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# CABLE LOCATOR
# SUCCESS CBI-309N

## TECHNICAL DESCRIPTION
## OPERATING INSTRUCTIONS

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# Introduction

This Operation manual contains description of the cable route locator AP-019.1, its working modes, and information necessary for its proper use. AP-019.1 (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 the use of the route locating transmitters at frequencies 512Hz, 1024 Hz, 8192 Hz, 32768 Hz («33 kHz»).

## Cable locator «Success CBI-309N» 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 «Success CBI-309N» 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, AP-019.1 receiver controls

AP-019.1 receiver is made in the solid cast IP54 body to the battery compartment the body provides the protection IP68, the device can be splitted in three components: the face panel with controls and displays, battery compartment and bottom part with the antenna block. There is external sensor connection port on the back side of receiver.

A slot for connection of the external sensors

A graphical display with the lighting

Six-button keyboard

Built-in sound transmitter

Battery compartment for four batteries «type C»

A module for omnidirected antenna

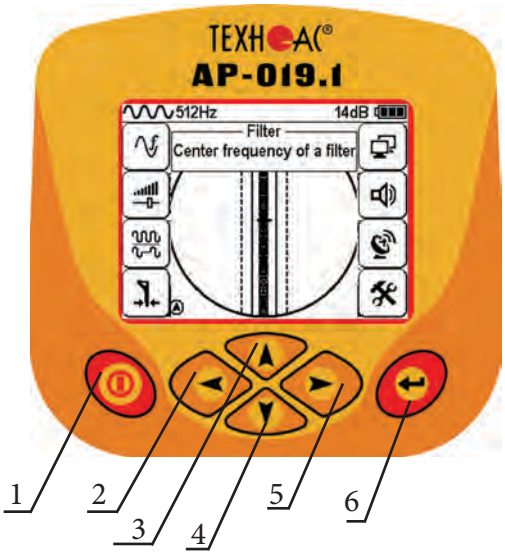
Connection of external sensors.

**Sensor DKI-117**

**Sensor DODK-117**

**CI-105**
**Inductive clamps**

**NR-117**
**Superimposed frame**



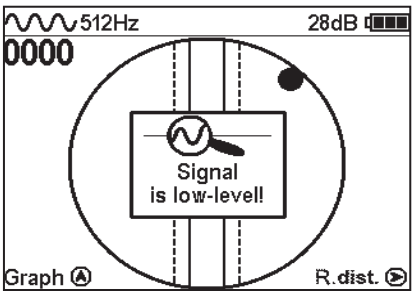

## Face panel, controls

| | |
|---|---|
|  | «Power» button (1)<br>Switching on/off the receiver |
|  | «Enter» button (6)<br>- calls out a menu,<br>- enters into the editing mode of the selected menu option,<br>- exit for the editing mode saving selected parameters. |
|  | Buttons «Up» (3), «Down» (4), «Right» (5), «Left» (2).<br>- selection of the menu option (icon),<br>- selection or changing the parameter inside the menu,<br>- operative change in the parameters |

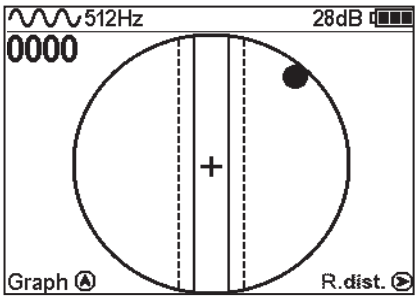
# 2. OPERATING MODES

## 2.1 “Route” mode

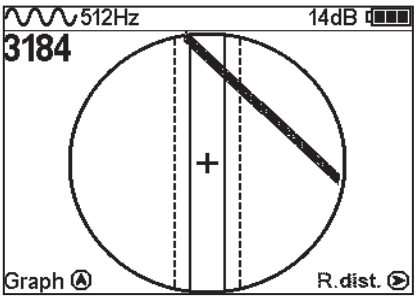
When turning on the receiver for the first time, the device will begin in route mode and the service information will appear. Route mode is the primary screen. Below, the indications are shown, which are dependent on the operator position near the located utility.



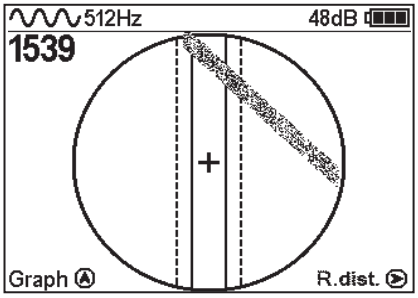

The receiver can’t detect the utility.



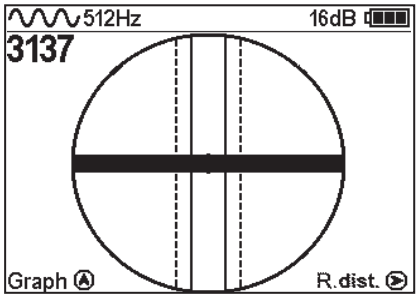

The ball on the screen shows the direction in which utility is located.



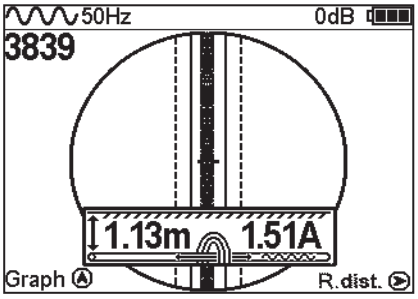

Position of utility axis shows, where the utility is situated.




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

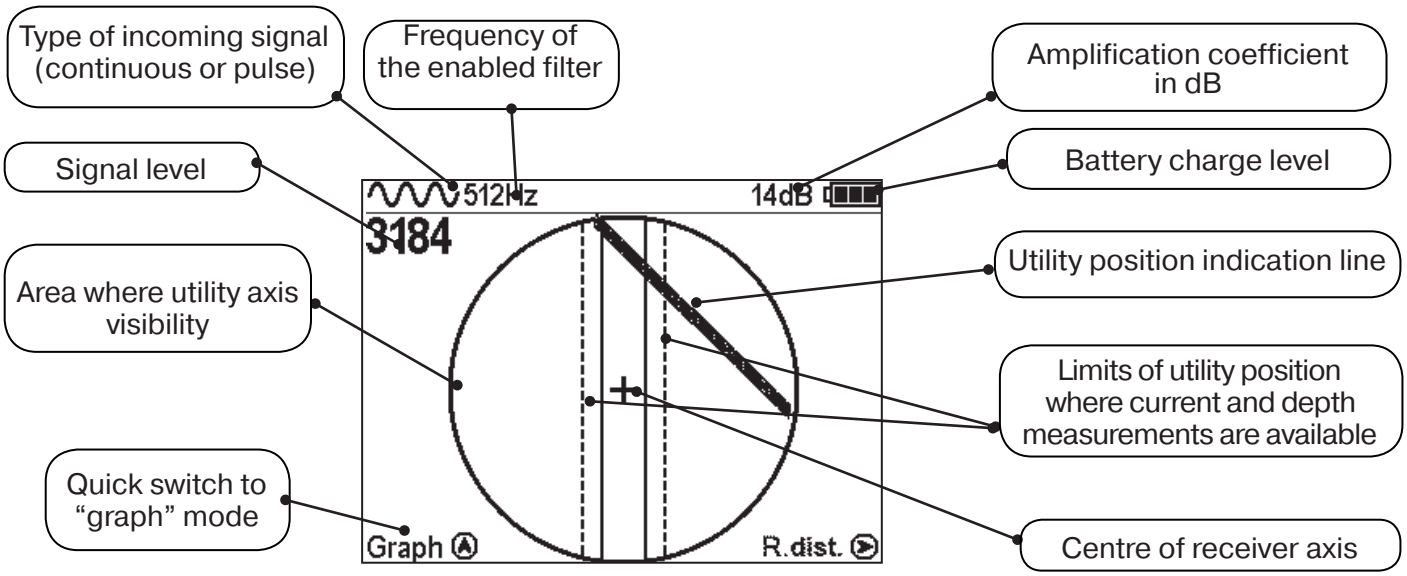



When above the utility, a solid line will appear which is perpendicular to the utility’s direction.




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

### Route Mode Description

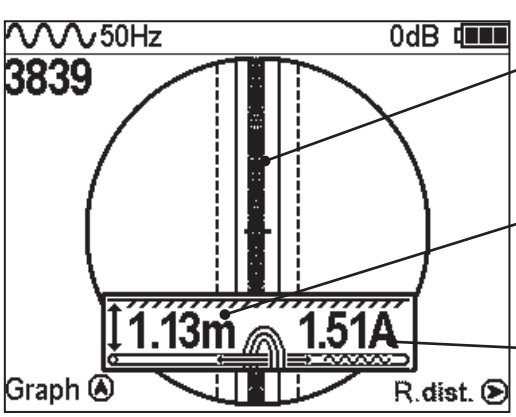



* The four-digit number “signal level” (0000 - 4100) represents the intensity of the electromagnetic field, which is dependent on the filter frequency. The numeric value of the “signal level” becomes greater when an operator approaches the source of electromagnetic signal of the chosen frequency. The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

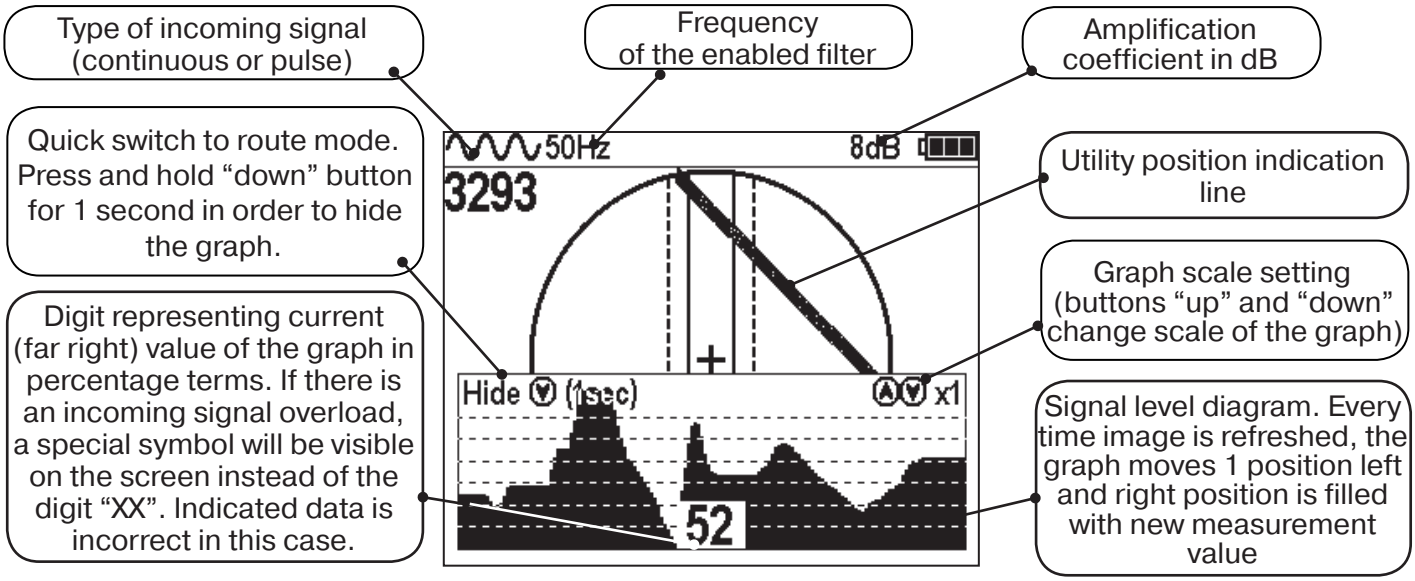
When the operator stands strictly above the utility and the line indicating the utility is positioned strictly in the centre field between the two dotted lines, an automatic depth and current measurement is performed.

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



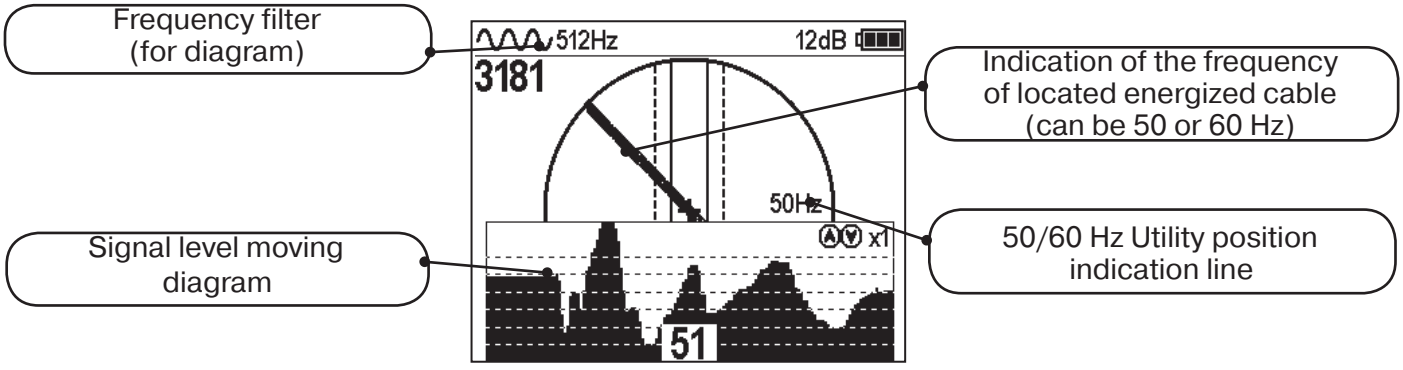

## 2.2 Graphic Mode

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




## 2.3 Graphic+ Mode

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

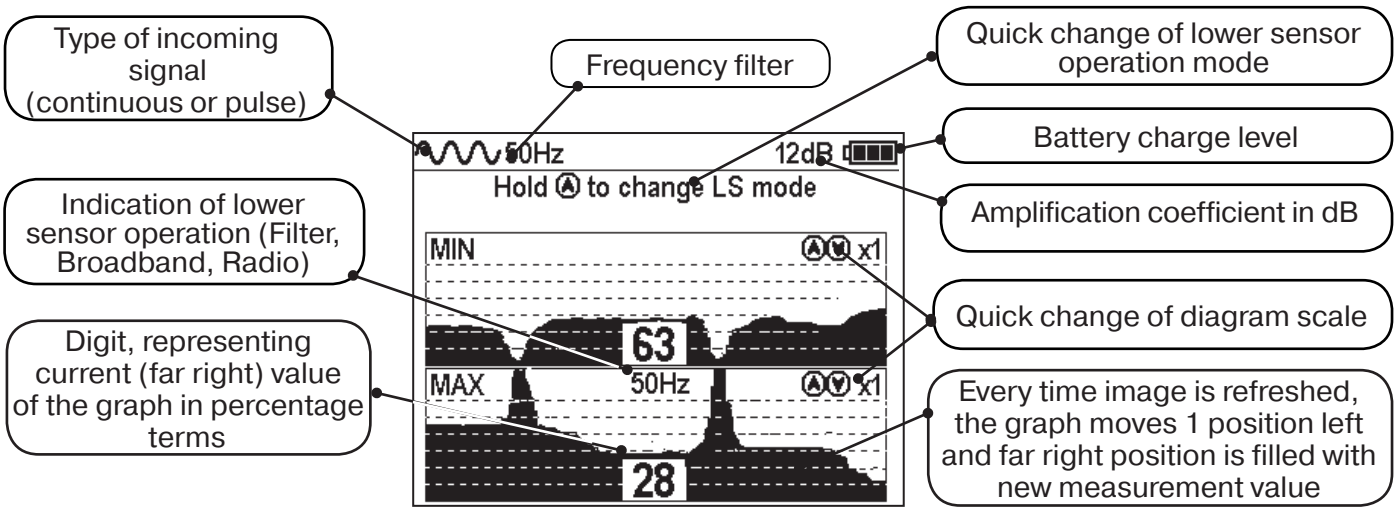


## 2.4 “Minimum maximum”

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

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

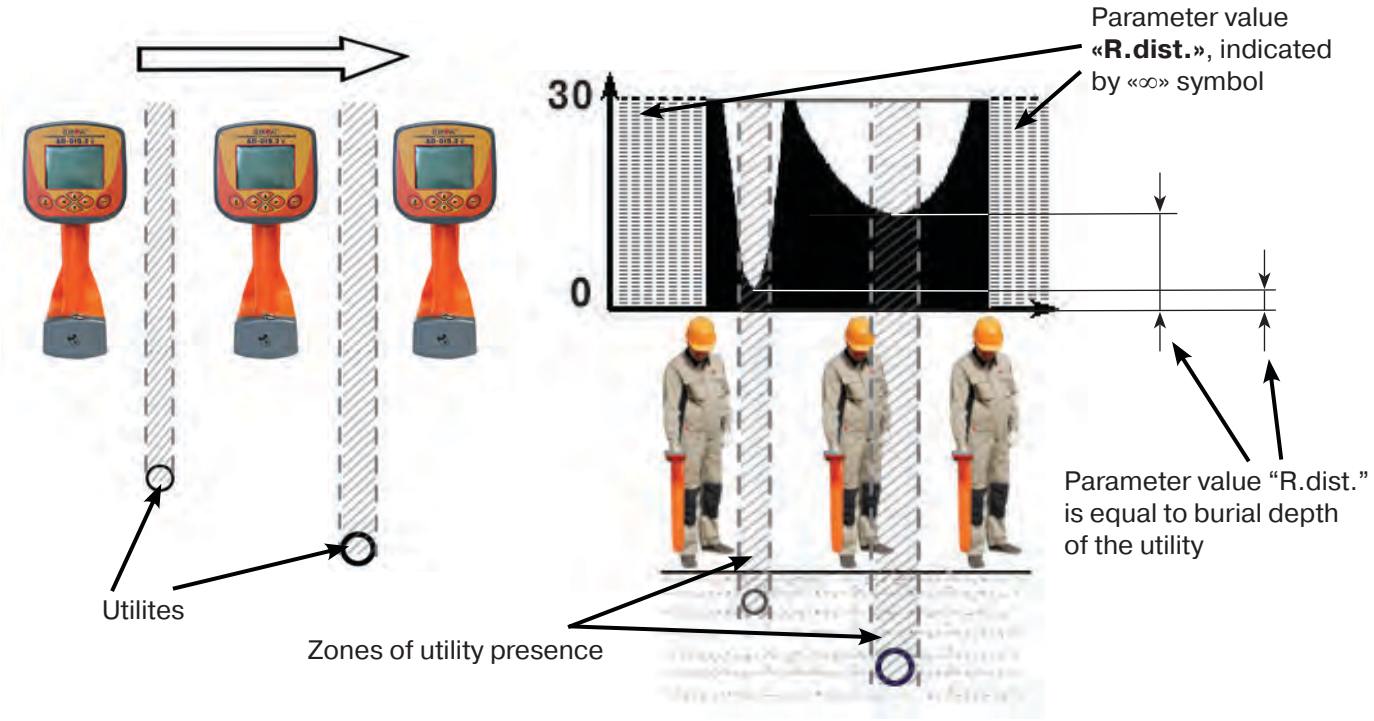
This mode does not allow depth and current measurements.



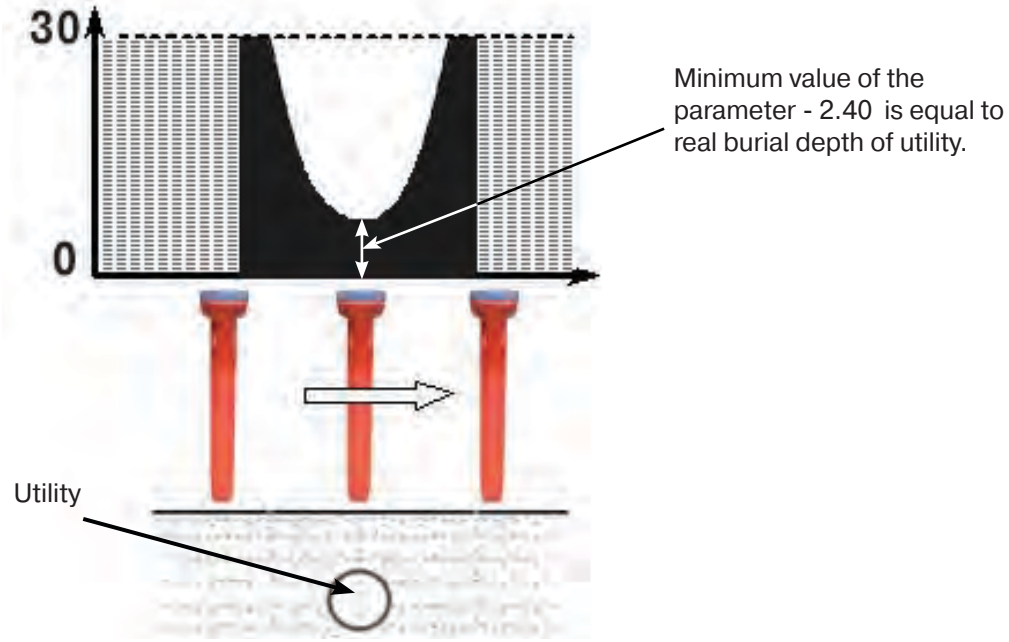

## 2.5 Modes with Graphic Representation of “Relative distance to the Utility” (R.dist.)

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

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



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.



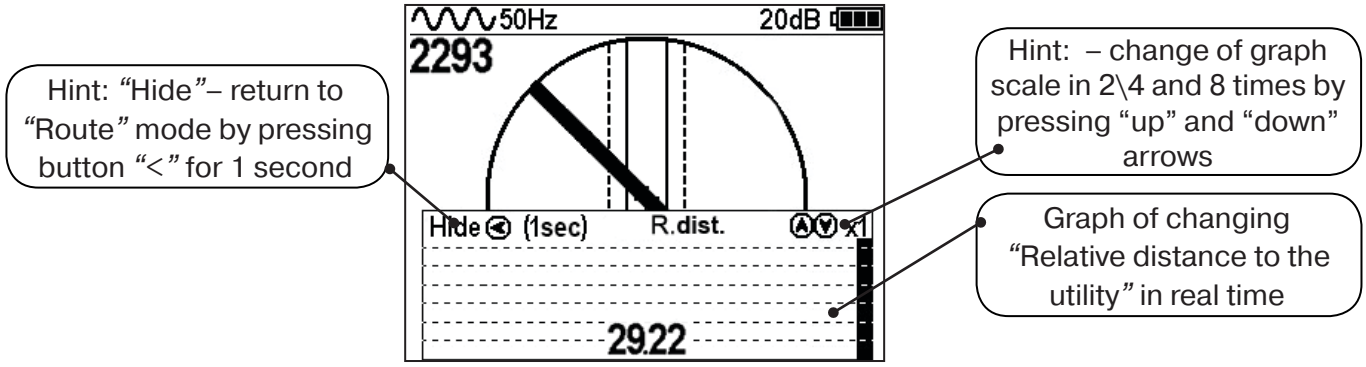

The receiver has two modes with indication of “relative distance to the utility”: **“R.dis. Graph”** is used when the “relative distance to the utility” graph and utility route are indicated simultaneously, whilst the **“MIN&R.Dist mode“** is used when screen of the receiver indicates 2 graphs (minimal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

## 2.5.1 “R.dis. Graph” mode

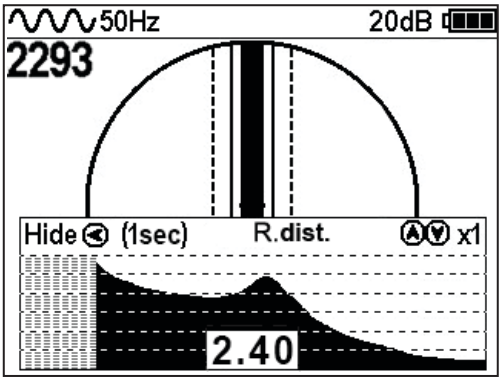
This mode is the same as “Graph” mode. The screen is split in two parts, an upper display and a lower display.

- 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:

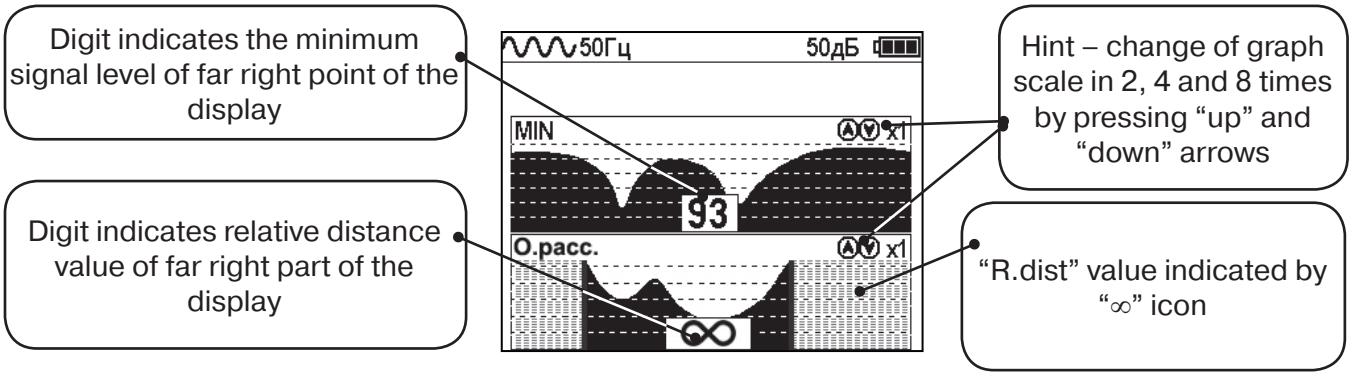



Minimal values of “relative distance to the utility” indicate the presence of the utility with some fault because in the case of multiple utilities laying nearby, minimum signal point may move due to coinfluence of the signals.

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

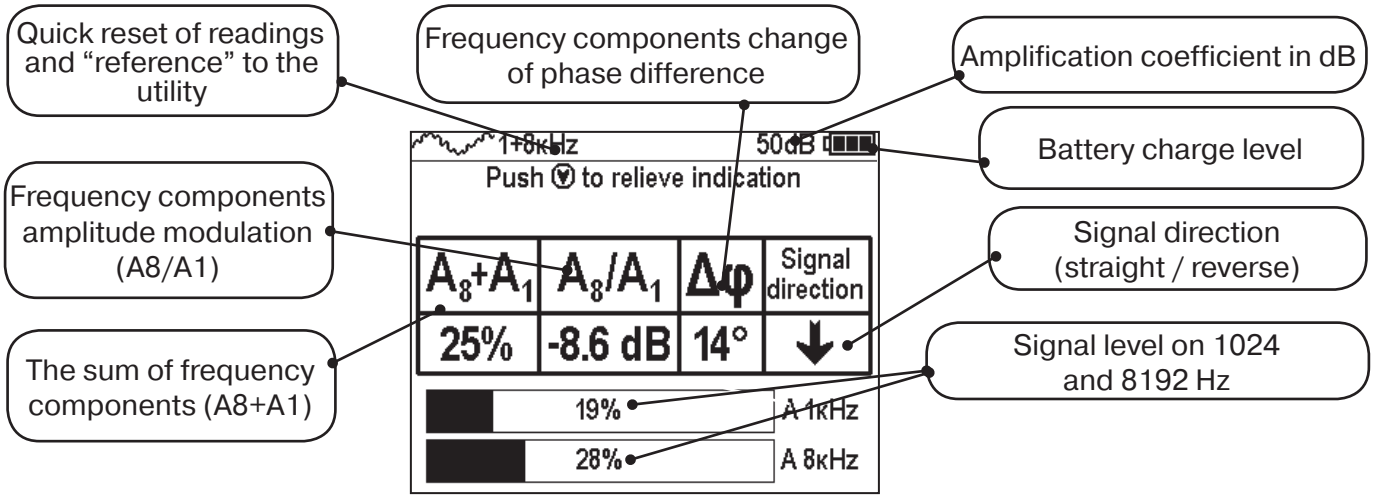
In this mode the screen is split in two parts. Upper part: Minimal signal graph, lower part: “relative distance to the utility” graph in real time.




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.

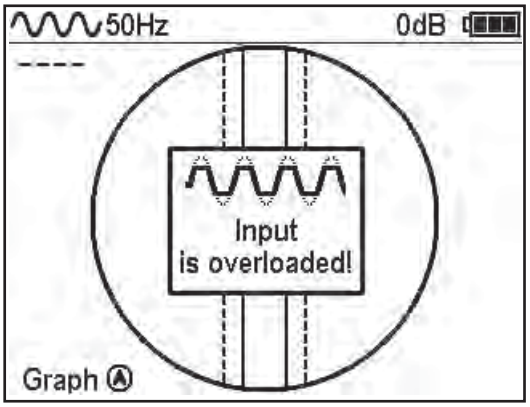


**IMPORTANT NOTE:**

**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", "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. Receiver menu description

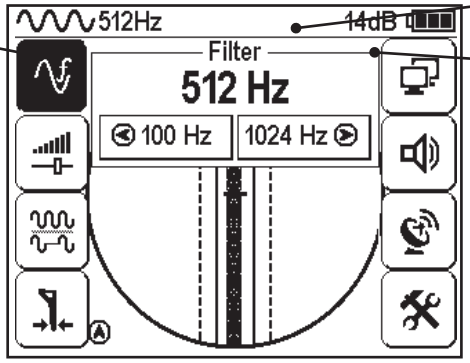
## 3.1 Receiver switching on and menu call

To switch on the receiver press the button «Power»

Press «Enter» button to open the Menu

## 3.2 The general view of the menu screen

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

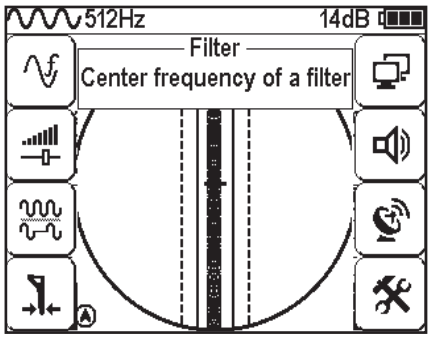



menu option name

brief menu option description

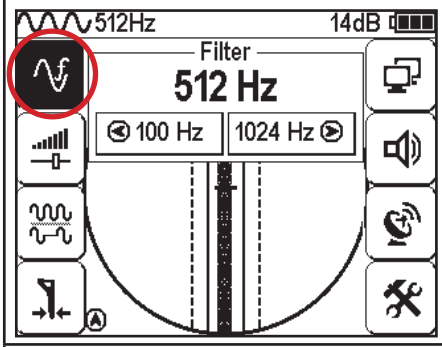
## 3.3 Menu parameter selection

To open the menu press «Enter».



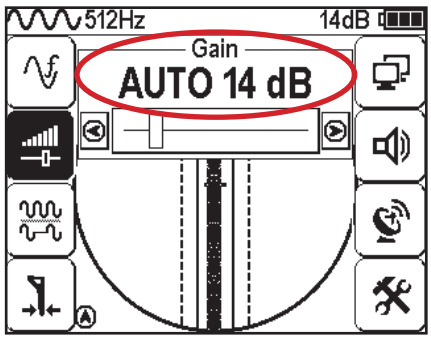

The menu will appear on the screen.

Menu option selection is performed with buttons «Up», «Down», «Right», «Left».




Active "icon" is flashing and highlighted by dotted line

to change or view the menu item




In the upper part of the indicator the parameter editing panel will open.

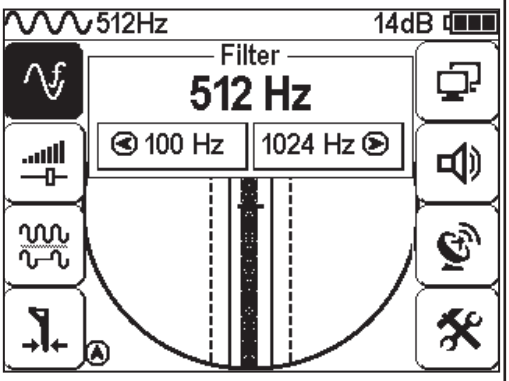
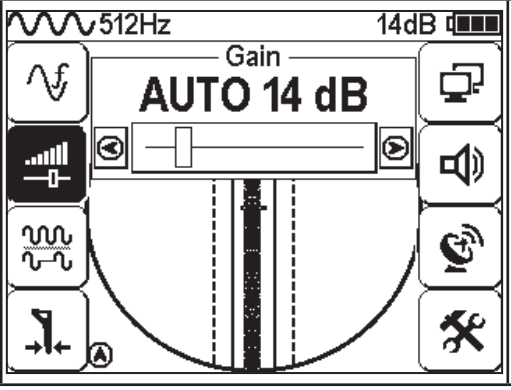
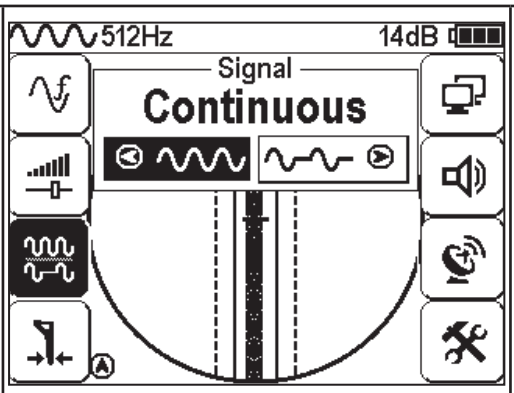
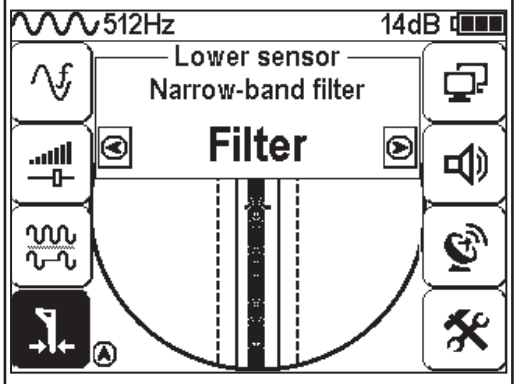
**The changed value is immediately applied.**

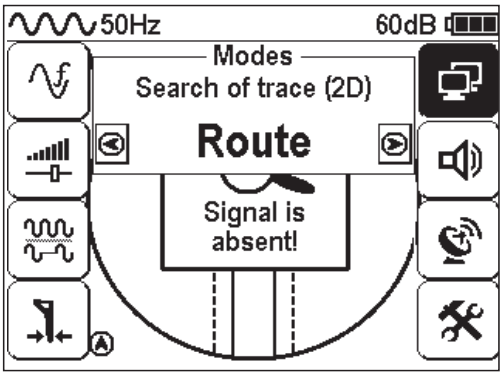
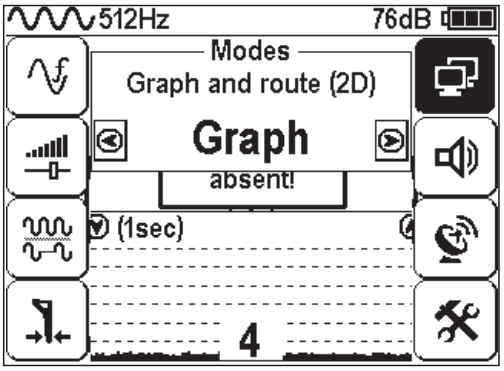
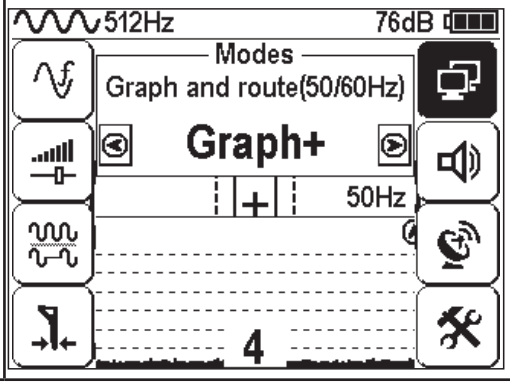
To exit the menu to the general menu or transfer to the set mode with the closing of the menu, you should press the button «Enter».
If you wait for several seconds, menu icons will disappear.

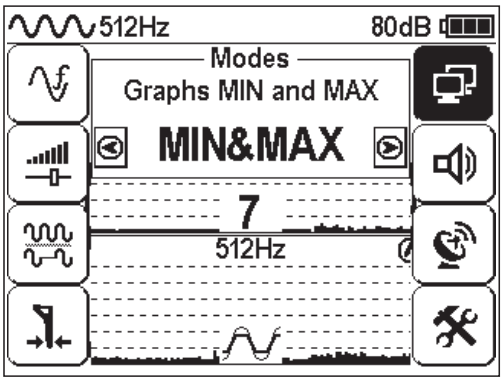
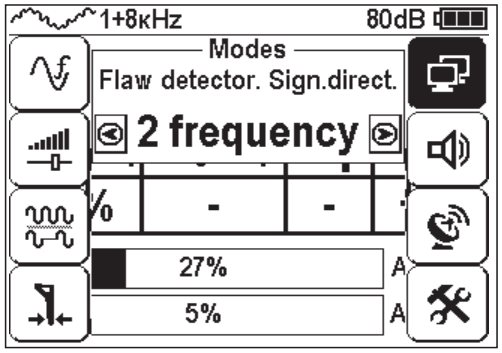
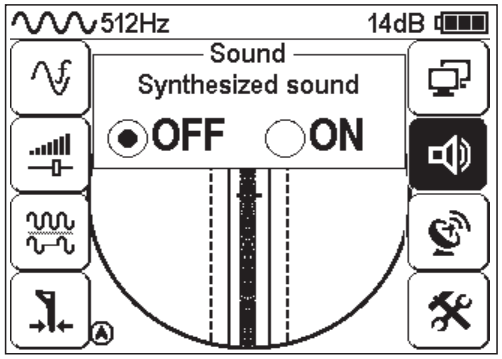
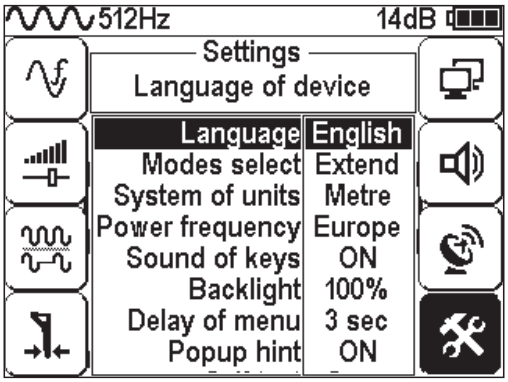
**If you don't press any buttons for a period of time, the menu will disappear automatically. The length os this period is set in the corresponding menu option (see Table 1. p.6)**

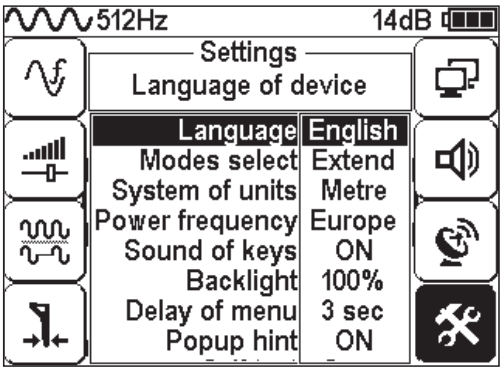
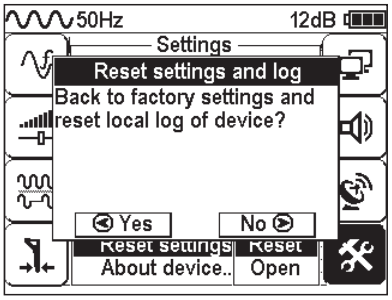
Thirteen items of menu contain parameters of setting, which are opened in the panel located in the upper part of the indicator.

**Table 1**

| № | Item of the menu | Display image | Parameter description |
|---|---|---|---|
| 1 | Filter  |   | The working frequency of the receiver It is selected from the set: **50(60) Hz, 100(120) Hz, 512 Hz, 1024 Hz, 8192 Hz 32768 Hz.** |
| 2 | Gain  |   | The amplification coefficient of the scaling amplifier can be changed from **0 dB to 80 dB** with 2 dB step. The optimum coefficient of amplification can be selected: **- manually,** -**semiautomatically** (by a command), -**automatically** depending on the regime of the analysis and signal representation. |
| 3 | Signal  |   | The type of signal received can be **«Continuous»** or **«Impulse»**. |
| 4 | Advanced bottom sensor setting  |   | This option has several settings affecting the efficiency og 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 | Base Mode |  | **Set of modes:**<br><br>- **«Route»** (2D display of the location of the route cable; |
| 6 | Base Mode |  | - **«Graph»** (visually represents the changes of signal level of surveyed cable); |
| 7 | Advanced Mode |  | **Advanced mode:**<br><br>- **«Graph+»** (this mode combines two previous modes and allows to locate two cables simultaneously: one on 50Hz, and the other on freqency set by transmitter.z); |

<table>
<tr><td>8</td><td>Advanced<br>Modes</td><td> 
</td><td>Advanced mode:<br><br>- «MIN&MAX» (graph representation of minimum and maximum signals)</td></tr>
<tr><td>9</td><td>Advanced<br>Modes</td><td> 
</td><td>Advanced mode:<br><br>«2 frequency» (simultaneous operation in two frequencies, also know as frend-or-foe mode).</td></tr>
<tr><td>10</td><td>Sound</td><td> 
</td><td>Switching on / switching off of sound notifications the created by the built-in speaker.</td></tr>
<tr><td>11</td><td>Settings</td><td> 
</td><td>This menu is opened in the main field of an indicator<br>Language — <Russian/English><br>Locale of the device<br>System of units — <Meter/Foot><br>Measurement system: metrical or imperial<br>Network frequency — <Europe/USA><br>The network frequency for passive search: «Europe» (50 и 100 Hz) / «USA» (60 and 120 Hz).</td></tr>
</table>

<table>
<tr>
<td>12</td>
<td>Settings<br>  </td>
<td> 
</td>
<td>
<table>
<tr><td>Sound of keys</td><td><ON/OFF></td></tr>
<tr><td colspan="2">Disables keys sound</td></tr>
<tr><td>Delay of menu</td><td><1 sec/2 sec/ 3 sec/ 4 sec/5 sec></td></tr>
<tr><td colspan="2">Time-out before closing the menu when no buttons are pressed.</td></tr>
<tr><td>· Popup hints</td><td><ON/OFF></td></tr>
<tr><td colspan="2">Disables pop-ups with useful hints.</td></tr>
<tr><td>· Reset osettings</td><td><Reset></td></tr>
<tr><td colspan="2">Resets the receiver to factory settings<br> 
</td></tr>
</table>
</td>
</tr>
</table>

## 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.

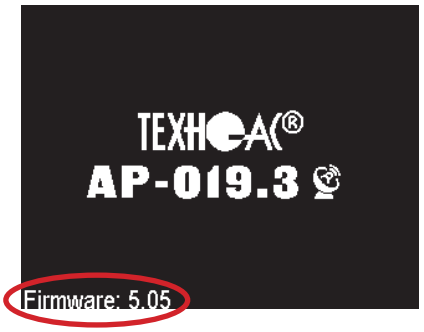

Install the batteries, observing the polarity

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

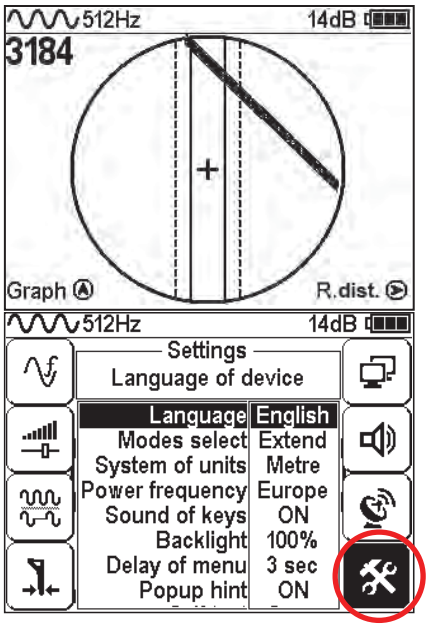
## Receiver switching

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

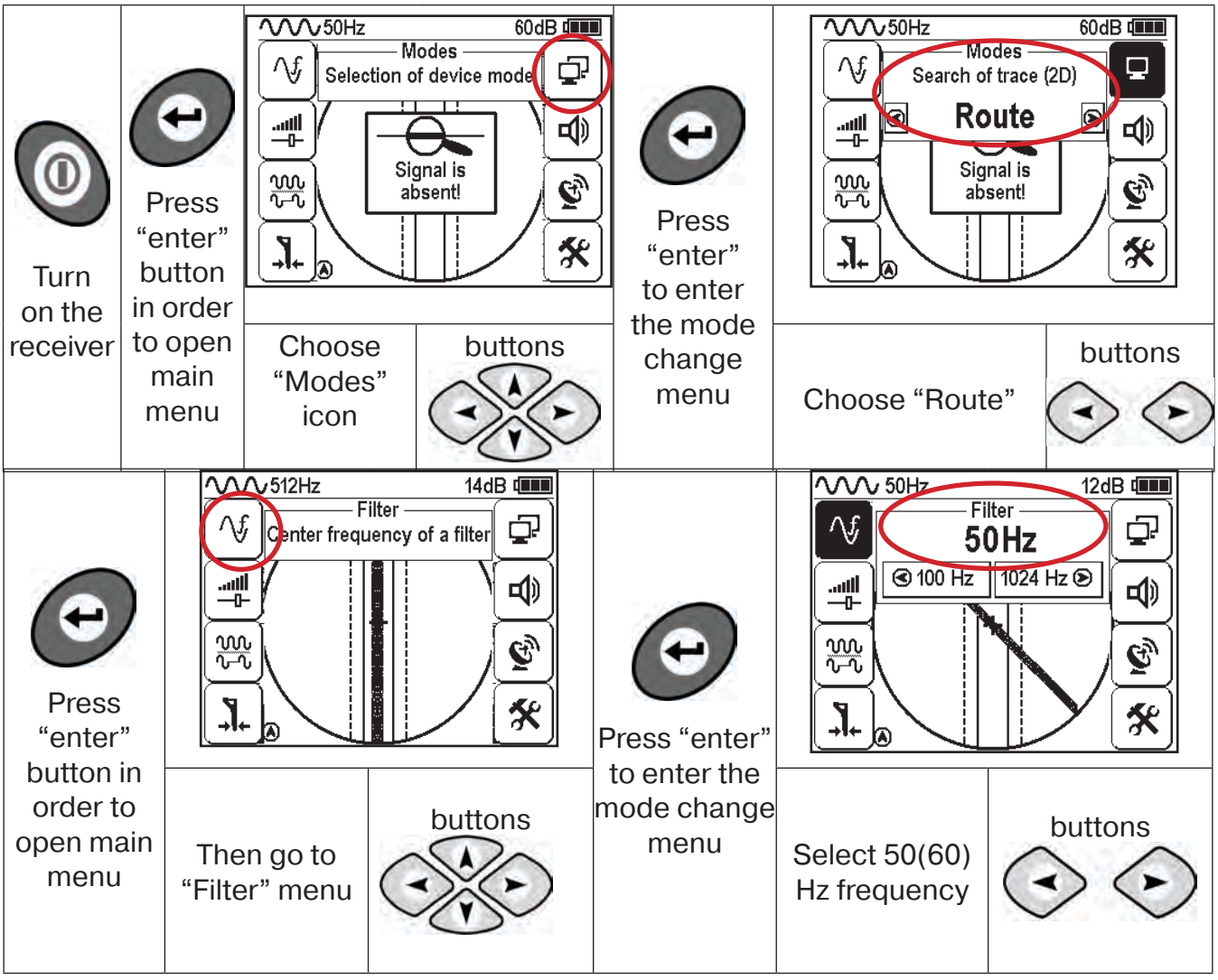
Route mode is the main mode for route location of various utilities (cables & pipelines) at all supported frequencies, both in “passive” cable route location and at the “active” (with the use of the route locating generator). In passive mode, the cable location is carried out at frequencies of 50(60) 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:

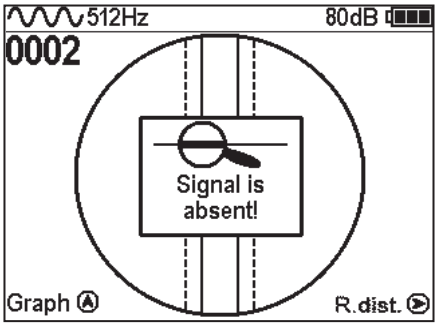


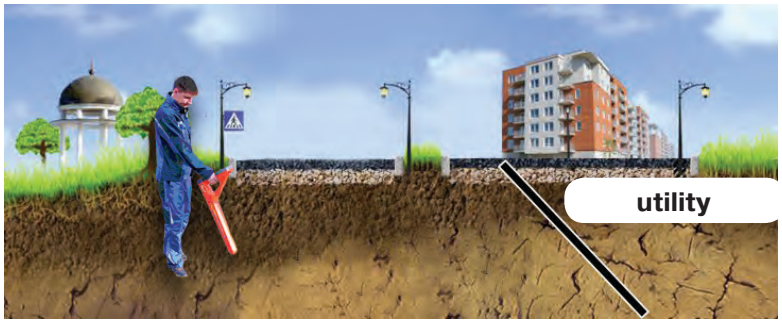

When filter 50(60)Hz is chosen, the type of incoming signal is automatically set to continuous.

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

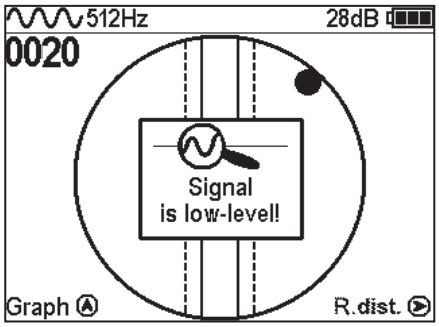
1. Come to the supposed place of the utility under the voltage or induced voltage in frequency 50(60)Hz.

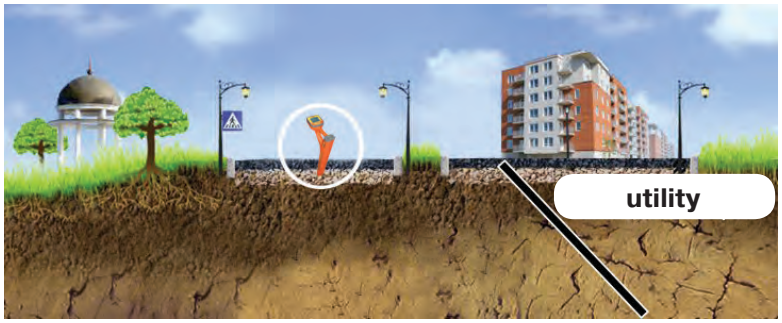
2. If the utility is far from the operator, you will see on the screen:



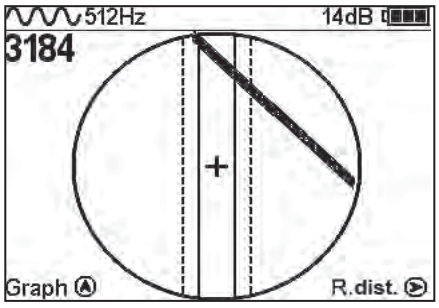




3. When moving towards the supposed place of the utility location, the “ball” will appear on the screen. It shows the presence of a utility and that it is a significant distance from the operator.



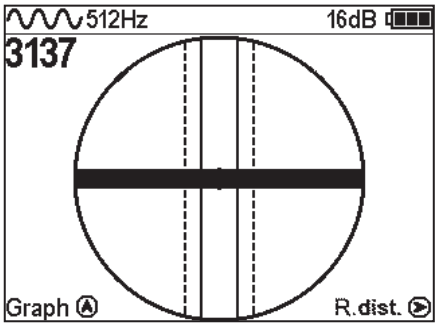




4. The “ball” position shows the direction of the utility relative to the operator.





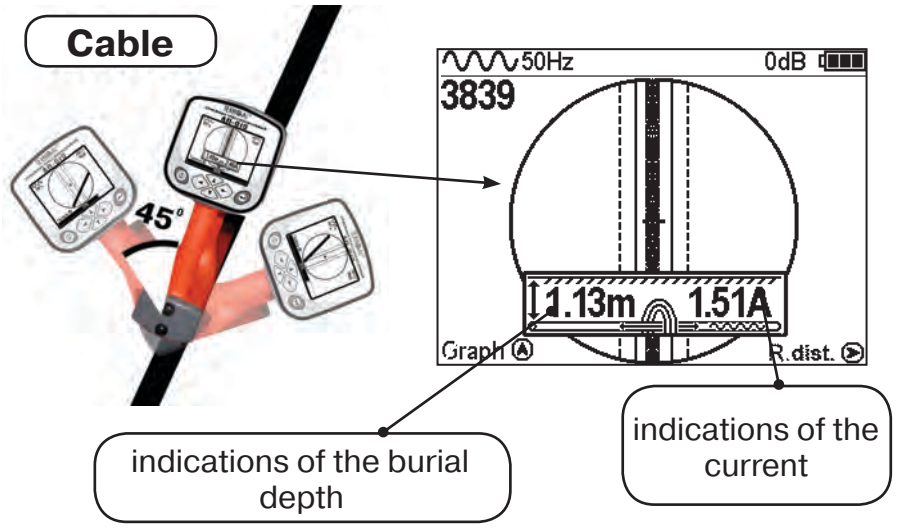
5. When the operator moves closer to the utility, the axis will move to the centre of the circle. This means that the operator is standing directly over the utility




## 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.

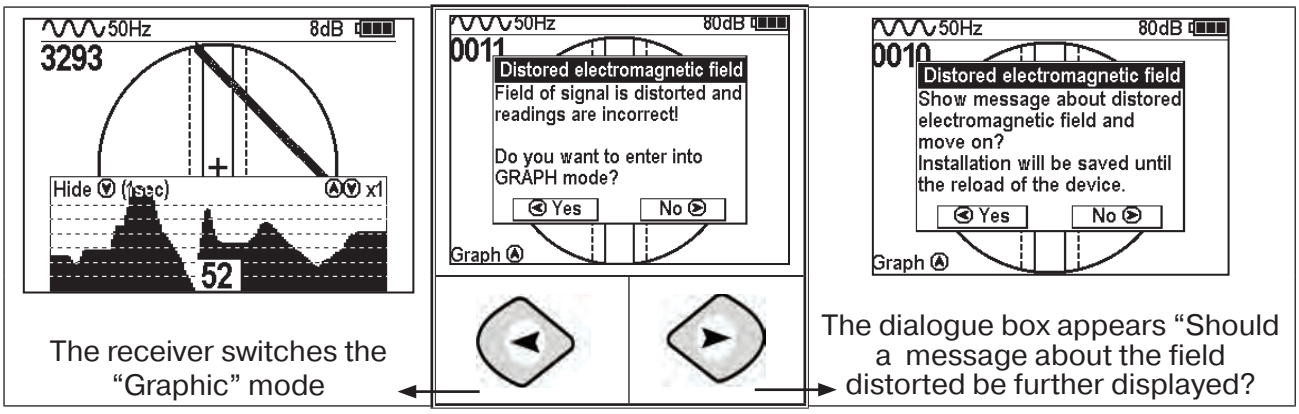
In this position, it is possible to move forward and trace a whole cable).




**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.

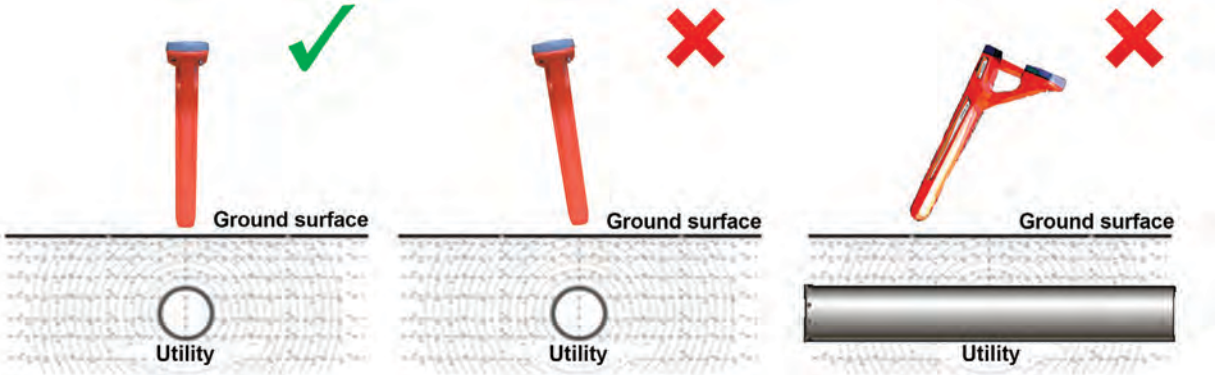
If the communication axis cannot be located exactly in the limited area, and the periodical jumps are happening from one border to the other, it indicates the presence of several cables under voltage with the 50 Hz frequency. You can specify number and position of the cables in "Graphic" mode.




**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 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.

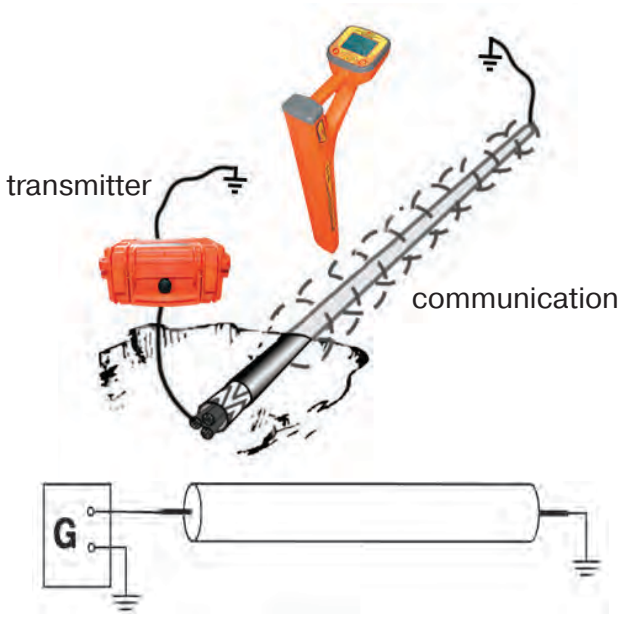
Note

**Transmitter Connection**

**Contact mode**
The generator output is connected directly to the communication

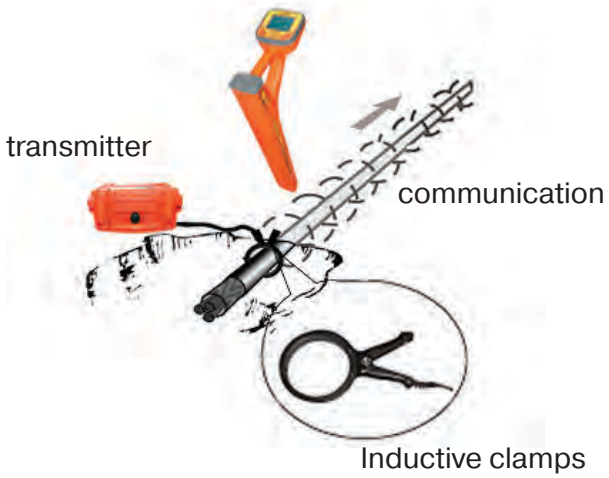
**Contactless method**
using the transmitting antenna

Note




**Contactless method**
Connection with internal inductive antenna of the transmitter

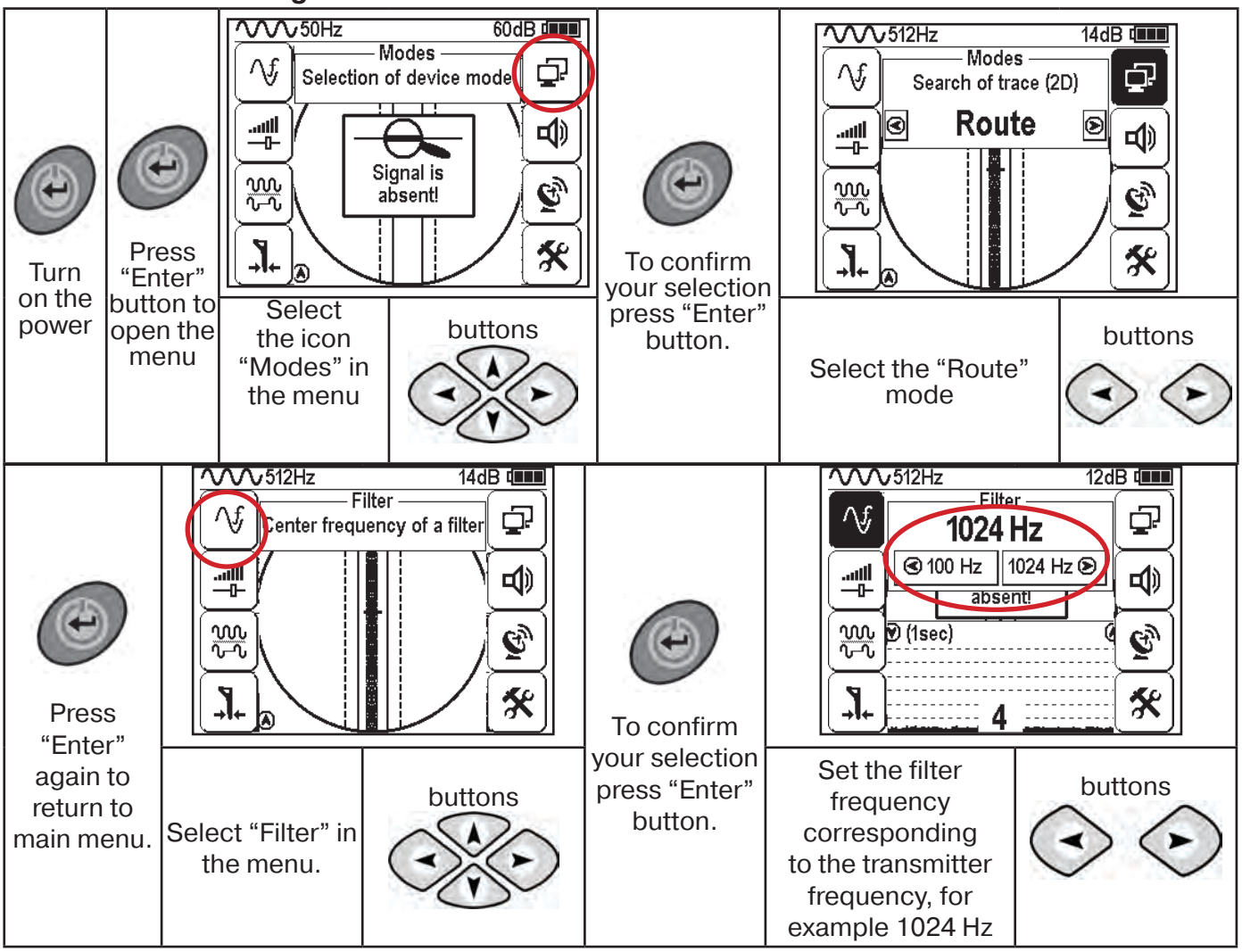

**Contactless method**
using the induction clamps

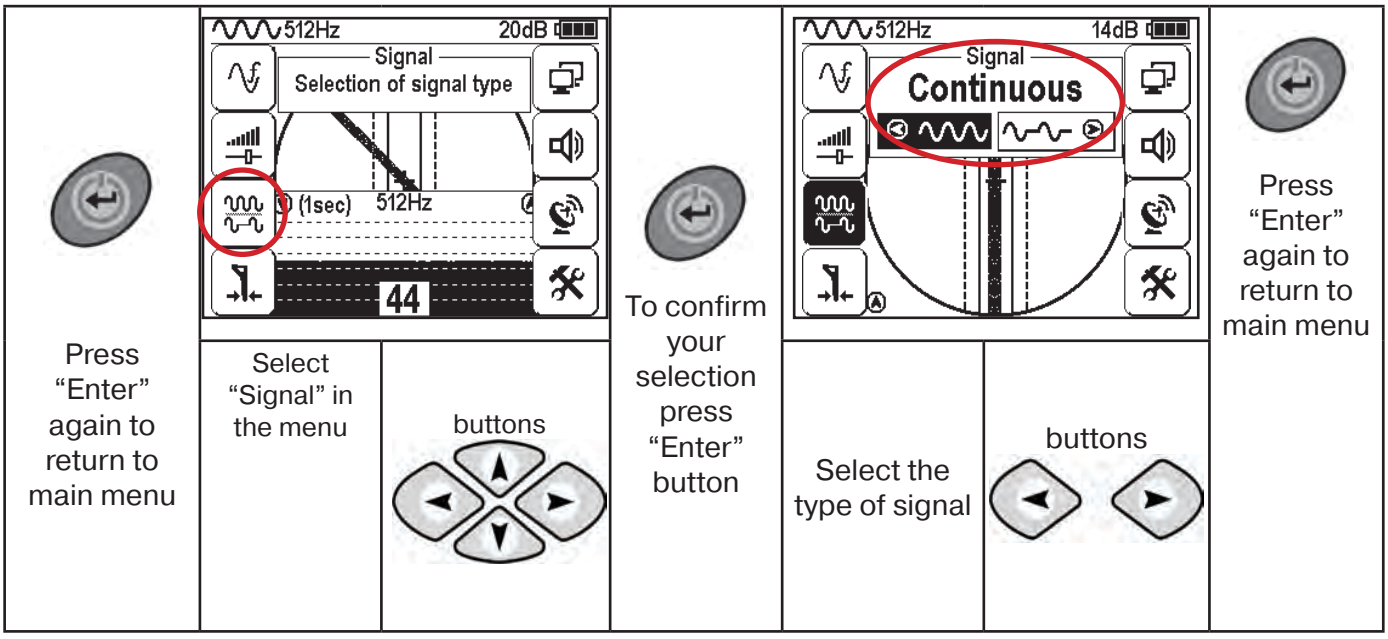


## Procedure for search of communication and conduction of cable route location

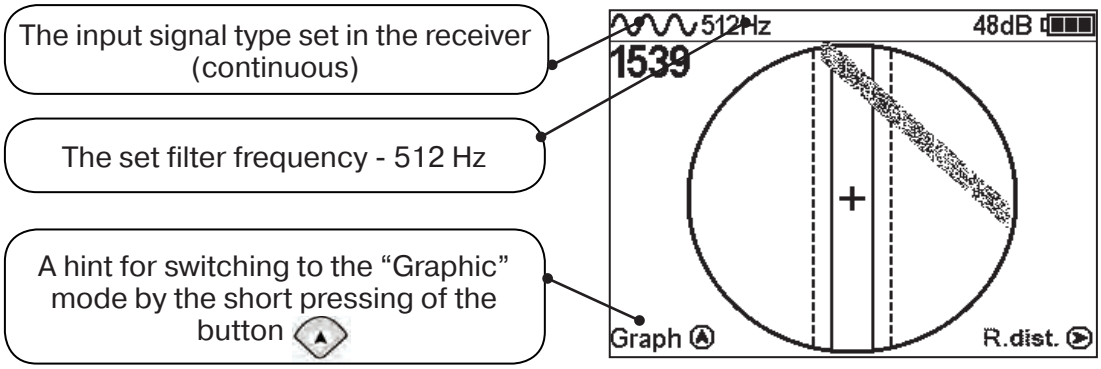
| | |
|---|---|
| 1. Connect the transmitter to the utility by contact or contactless method.<br>**Note** When possible, the preference should be given to the contact method of connection, which allows the user to perform the cable route location for more distantly. | 2. Turn on the transmitter. Set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

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






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




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

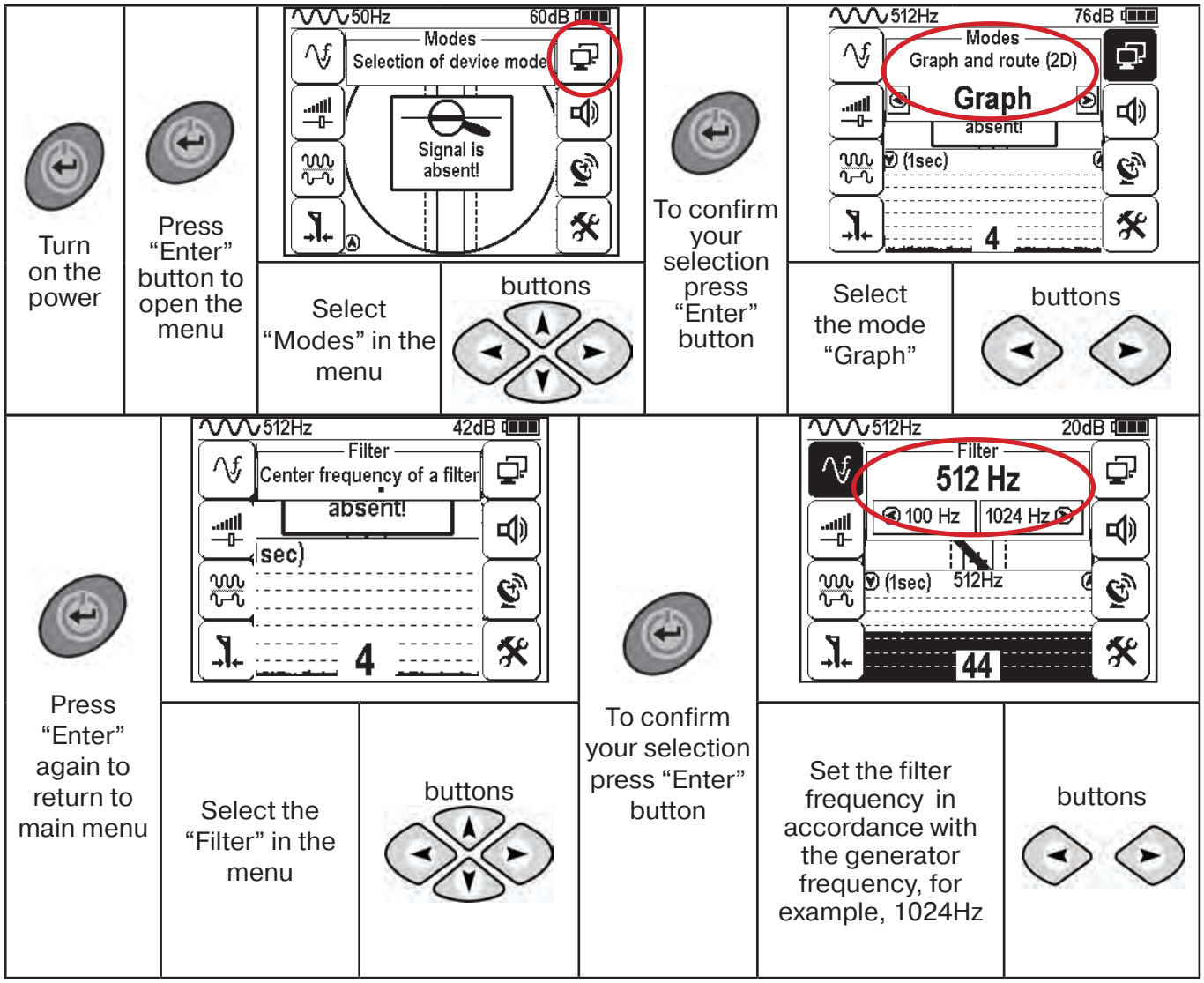
When working in the "Route" mode, the following can sometimes occur:
- the positioning of the utility axis into the centre is impossible
- the presence of several near located communications
- low signal in the cable

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

# 6. Search of Utilities in “Graph” Mode

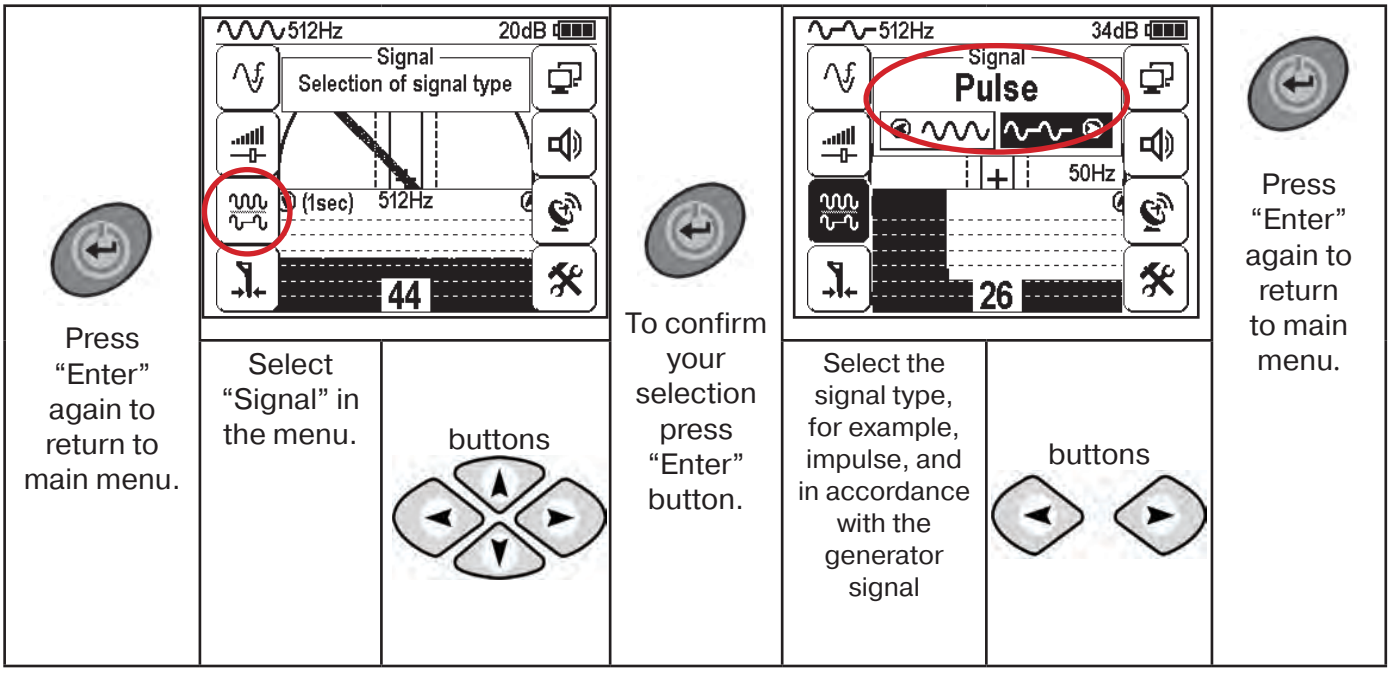
The “Graph” mode is the support mode and is able to locate various utilities (cables and pipelines), both in the passive and active modes with the route locating transmitter. In passive mode, the cable location is carried out at frequencies of **50(60) and 100(120)Hz** and in the active mode - **512,1024, 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




*** 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.

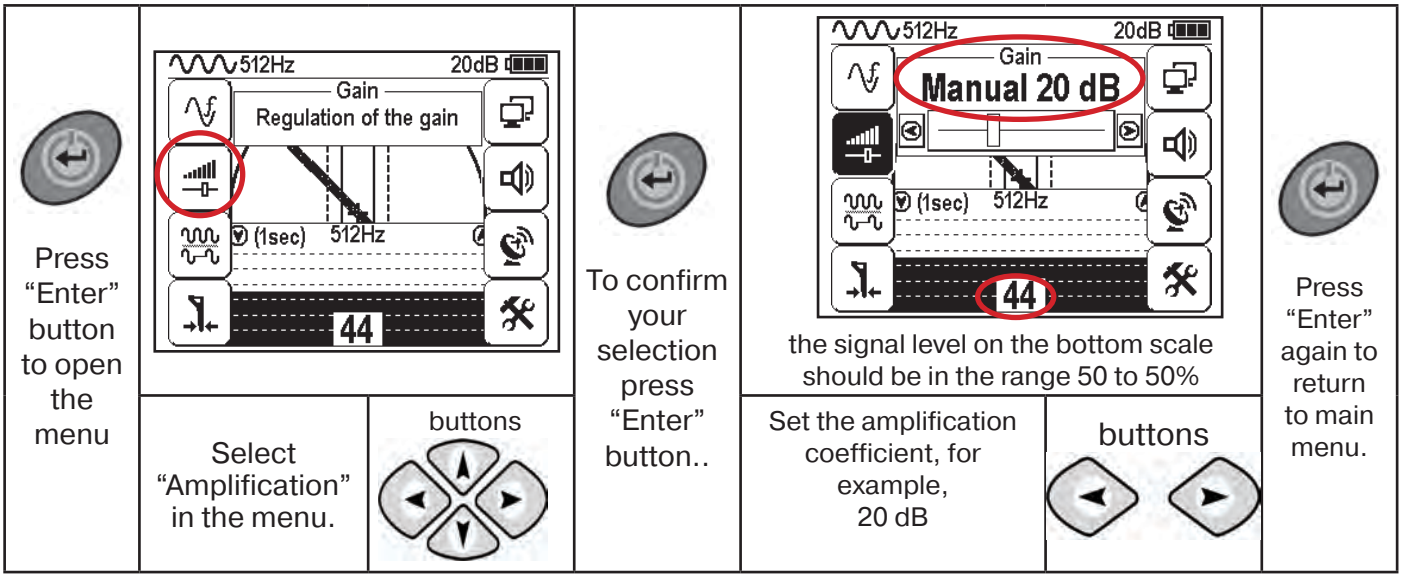



**Note**

When working in the passive mode **50(60) Hz, 100(120) Hz** - you should always select the **continuous type of the signal.**

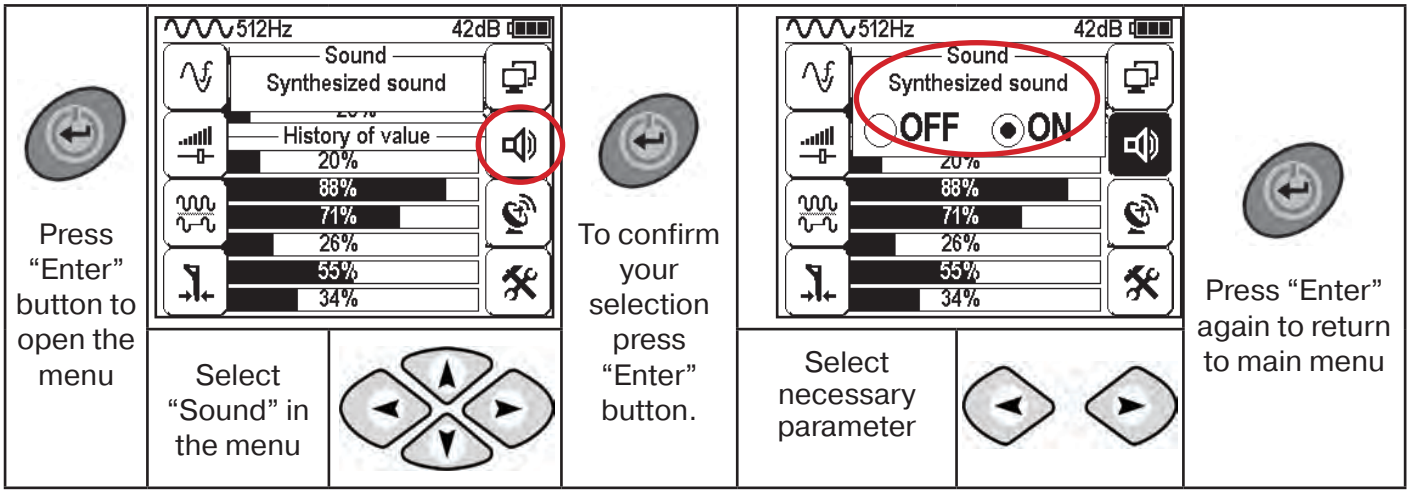
When working with the generator (in the **active mode) 512, 1024, 8192 Hz, 33 kHz** - the type of the signal on the receiver is **continuous or impulse**, in accordance with the signal set on the transmitter.

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

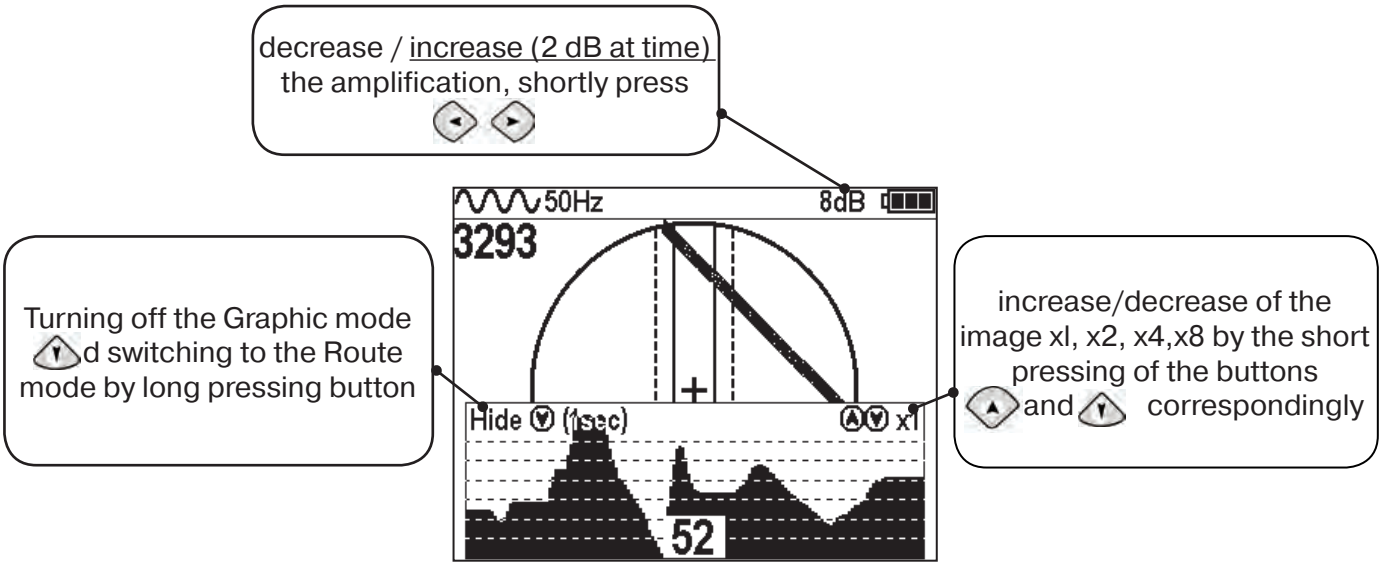


**The change of the input signal amplification coefficient should be performed manually by short pressing buttons ◄ ► or semi-automatically by holding one of them pressed for 1 sec.**

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:

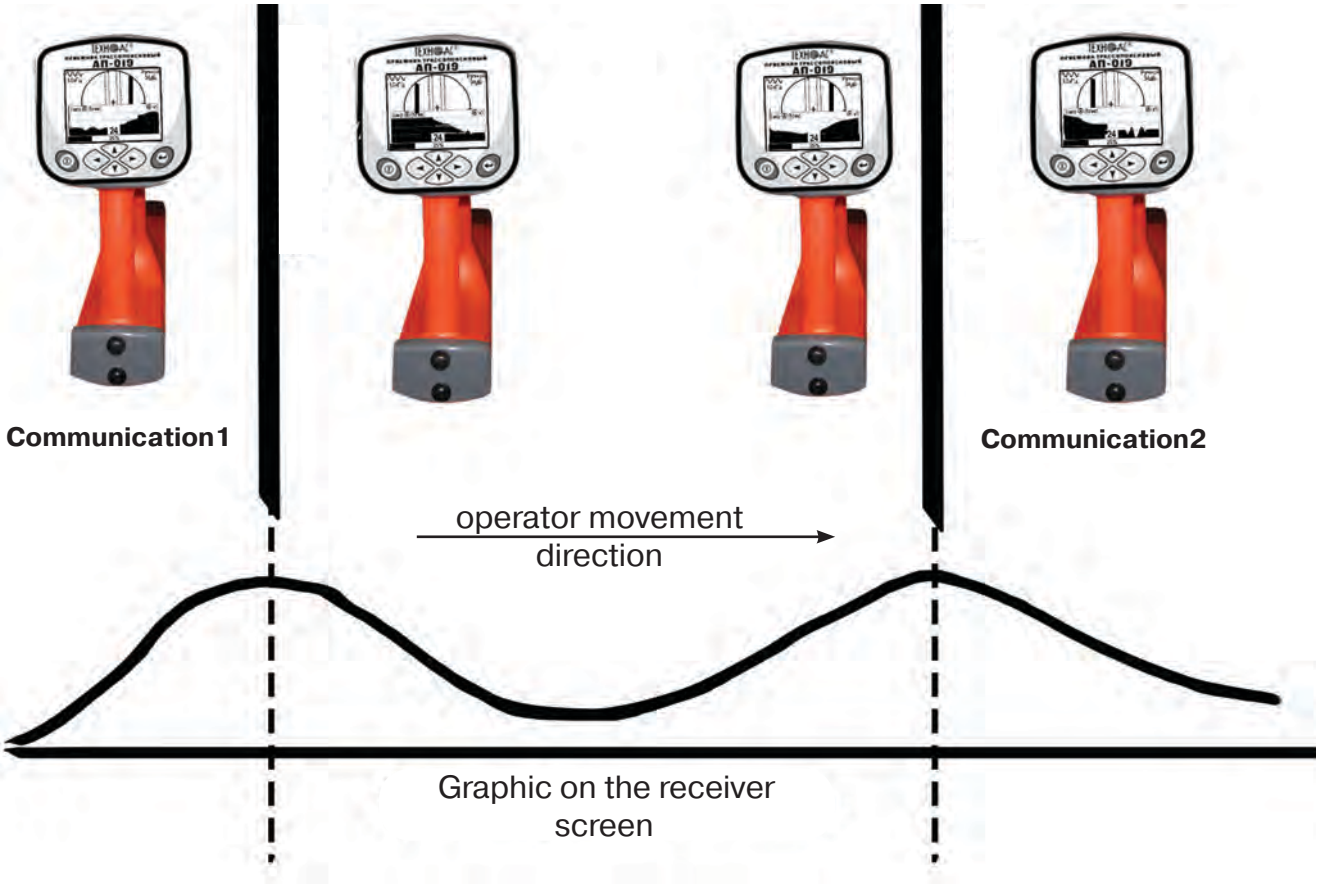
1. Decrease the graphic scale to the value x1 by pressing button ▼
2. Decrease the signal amplification coefficient by pressing button ◄ until the appearance of the decrease of the input signal level is less than 80%.
3. In case of low signal, increase the amplification coefficient by pressing the button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

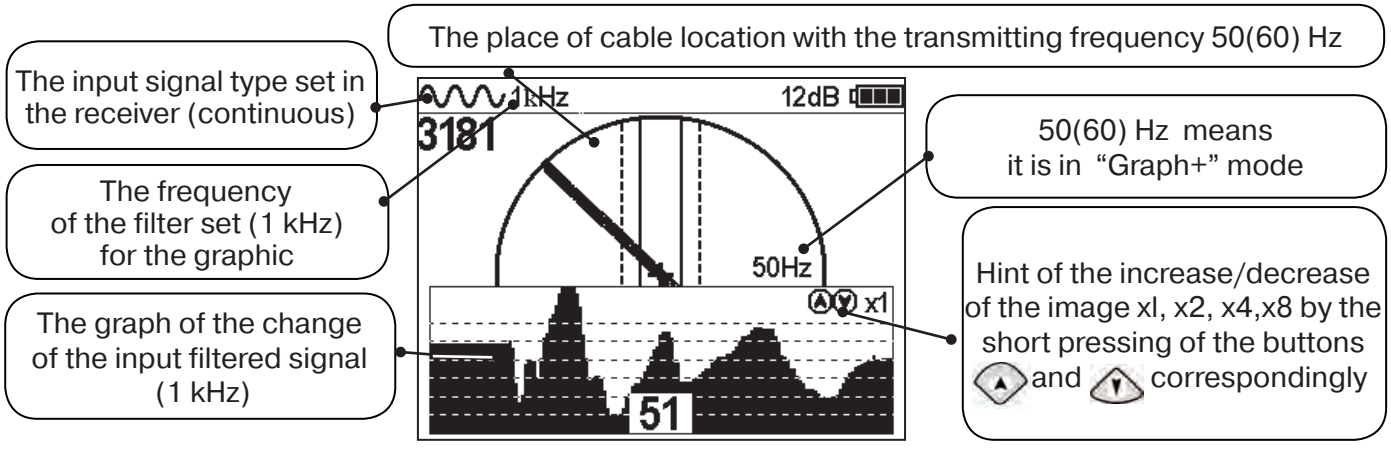
## 7.1 Setting of the Receiver for Work in the “Graph+” Mode

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

| | |
|---|---|
| Note 1. 1. Connect the transmitter to the communication by contact or contactless method. When possible, preference should be given to the contact method of connection, which allows the user to conduct the cable route location more distantly. | Note 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. |
| 3. Set up the receiver for work in the “**Graph**+” mode (section 7 1), set the frequency and type of the signal the same as on the transmitter | 4. Start the generation, wait for the transmitter to power up. |

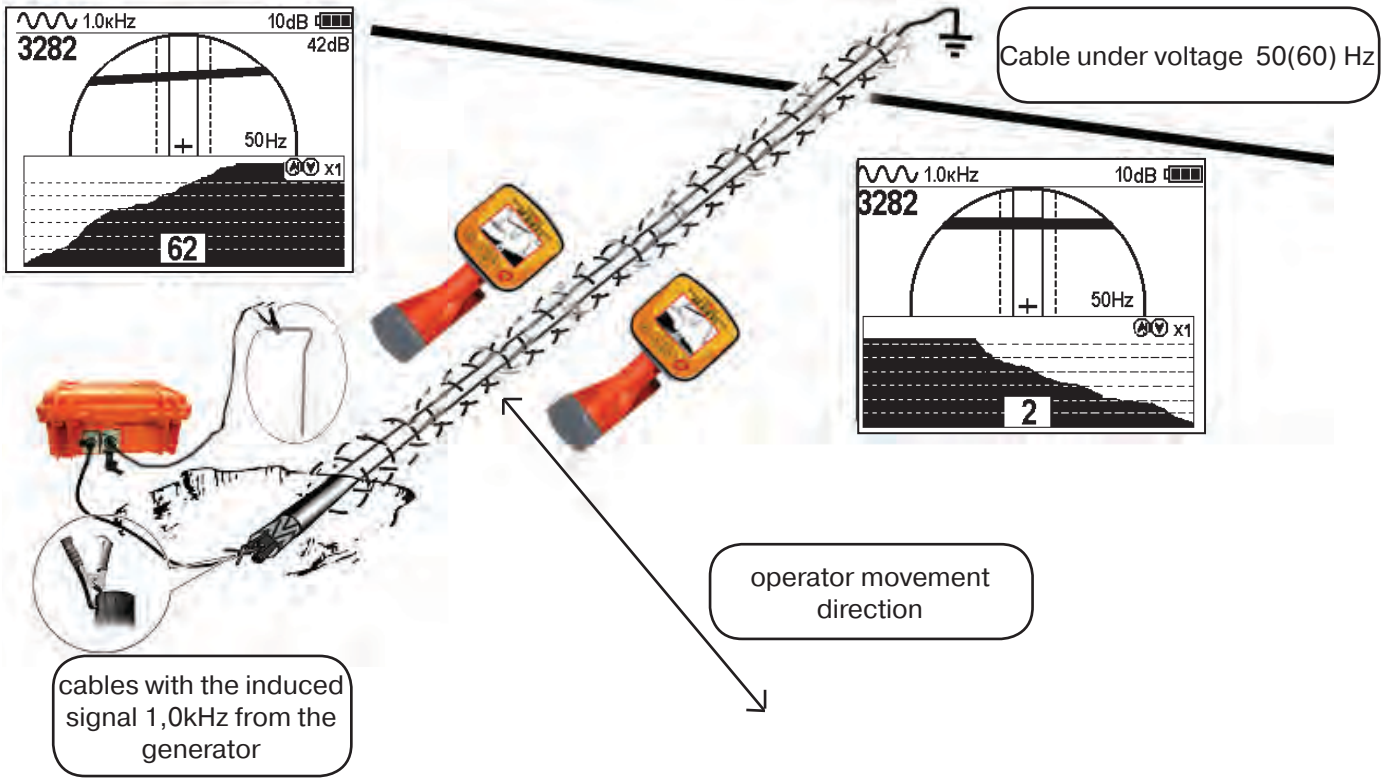
## View of the Receiver Screen for Route Location in the Active Mode



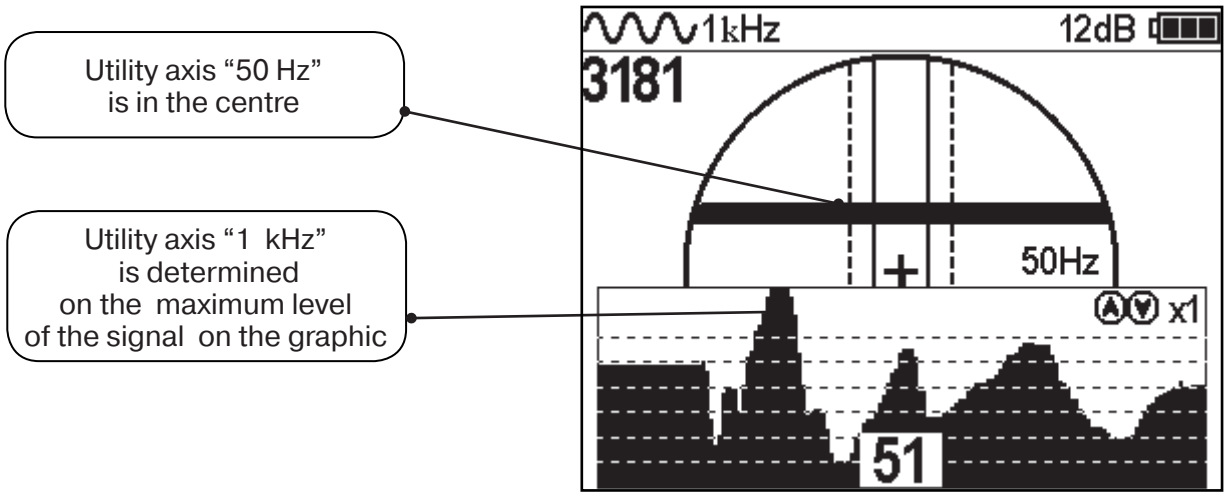
5. Approach the supposed place of cable route, on which the signal from the generator was transmitted. Locate the receiver axis in parallel to the utility axis.

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

You should move the receiver as shown on the figure.




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

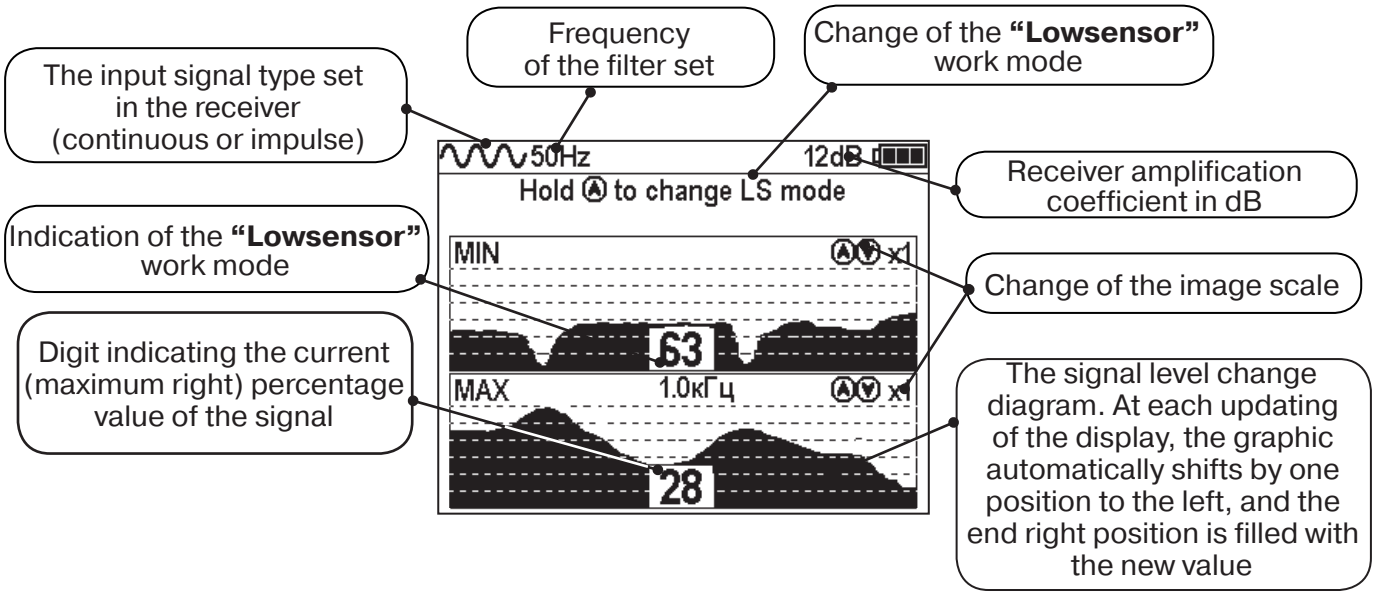


# 8. Performing a Cable Location in the Mode “MIN & MAX”

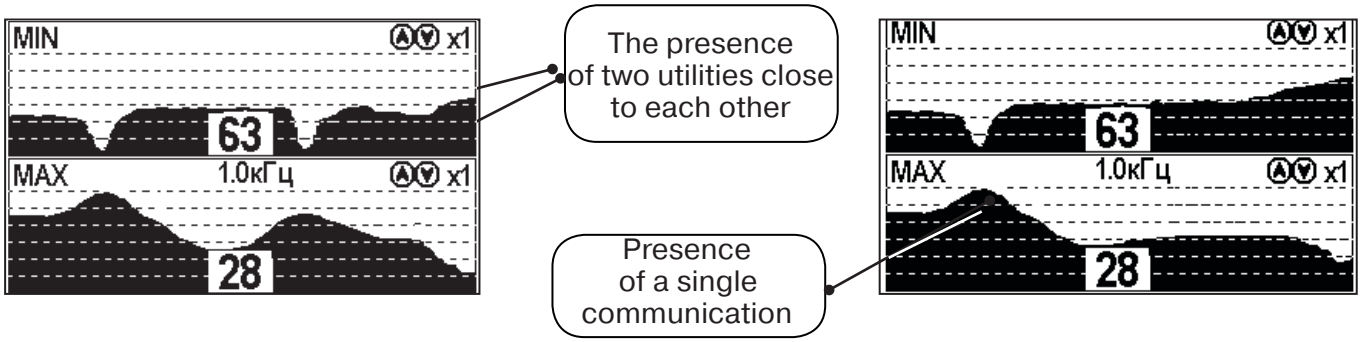
In the mode **“MIN & MAX”**, the device works simultaneously both on the method “maximum” and the method “minimum”. This mode is used in the conditions of distorted field, in the presence of nearby utilities and at the low induced signal. It allows the user to perform location and to determine the presence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

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

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



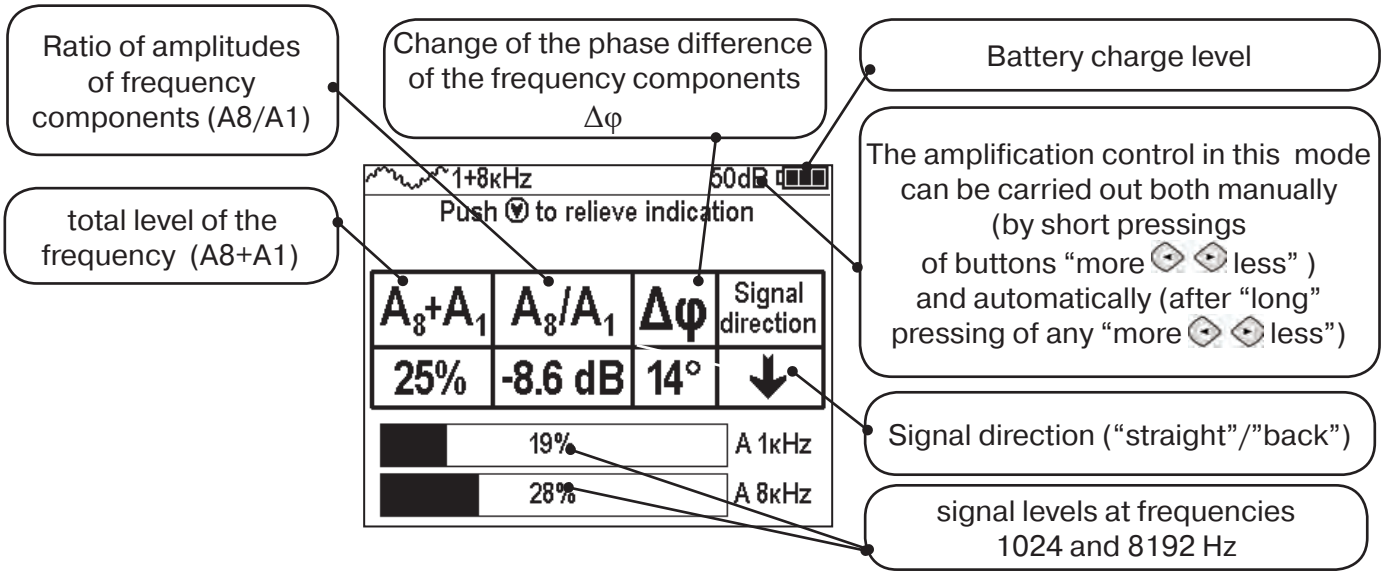

The cable route location is performed similarly to route location in the “Graph” mode, orienting on the maximum level of the signal on the lower scale of the graphic and the minimum level of the signal on the upper scale. To determine the number of the nearby utilities, you should step aside from the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



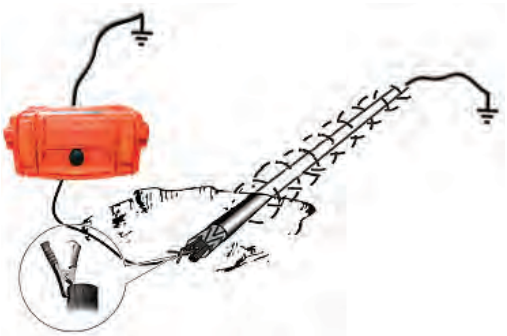
# 9. Performing Cable Route Location in “2 Frequencies” Mode

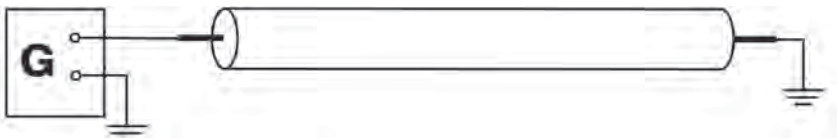
The mode “2 frequencies” was added so the user could determine the signal direction in cables.
**Additional possibilities of the mode are described in App. 2:**
Append. 2 p.3 Amplitude “two-frequency” method “ΔA”;
Append. 2 p.4 Phase “two-frequency” “Δφ”

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



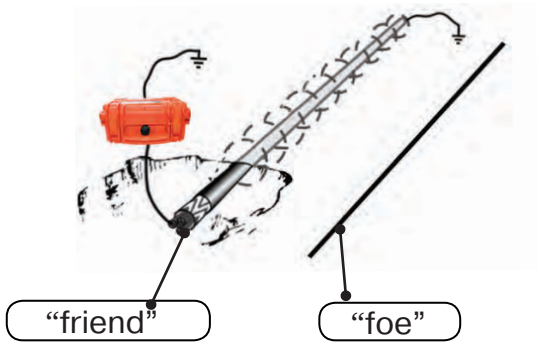

1. One output of the transmitter should be connected to the point of the utility that is more distant from the supposed place of the defect (start of the diagnostic site). The other output of the generator is grounded on the maximum possible distance from the utility from the other side (end of the diagnostics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



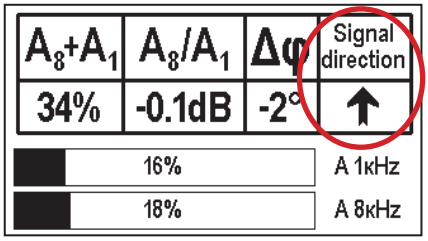



2. The transmitter in the mode “2F” sends to the utility the signals of two frequencies (1024Hz and 8192Hz) simultaneously.

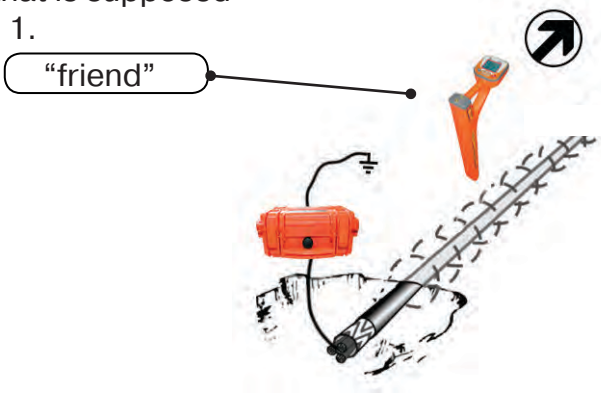
3. The signal from the utility, to which the route locating transmitter is directly connected, is conventionally named - “friend”. The “parasitic” signal from the nearest utility, on which the generator signal is transferred, in conventionally named as “somebody else’s”.

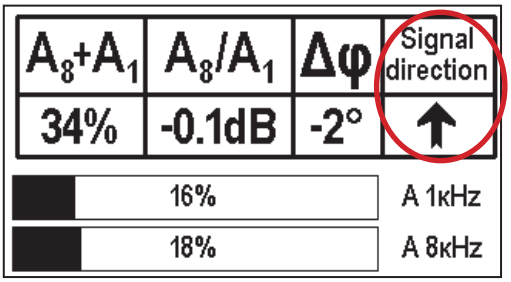



4. Based on the direction of the “arrow”, it is possible to distinct a “friend” signal from a “foe” one, since the current direction in “friend” utilities is opposite the “transferred” currents flowing through “foe” utilities.

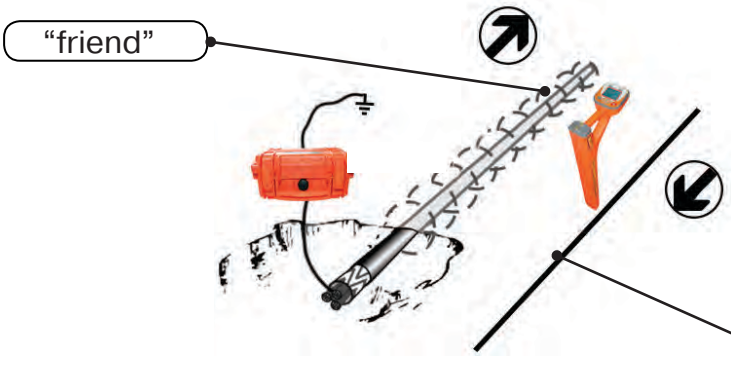


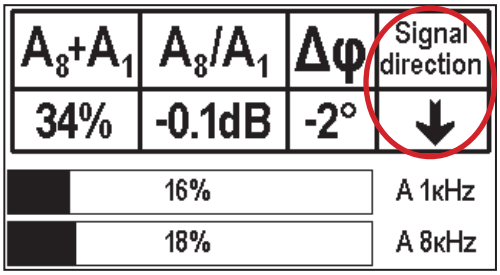

5. “Signal direction - forward” is the conventional concept and “assigned” by the operator, for this position of the sensor relative to the route. The “assignment” is performed by the pressing of the button “ ”; when the sensor is located exactly over the “allocated” utility that is supposed to be a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




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”.

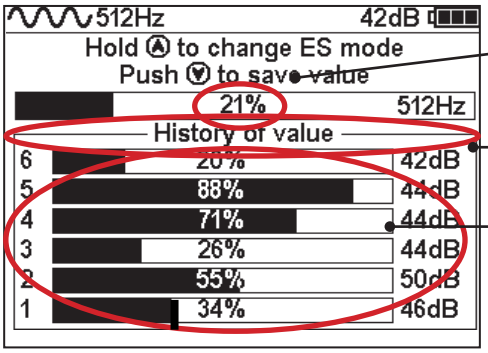


# 10. The work mode «Cable selection from a bunch»

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

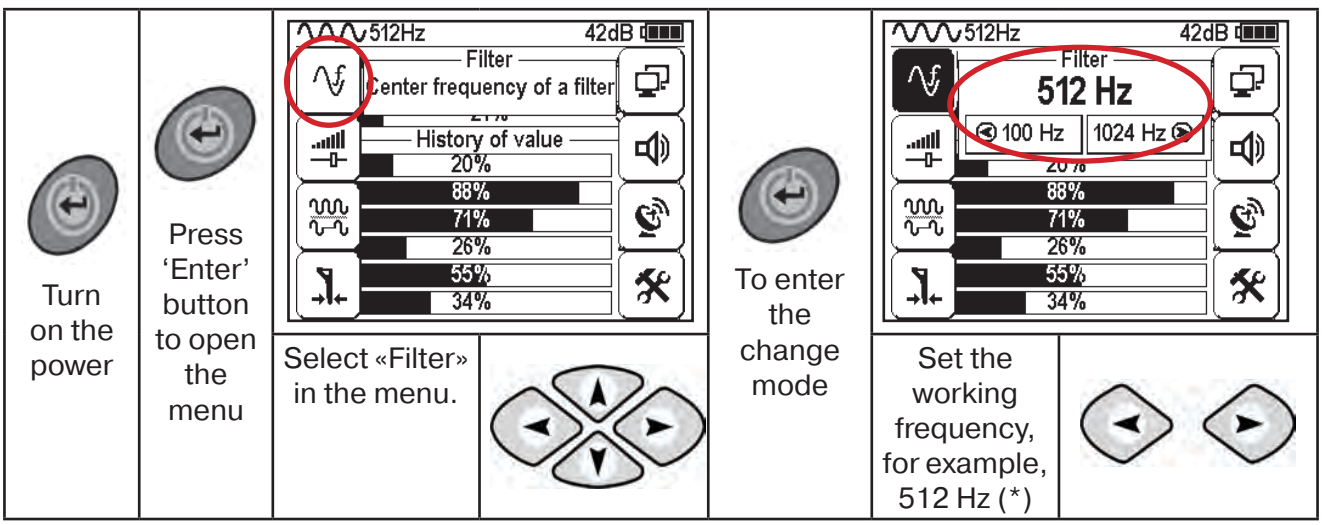
## 10.1. The work with the receiver in the mode «Selection of the cable from a bunch»

**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**

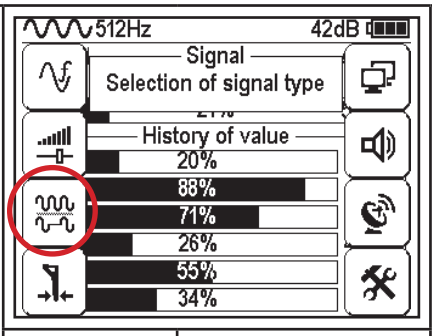
**Fig 10.2**

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



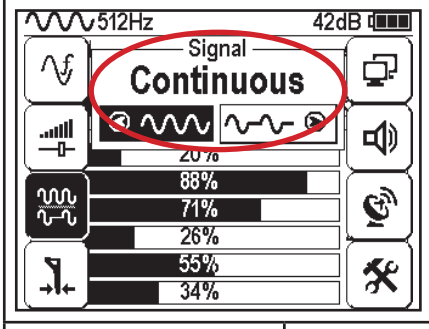

**(*) at that the signal should be sent into the cable from the transmitter with the same frequency 512Hz**

Press 'Enter' again to return to main menu.



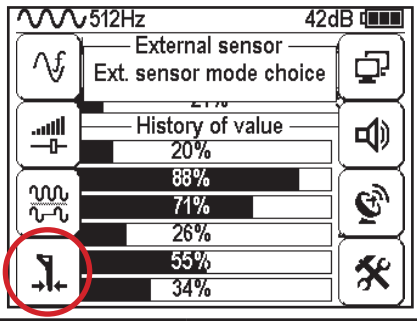

Select «Signal» in the menu.

To confirm your selection press 'Enter' button.



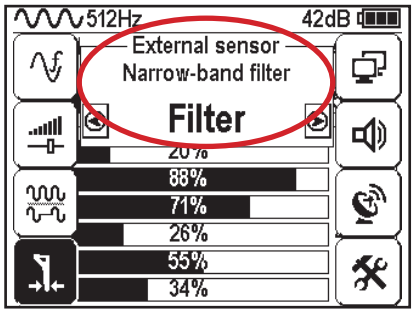

Select the signal type corresponding to the signal type from the transmitter, for example, continuous.

Press 'Enter' again to return to main menu.




Select the icon «Mode of the lower sensor» in the window.

To enter the selection




Select the mode of the bottom sensor «Filter»

To exit from the menu you should press the button «Enter». If you will wait for several seconds, menu icons will disappear.

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

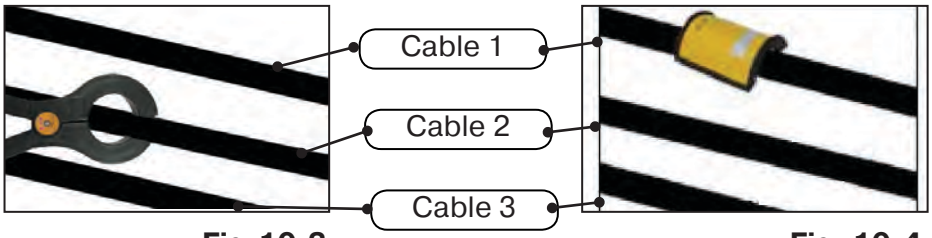
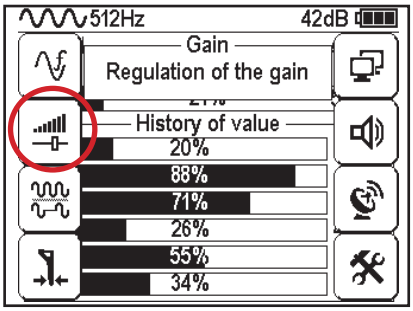


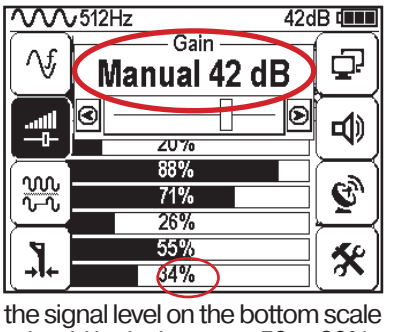

**Fig.10.3** **Fig. 10.4**

Press 'Enter' again to return to main menu.




Select «Amplification» in the menu.

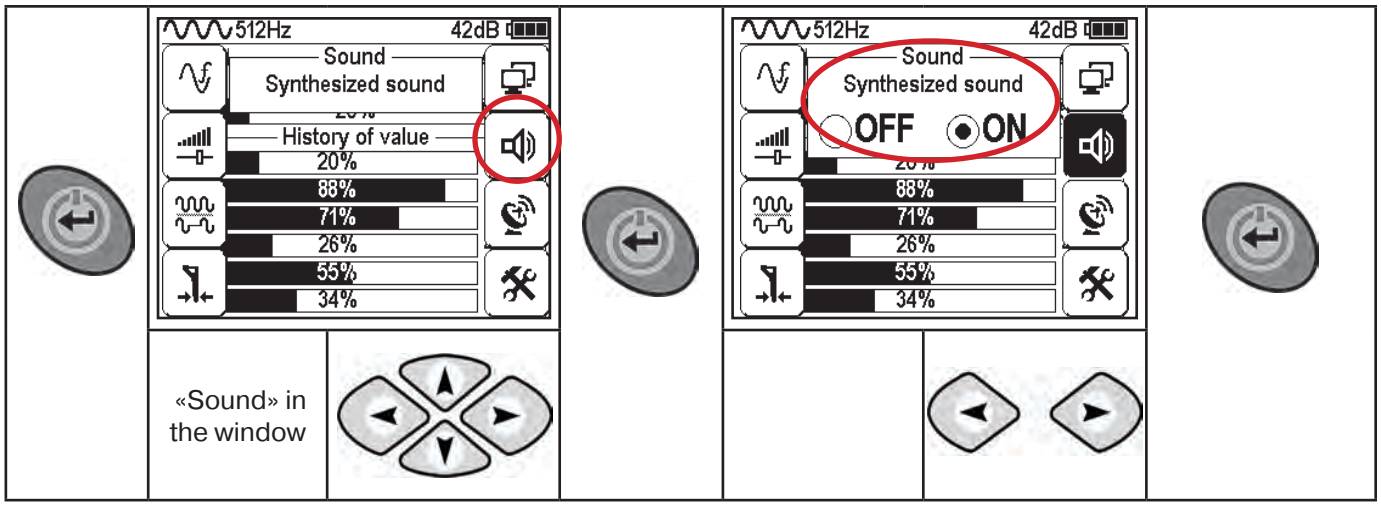
To confirm your selection press 'Enter' button.




the signal level on the bottom scale should be in the range 50 to 80%

Set the amplification coefficient, for example, 40 dB

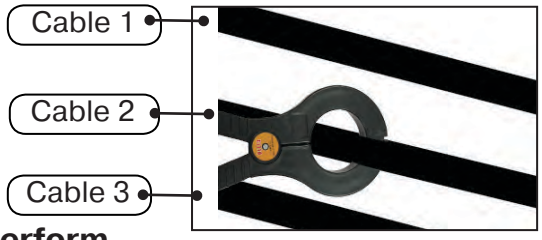
Press 'Enter' again to return to main menu




**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).

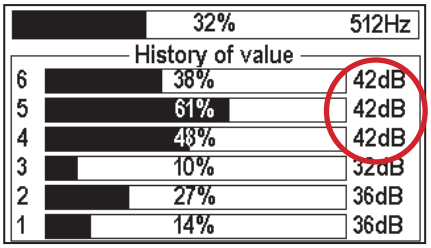
The tone pitch of the synthesised sound correspond to the signal value (including and «impulse» amplitude)




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.**



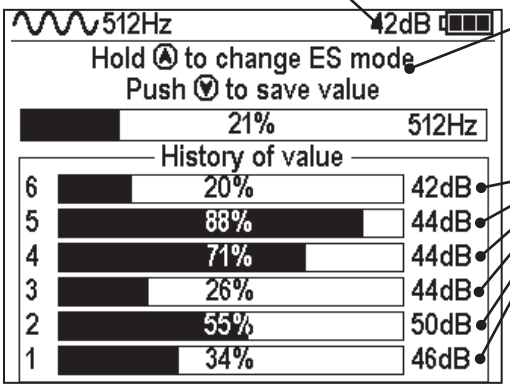

**The maximum signal 80% (42 dB) corresponds to the cable No.2**

**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)

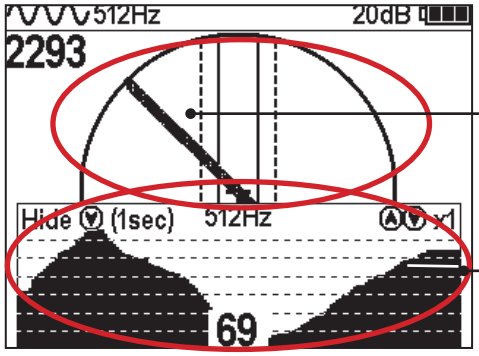
Note

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.



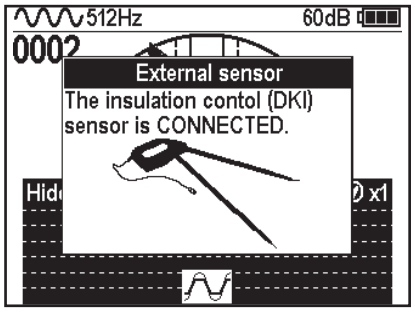

2D display of the route location

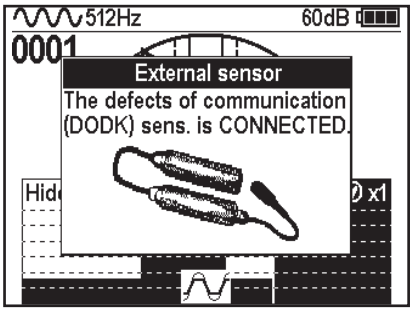
2 The graphic of time change of the external sensor signal level
The graphic can be hidden by long pressing of the button and appears at the short holding of the button.

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

Fig.11.1

Fig.11.2

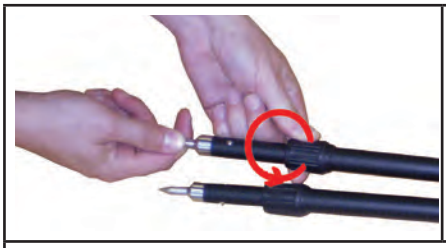
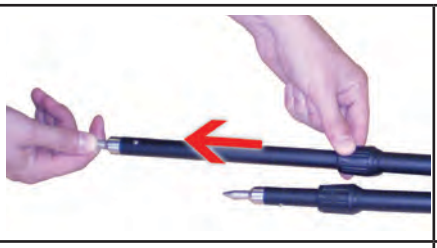
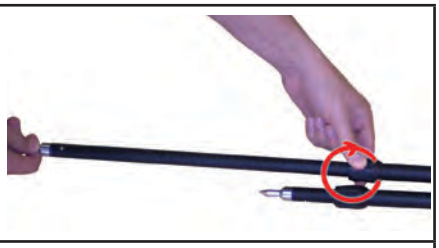
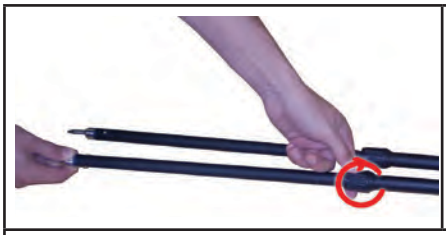
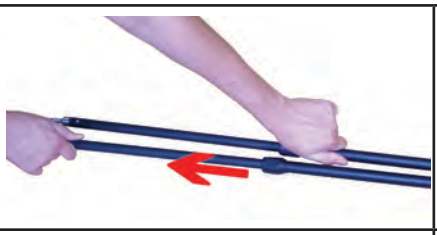
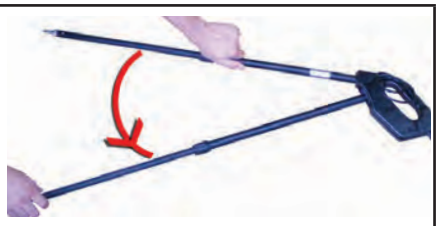



- Connect to the sensor to the receiver of the insulation control DKI-117 (fig. 11.1) or DODK-117 (fig. 11.2).

# Preparation of the sensors for work DKI-117

Prepare the sensor for operation.

| | | |
|---|---|---|
|  |  |  |
| release the slip pull out the internal nut of the rod till stop | | tighten the slip nut of the rod |
|  |  |  |
| similarly pull out pull out the second support internal rod | | move the rod to the right till the connection with the fixator |

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.

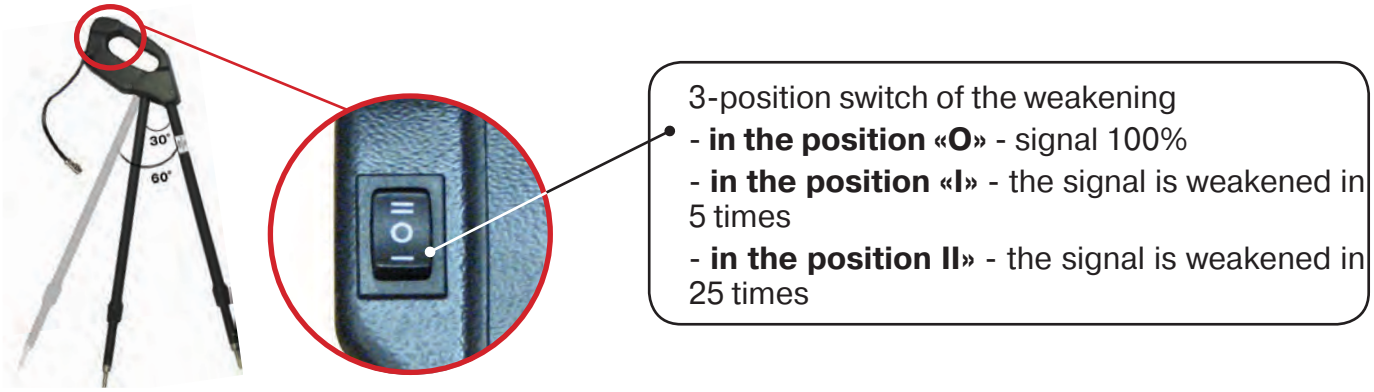



**Fig. 11. 3.**

**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)**

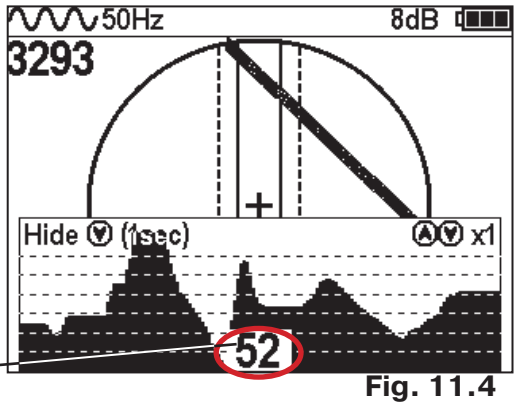



**Fig. 11.4**

## 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**

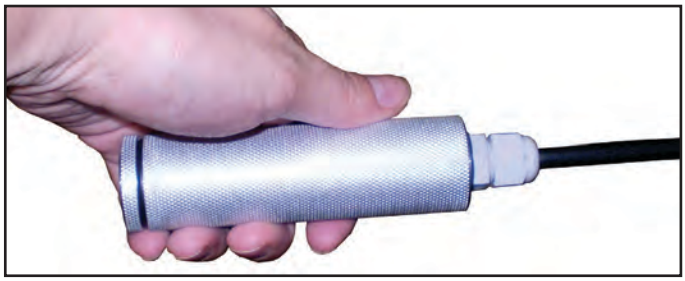


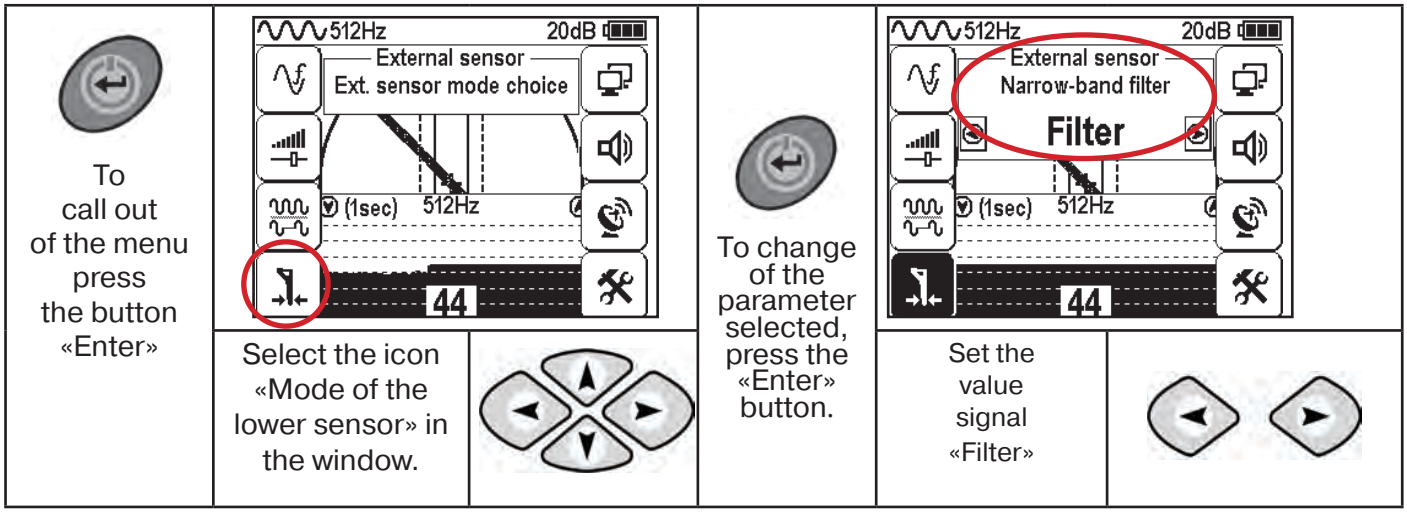
**Fig. 11.6**

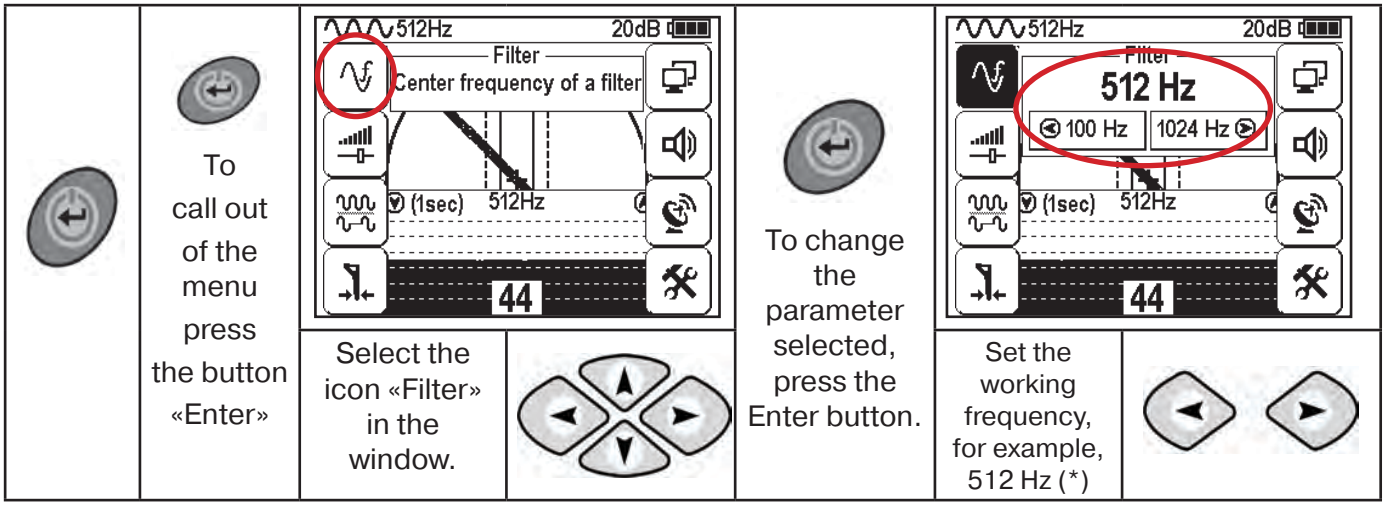
### Receiver setting

1.Turn on the receiver

2. Set the work mode of the lower sensor to the value **«Filter»**

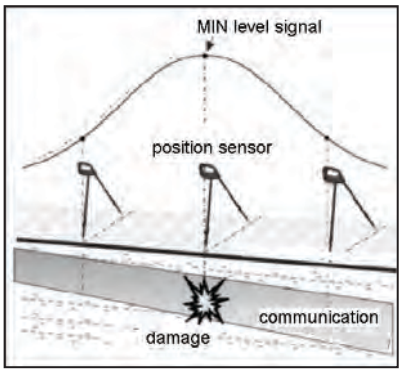
3. Set the working frequency and type of the signal:



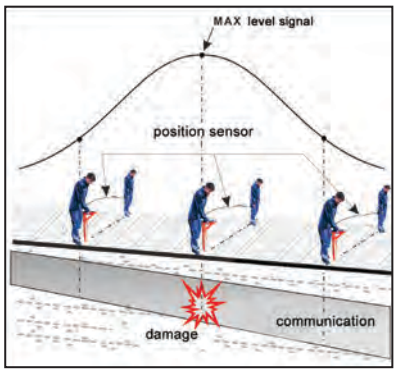



**Wait for several seconds till menu icons disappear**

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).

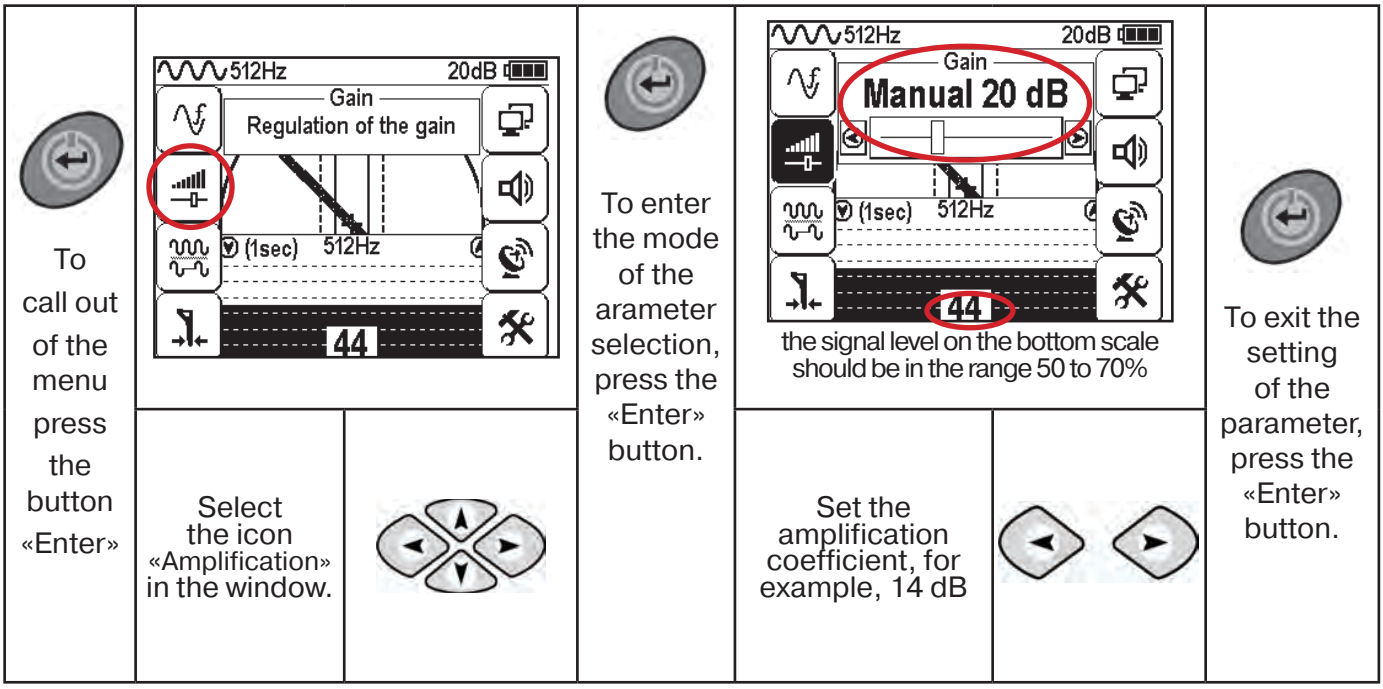



**(fig. 11.7.)**

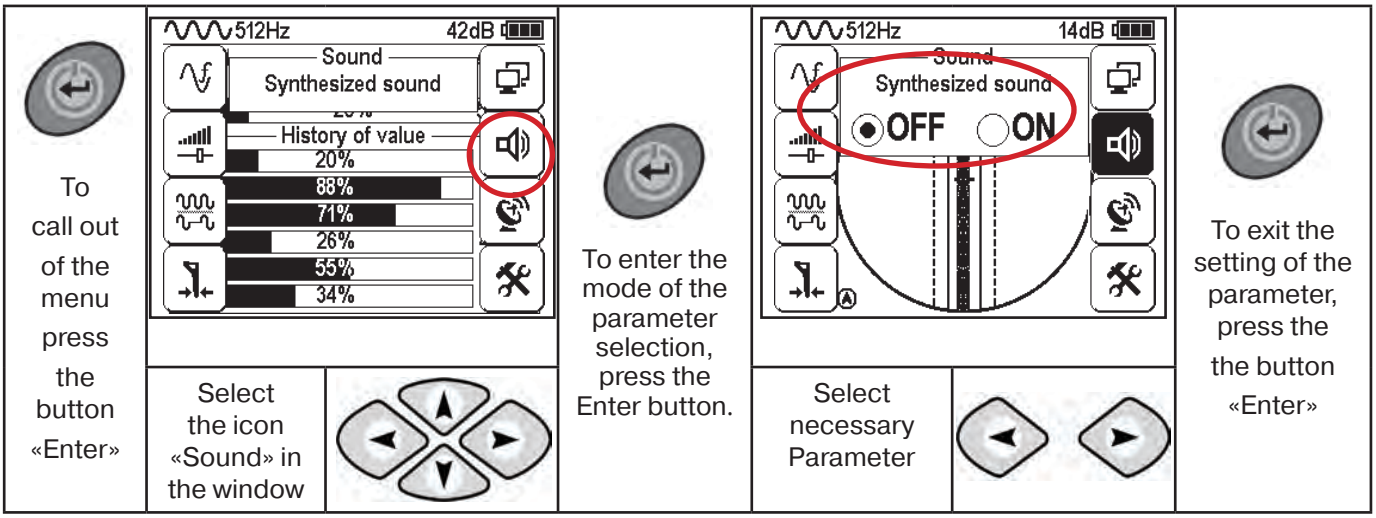



**(fig. 11.8.)**

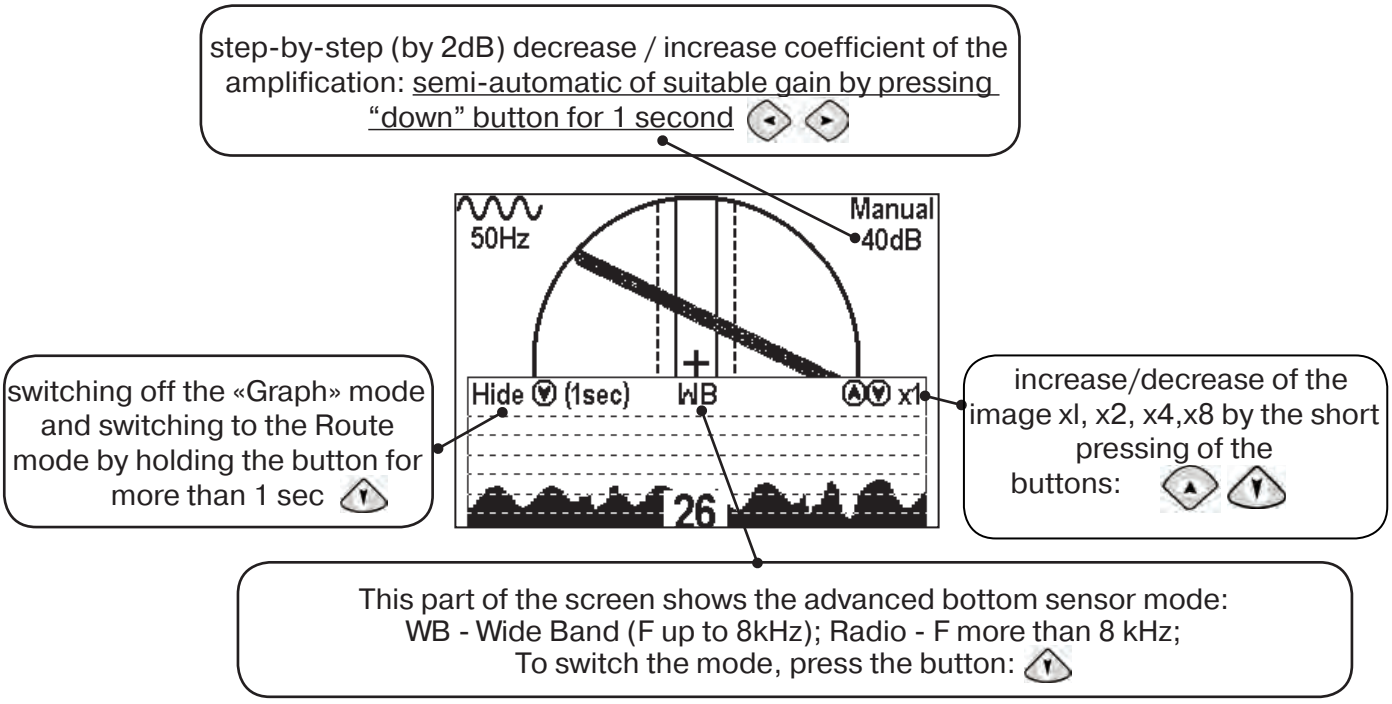
When working with sensors you should regulate the receiver amplification coefficient so that the signal level was in the rang 50 to 90 %.



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




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 levele 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.

## Appendix 1
## Receiver AP-019.1 Specifications

| Parameter | Value |
|---|---|
| Receiver filter centre frequency | Switching 50(60)/ 100(120)/ 512/ 1024/ 8192 / 32768 Hz |
| «Wide band»frequency band | 0,04…8 kHz |
| Frequency range "Radio" | 8…40 kHz |
| Maximum amplification factor of the electric path | 120 dB |
| Dynamic range of the input signal | 100 dB |
| Number of embedded sensors | 4 |
| Max. Sensitivity | 5 mkA at 1m distance (at 33 kHz) |
| Selectivity | $Q_{-3\,dB}$>100, stopband supression up to 120 dB |
| Sensors type | Inductive |
| Sensitivity control | Auto - for 2D display «Route». Semi-automatic or manual (optional) - for the «Graphics». Automatic or manual (optional) - for the «2F» mode. |
| Determination the burial depth of the route | Automatically in «Route» mode 0…9,99 m |
| Laying 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 "TECHNO-AC" ("Pulse" mode) |
| Visual indication | Graphic display LCD display, 320x240 pix., with LED backlight |
| Induced parameters | -parameters of setting and control<br>- 2D visualization of the route location relative to the device<br>-graphics of the signal level from sensors<br>- route burial depth - signal current |
| Audio indication | Headphones:<br>-natural filtered sound |
| | Built-in transmitter - synthesized sound FM-sound indication of buttons pressing |
| Permissible impedance of the headphones | min.32 Ohm |
| Power source | 4…7 V (4 type C batteries) |
| 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 | 2,4 kg |

# Appendix 2
# Searching methods by AP-019.1

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

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

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

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

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

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

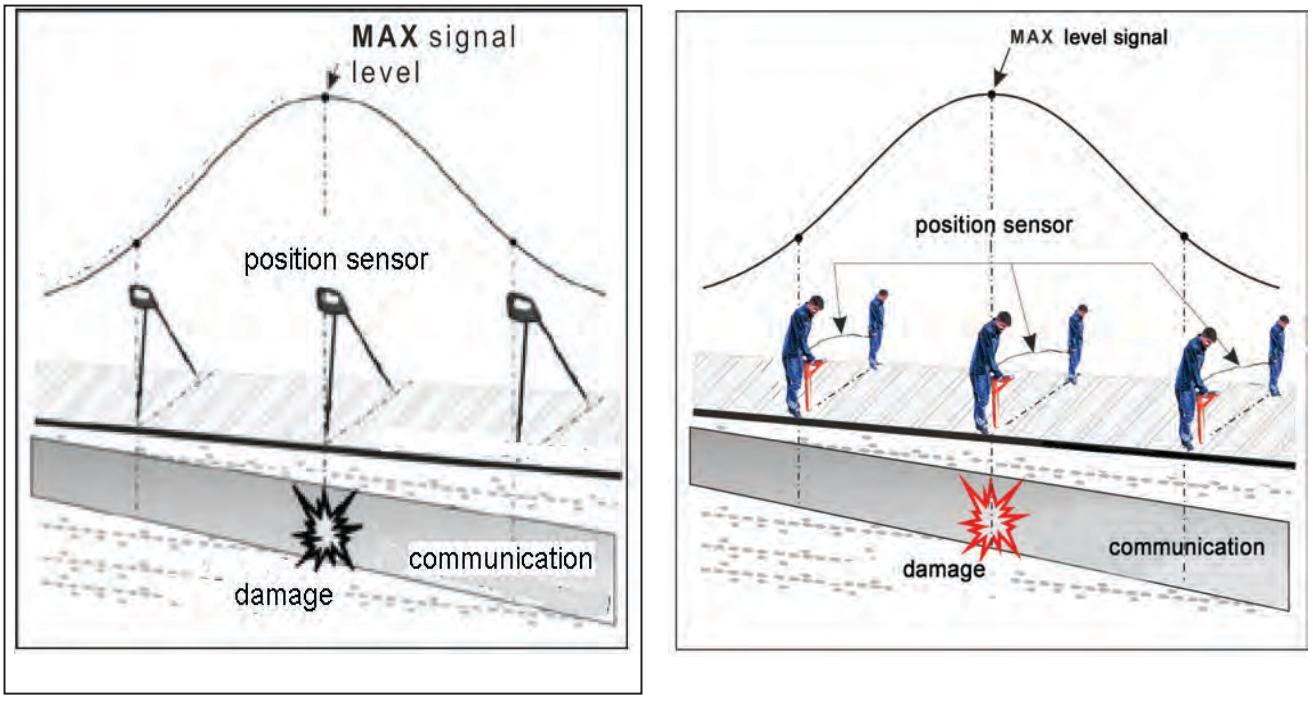



**Fig. A.1**

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

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

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

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

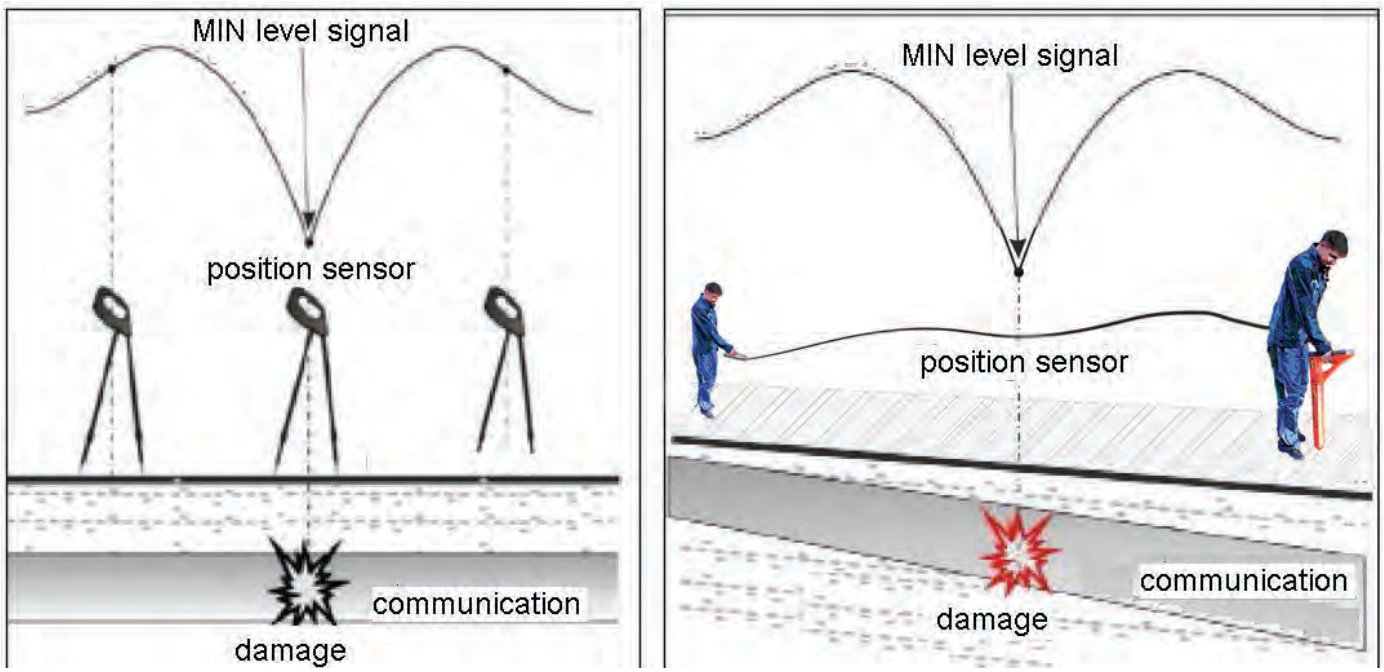


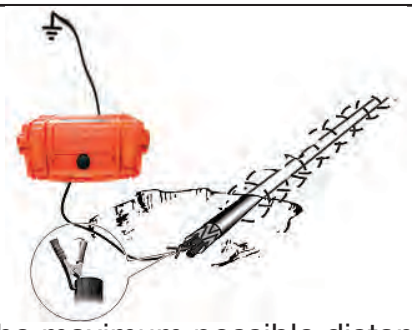

**Fig. A.2**

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

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

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

**Table 8**

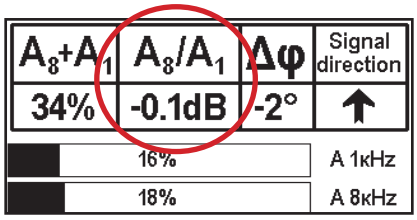


1. Exit output of the generator should be connected to the «start» of communication (more distant from the supposed place of the defect). The other output of the generator is grounded on the maximum possible distance from the communication. The «end» of the communication is not grounded.

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

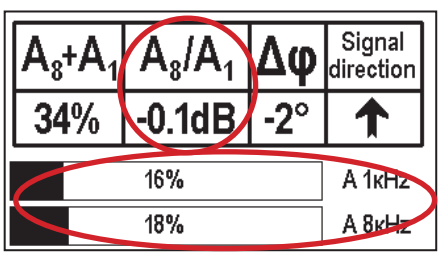
3. The defect localisation is performed in direction «from generator».

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




***Note***

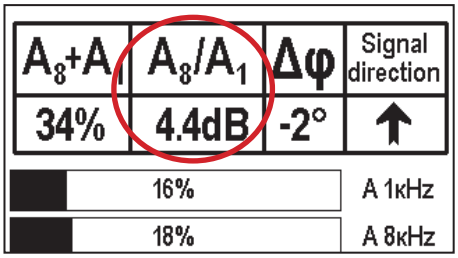
A8/A1 indication can have negative value. In such cases it recommended to reset indication periodically, using the button «▼».




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 «Δφ», the inscriptions «A8kHz» and «A1kHz» are correspondingly «darkening», and the value «X.XdB» disappears.

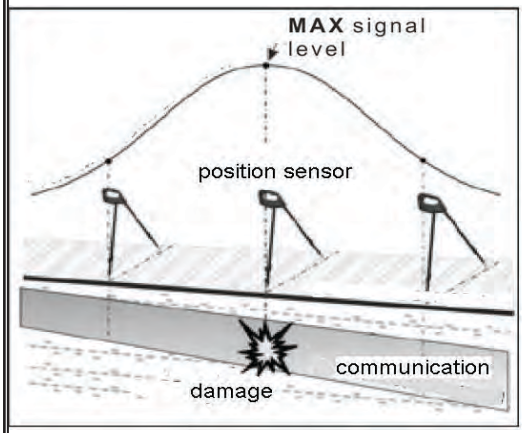
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, A8/A1 did not changed, it means that there are no damages on the surveyed site.

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




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

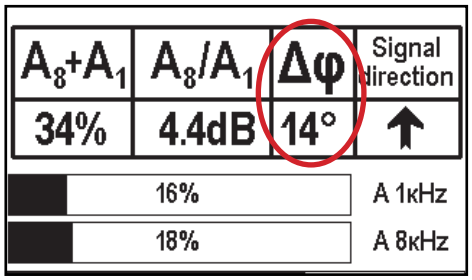
8. To validate the existance of the damage, use 2contact method, using. (the methodology in app. 2 of p.1.2)




## 4. Phase «two-frequency» method «Δφ»

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.

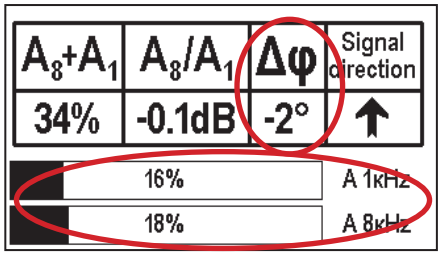
Steps 1-3 are similar to those in p.3.




4. «Δφ» shows - the change of the phase difference «φ1024 – φ8192», after the resetting (in degrees reduced to the frequency 1024 Hz). The value «Δφ» is sharply changes, when operator passes the place of leakage of the signaling current into the ground.

***Note***

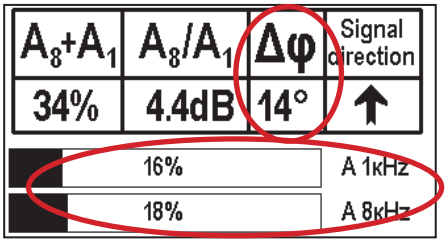
Δφ indication can be negative, «running» in the process of increase of distance from the generator. It is recommended to periodically reset such indications (exactly over the route), using the button «▼».




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 Δφ, the inscriptions A8kHz and A1kHz are correspondingly «darkening», and the value «$X^0$» disappears.

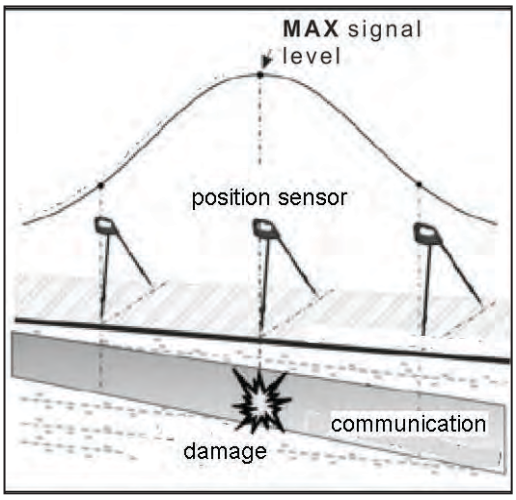
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, «Δφ» did not changed, it means that there are no damages on the surveyed site.

The sharp positive overfall of the «Δφ» value by $5^0$ and more indicates the possibility of defect existence (the resistance is less than 10 kOhm). The sensor should be located straight across the communication.




If you go through the same site in the opposite direction (towards the generator), holding the receiver the same as before with reset of the indication (using the button «  »), negative value of the reading (more than minus $5^0$) will mean that there is damage in the cable.

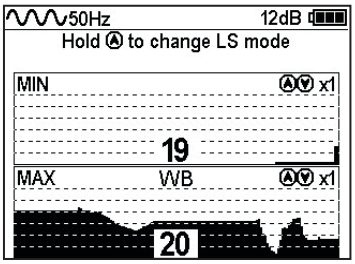
To validate the existence of the damage, use contact method, using. Append. 2 p.1,2)

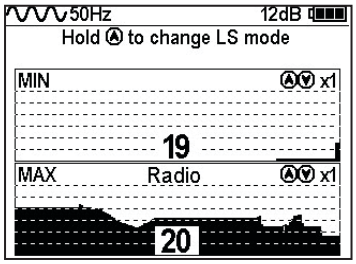


## Appendix 3

## Area survey before excavation works

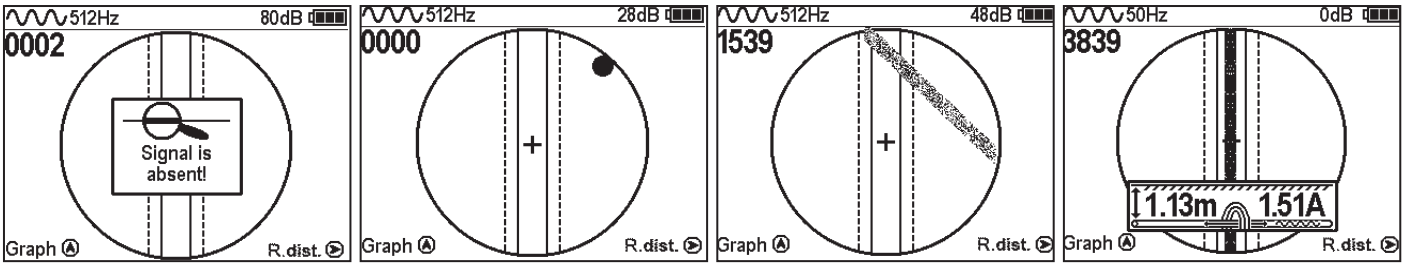
First of all the area should be surveyed with the receiver in passive mode, in order to locate the signal from energized power cables, pipes with cathodic protection or any other current providing utility. To do that, use the following frequencies consequently: 50 Hz, 100 Hz , Radio and Broadband mode.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



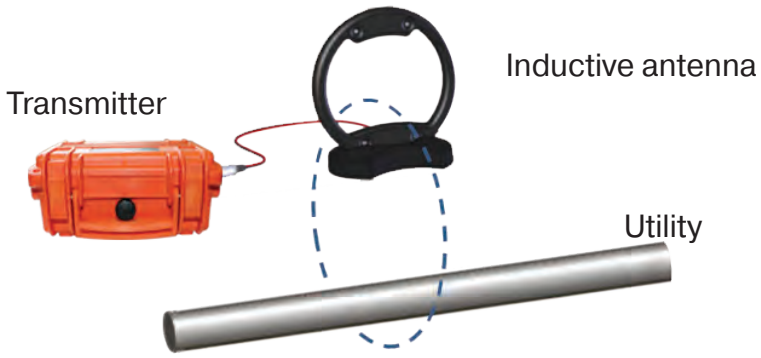




In this case the operator should rely on “MAX” scale.

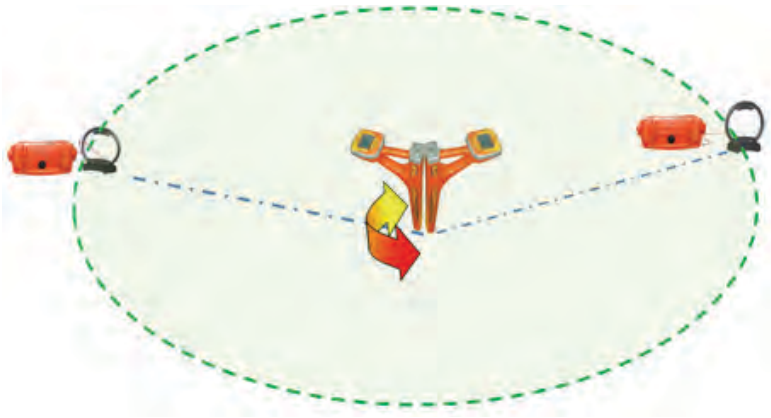
At 50 a 100Hz frequencies in Route mode the signal strength will increase as you are moving to the utility. Following indication should appear on the screen while performing these actions:




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.

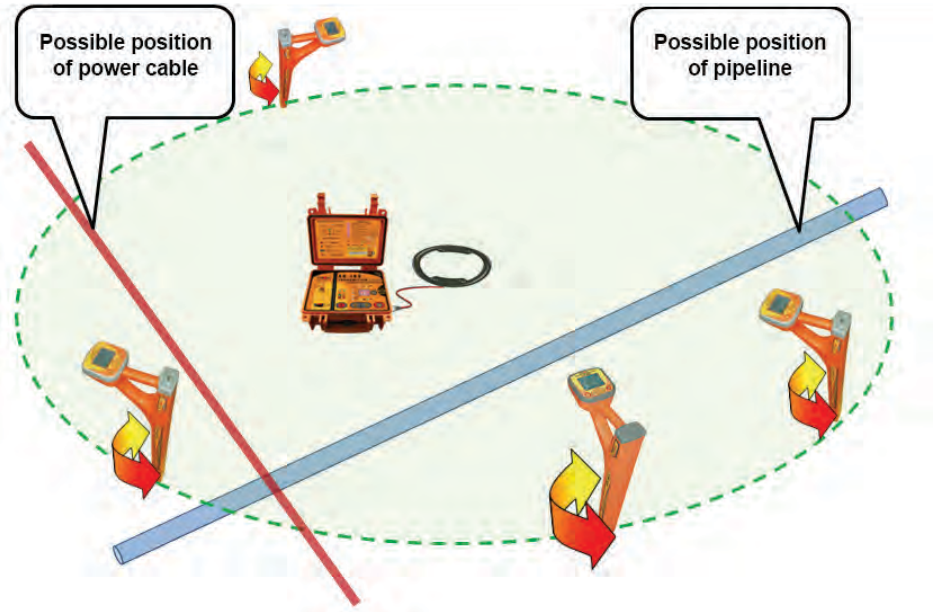


If there is no utility in center point of the area, then start the general location routine described below.

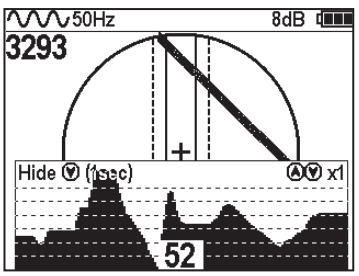
When surveying the area in active mode, it is necessary to place. IEM-301.5 antenna horizontally in the center of the plot (you can remove the antenna from its stand). In this position the antenna will be in the flatness parallel to all surrounding utilities in the area.

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

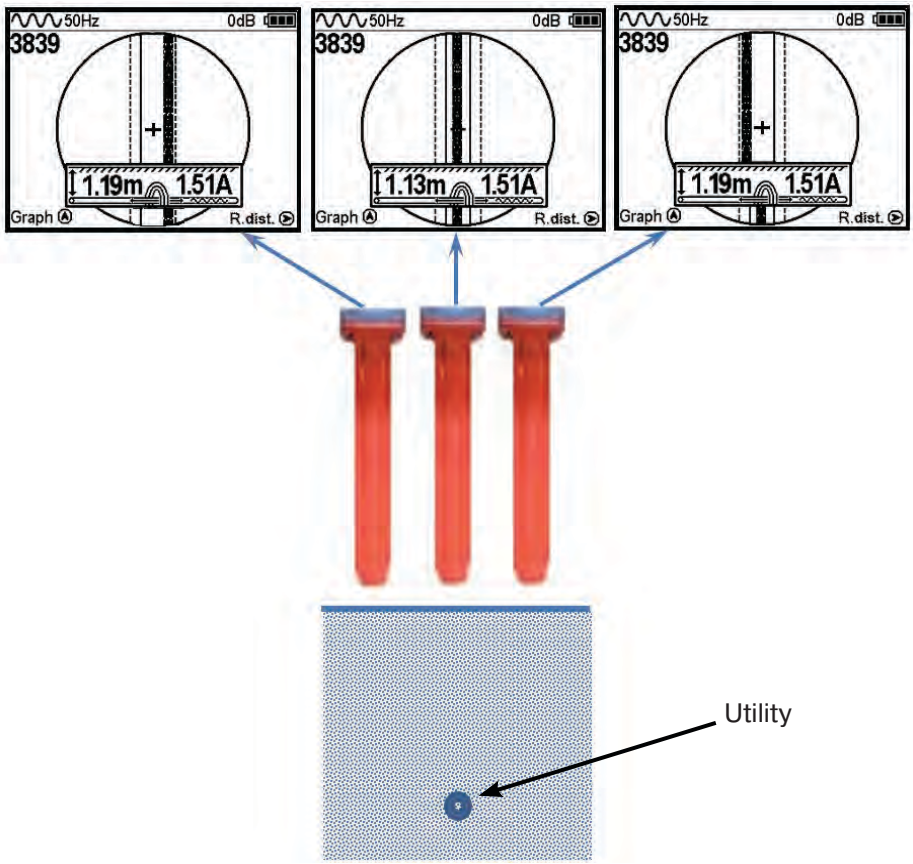
***External influence during receiver operation***

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.

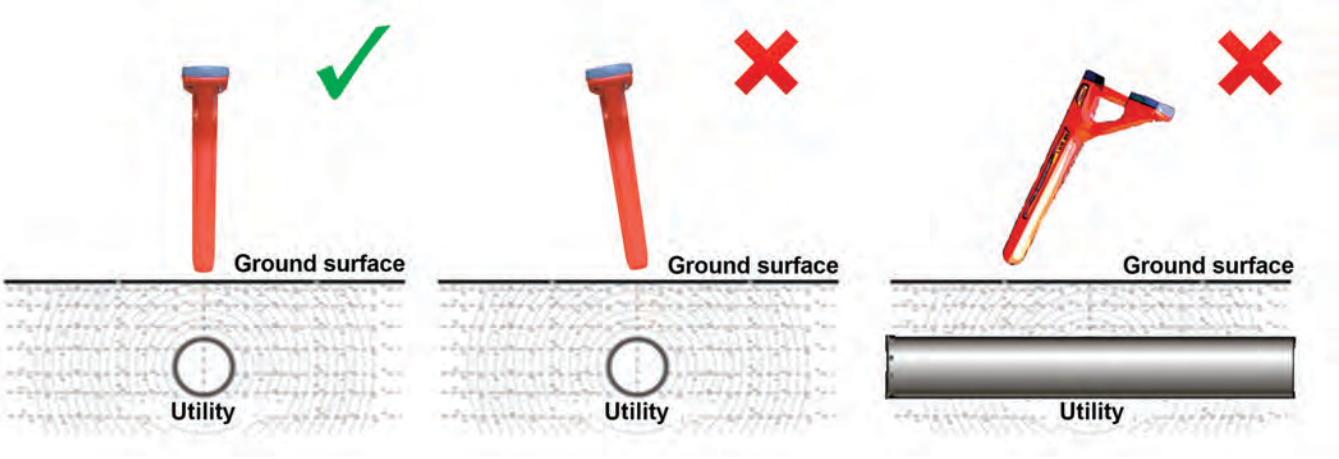
***Specialties of utility depth measurements***

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.