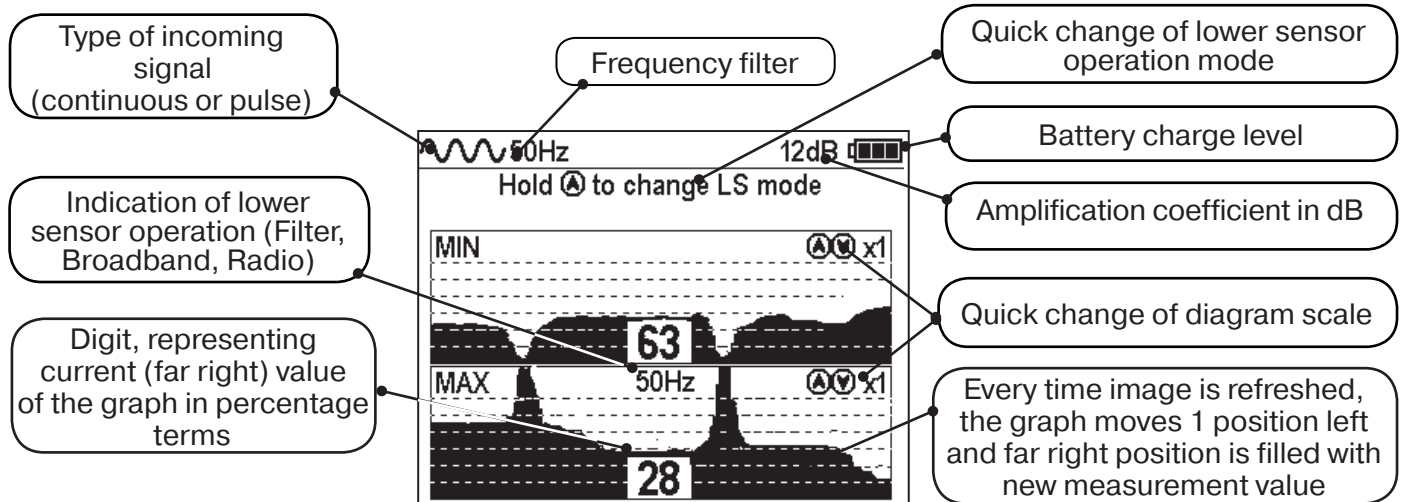


## 2.4 “Minimum maximum”

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.

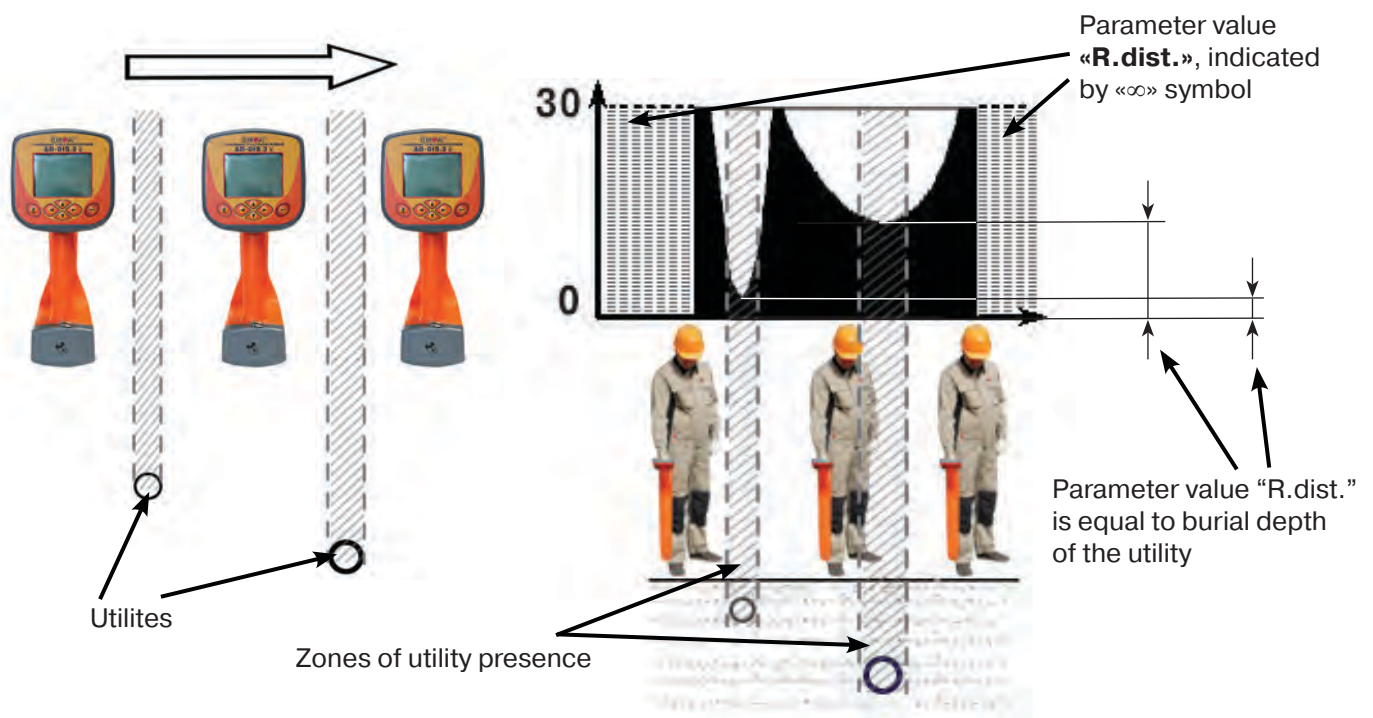
This mode does not allow depth and current measurements.



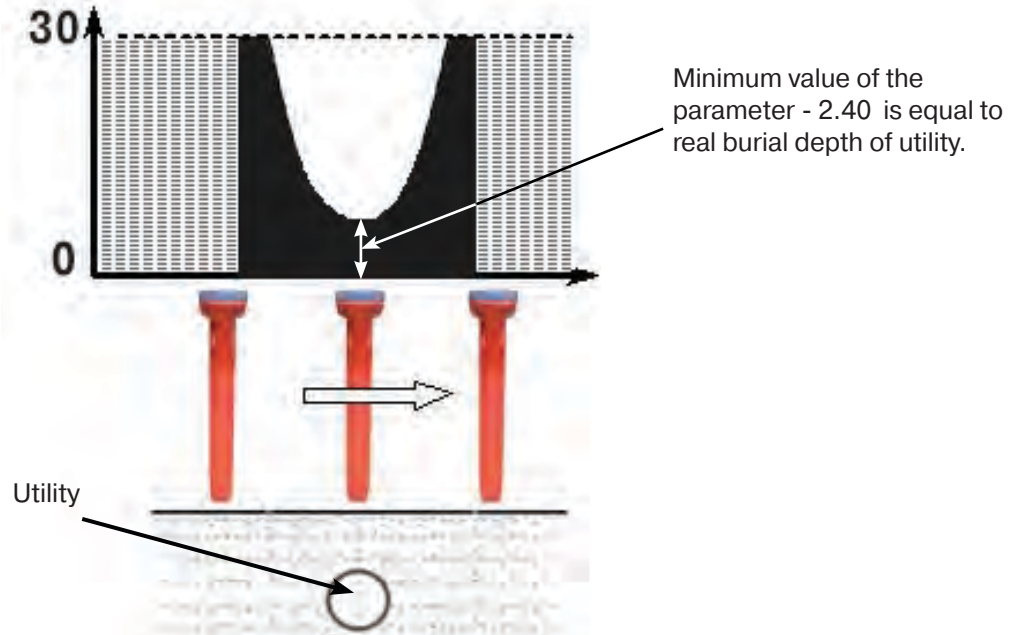
## 2.5 Modes with Graphic Representation of “Relative distance to the Utility” (R.dist.)

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:



This parameter can have values from “0.01” to “30.00”, “>30” and “∞”. Value “∞” are indicated when the receiver is positioned aside from the utility or when the utility is positioned above the receiver (an example being when there are overhead voltage lines around). The parameter “relative distance to the utility” will have its minimum value when the receiver is positioned directly above the utility axis. In this case, this value is equal to the real burial depth of the utility.



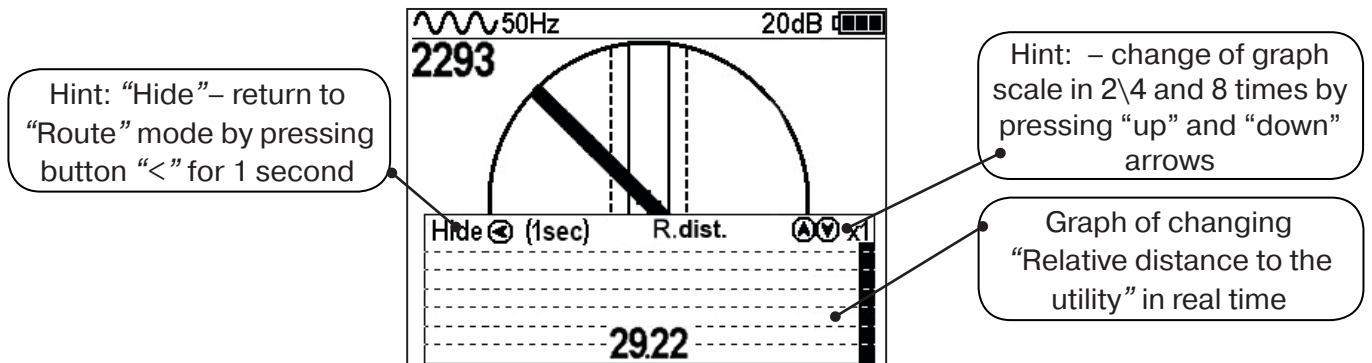
The receiver has two modes with indication of “relative distance to the utility”: “**R.dis. Graph**” is used when the “relative distance to the utility” graph and utility route are indicated simultaneously, whilst the “**MIN&R.Dist mode**” is used when screen of the receiver indicates 2 graphs (minimal signal and “relative distance to the utility”).

### 2.5.1 “R.dis. Graph” mode

This mode is the same as “Graph” mode. The screen is split in two parts, an upper display and a lower display.

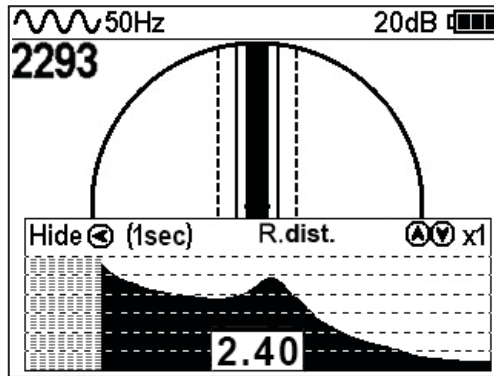
- Upper Part: Route axis indication
- Lower Part: “relative distance to the utility” graph

#### Indication of “R.dis. Graph”:





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

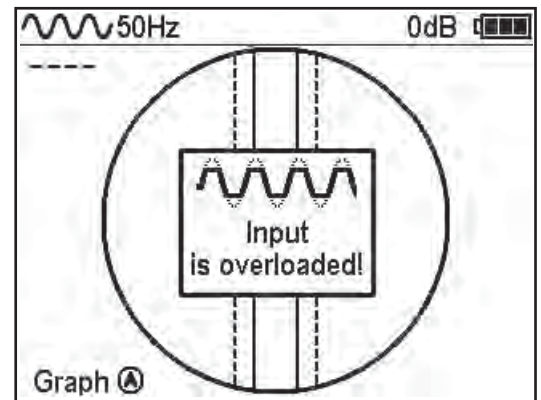
“Sonde” mode is used for tracing of non-metal pipelines by using a special pipe transmitter working on 512Hz frequency. (see paragraph 12)

### 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.

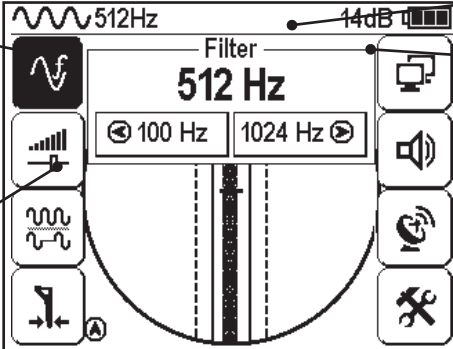


### 3. Menu description

#### 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




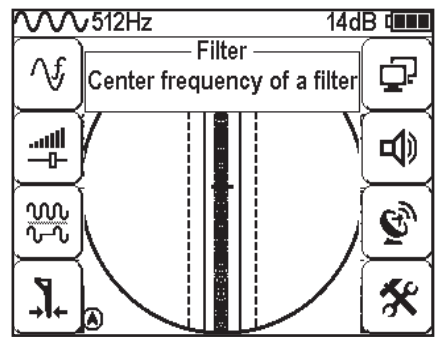

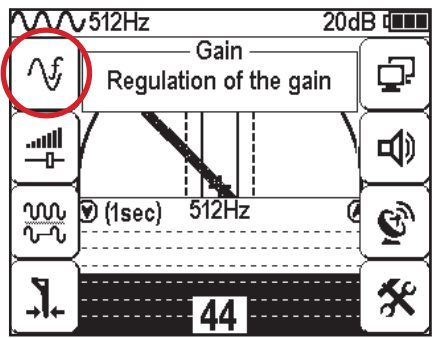

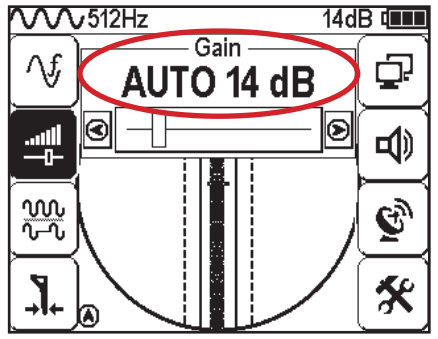


The selected menu option is highlighted with the dotted line, flashes with light/dark

Icons represent each menu option

Menu option name

Brief menu option description


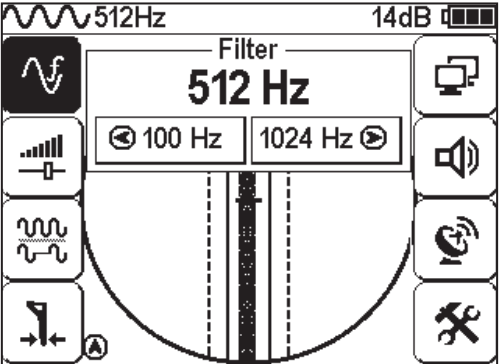

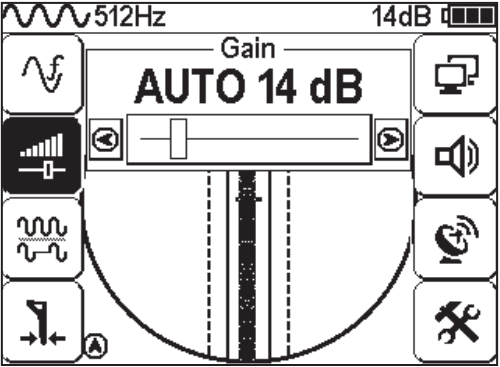

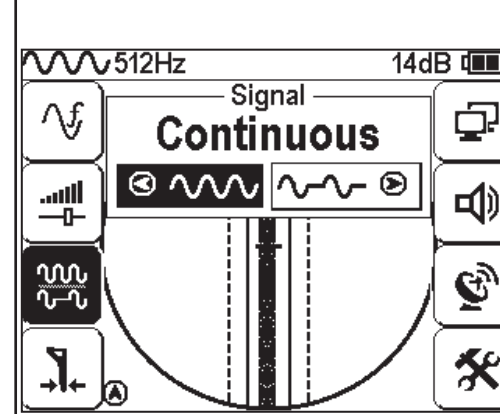

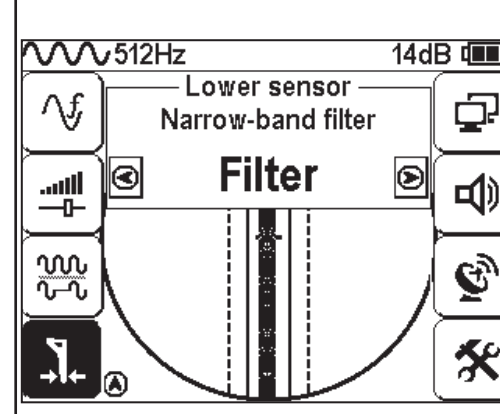
#### 3.3 Menu Parameter Selection General Principle


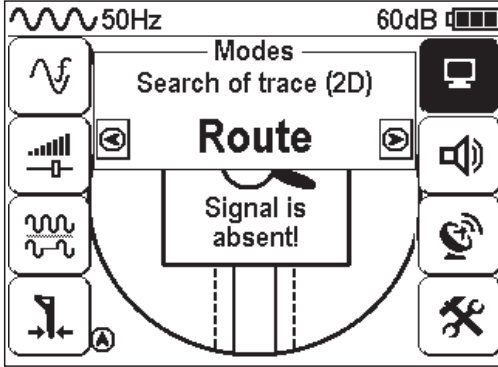

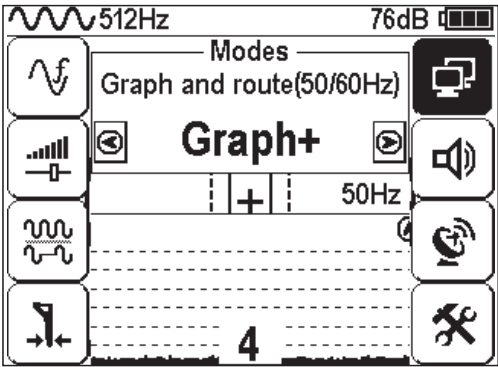

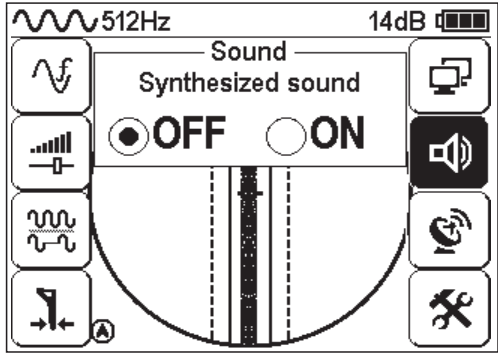

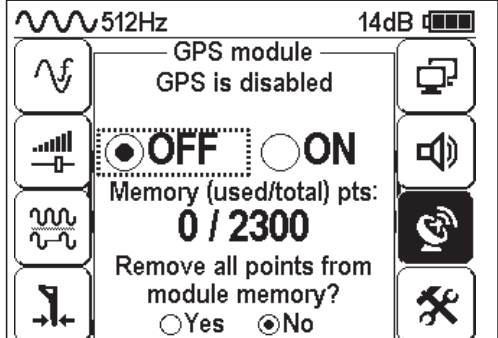
 <p>To open the menu, press "Enter".</p>	 <p>The menu will appear on the screen.</p>	 <p>Menu option selection is performed with buttons "Up", "Down", "Right" and "Left".</p>	 <p>Active "icon" is flashing and is highlighted by dotted line</p>
 <p>To change or view the menu item</p>	 <p>In the upper part of the indicator, the parameter editing panel will open.</p>	 <p>Values setting is performed with the buttons "Up", "Down", "Right" and "Left". <b>The changed value is immediately applied.</b></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>


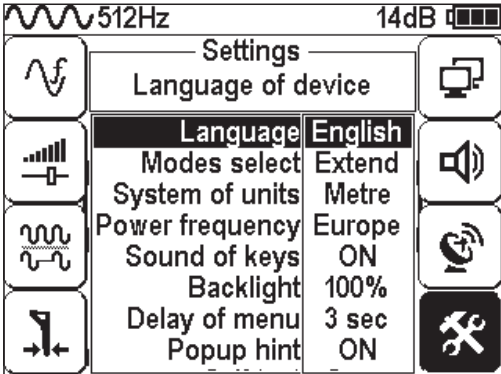
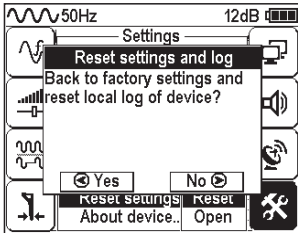
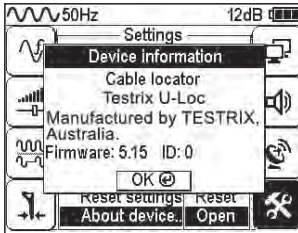
\* If no buttons are pressed for a period of time, the menu will disappear automatically. The length of this period is set in the "settings" menu option.




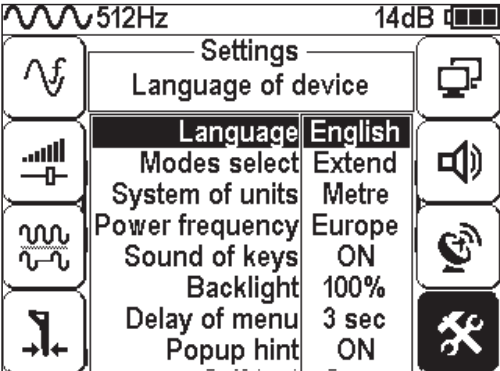
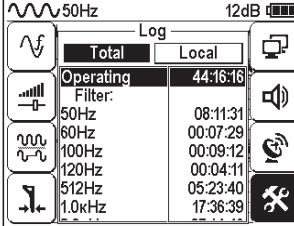
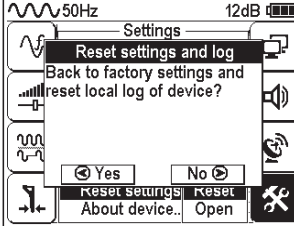
8 items of menu contain parameters of setting, which are opened in the panel located in the upper part of the indicator. **Table 1**

№	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: <b>50(60) Hz, 100(120) Hz, 512 Hz, 1024 Hz, 8192 Hz or 32768 Hz.</b>
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: - <b>manually</b> , - <b>semi-automatically</b> (by command), - <b>automatically</b> depending on the regime of the analysis and signal representation.
3	Signal 		The type of signal received can be <b>“Continuous” or “Impulse”</b> <b>Continuous</b> - operation on passive frequencies 50(60)Hz and 100(120)Hz, cathodic protection of pipeline. <b>Impulse or Continuous</b> - 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><b>Basic set of modes:</b></p> <ul style="list-style-type: none"> <li>- <b>“Route”</b> (2D display of the location of the utility);</li> <li>- <b>“Graph”</b> (visually represents the changes of signal level of surveyed cable as a diagram along with a 2D representation);</li> </ul>
	<p>Advanced Mode</p> 		<p><b>Extended set of modes:</b></p> <ul style="list-style-type: none"> <li>- <b>“Graph+”</b> (visually represents the changes of signal level of surveyed cable as diagram alongside with 2D representation of 50 (60) Hz cable;</li> <li>- <b>“MIN&amp;MAX”</b> (graph representation of minimum and maximum signals)</li> <li>- <b>“2 frequency”</b> (amplitude and phase Non-destructive testing, detection of “friend” or “foe” signal on two frequencies).</li> </ul>
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"> <li>-OFF</li> <li>-ON</li> </ul>
7	<p>GPS</p> 		<p>GPS Status bar can indicate the following information:</p> <ul style="list-style-type: none"> <li>- GPS module is on.</li> <li>- GPS setting</li> <li>- GPS is switched off</li> <li>- Looking for GPS satellites</li> <li>- Coordinates of latitude and longitude</li> </ul>

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



	<p>Settings</p> 		<p><b>LOG</b></p> <p>The statistics of device usage including all applied settings</p> 
			<p><b>Reset settings</b></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

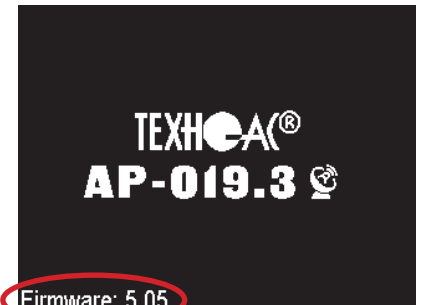


Install four new elements into the battery compartment of the device, minding polarity. Install the battery compartment into the body until it snaps.

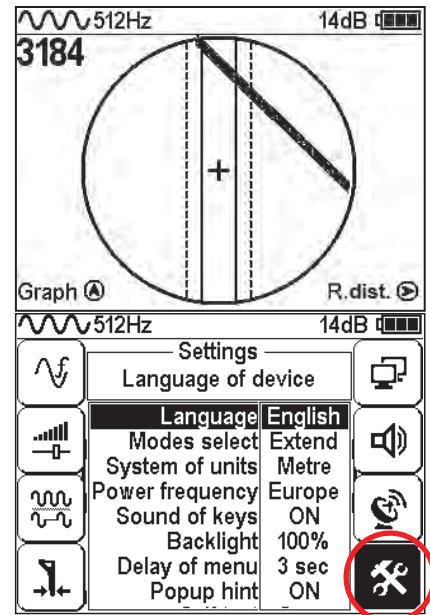
## Receiver switching

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



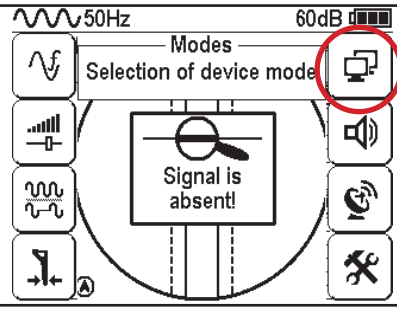


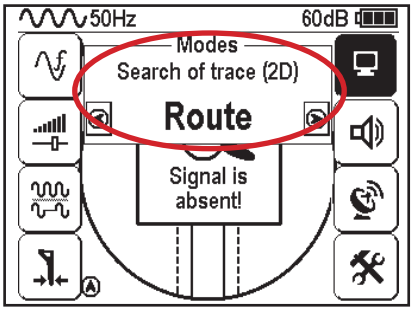



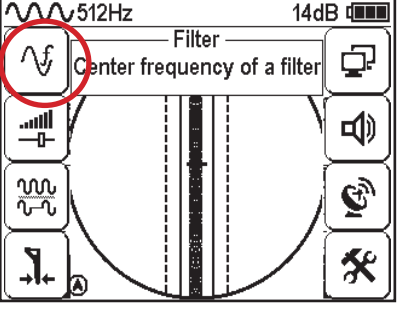

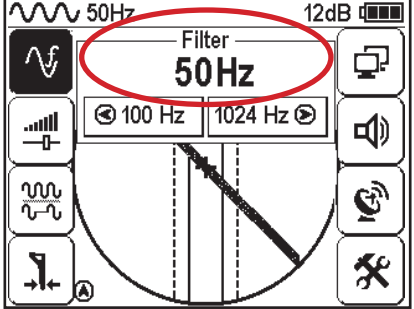

Route mode is the main mode for route location of various utilities (cables & pipelines) at all supported frequencies, both in “passive” cable route location and at the “active” (with the use of the route locating generator). In passive mode, the cable location is carried out at frequencies of 50(60) 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>Press “enter” to enter the mode change menu</p> 	 <p>Select 50(60) Hz frequency</p> 

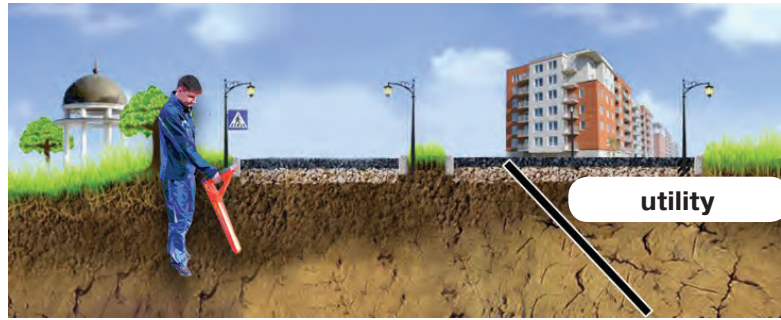
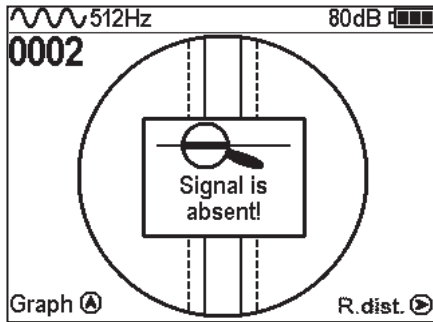
When filter 50(60)Hz is chosen, the type of incoming signal is automatically set to continuous.



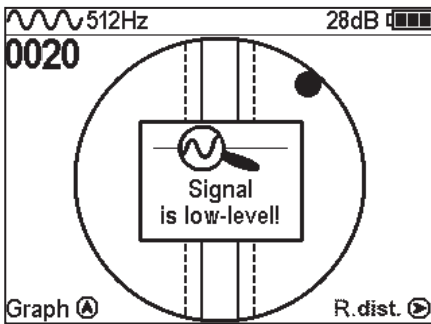
## 5.2 Search of a Communication and Measurement of its Burial Depth

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

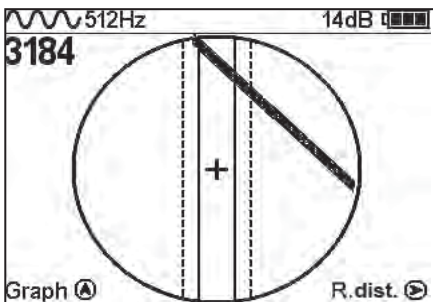
2. If the utility is far from the operator, you will see on the screen:



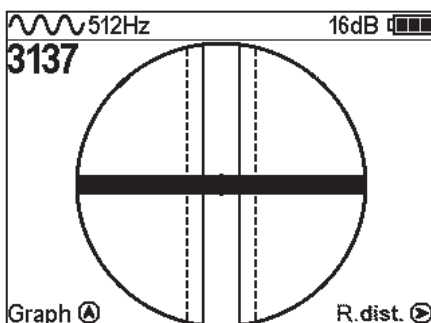
3. When moving towards the supposed place of the utility location, the “ball” will appear on the screen. It shows the presence of a utility and that it is a significant distance from the operator.



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



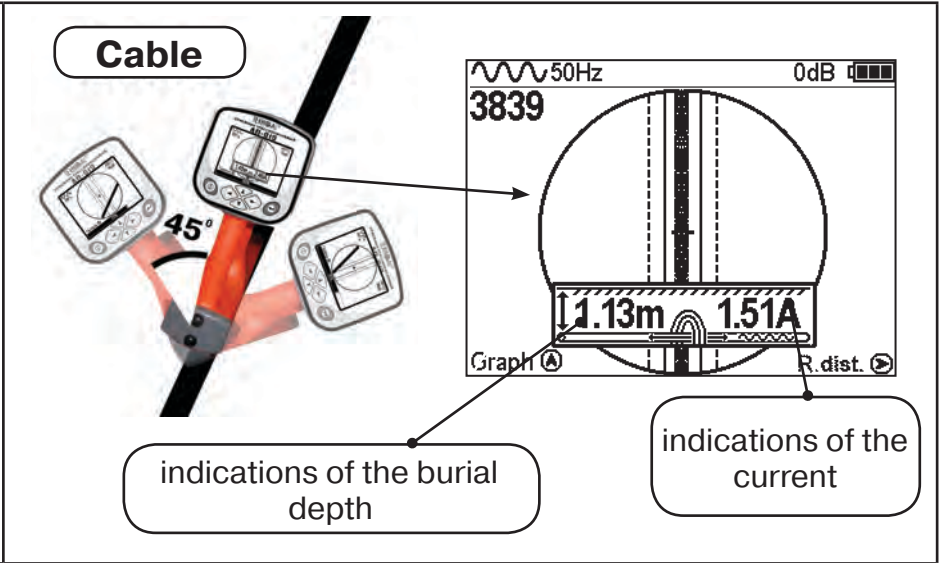
5. When the operator moves closer to the utility, the axis will move to the centre of the circle. This means that the operator is standing directly over the utility



## 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.

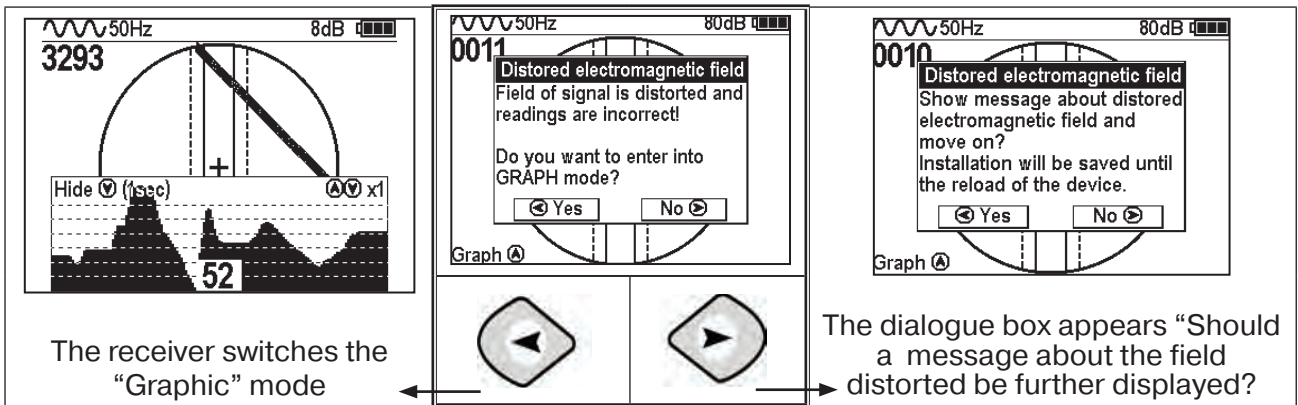
In this position, it is possible to move forward and trace a whole cable).



**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.

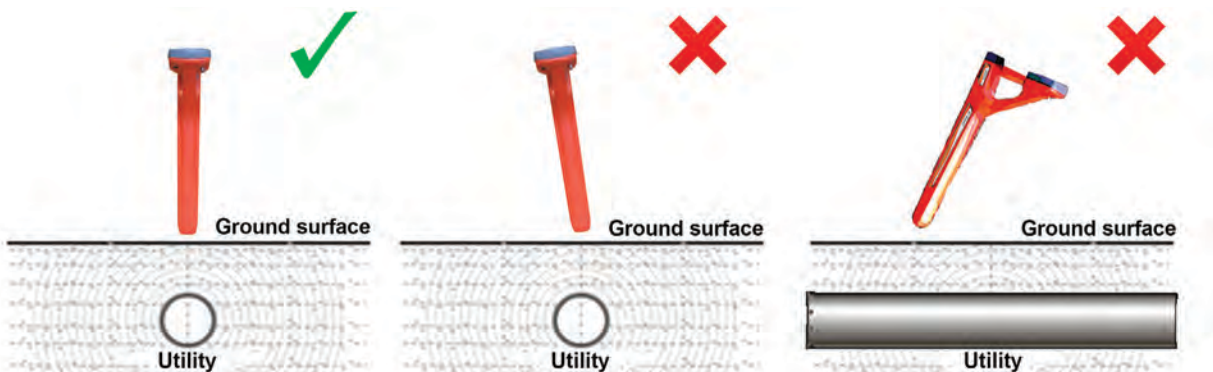
If the communication axis cannot be located exactly in the limited area, and the periodical jumps are happening from one border to the other, it indicates the presence of several cables under voltage with the 50 Hz frequency. You can specify number and position of the cables in "Graphic" mode.



**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

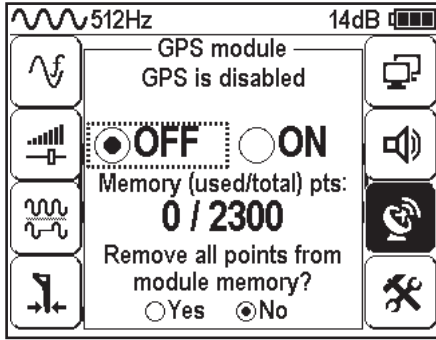


Fig.1

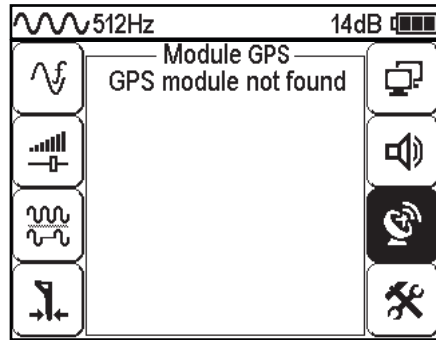


Fig.2

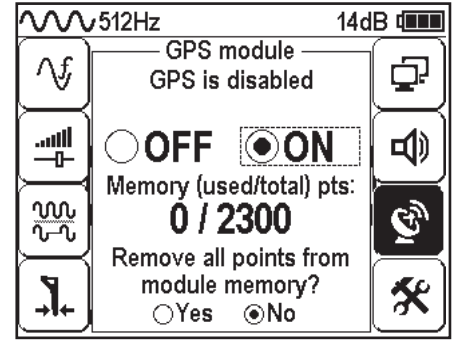



Fig.3

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.

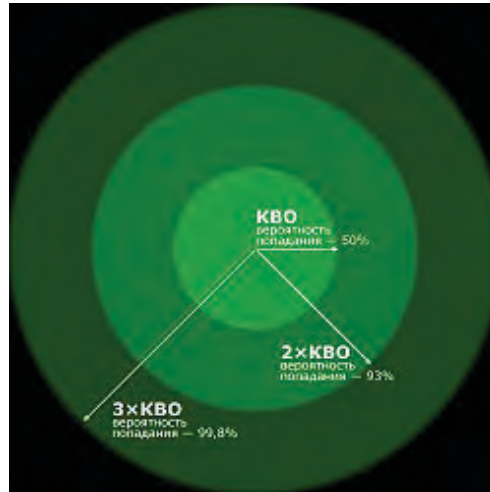
Operating mode of the receiver is saved every time because it is constantly available. When saving the data to receiver memory, you will see a corresponding message "Saving new point #X" (where X – is a serial number of the point). The receiver can store up to 2300 points. Uploading the data to a PC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

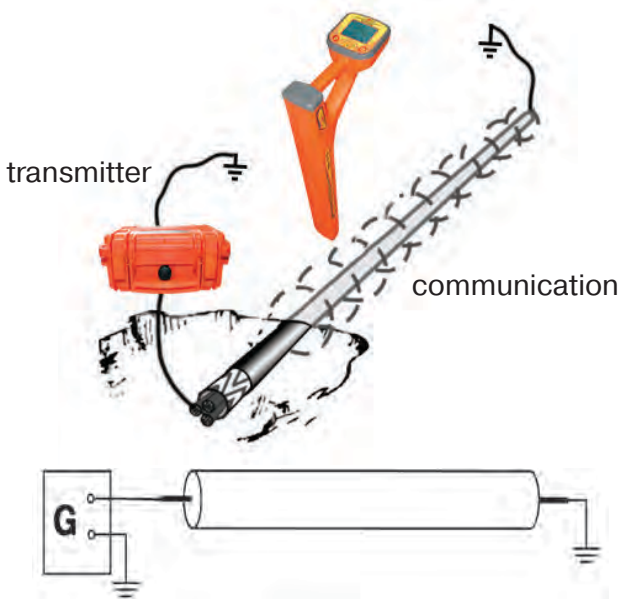
### Transmitter Connection

#### Contact mode

The generator output is connected directly to the communication

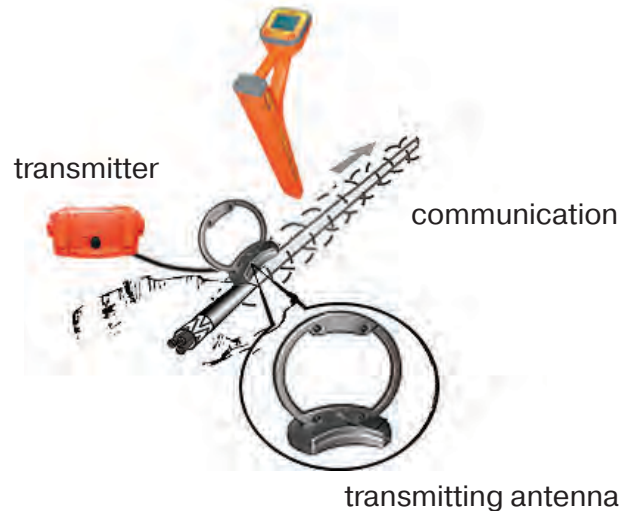
#### Contactless method

using the transmitting antenna



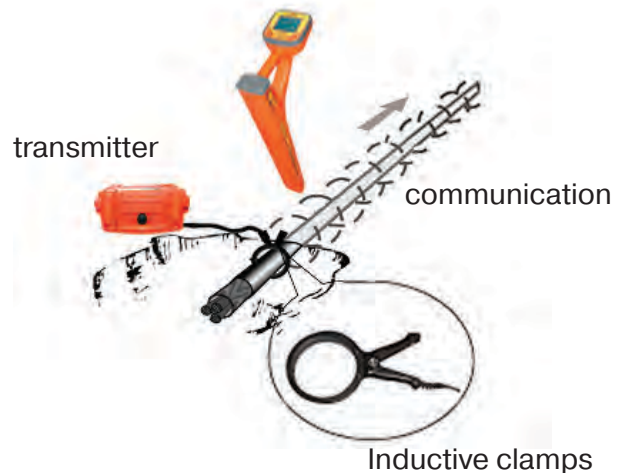
#### Contactless method

Connection with internal inductive antenna of the transmitter



#### Contactless method

using the induction clamps



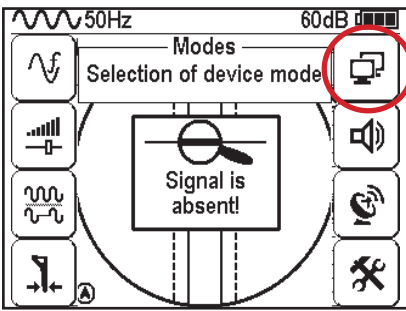

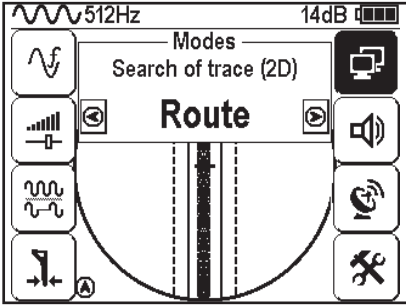

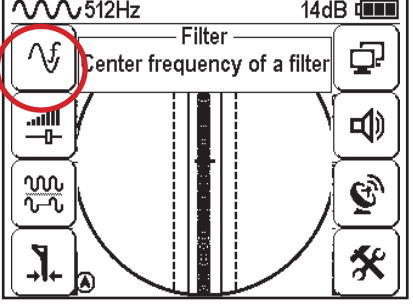


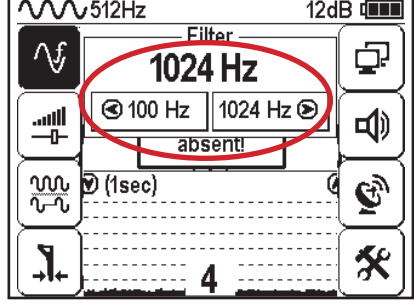




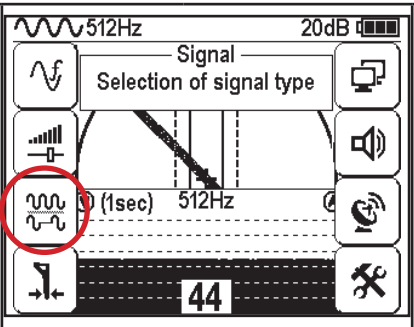


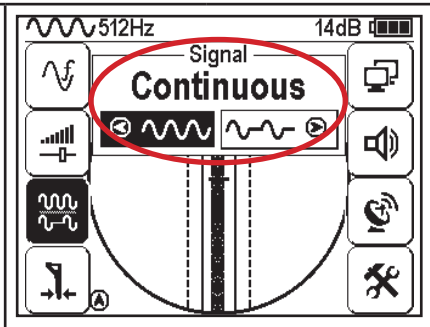


**Note**

**Procedure for search of communication and conduction of cable route location**

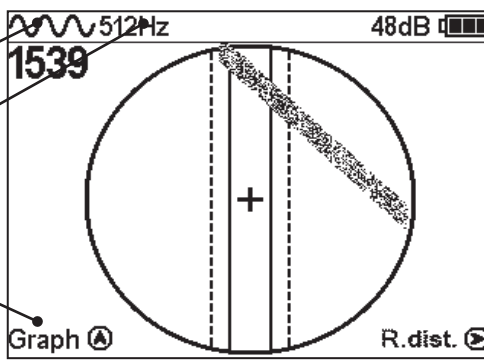

<p>1. Connect the transmitter to the utility by contact or contactless method.</p> <p><b>Note</b> When possible, the preference should be given to the contact method of connection, which allows the user to perform the cable route location for more distantly.</p>	<p>2. Turn on the transmitter. Set the signal type - impulse "Co"/continuous "Pu" / pulse. The generation frequency on the transmitter - 512, 1024, 8192, 32768 Hz.</p> <p><b>Impulse mode (Pu)</b> is used to increase the time of work of the transmitter.</p> <p><b>Continuous signal (Co)</b> 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>To confirm your selection press "Enter" button.</p> 	 <p>Select the "Route" mode</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:



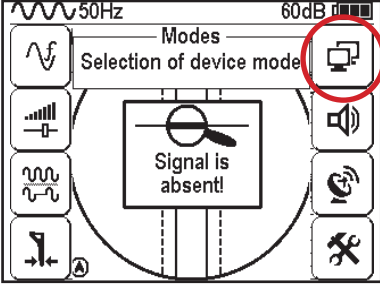
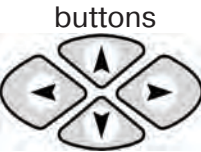

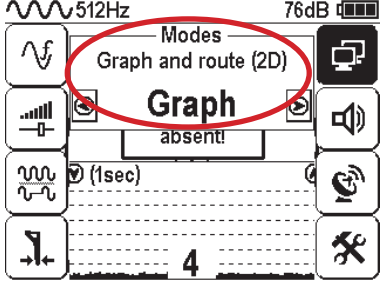


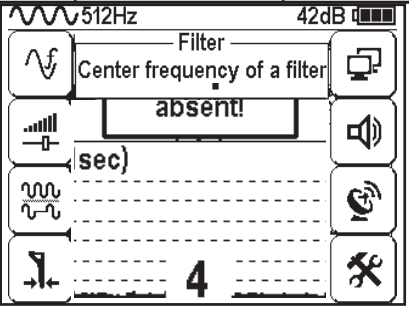
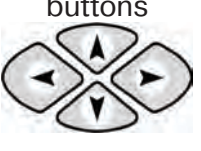

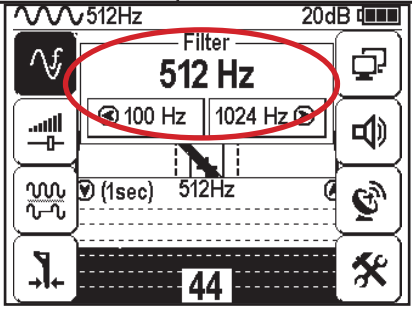

- the positioning of the utility axis into the centre is impossible
- the presence of several near located communications
- low signal in the cable

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.


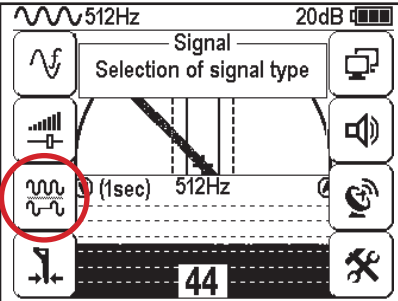

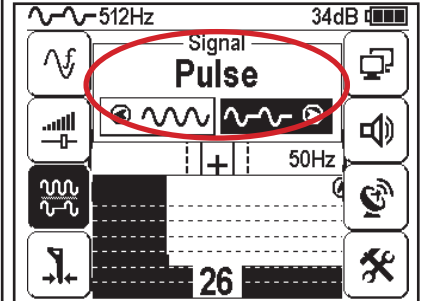



### 6.1 Setting of the Receiver for Work in the “Graph” Mode

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


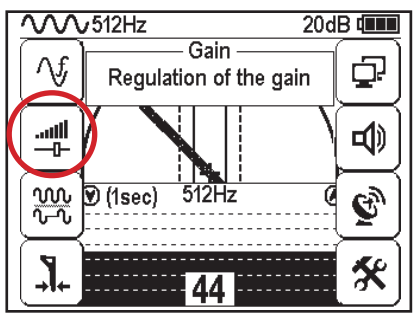

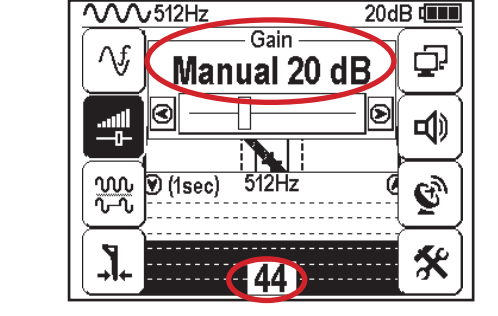





In the **“Graph”** mode the work is performed in the **“Continuous”** or **“Impulse”** signal. The difference at the work with the **“Impulse”** signal is in that the digit in the center of the analogue scale shows not the current value of the signal, but the maximum value (amplitude) of the transmissions 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>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>buttons</p> 	<p>Select the signal type, for example, impulse, and in accordance with the generator signal</p>	<p>buttons</p> 

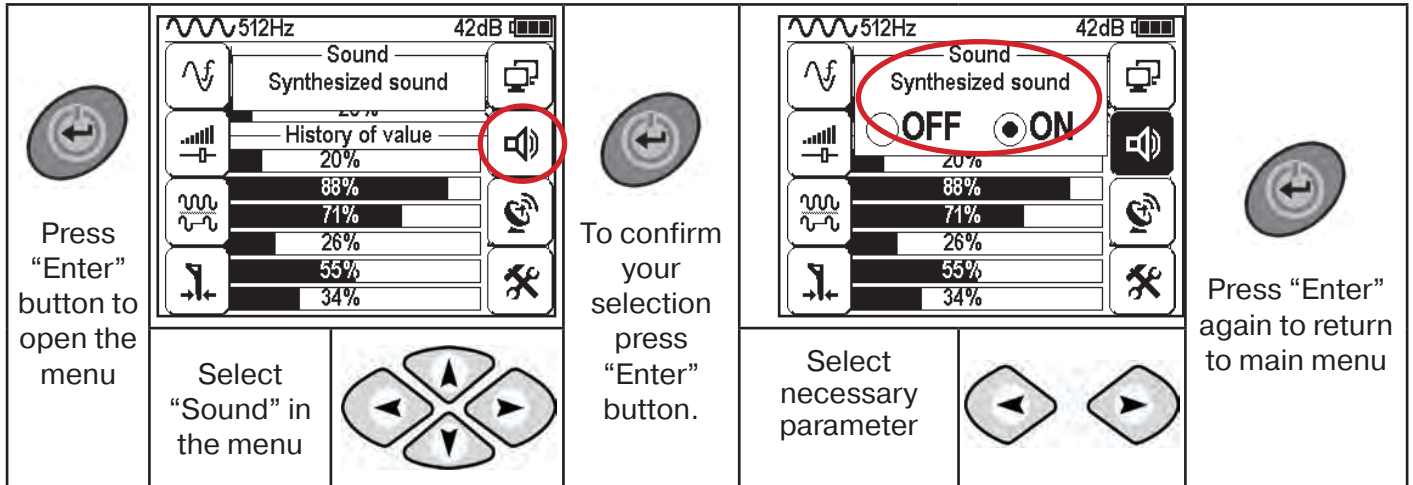
**Note** When working in the passive mode **50(60) Hz, 100(120) Hz** - you should always select the **continuous type of the signal**.  
 When working with the generator (in the **active mode**) **512, 1024, 8192 Hz, 33 kHz** - the type of the signal on the receiver is **continuous or impulse**, in accordance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

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

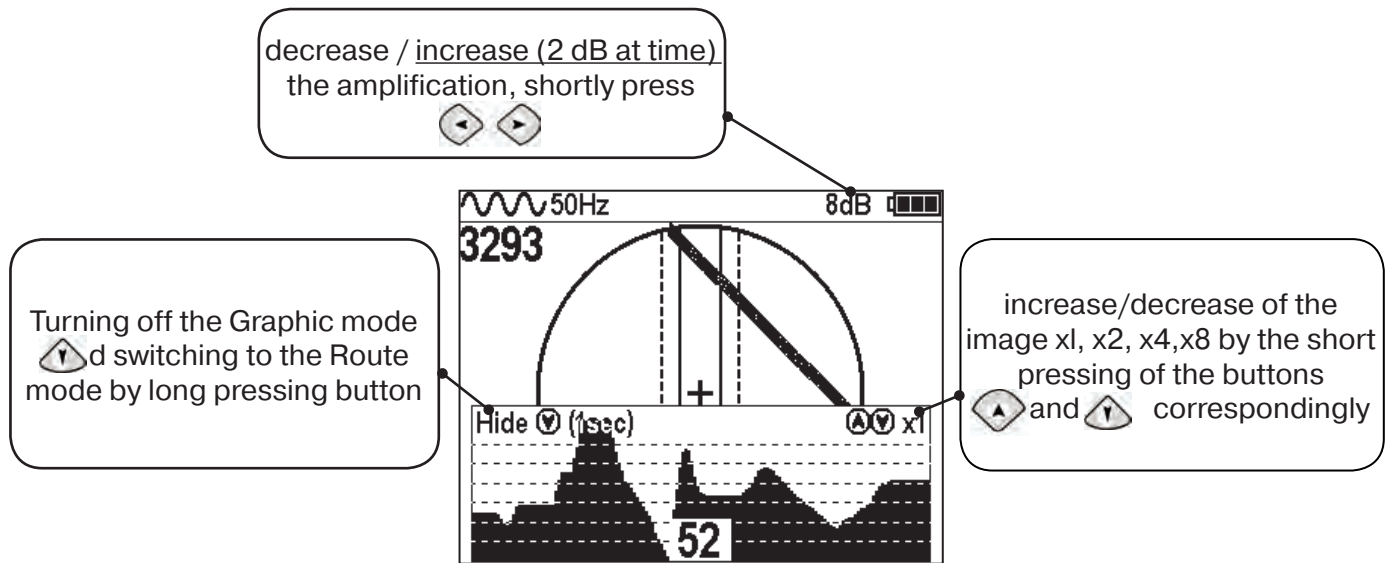
 <p>Press “Enter” button to open the menu</p>		 <p>To confirm your selection press “Enter” button..</p>	 <p>the signal level on the bottom scale should be in the range 50 to 50%</p>	 <p>Press “Enter” again to return to main menu.</p>
	<p>Select “Amplification” in the menu.</p>	<p>buttons</p> 	<p>Set the 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 .

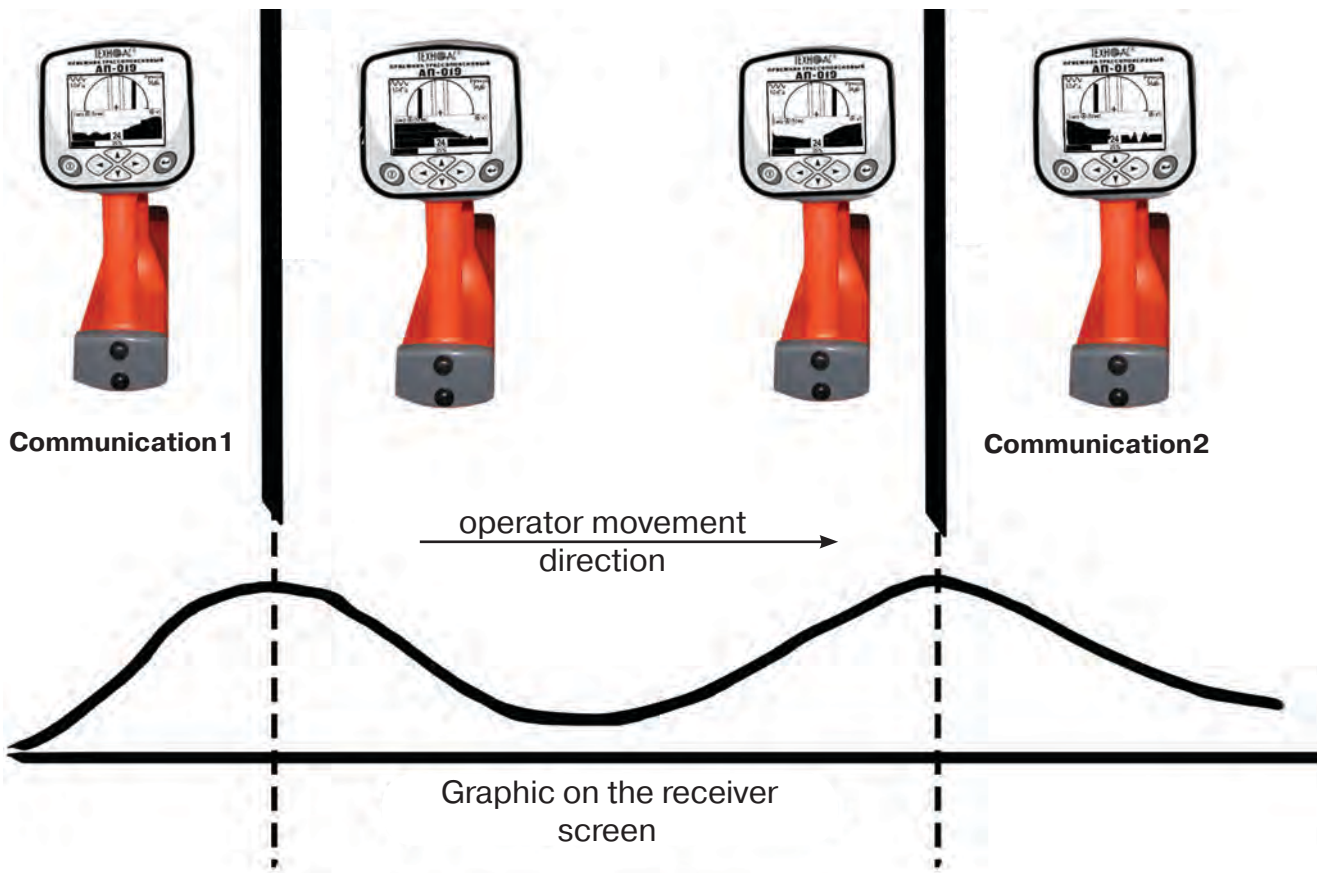
### 6.3. Search of Utilities in “Graph” Mode

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.

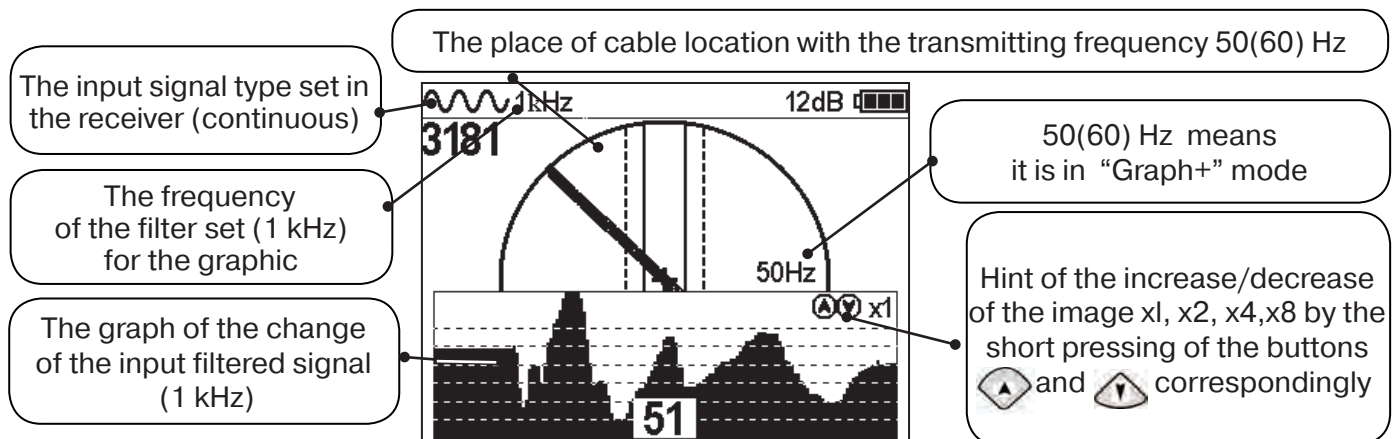
### 7.1 Setting of the Receiver for Work in the “Graph+” Mode

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><b>Note</b></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><b>Note</b></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 “<b>Graph+</b>” 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

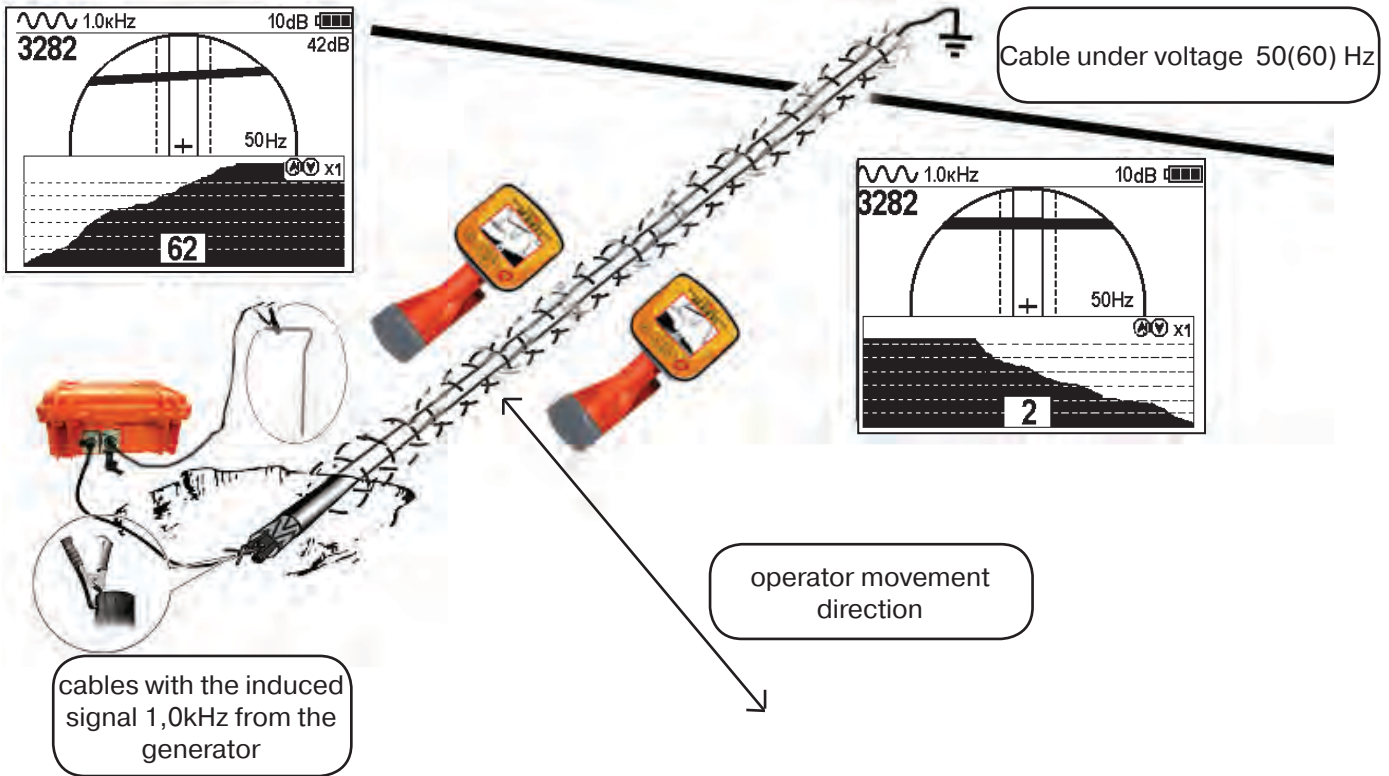




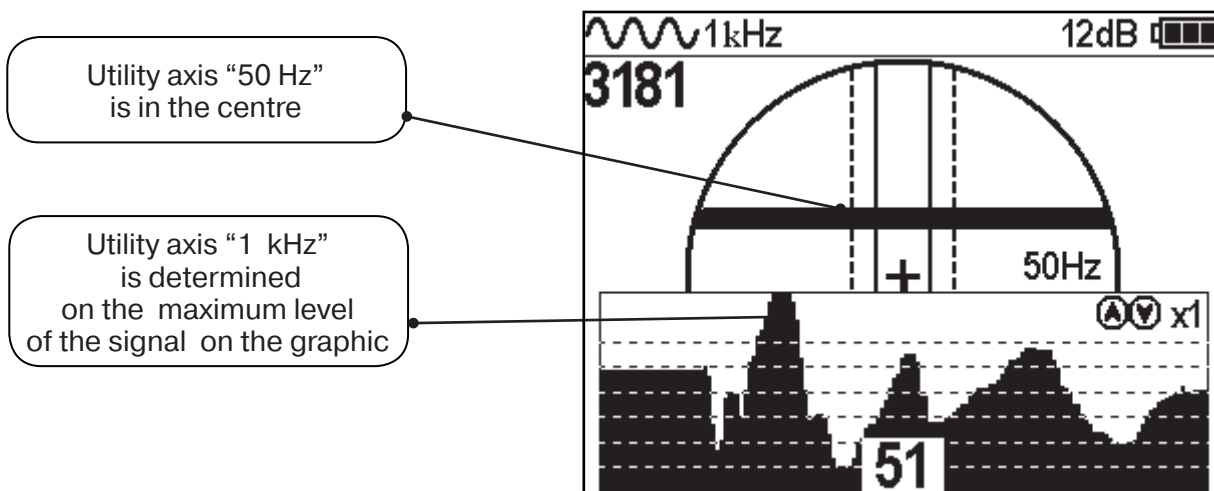
5. Approach the supposed place of cable route, on which the signal from the generator was transmitted. Locate the receiver axis in parallel to the utility axis.

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.

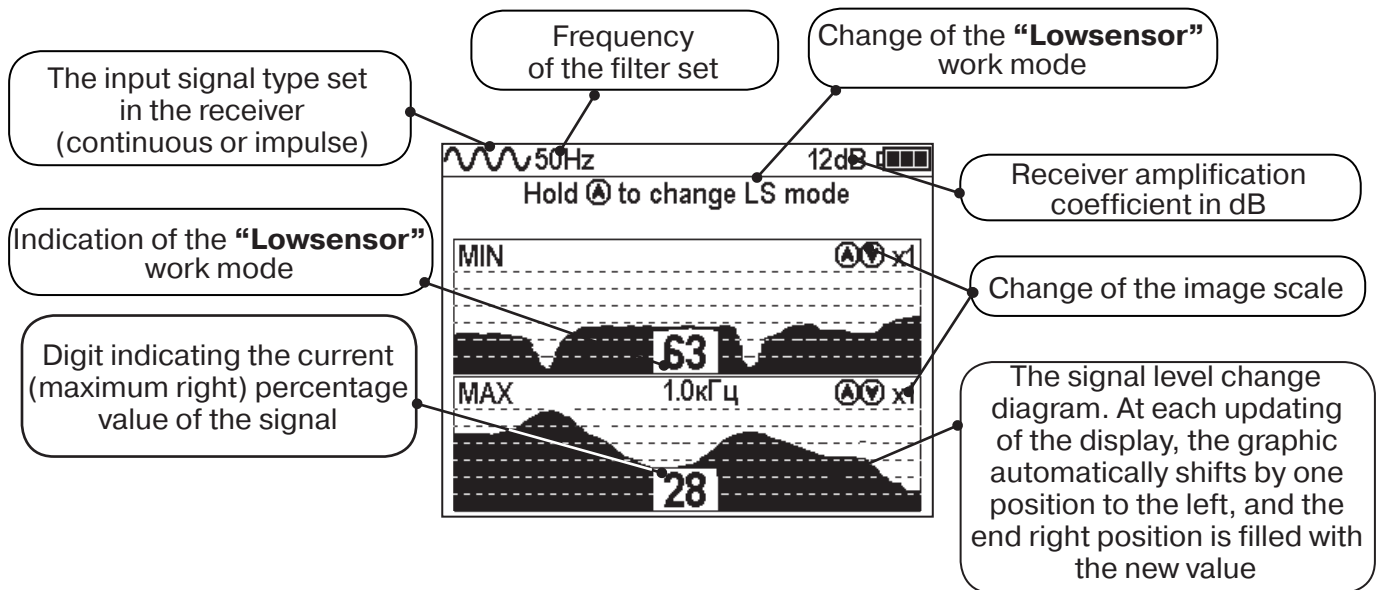


## 8. Performing a Cable Location in the Mode “MIN & MAX”

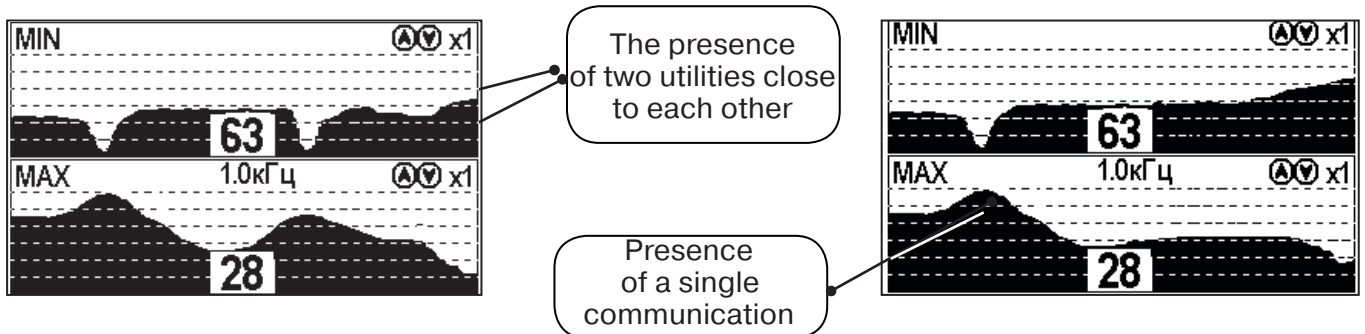
In the mode “**MIN & MAX**”, the device works simultaneously both on the method “maximum” and the method “minimum”. This mode is used in the conditions of distorted field, in the presence of nearby utilities and at the low induced signal. It allows the user to perform location and to determine the presence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

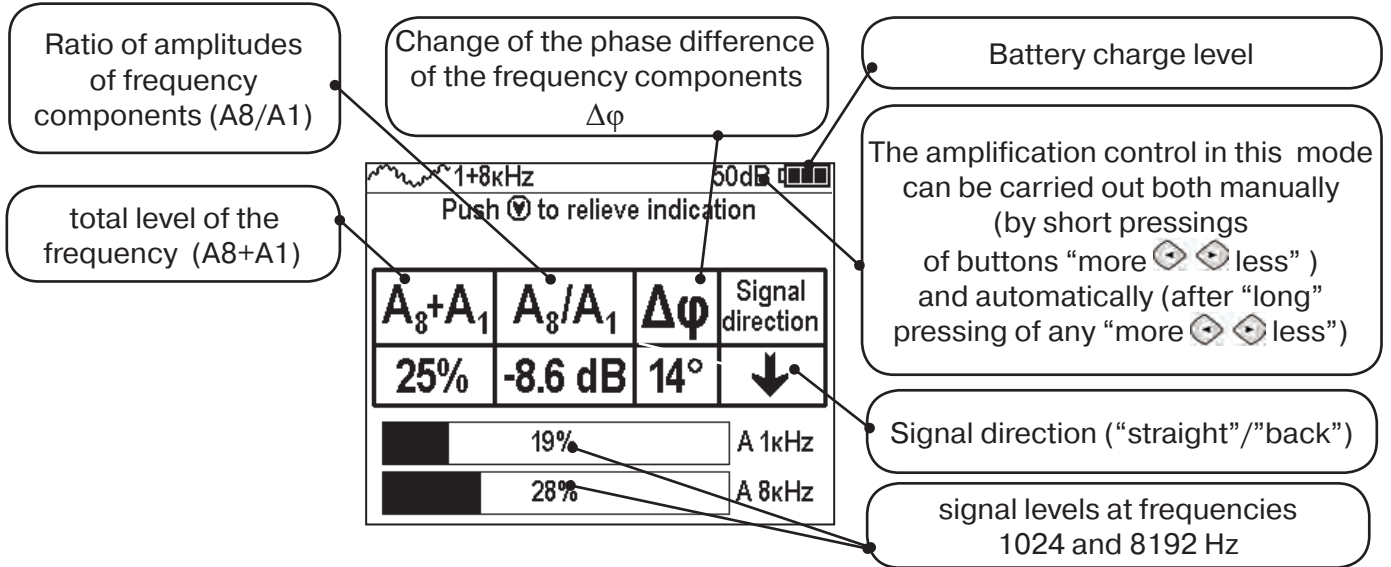
**Additional possibilities of the mode are described in App. 2:**

Append. 2 p.3 Amplitude “two-frequency” method “ $\Delta A$ ”;

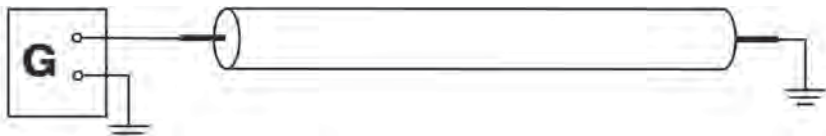
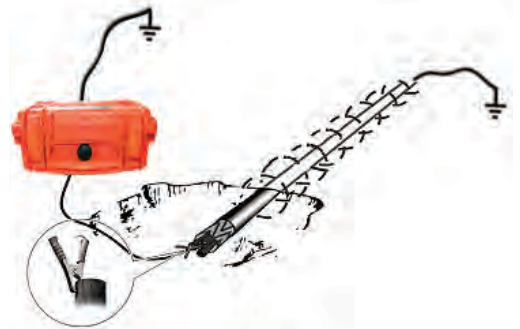
Append. 2 p.4 Phase “two-frequency” “ $\Delta\phi$ ”



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

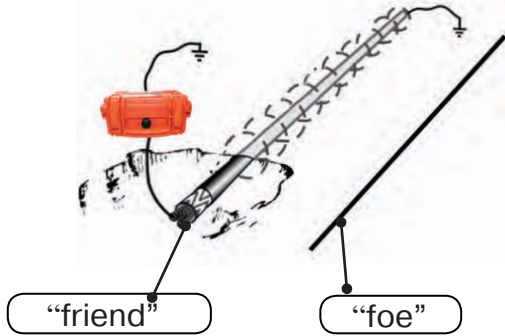


1. One output of the transmitter should be connected to the point of the utility that is more distant from the supposed place of the defect (start of the diagnostic site). The other output of the generator is grounded on the maximum possible distance from the utility from the other side (end of the diagnostics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

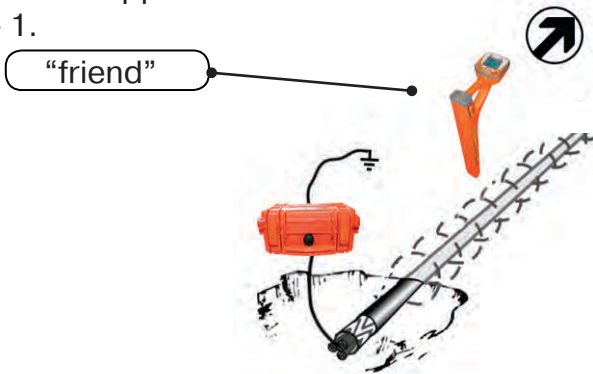
3. The signal from the utility, to which the route locating transmitter is directly connected, is conventionally named - "friend". The "parasitic" signal from the nearest utility, on which the generator signal is transferred, is conventionally named as "somebody else's".



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.

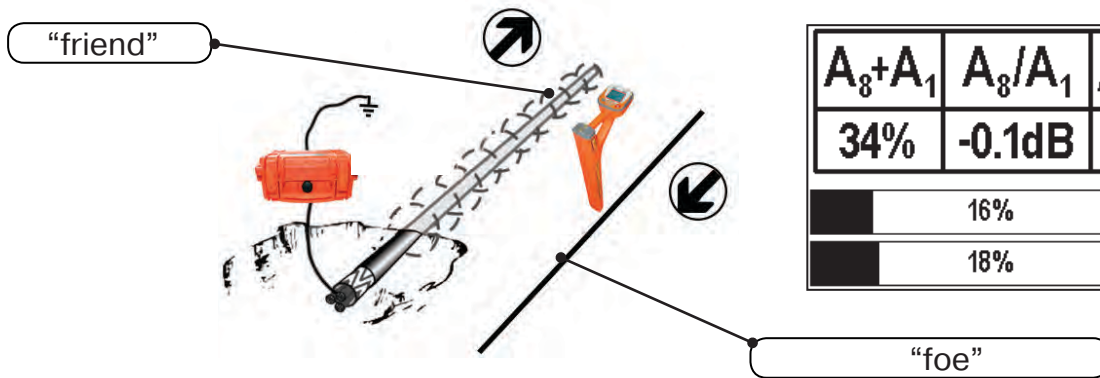
$A_8+A_1$	$A_8/A_1$	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↑
16%		A 1kHz	
18%		A 8kHz	

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".



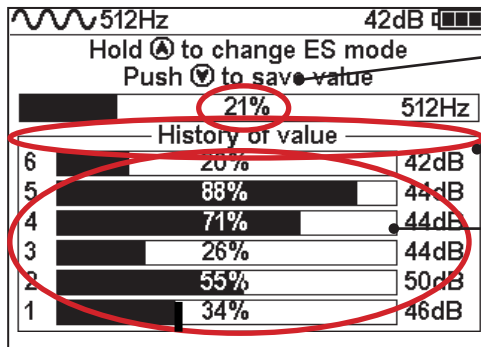
$A_8+A_1$	$A_8/A_1$	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↓
16%		A 1kHz	
18%		A 8kHz	



## 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


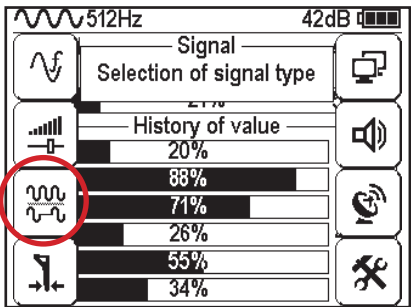

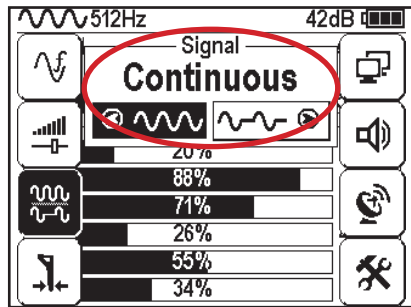





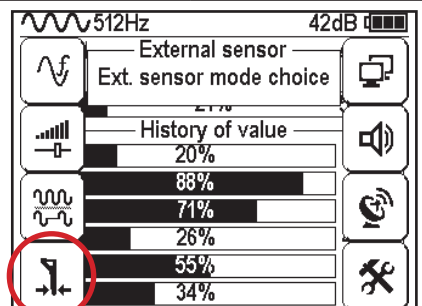

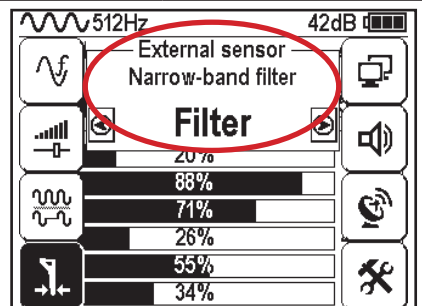



Fig 10.2

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

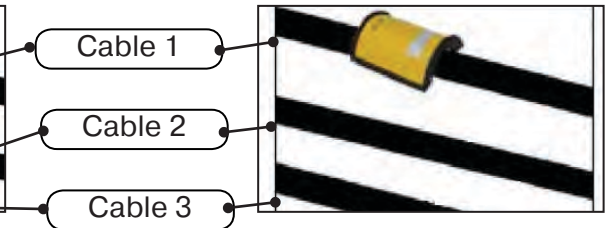

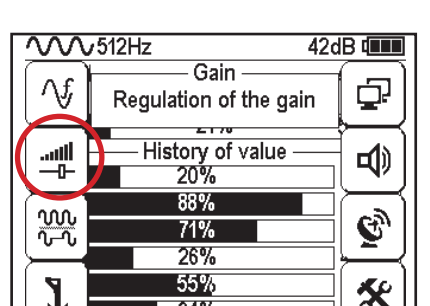

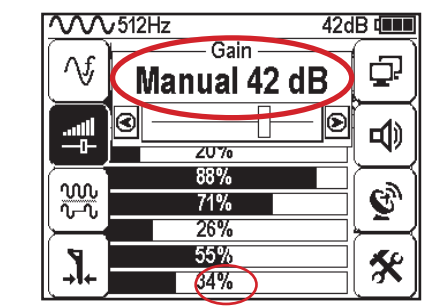



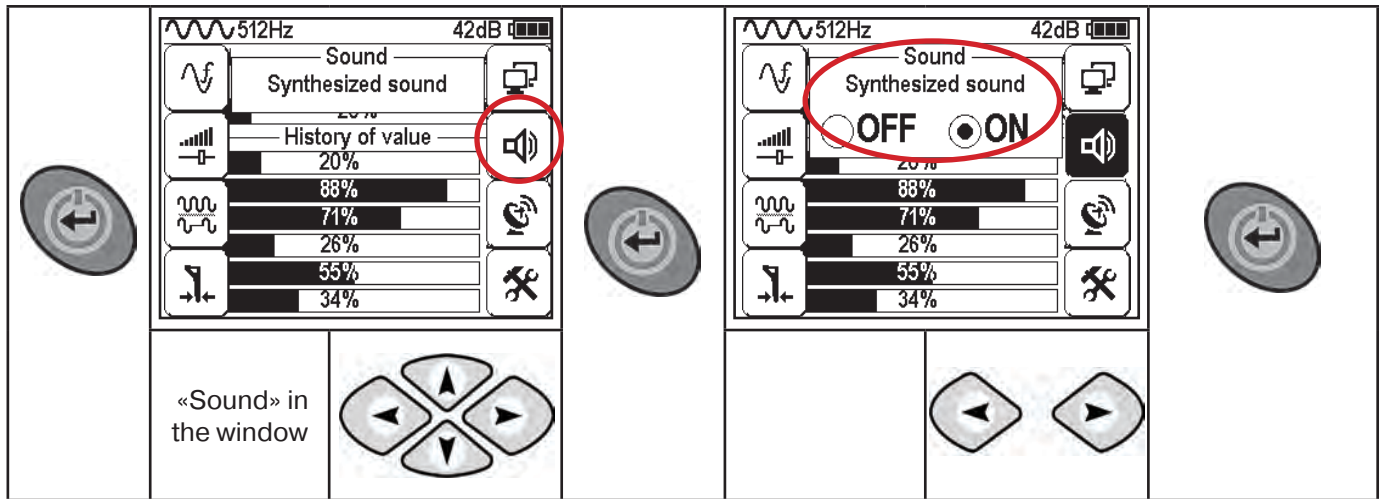


Fig. 10.4

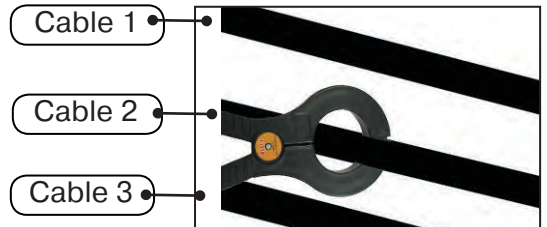
 <p>Press 'Enter' again to return to main menu.</p>		 <p>To confirm your selection press 'Enter' button.</p>	 <p>the signal level on the bottom scale should be in the range 50 to 80%</p>	 <p>Press 'Enter' again to return to main menu</p>
	<p>Select «Amplification» in the menu.</p> 		<p>Set the amplification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

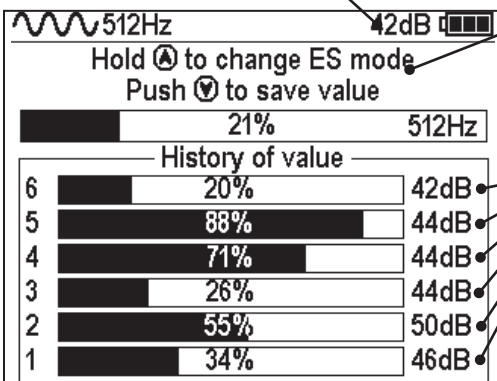
	32%	512Hz
History of value		
6	38%	42dB
5	61%	42dB
4	48%	42dB
3	10%	32dB
2	27%	36dB
1	14%	36dB

**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)

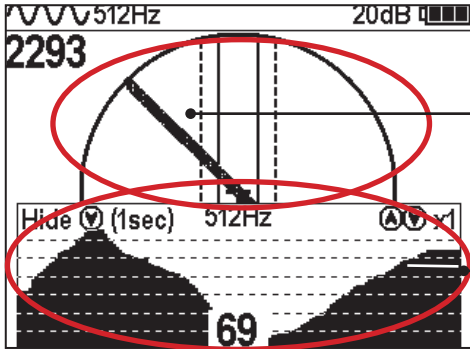
**Note**

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.



2D display of the route location

2 The graphic of time change of the external sensor signal level  
The graphic can be hidden by long pressing of the button  and appears at the short holding  of the button.

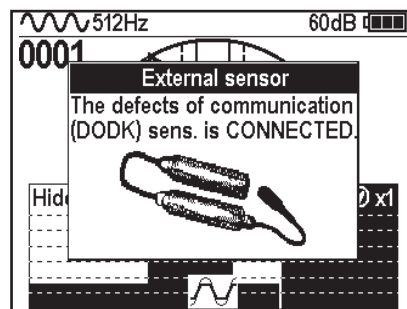
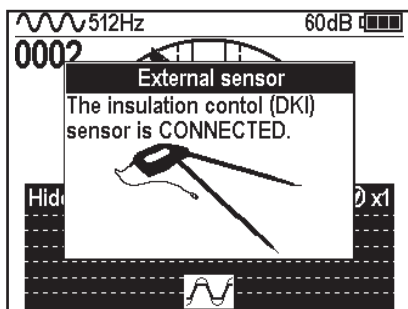
### 11.1. The work with the receiver in the mode «Search for defects»



Fig. 11.1



Fig. 11.2

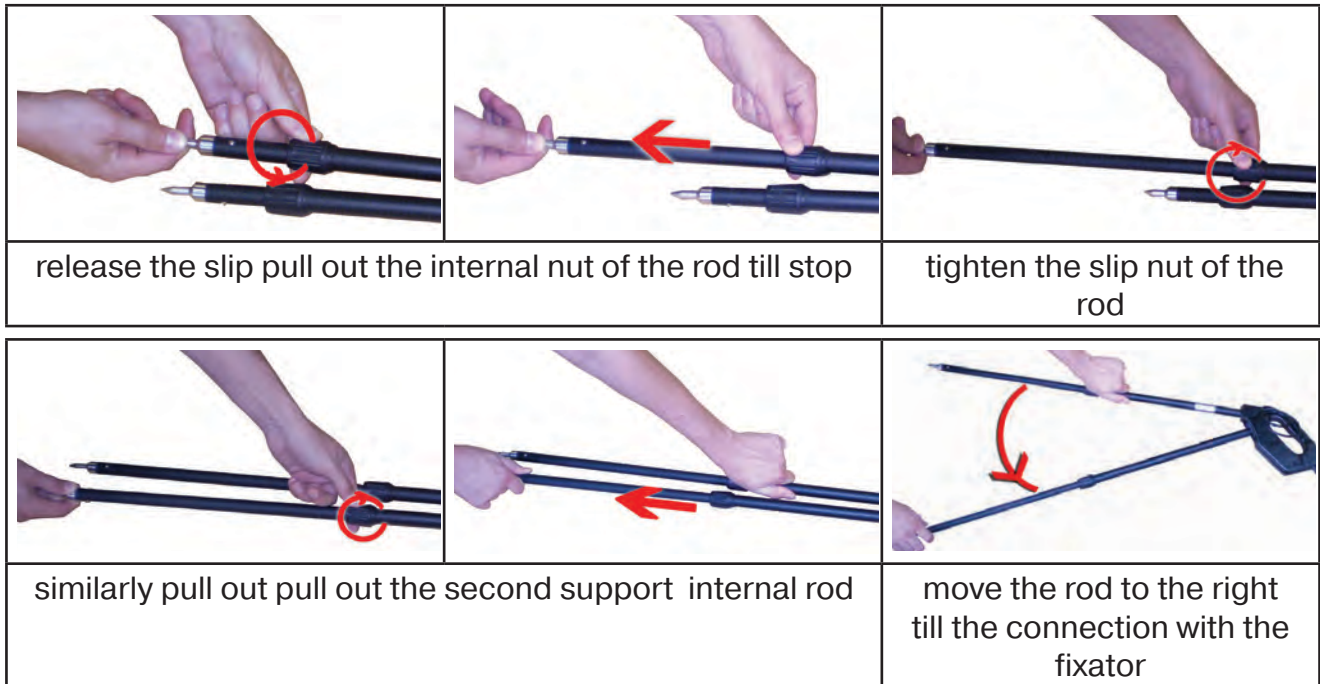


- Connect to the sensor to the receiver of the insulation control DKI-117 (fig. 11.1) or DODK-117 (fig. 11.2).

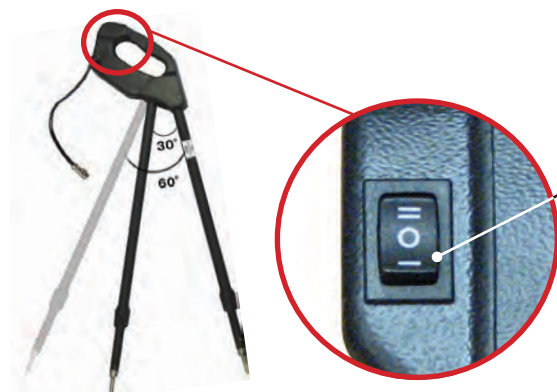


## Preparation of the sensors for work DKI-117

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)

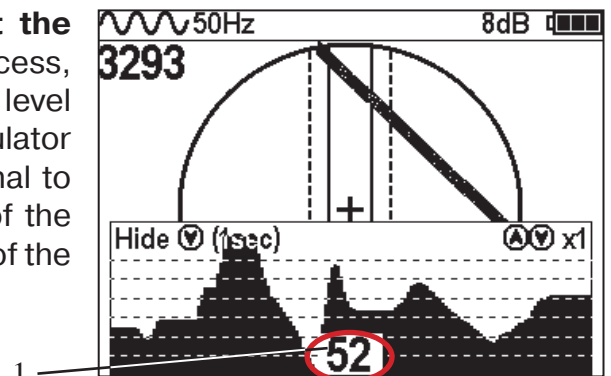


Fig. 11.4

## 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)**




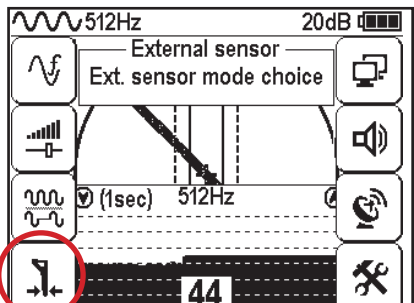


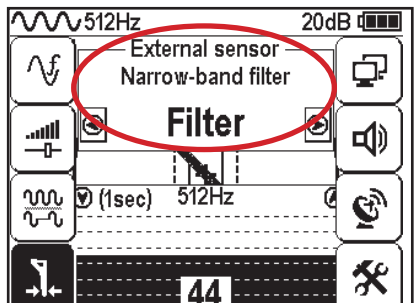


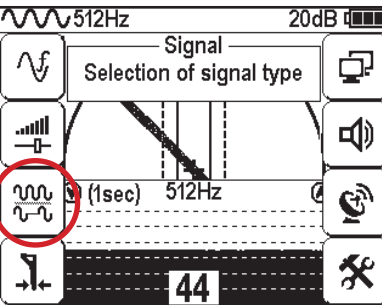


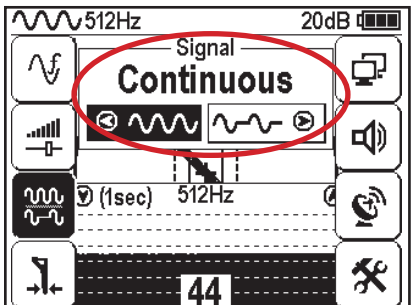

Fig. 11.5



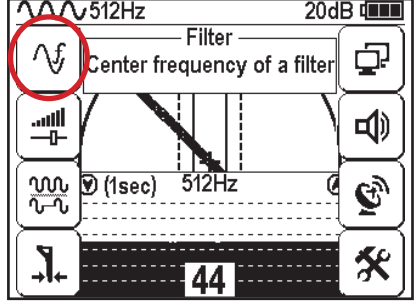


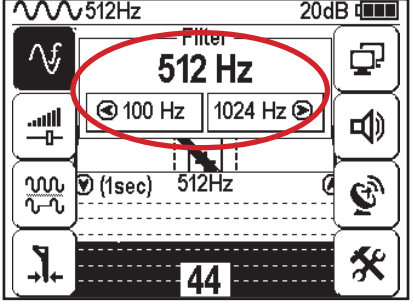



Fig. 11.6

### Receiver setting

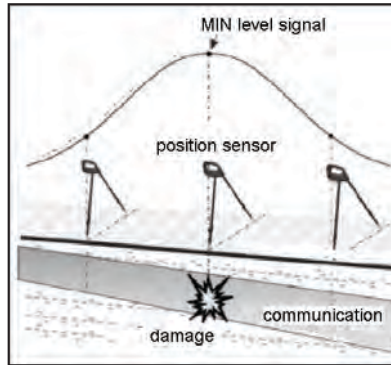
1. Turn on the receiver
2. Set the work mode of the lower sensor to the value «Filter»
3. Set the working frequency and type of the signal:

 <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> 

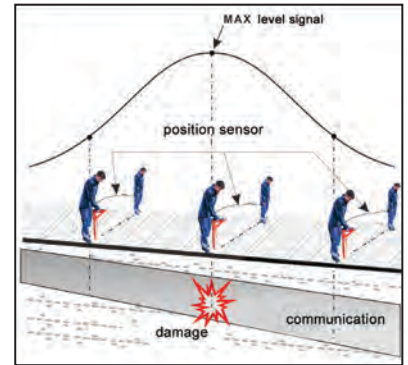
 <p>To call out of the menu press the button «Enter»</p>	 <p>Filter Center frequency of a filter</p>	 <p>512Hz 20dB</p> <p>Select the icon «Filter» in the window.</p> 	 <p>To change the parameter selected, press the Enter button.</p>	 <p>512Hz 20dB</p> <p>Filter 512 Hz</p> <p>Set the working frequency, 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).



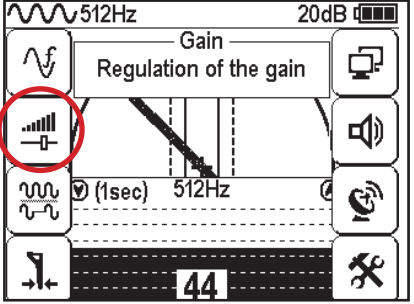


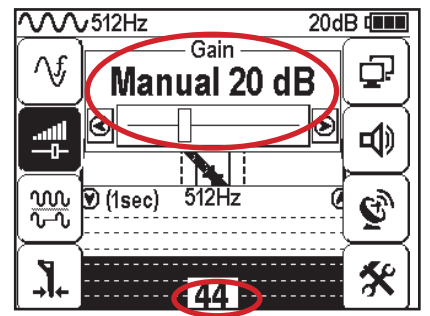




(fig. 11.7.)



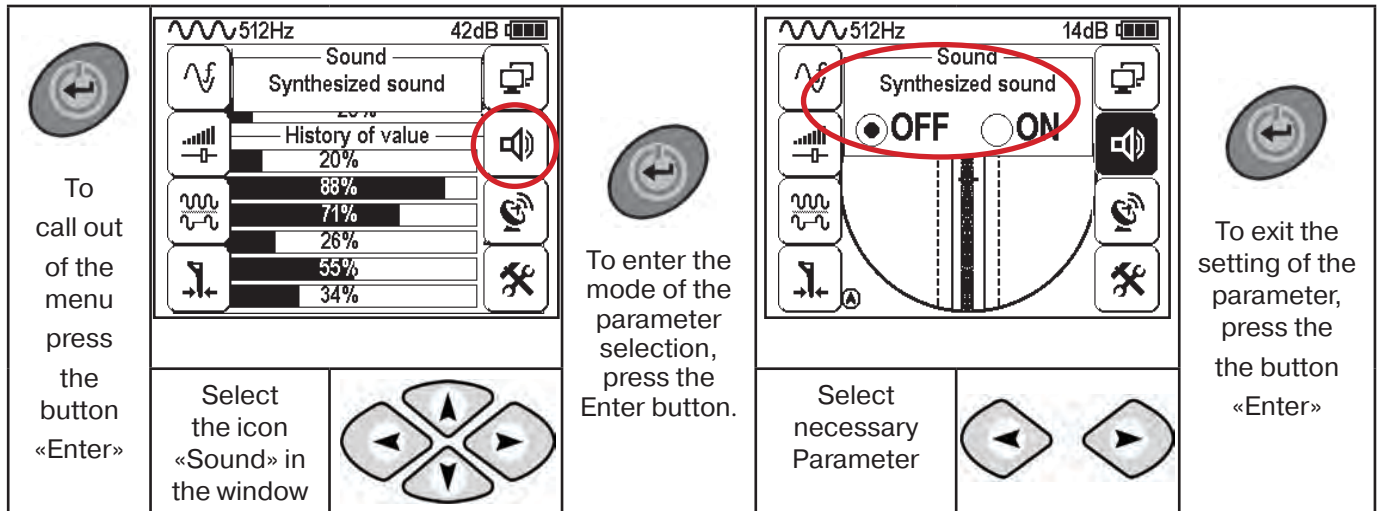
(fig. 11.8.)

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>the signal level on the bottom scale should be in the range 50 to 70%</p> <p>44</p> <p>Set the amplification coefficient, for example, 14 dB</p> 	 <p>To exit the setting of the parameter, press the «Enter» button.</p>
---	--	---	---	---	--



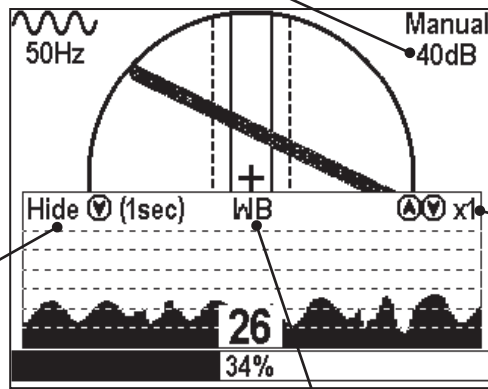
The user can listen synthesized sound through the built-in sound speaker. The sound tone pitch changes depending on the signal level. The synthesized sound can be switched on in the menu «**Sound**».



### 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.

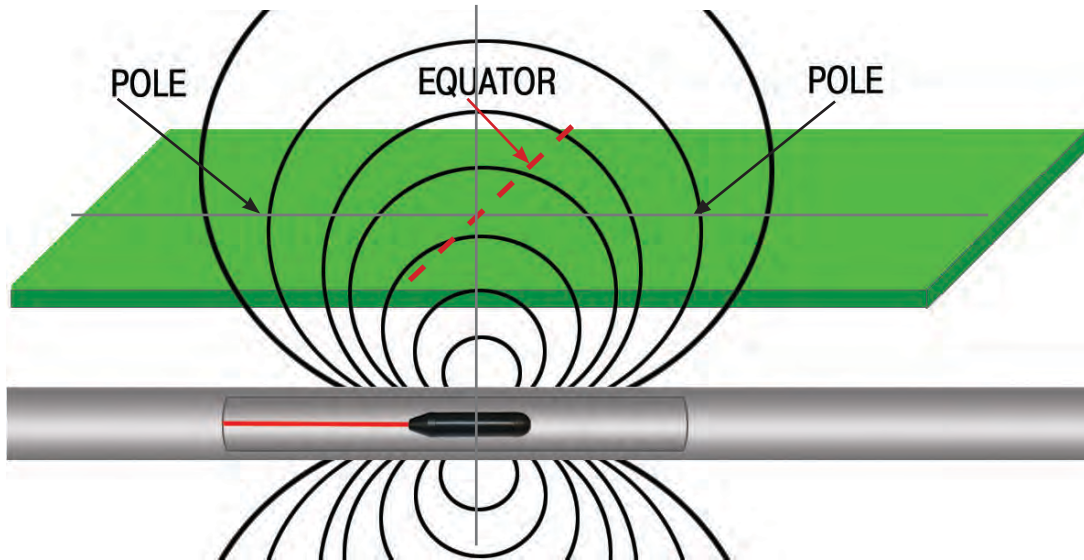
The presence of local maximums indicates that there are several places with damaged insulation which are placed closely to each other. It is advised to wright down the signal level of the places with 'normal' signal level and the places where the signal reached its maximum. The range of signal increase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

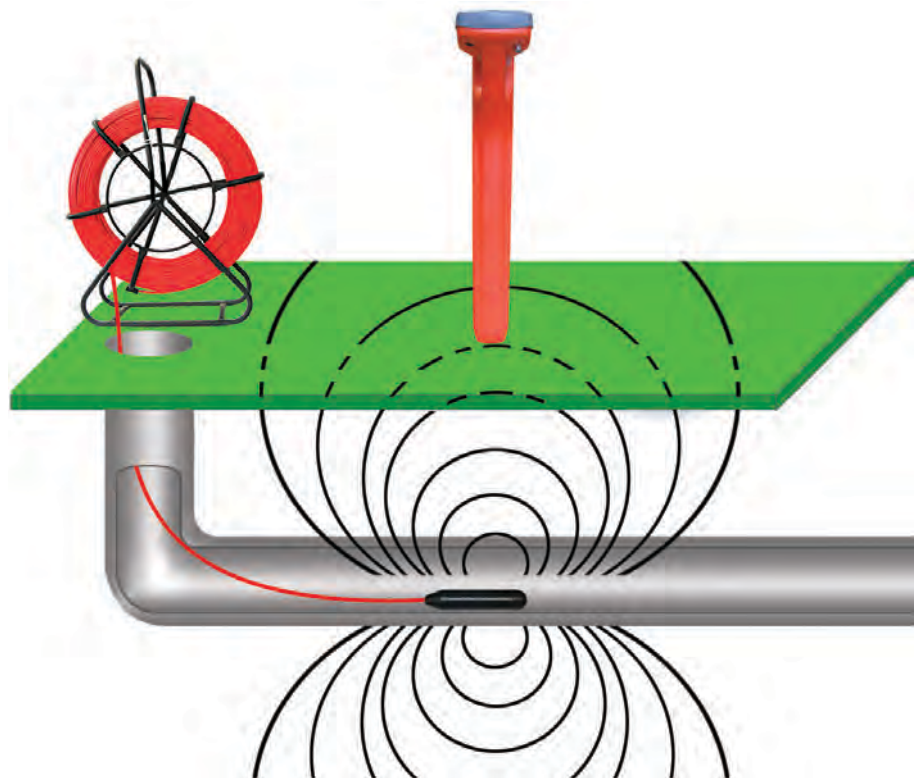
In poles, the angle of magnetic field is equal 90 degrees (lines are drawn vertically). In equator, this angle of magnetic field is equal 0 degrees (horizontal lines). Poles are constant characteristics of magnetic field. This is why they can be used as markers for precise location of the sonde.

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

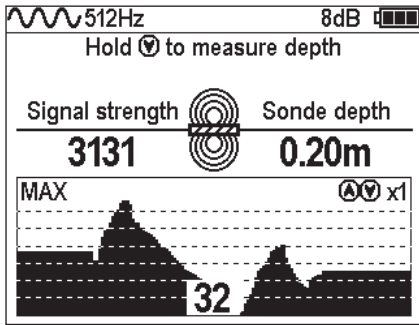
The locator scans the signal from the sonde and detects its position and burial depth.

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.

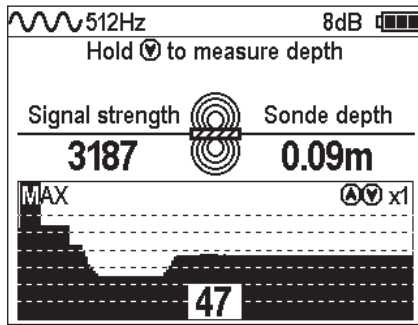
"Main peak" ("general maximum") of signal level is located at the centre of Sonde's emitting coil (Equator's centre) and two "false peaks" (two local maximums) are situated outside of two "local minimums" (POLES). "local minimums" (POLES)



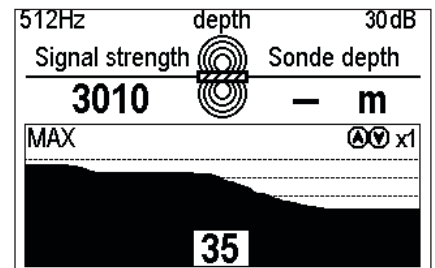
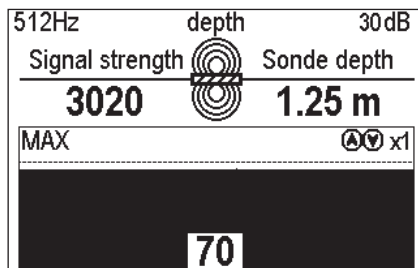
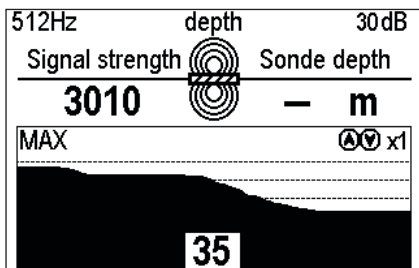
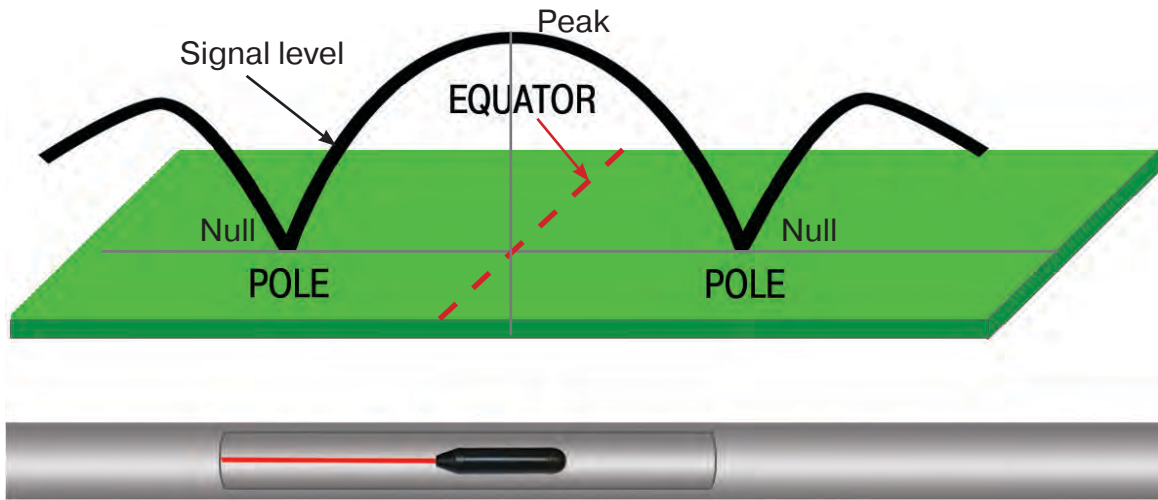
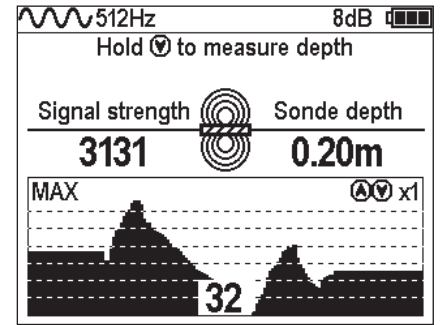
**Deviation left from equator**



**Above center of equator**



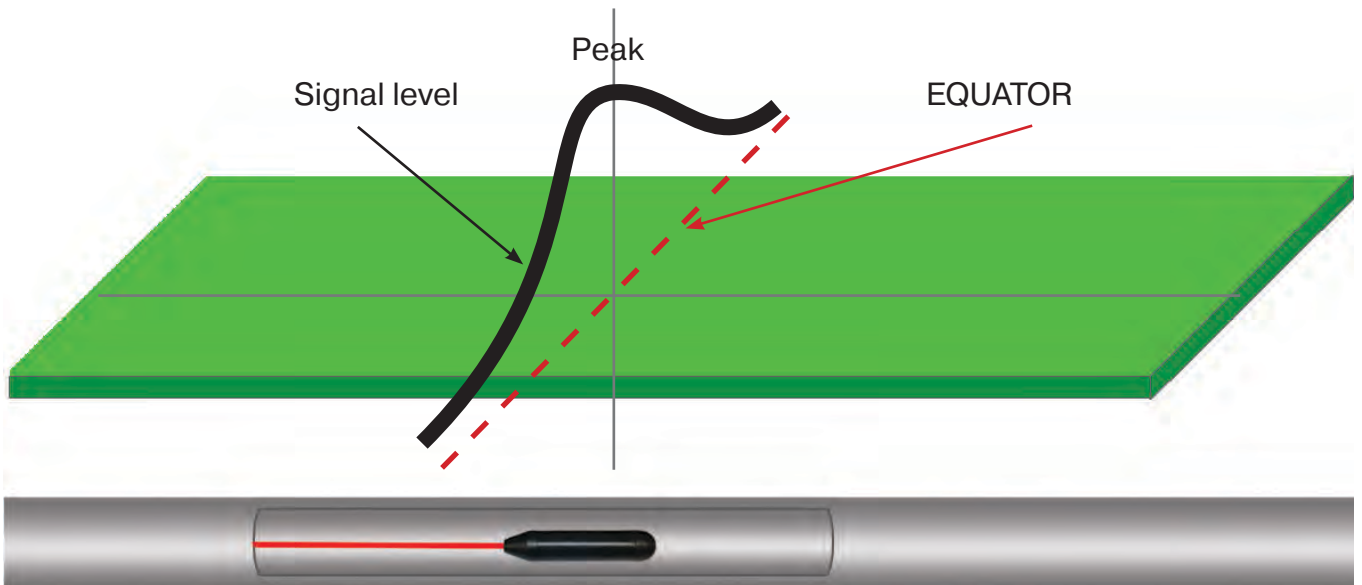
**Deviation right from equator**



**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!**

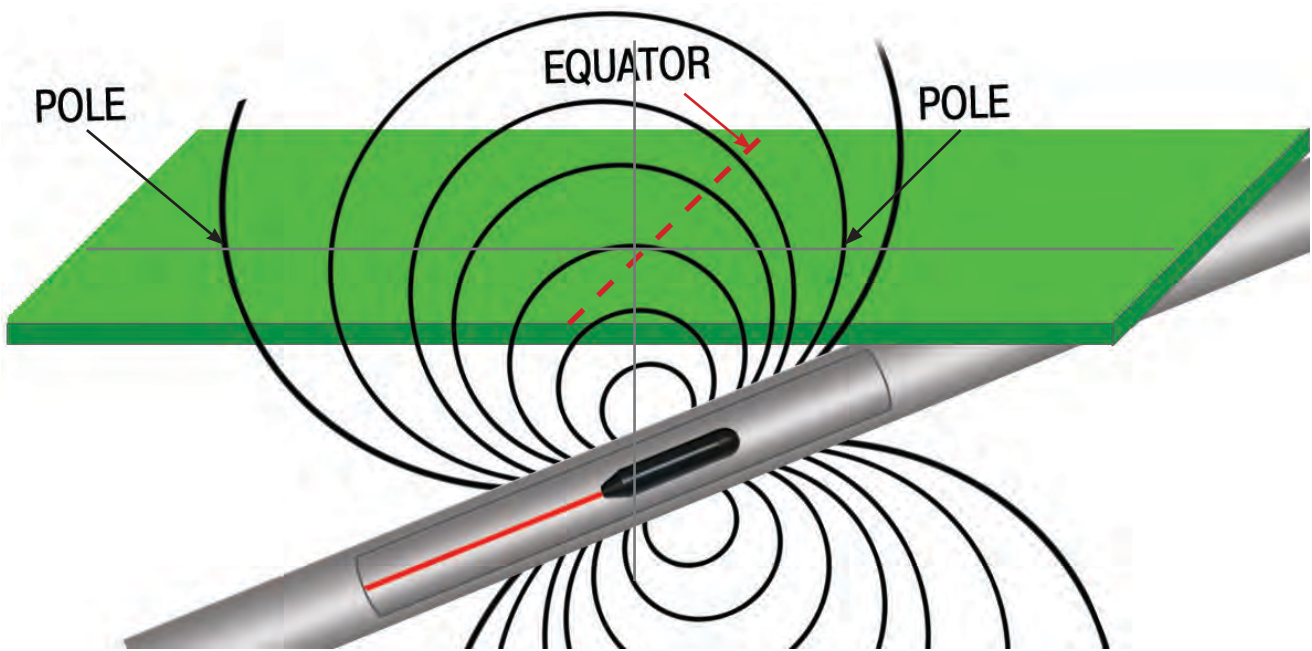
**Standing on the equator doesn’t mean that you are standing over the sonde; Remember, that the key goal of locating the sonde is to locate the spot with a maximum signal. You must be at the point of the strongest signal in order to locate the sonde.**

### 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

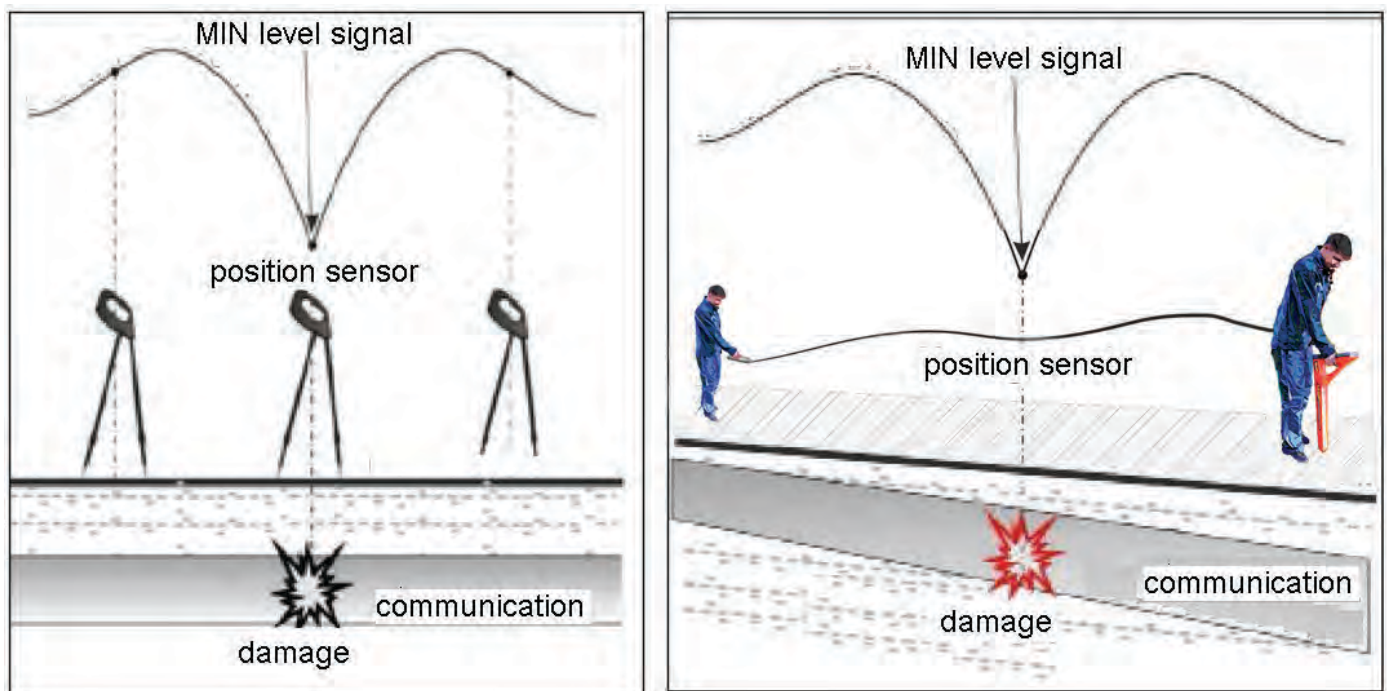
When searching for insulation damage by «MAX» method, the one of the input terminals (contact pins of DKI or electrodes of DODK) should be placed over the route, and the second one - at a maximum distance from the route, in the direction straight across its axis.

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.



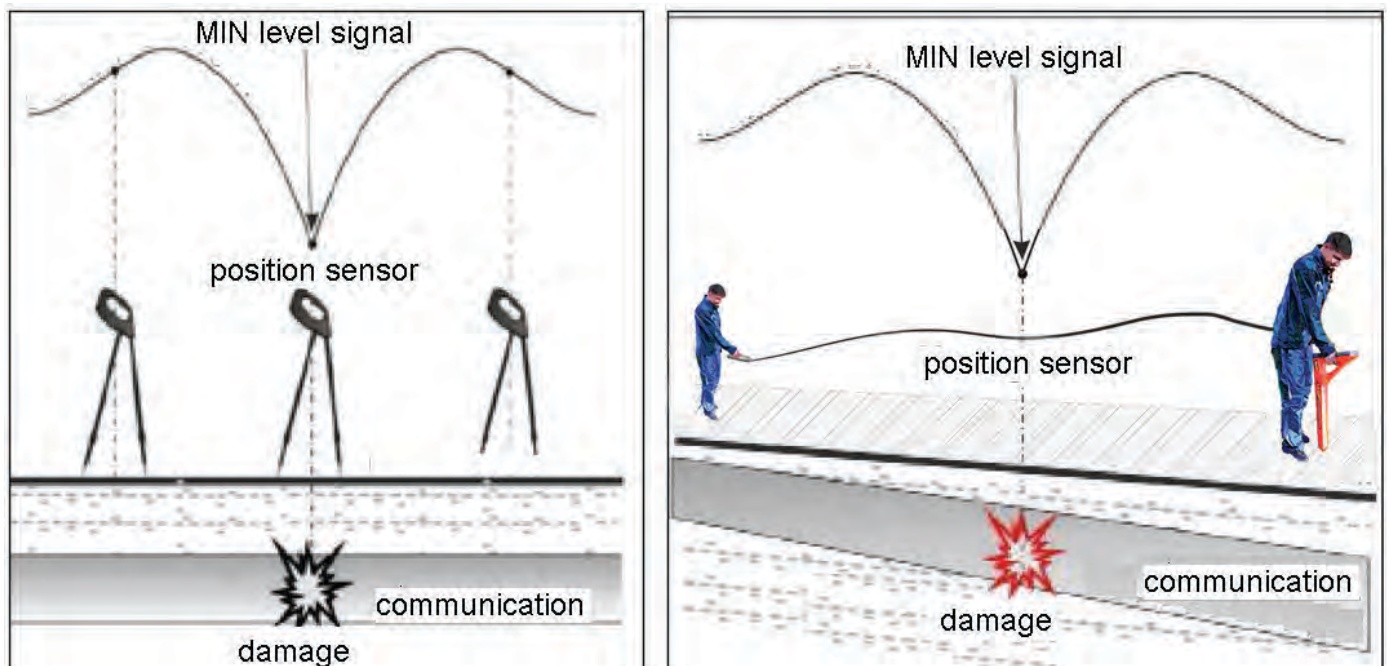
**Fig. A.2**

## 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 « $\Delta A$ »


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 description:** 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 « $A_8/A_1$ » 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.

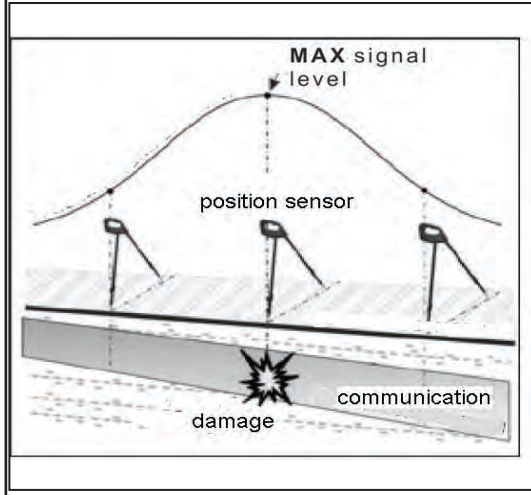


7. The sharp positive overfall of the « $\Delta\varphi$ » value by 3dB and more indicates the possibility of defect existence (the resistance is less than 5 kOhm). The sensor should be located straight across the communication.

$A_8+A_1$	$A_8/A_1$	$\Delta\varphi$	Signal direction
34%	4.4dB	-2°	↑
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 « $\nabla$ »), 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 « $\Delta\varphi$ »

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.

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

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

**Note**

$\Delta\varphi$  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 « $\nabla$ ».

$A_8+A_1$	$A_8/A_1$	$\Delta\varphi$	Signal direction
34%	-0.1dB	-2°	↑
16%		A 1kHz	
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  $\Delta\varphi$ , the inscriptions A8kHz and A1kHz are correspondingly «darkening», and the value «X<sup>0</sup>» disappears.

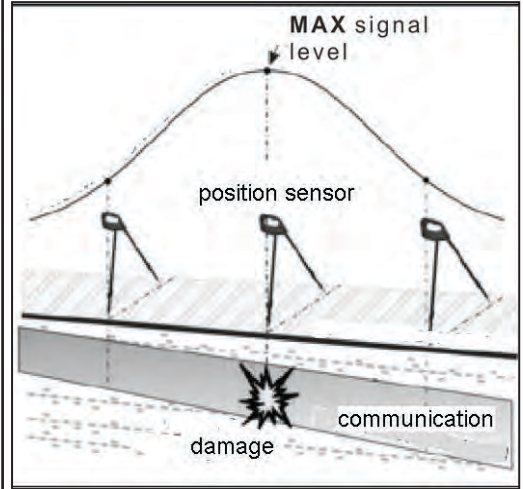
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, « $\Delta\varphi$ » did not changed, it means that there are no damages on the surveyed site.

The sharp positive overfall of the « $\Delta\varphi$ » value by  $5^\circ$  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

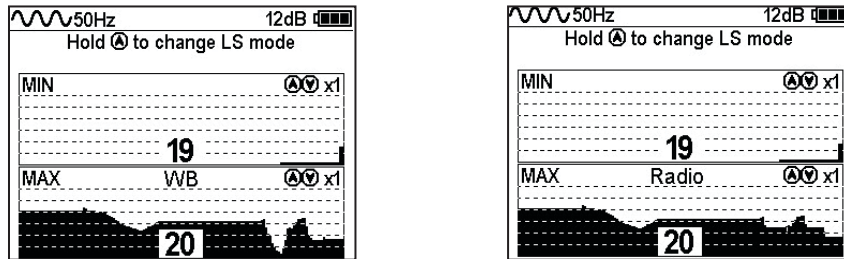
If you go through the same site in the opposite direction (towards the generator), holding the receiver the same as before with reset of the indication (using the button « $\odot$ »), negative value of the reading (more than minus  $5^\circ$ ) will mean that there is damage in the cable.

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



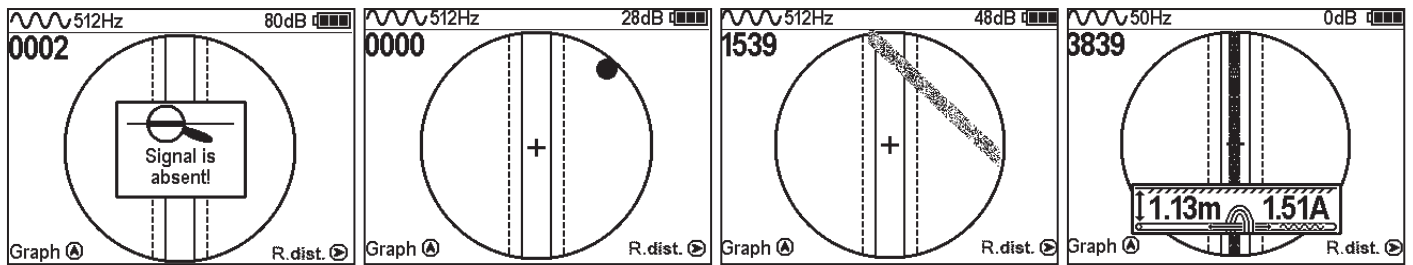
### Appendix 3 Area survey before excavation works

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).

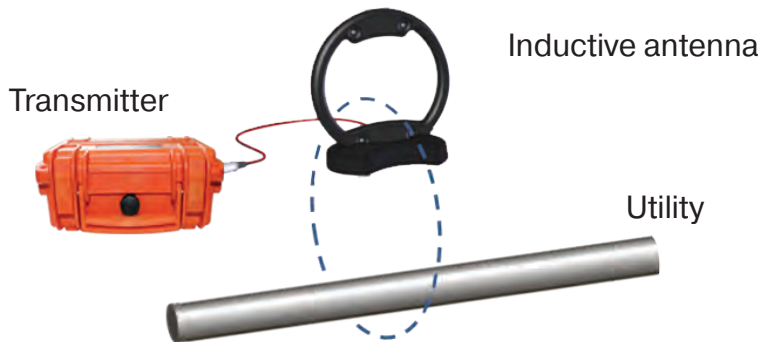


In this case the operator should rely on “MAX” scale.

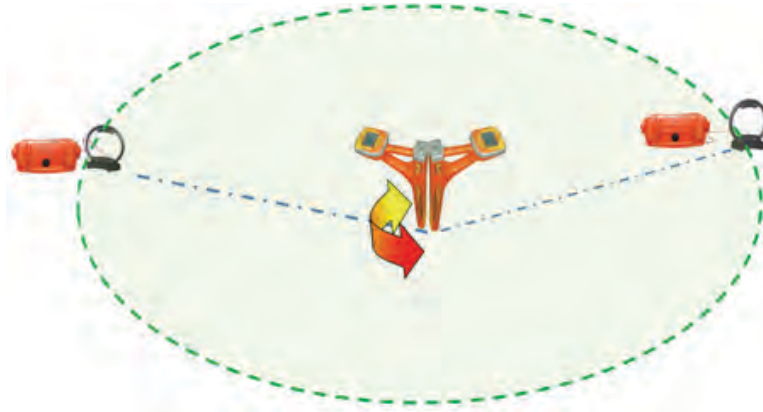
At 50 a 100Hz frequencies in Route mode the signal strength will increase as you are moving to the utility. Following indication should appear on the screen while performing these actions:



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.

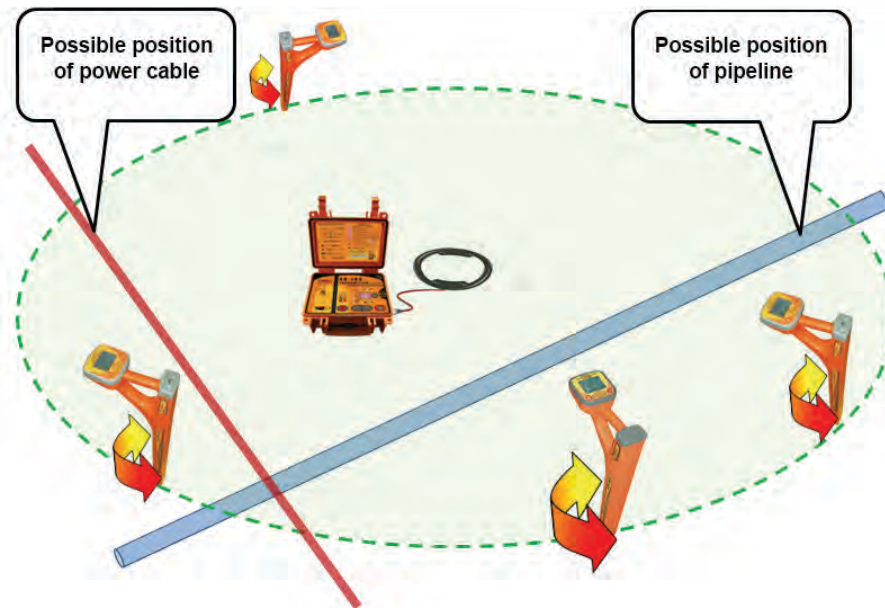


If there is no utility in center point of the area, then start the general location routine described below.

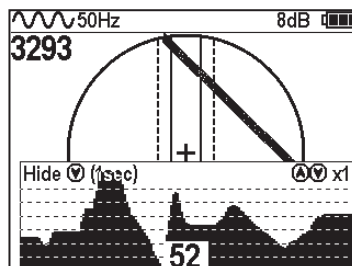
When surveying the area in active mode, it is necessary to place IEM-301.5 antenna horizontally in the center of the plot (you can remove the antenna from its stand). In this position the antenna will be in the flatness parallel to all surrounding utilities in the area.

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

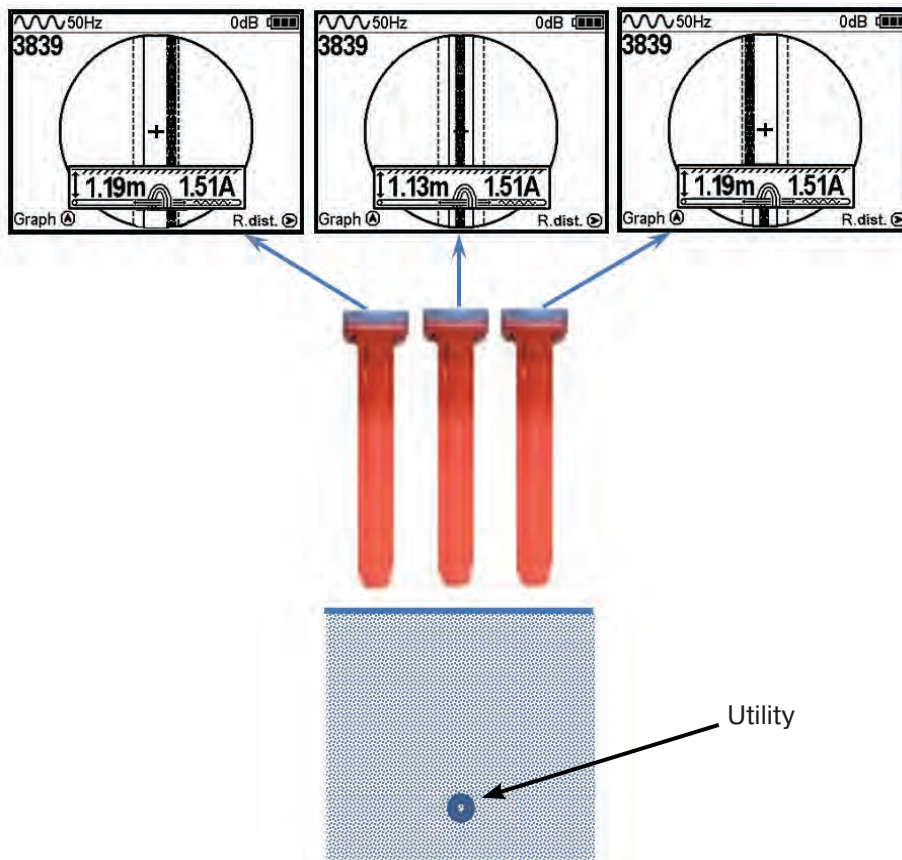
### **External influence during receiver operation**

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.

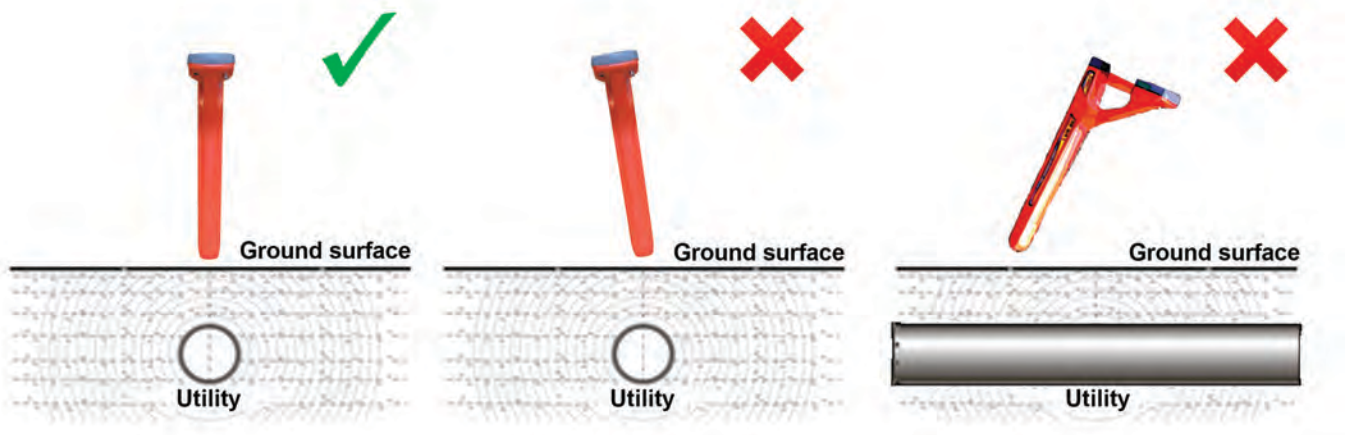
### **Specialties of utility depth measurements**

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.