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TECHNICAL DESCRIPTION
OPERATION INSTRUCTIONS

# CABLE AND PIPE LOCATOR SUCCESS AG-319N

## Table Page of Contents

# Introduction

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

## Intended use

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

## Operation conditions

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

## Receiver working principle

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

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

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

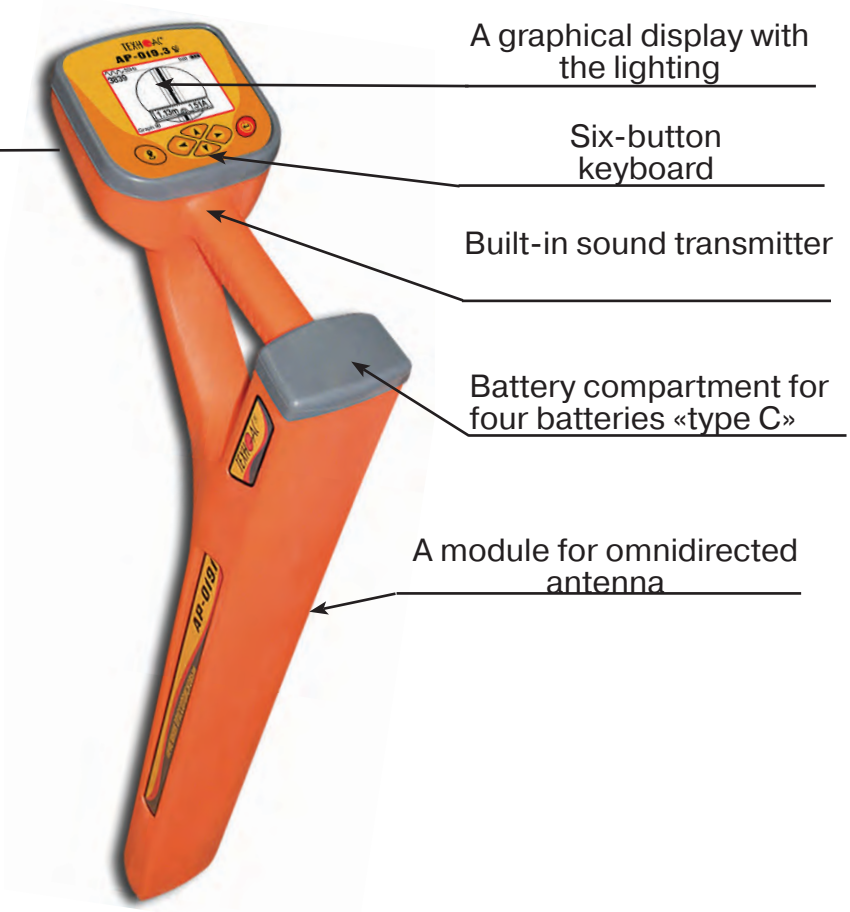
Cable or pipeline may be the load for generator. The transmitter can be connected to the load either directly (with connecting wires) or with the use of the inductive antenna or inductive clamp providing for contactless (inductive) connection of the utility under examination.

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

# 1. Appearance, 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



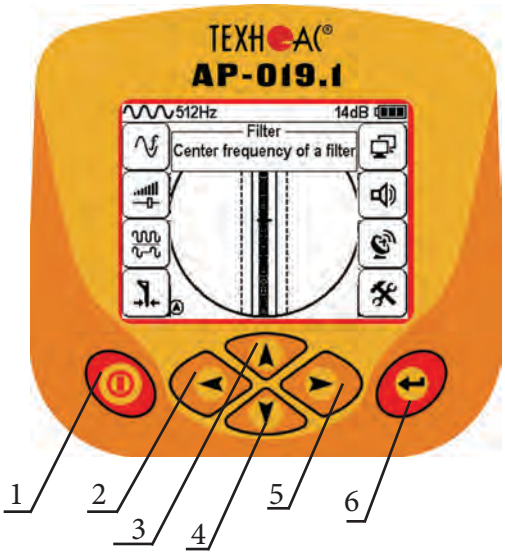

Connection of external sensors.

**Sensor DKI-117**

**Sensor DODK-117**

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

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



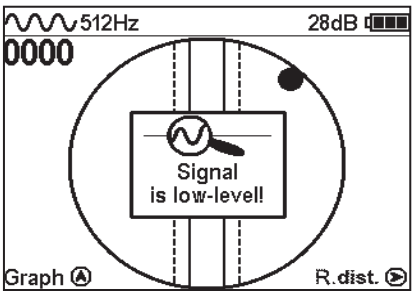

## Face panel, controls

| | |
|---|---|
|  | «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 |

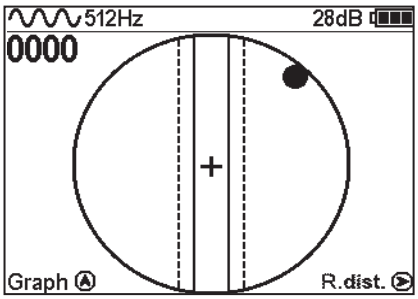
# 2. OPERATING MODES

## 2.1 “Route” mode

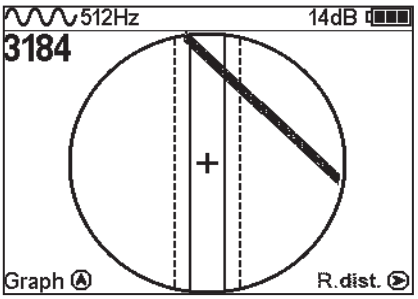
When turning on the receiver for the first time, the device will begin in route mode and the service information will appear. Route mode is the primary screen. Below, the indications are shown, which are dependent on the operator position near the located utility.



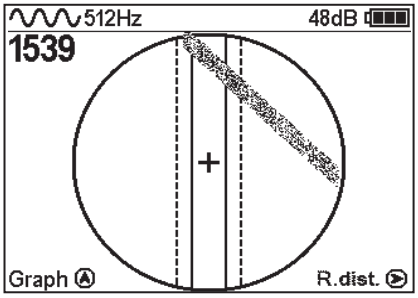

The receiver can’t detect the utility.



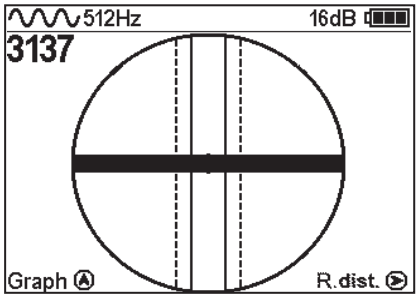

The ball on the screen shows the direction in which utility is located.



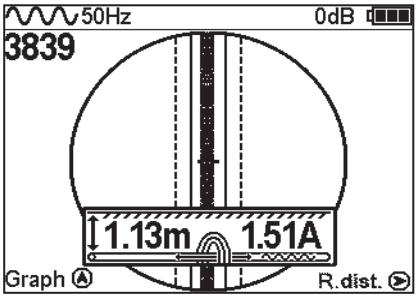

Position of utility axis shows, where the utility is situated.




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

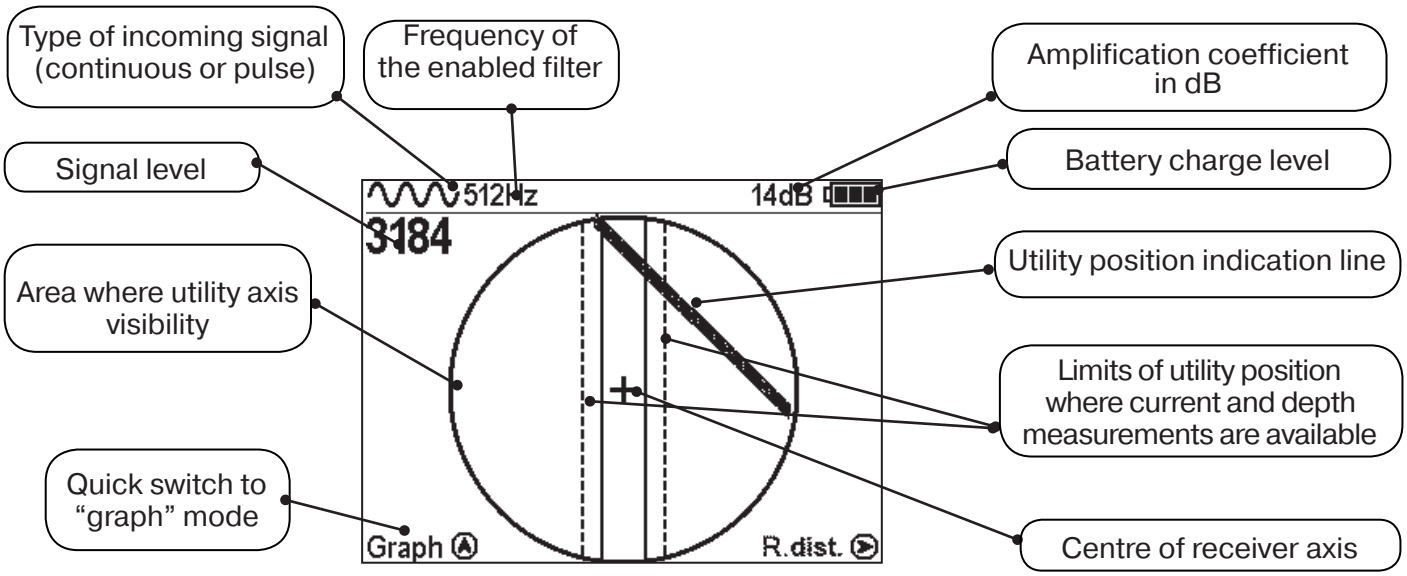



When above the utility, a solid line will appear which is perpendicular to the utility’s direction.




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

### Route Mode Description

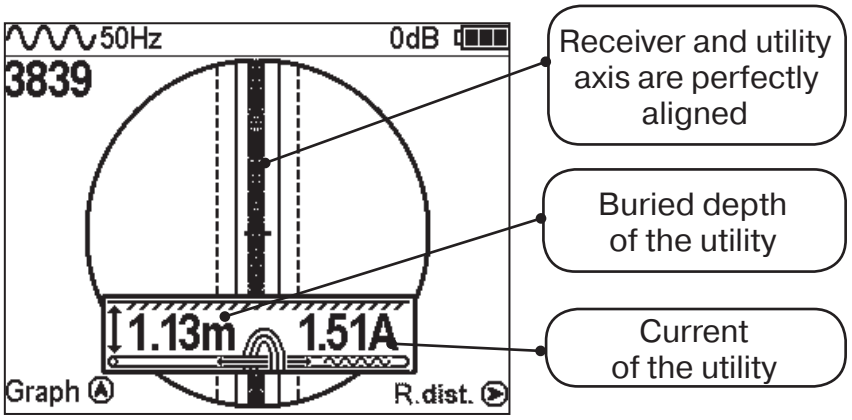



* The four-digit number “signal level” (0000 - 4100) represents the intensity of the electromagnetic field, which is dependent on the filter frequency. The numeric value of the “signal level” becomes greater when an operator approaches the source of electromagnetic signal of the chosen frequency. The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

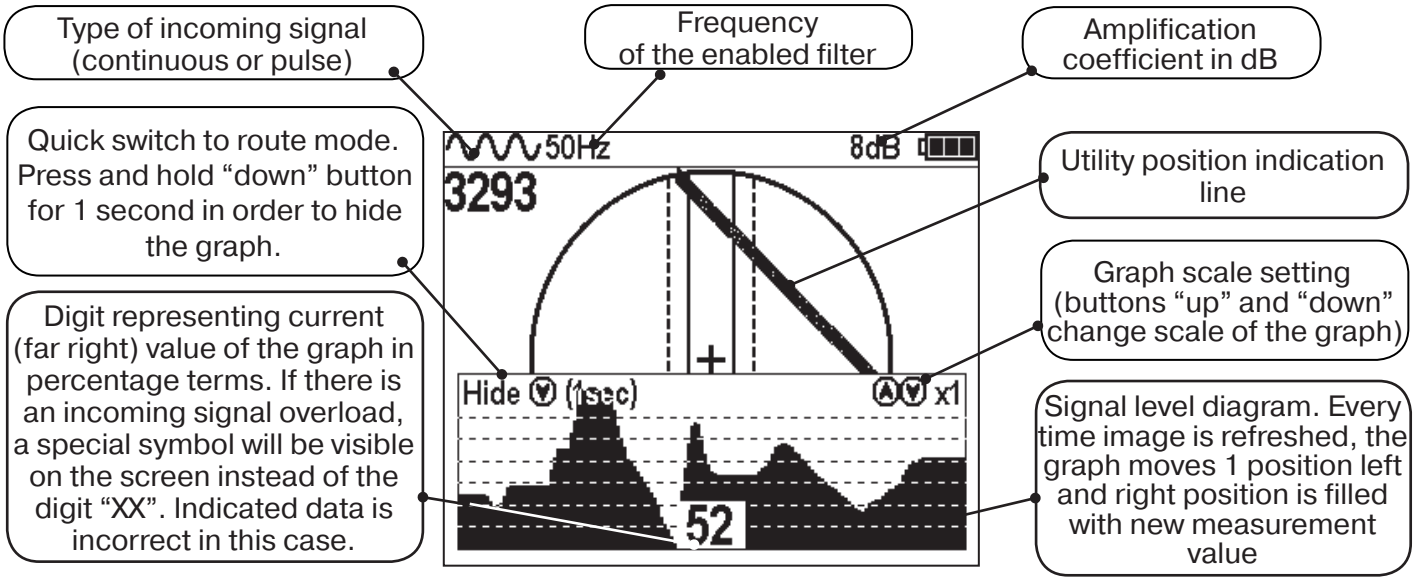
When the operator stands strictly above the utility and the line indicating the utility is positioned strictly in the centre field between the two dotted lines, an automatic depth and current measurement is performed.

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



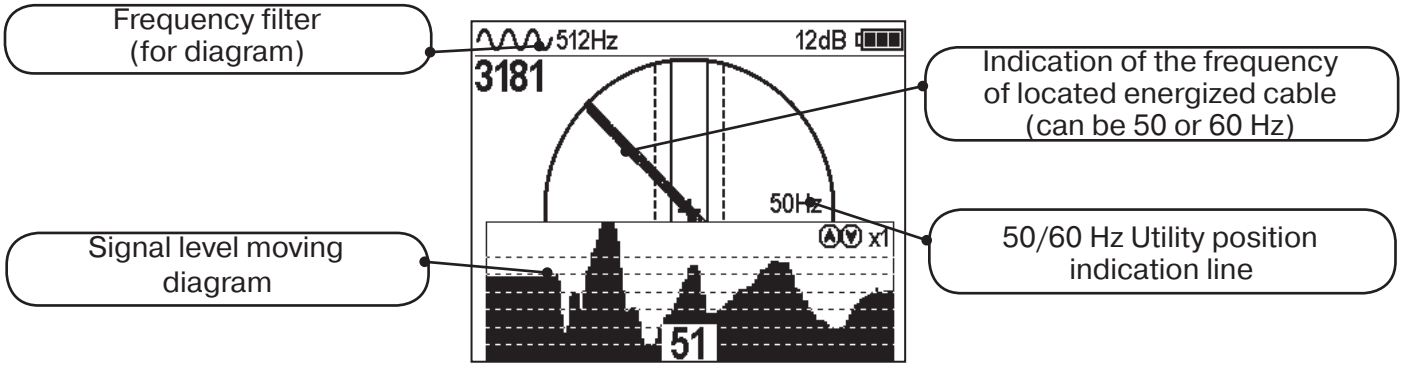

## 2.2 Graphic Mode

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.

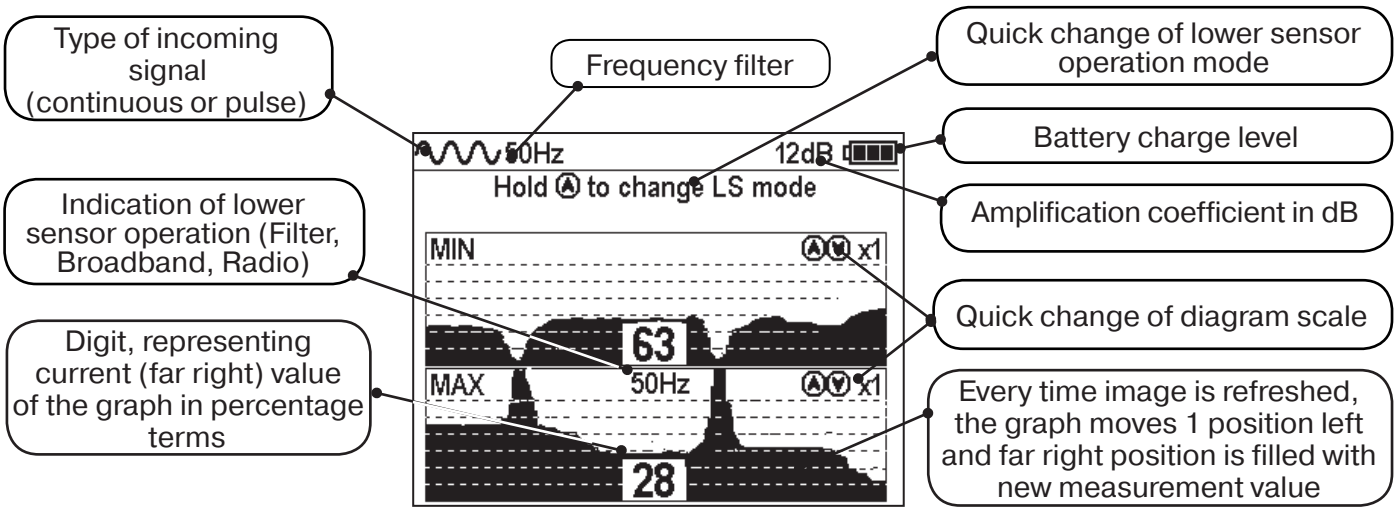


## 2.4 “Minimum maximum”

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.

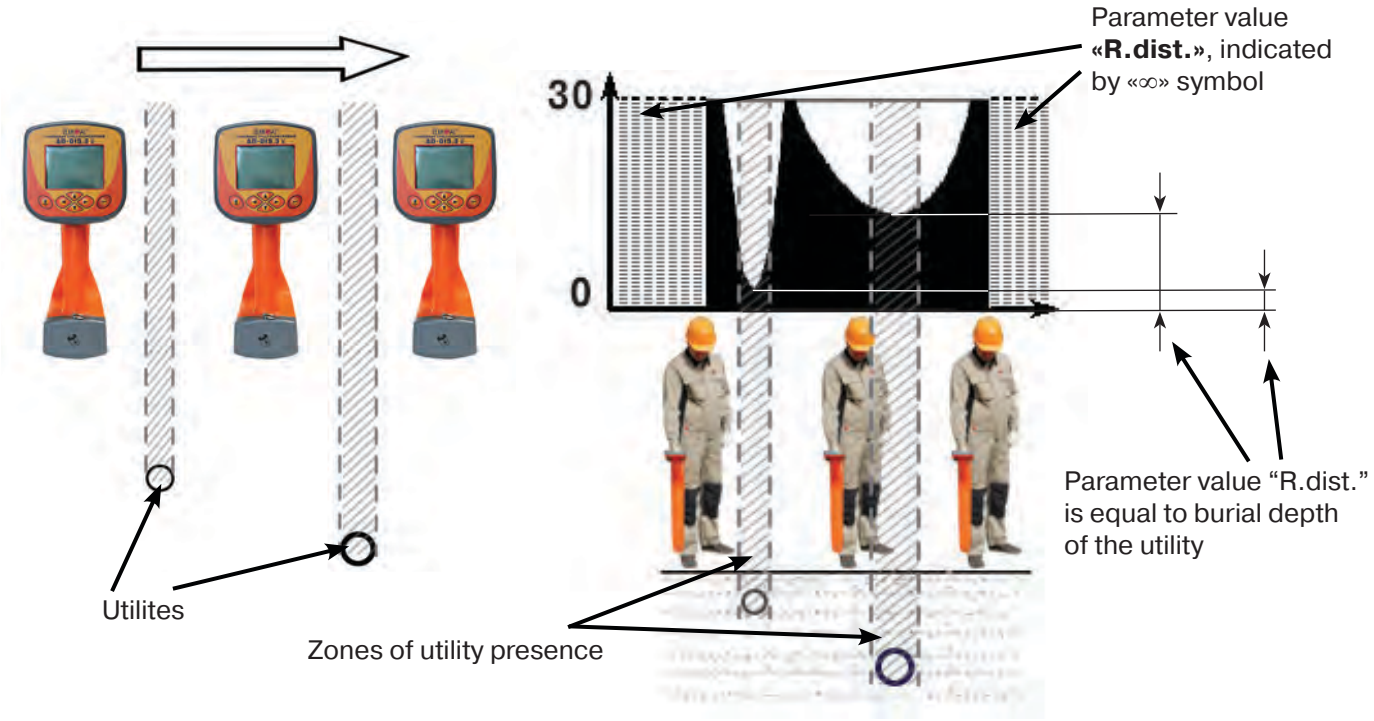
This mode does not allow depth and current measurements.



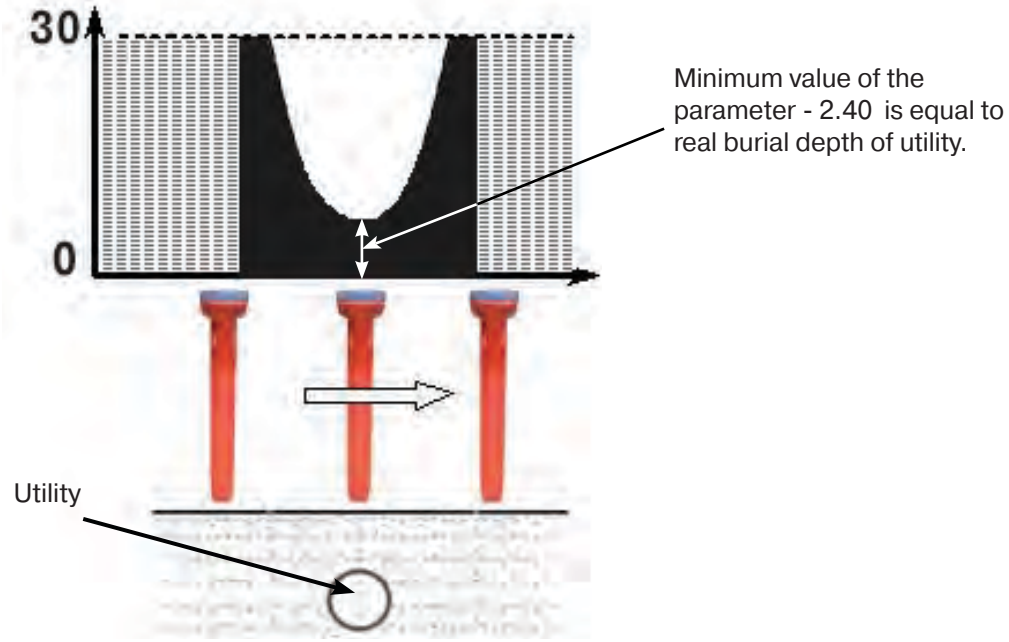

## 2.5 Modes with Graphic Representation of “Relative distance to the Utility” (R.dist.)

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.



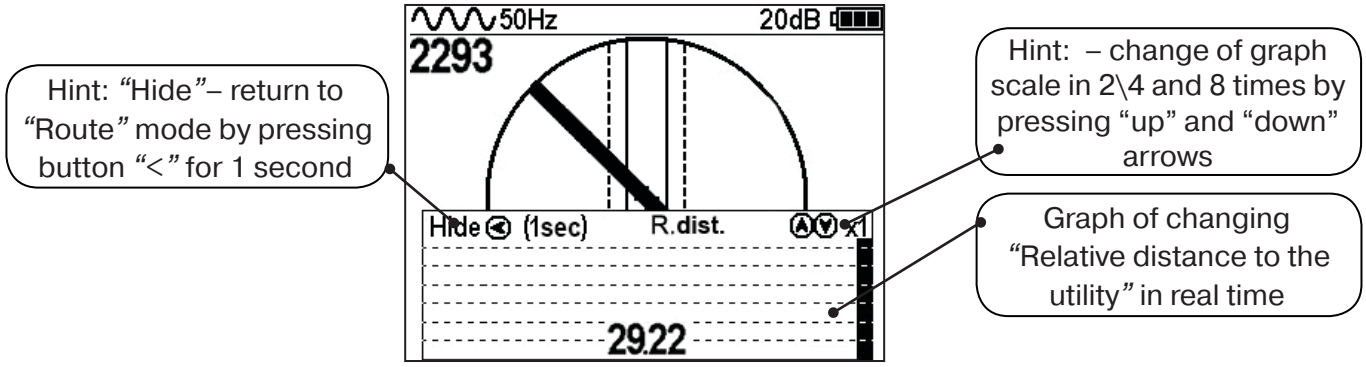

The receiver has two modes with indication of “relative distance to the utility”: **“R.dis. Graph”** is used when the “relative distance to the utility” graph and utility route are indicated simultaneously, whilst the **“MIN&R.Dist mode“** is used when screen of the receiver indicates 2 graphs (minimal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

## 2.5.1 “R.dis. Graph” mode

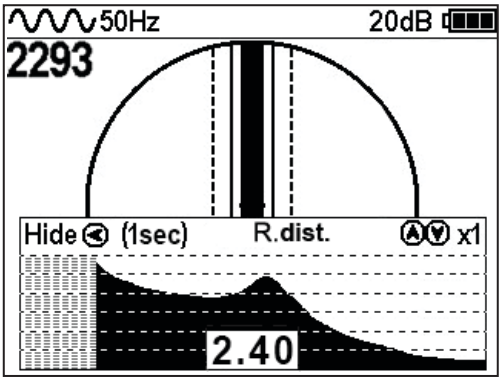
This mode is the same as “Graph” mode. The screen is split in two parts, an upper display and a lower display.

- 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:

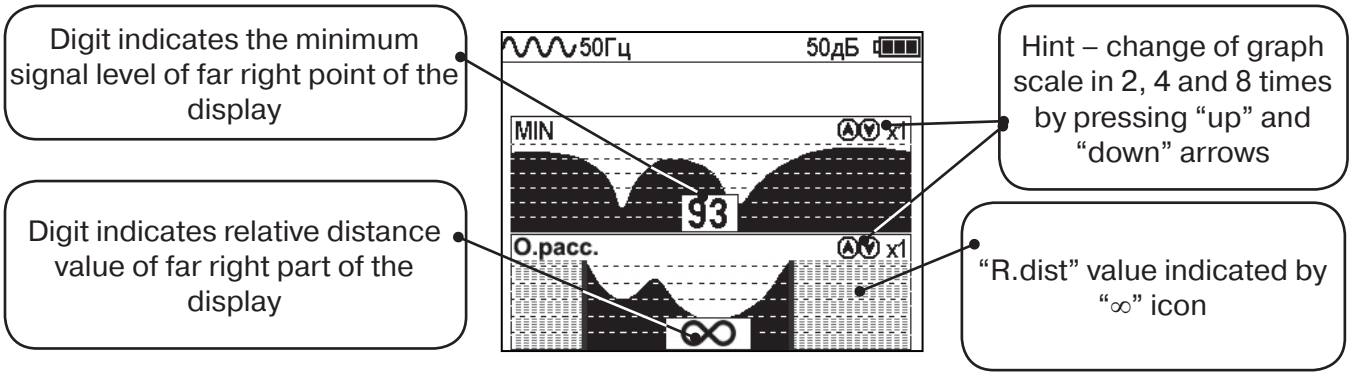



Minimal values of “relative distance to the utility” indicate the presence of the utility with some fault because in the case of multiple utilities laying nearby, minimum signal point may move due to coinfluence of the signals.

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

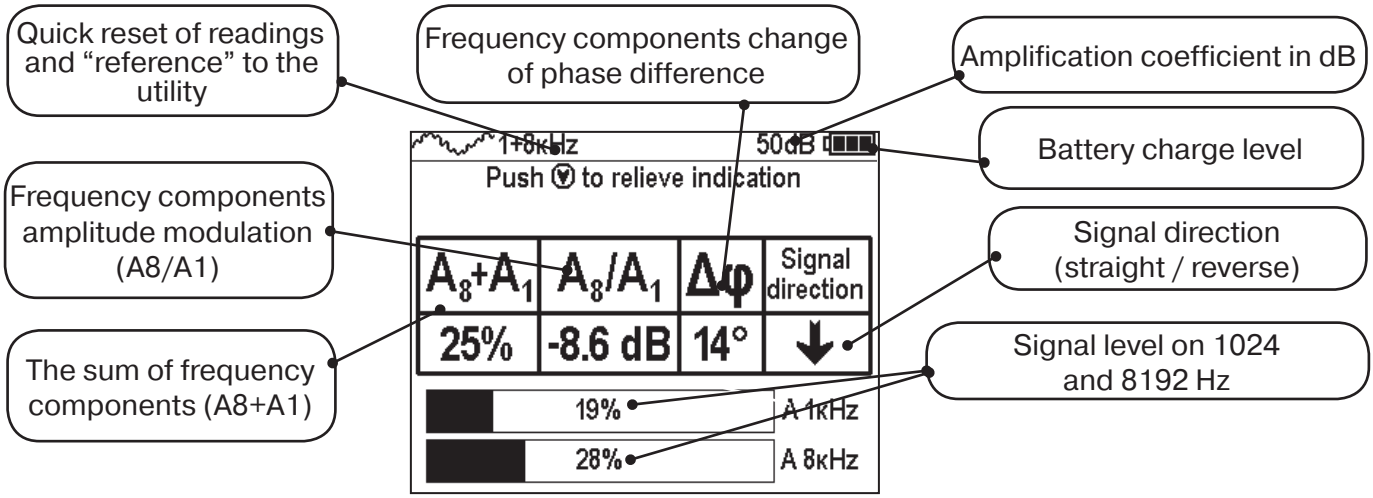
In this mode the screen is split in two parts. Upper part: Minimal signal graph, lower part: “relative distance to the utility” graph in real time.




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.

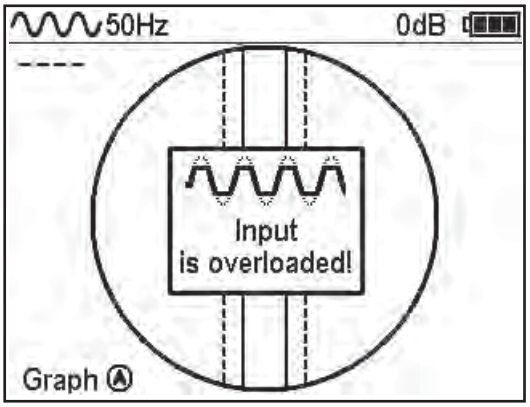


**IMPORTANT NOTE:**

**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

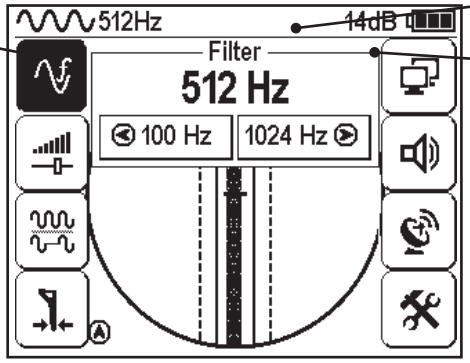
## 3.1 Receiver switching on and menu call

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

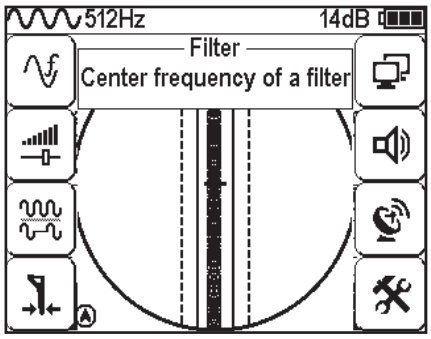



menu option name

brief menu option description

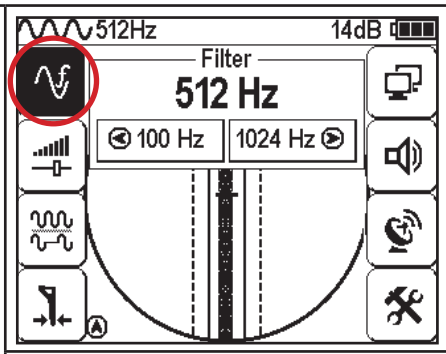
## 3.3 Menu parameter selection

To open the menu press «Enter».



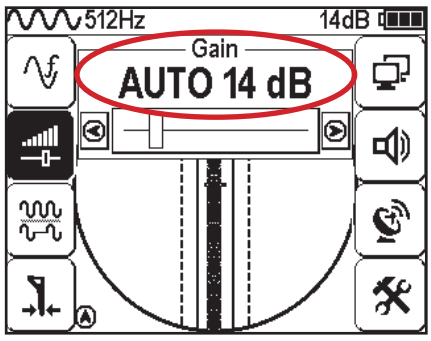

The menu will appear on the screen.

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.

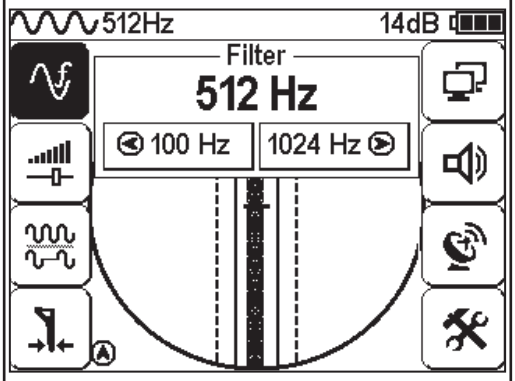
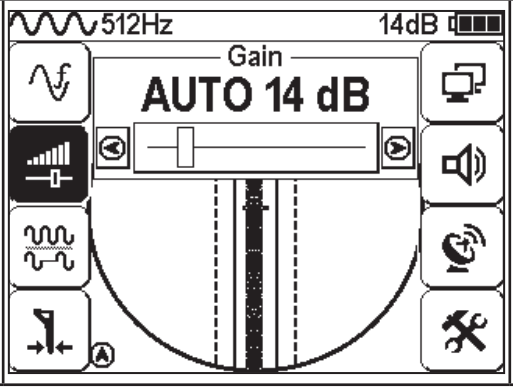
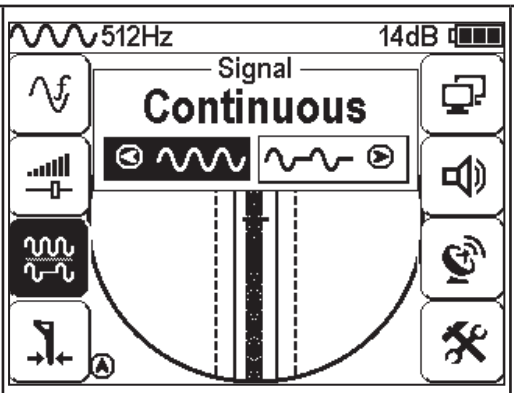
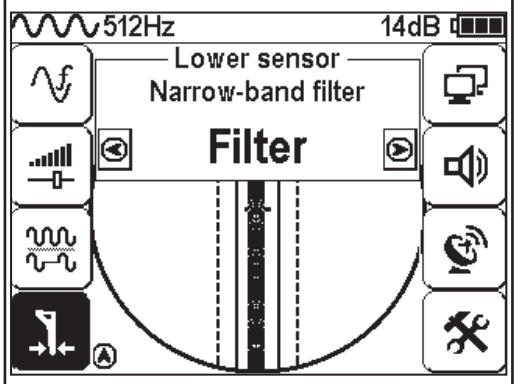
**The changed value is immediately applied.**

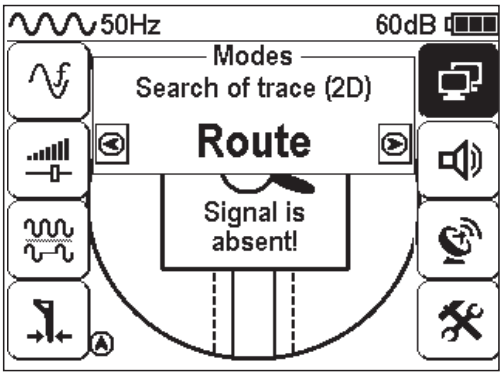
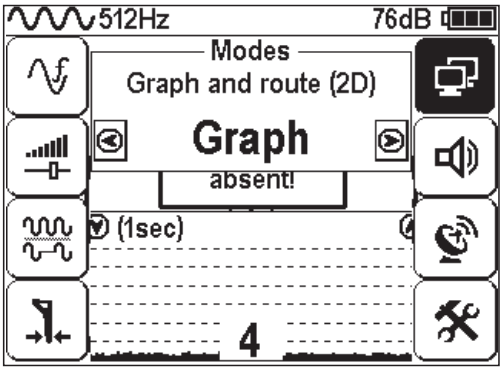
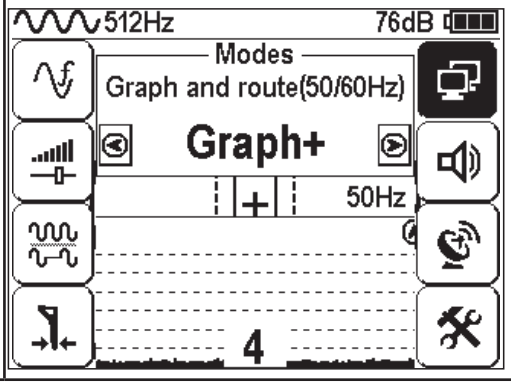
To exit the menu to the general menu or transfer to the set mode with the closing of the menu, you should press the button «Enter».
If you wait for several seconds, menu icons will disappear.

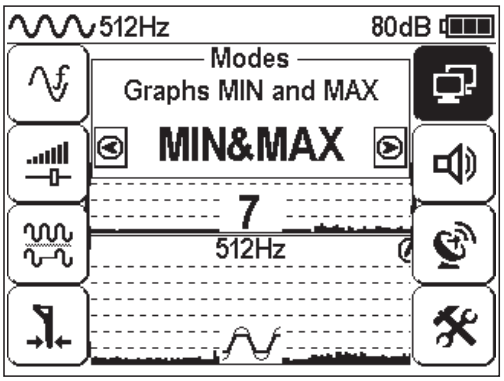
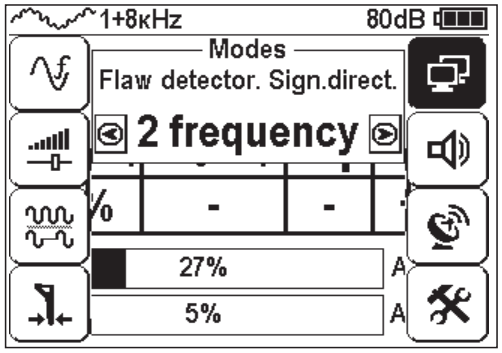
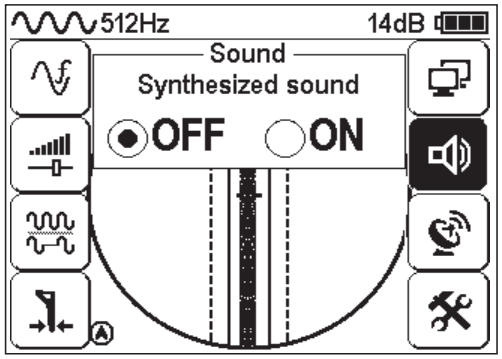
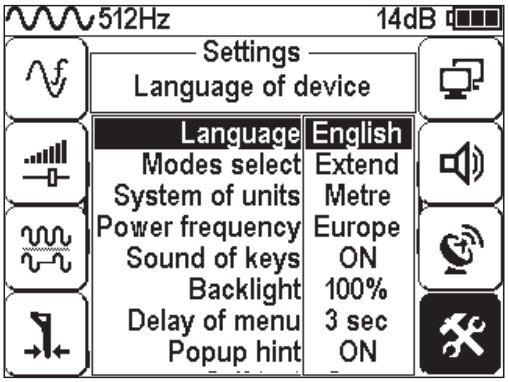
**If you don't press any buttons for a period of time, the menu will disappear automatically. The length os this period is set in the corresponding menu option (see Table 1. p.6)**

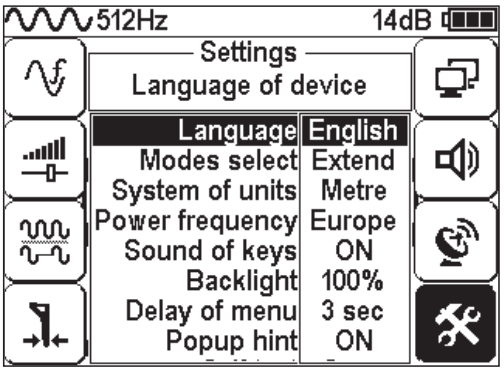
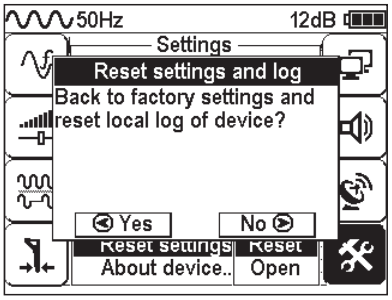
Thirteen items of menu contain parameters of setting, which are opened in the panel located in the upper part of the indicator.

**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><br>Language — <Russian/English><br>Locale of the device<br><br>System of units — <Meter/Foot><br>Measurement system: metrical or imperial<br><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.

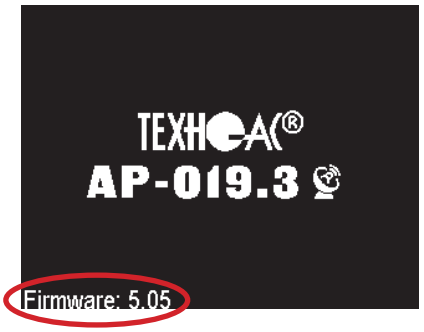

Install the batteries, observing the polarity

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

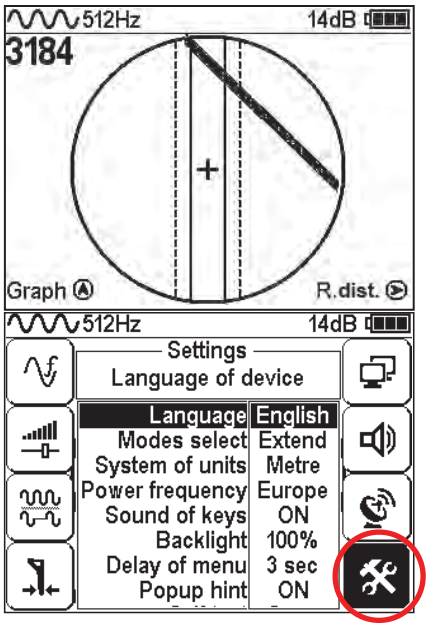
## Receiver switching

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

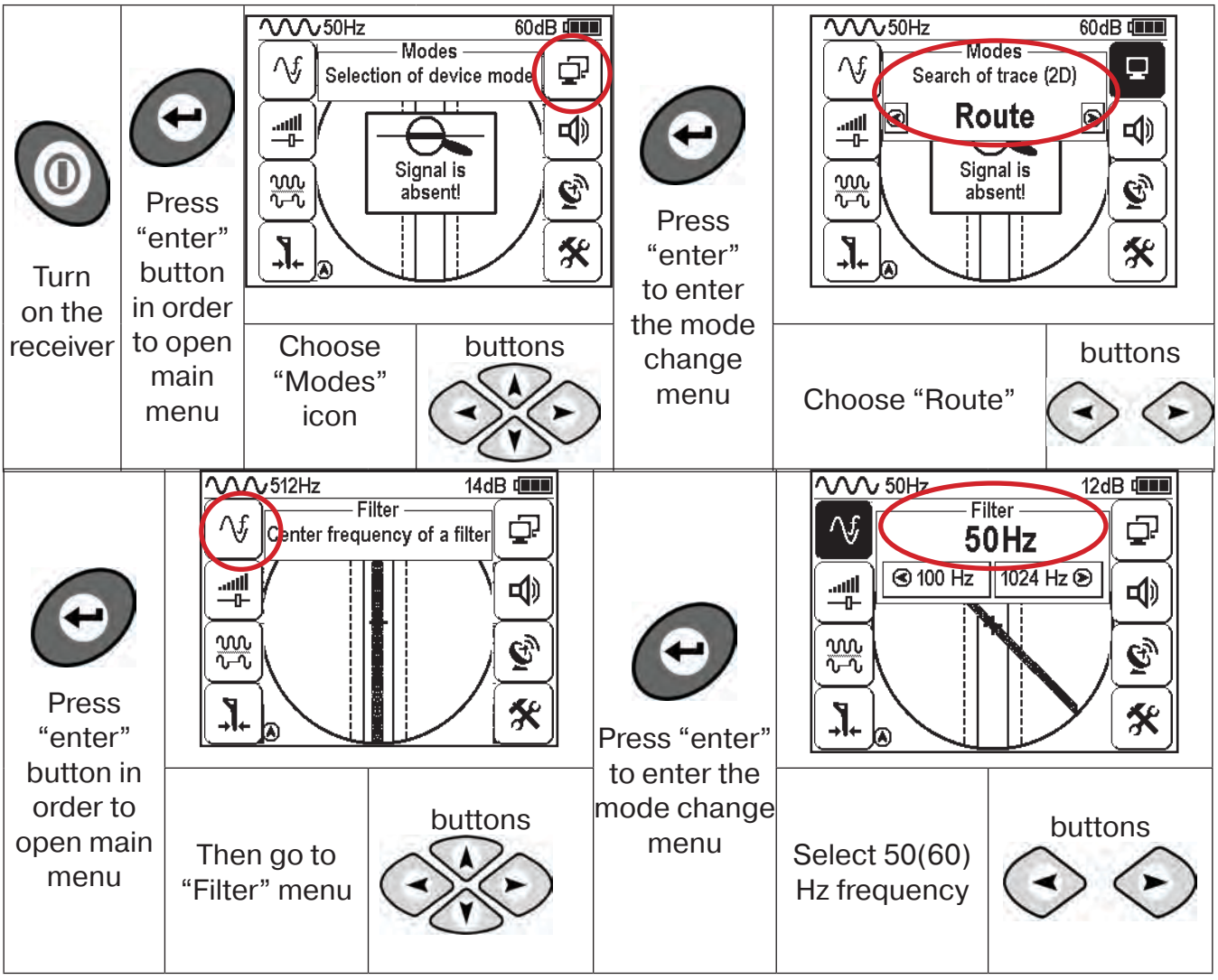
Route mode is the main mode for route location of various utilities (cables & pipelines) at all supported frequencies, both in “passive” cable route location and at the “active” (with the use of the route locating generator). In passive mode, the cable location is carried out at frequencies of 50(60)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

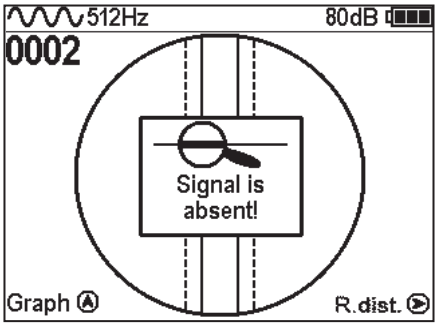


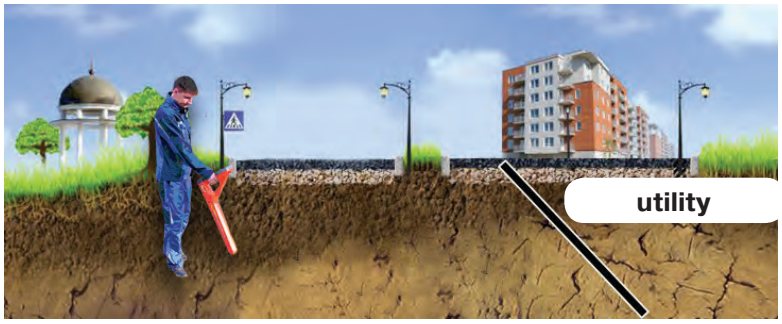

When filter 50(60)Hz is chosen, the type of incoming signal is automatically set to continuous.

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

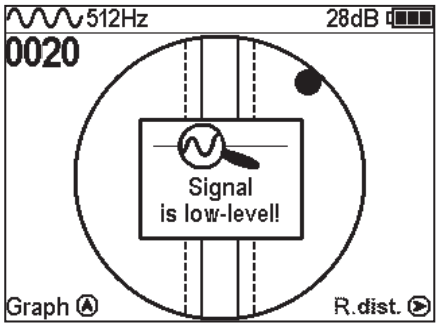
1. Come to the supposed place of the utility under the voltage or induced voltage in frequency 50(60)Hz.

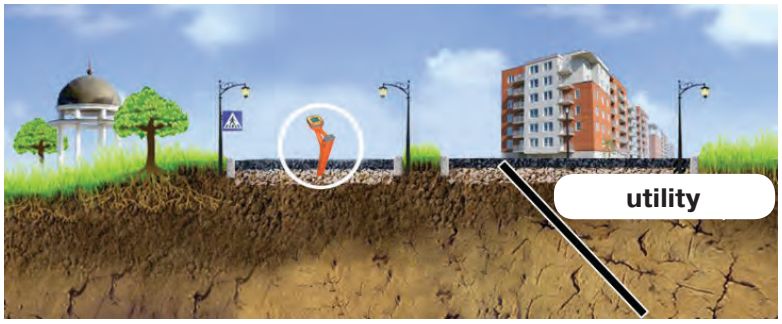
2. If the utility is far from the operator, you will see on the screen:



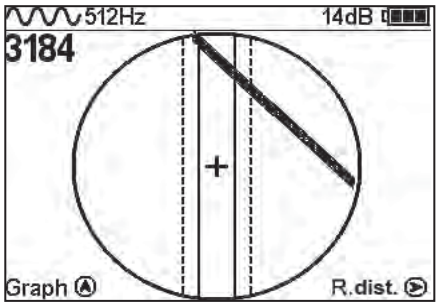




3. When moving towards the supposed place of the utility location, the “ball” will appear on the screen. It shows the presence of a utility and that it is a significant distance from the operator.



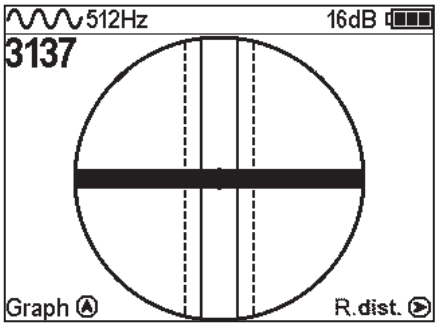




4. The “ball” position shows the direction of the utility relative to the operator.





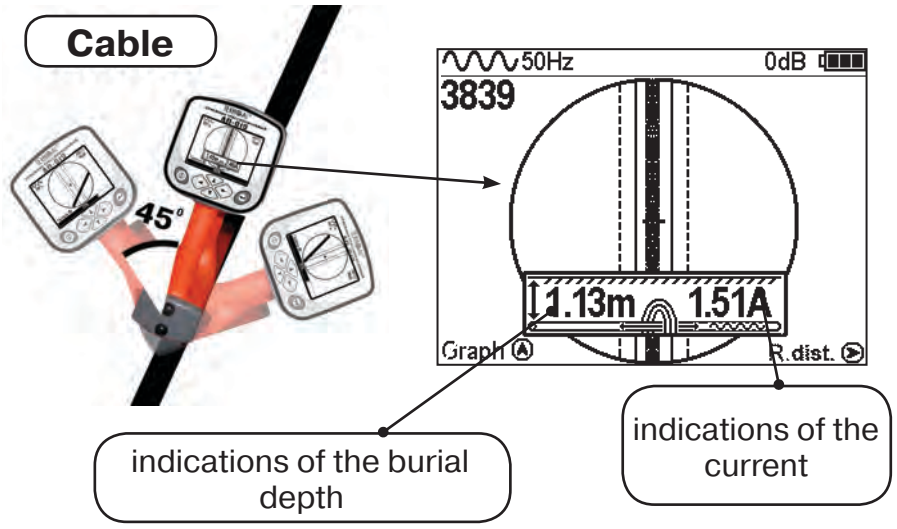
5. When the operator moves closer to the utility, the axis will move to the centre of the circle. This means that the operator is standing directly over the utility




## 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.

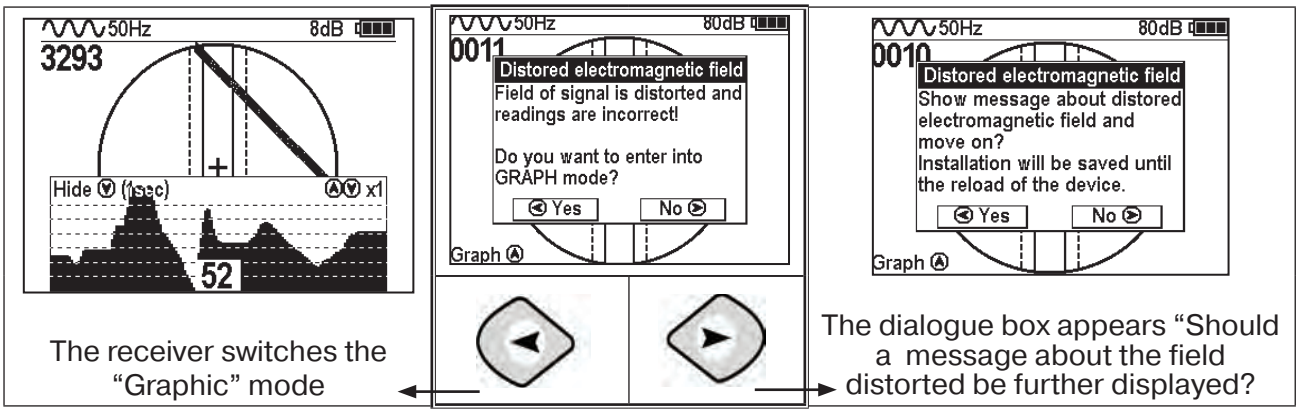
In this position, it is possible to move forward and trace a whole cable).




**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.

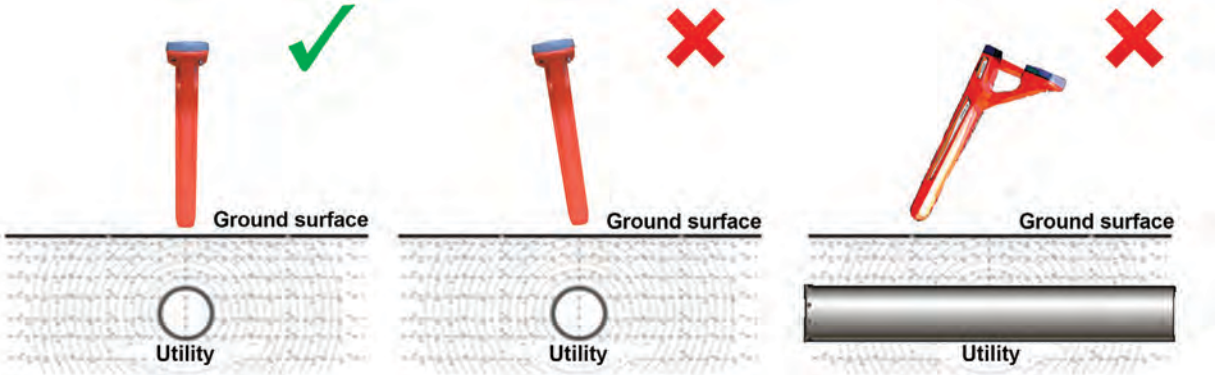
If the communication axis cannot be located exactly in the limited area, and the periodical jumps are happening from one border to the other, it indicates the presence of several cables under voltage with the 50 Hz frequency. You can specify number and position of the cables in "Graphic" mode.




**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.

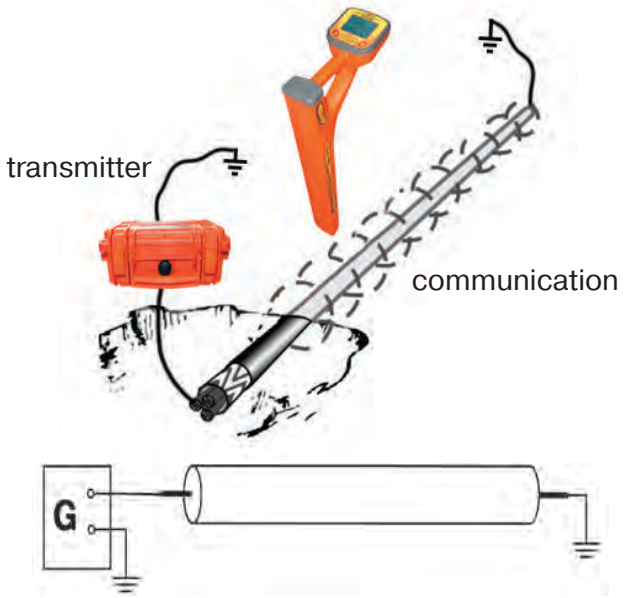
Note

**Transmitter Connection**

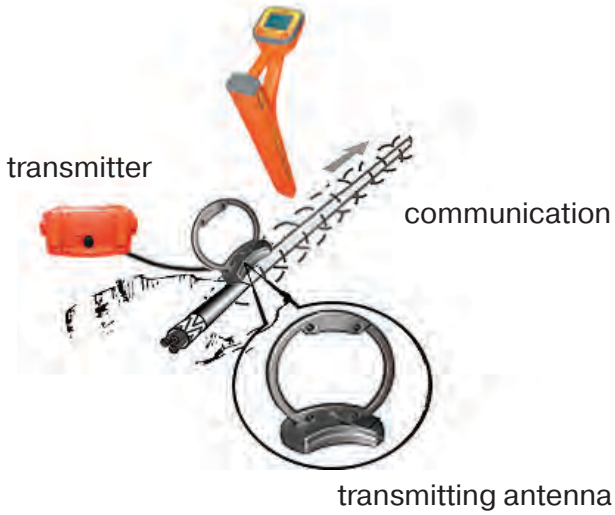
**Contact mode**
The generator output is connected directly to the communication

**Contactless method**
using the transmitting antenna

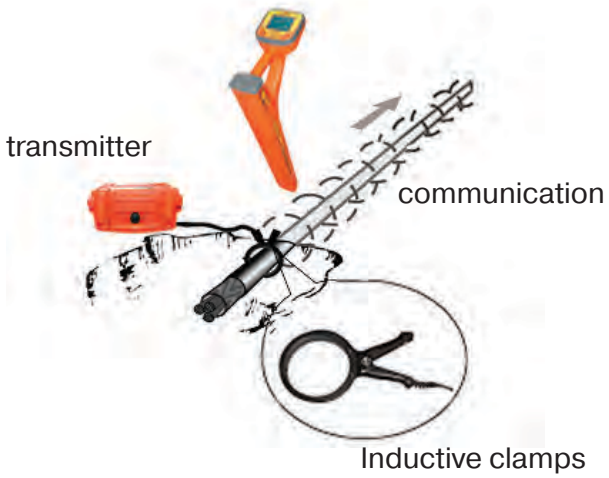
Note




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



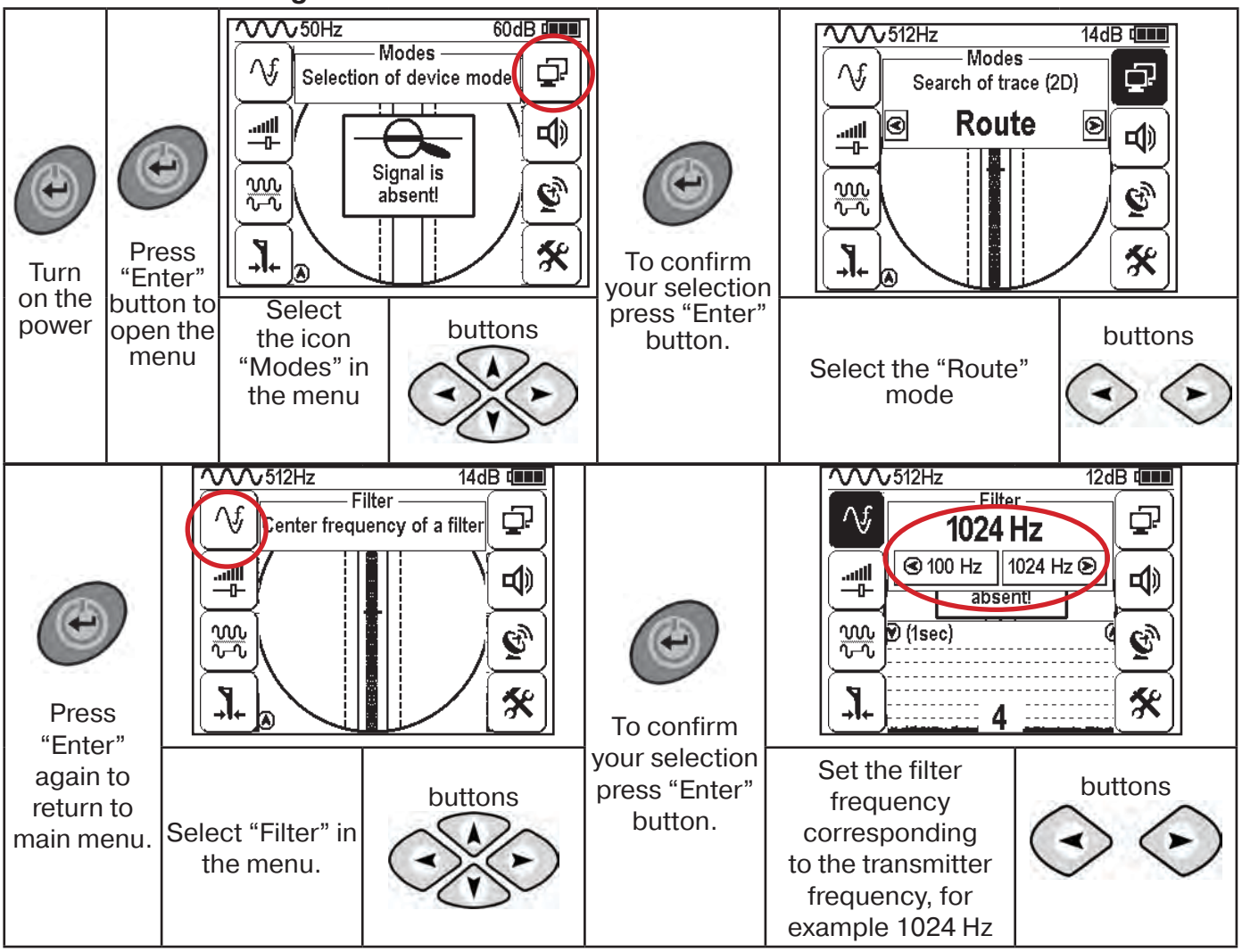

**Contactless method**
using the induction clamps

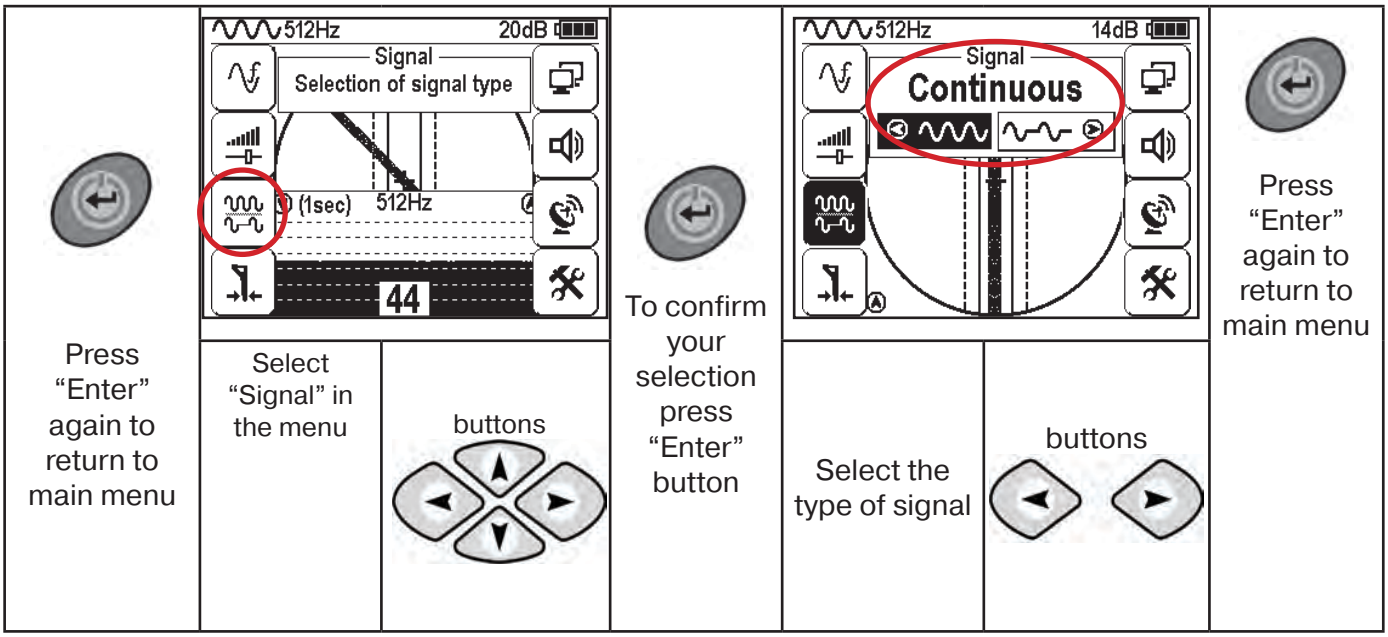


## Procedure for search of communication and conduction of cable route location

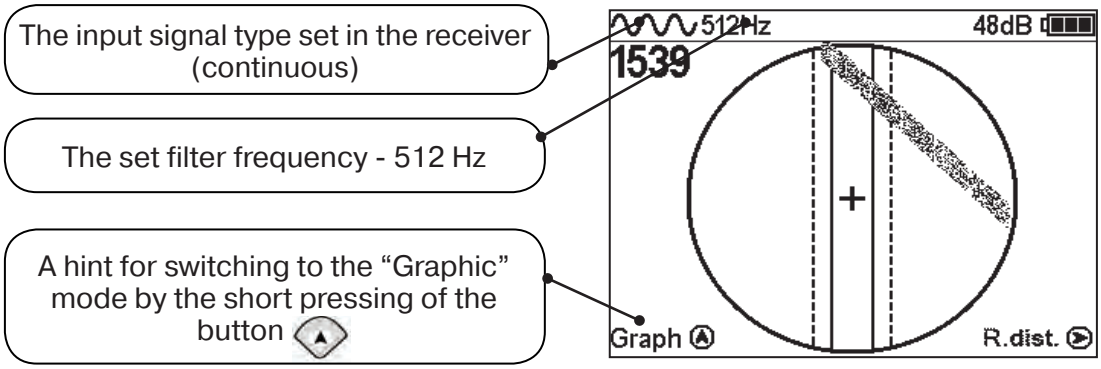
| | |
|---|---|
| 1. Connect the transmitter to the utility by contact or contactless method.<br>**Note** When possible, the preference should be given to the contact method of connection, which allows the user to perform the cable route location for more distantly. | 2. Turn on the transmitter. Set 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.**

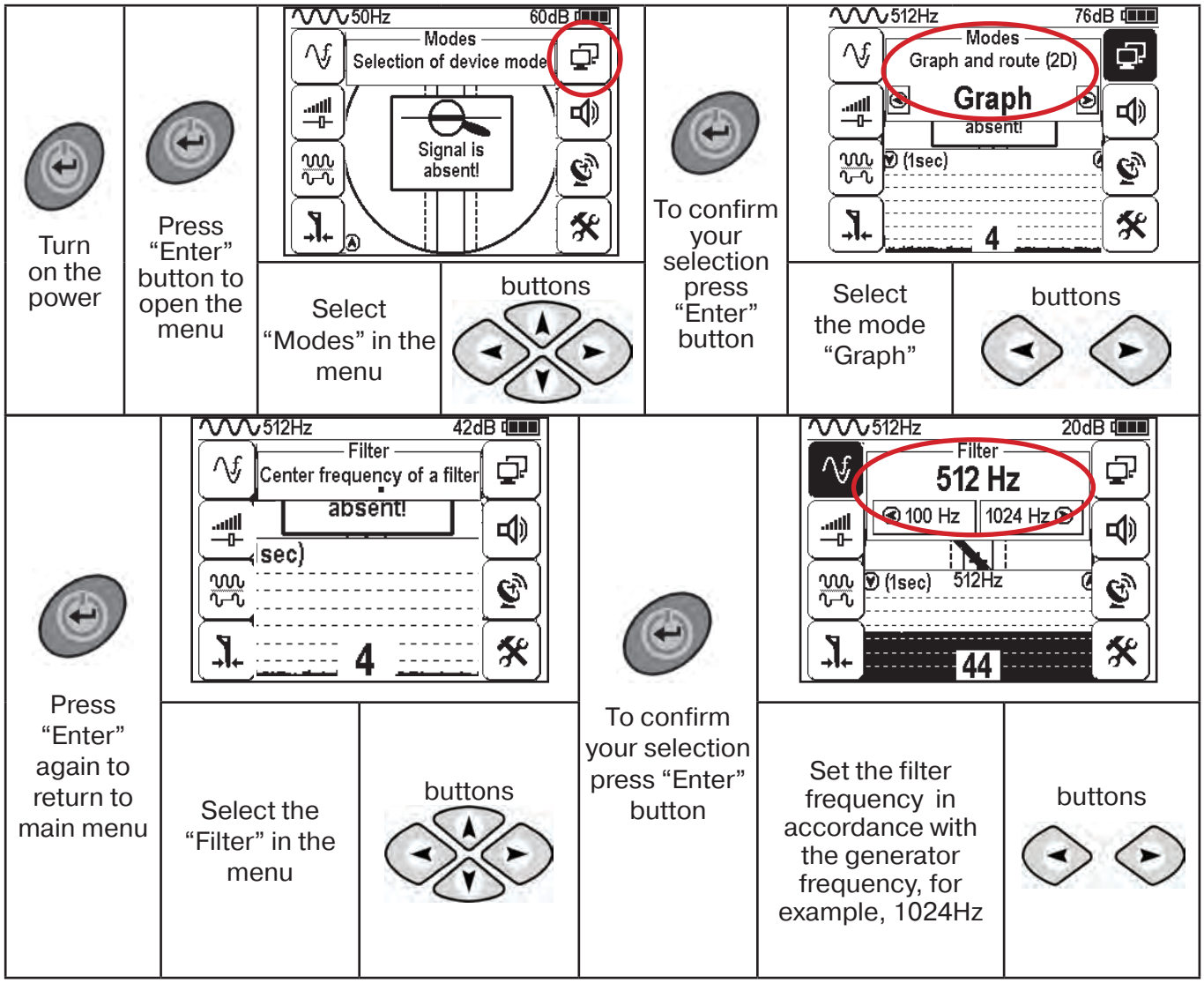
When working in the "Route" mode, the following can sometimes occur:
- the positioning of the utility axis into the centre is impossible
- the presence of several near located communications
- low signal in the cable

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

# 6. Search of Utilities in “Graph” Mode

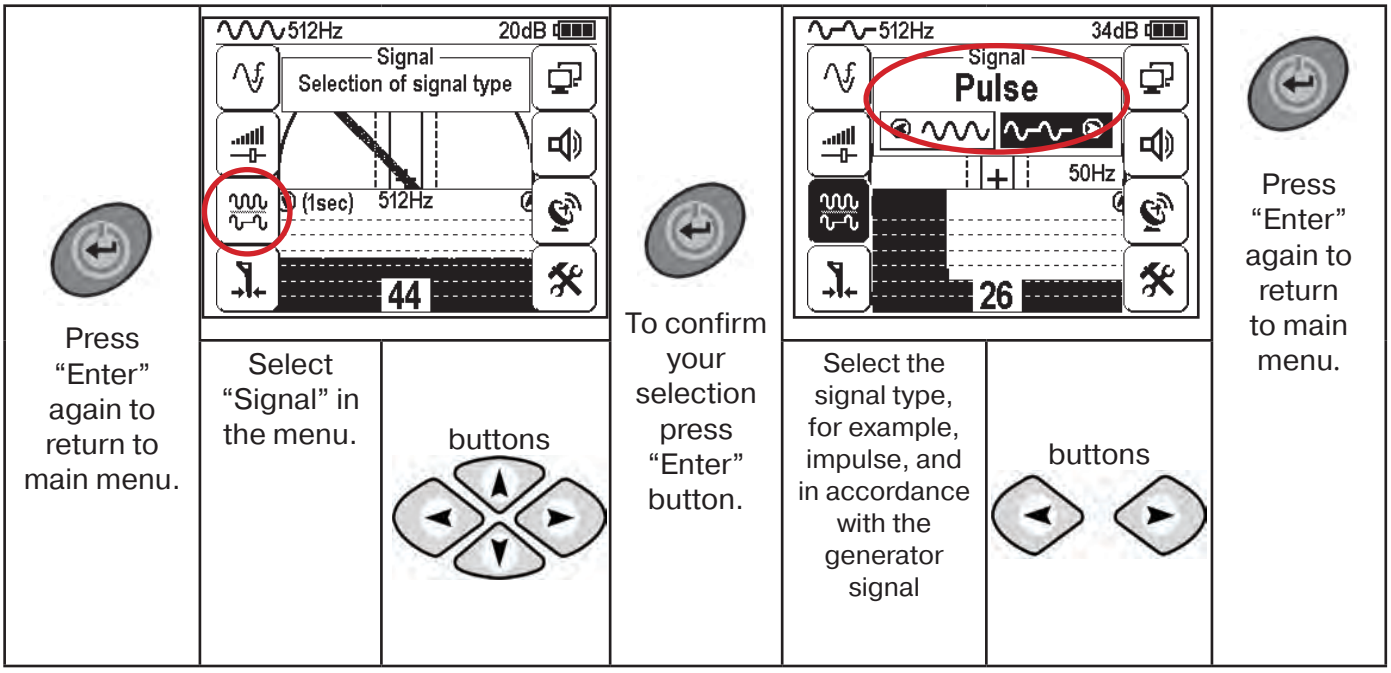
The “Graph” mode is the support mode and is able to locate various utilities (cables and pipelines), both in the passive and active modes with the route locating transmitter. In passive mode, the cable location is carried out at frequencies of **50(60) and 100(120)Hz** and in the active mode - **512,1024,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

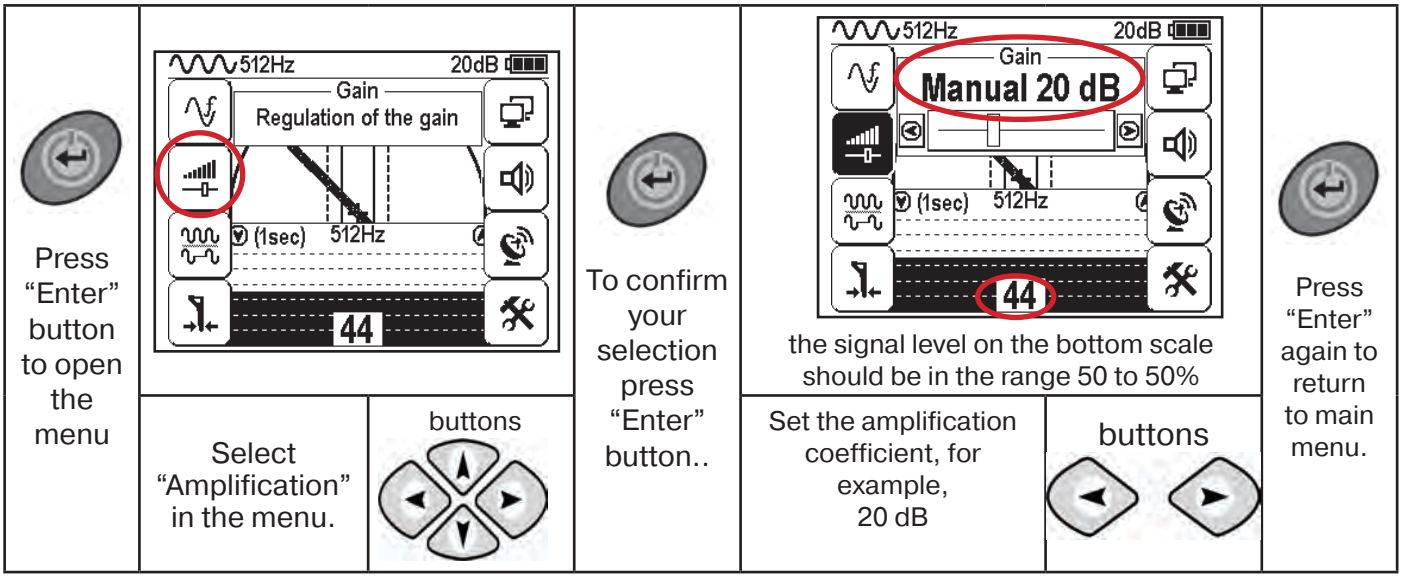



**Note**

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

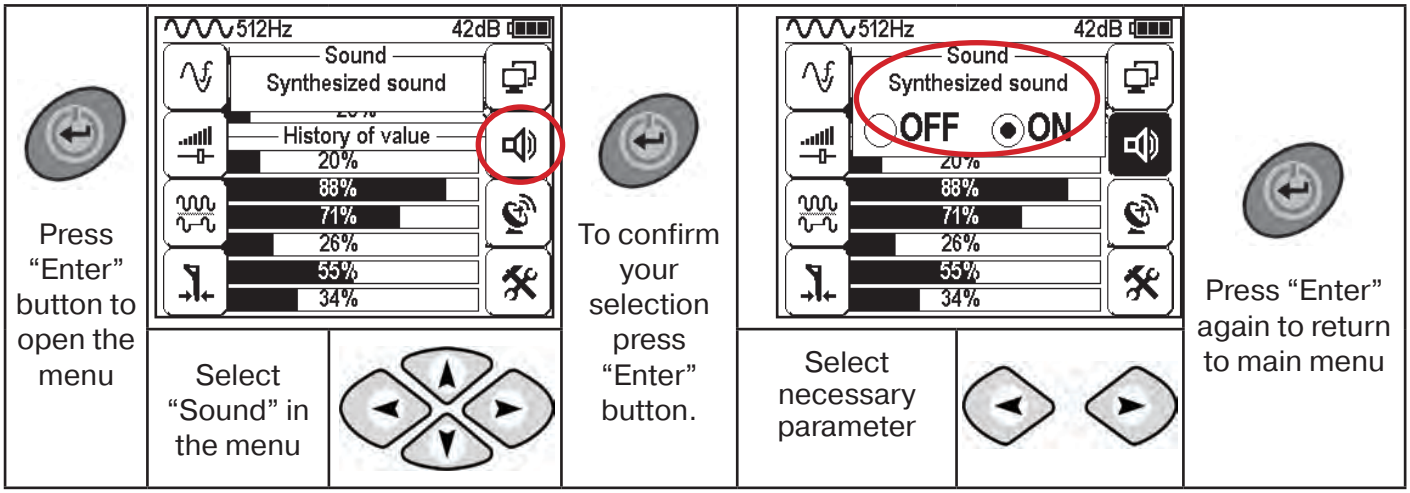
When working with the generator (in the **active mode) 512, 1024, 8192 Hz, 33 kHz** - the type of the signal on the receiver is **continuous or impulse**, in accordance with the signal set on the transmitter.

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

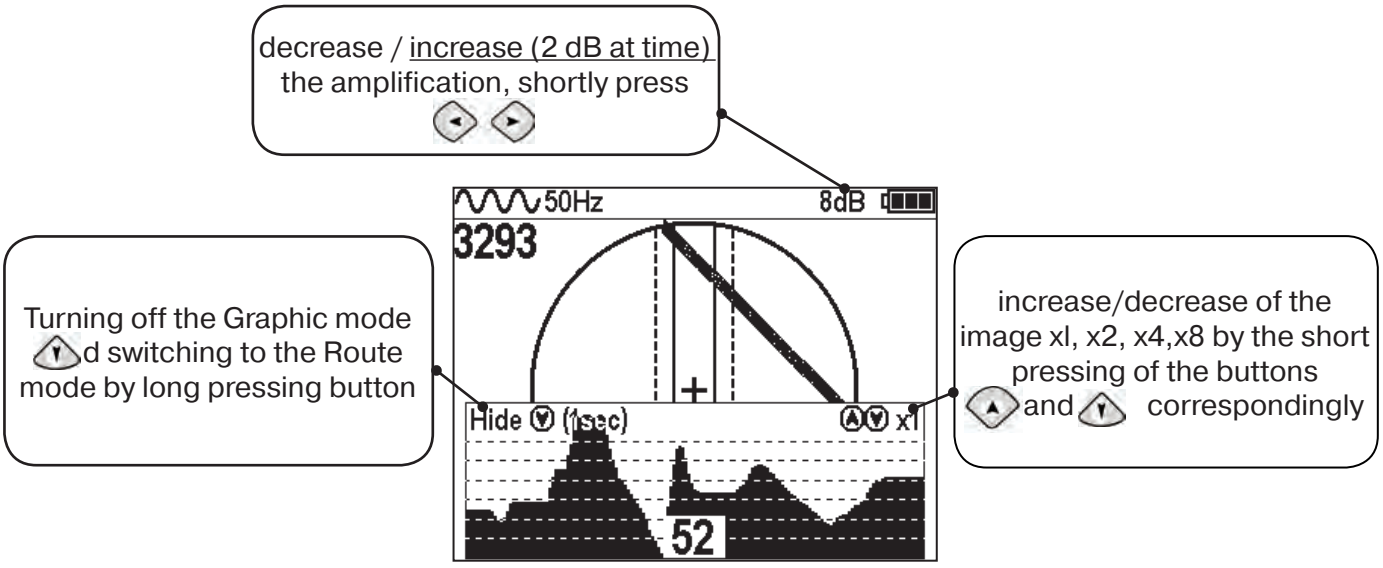


**The change of the input signal amplification coefficient should be performed manually by short pressing buttons ◄ ► or semi-automatically by holding one of them pressed for 1 sec.**

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:

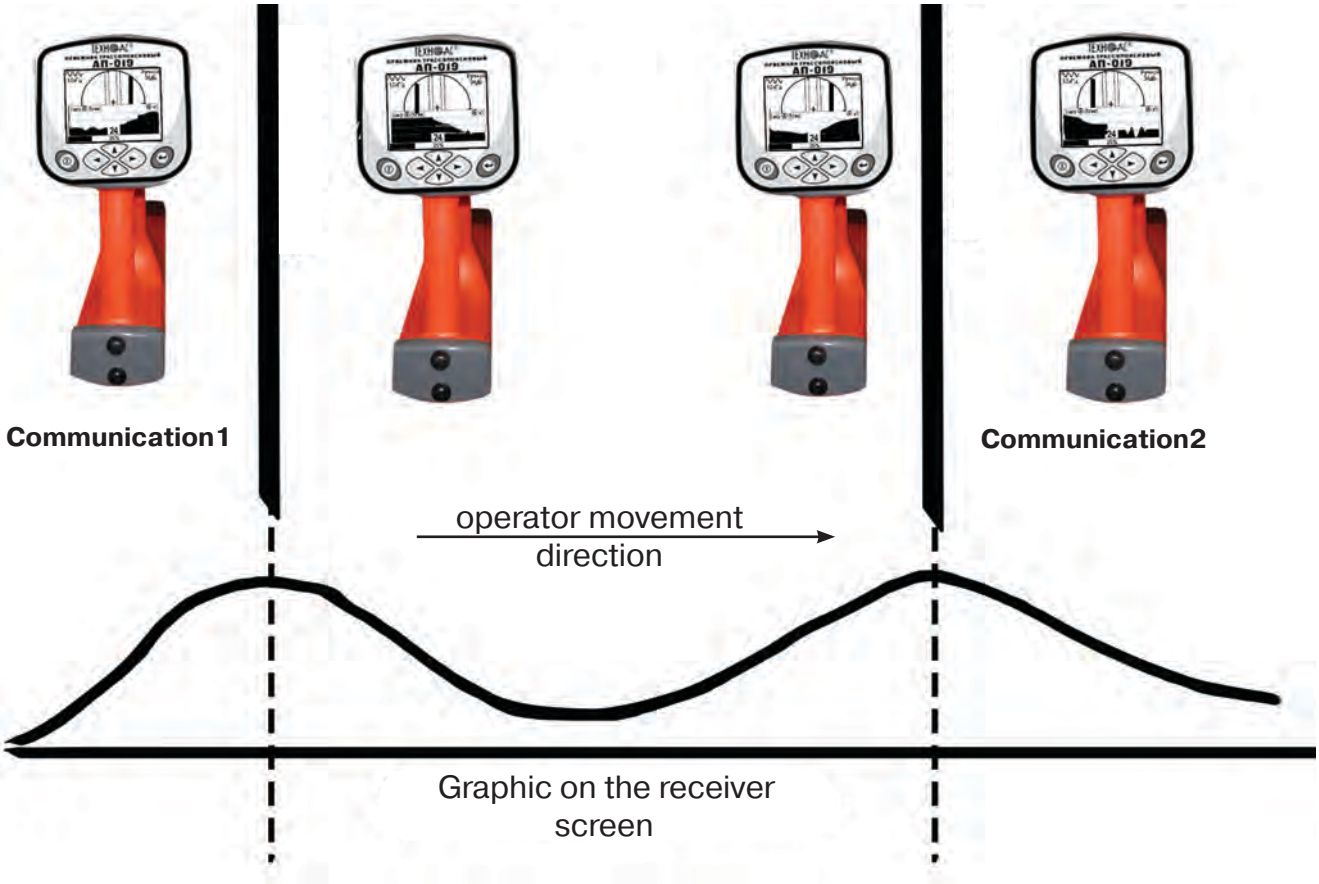
1. Decrease the graphic scale to the value x1 by pressing button ▼
2. Decrease the signal amplification coefficient by pressing button ◄ until the appearance of the decrease of the input signal level is less than 80%.
3. In case of low signal, increase the amplification coefficient by pressing the button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

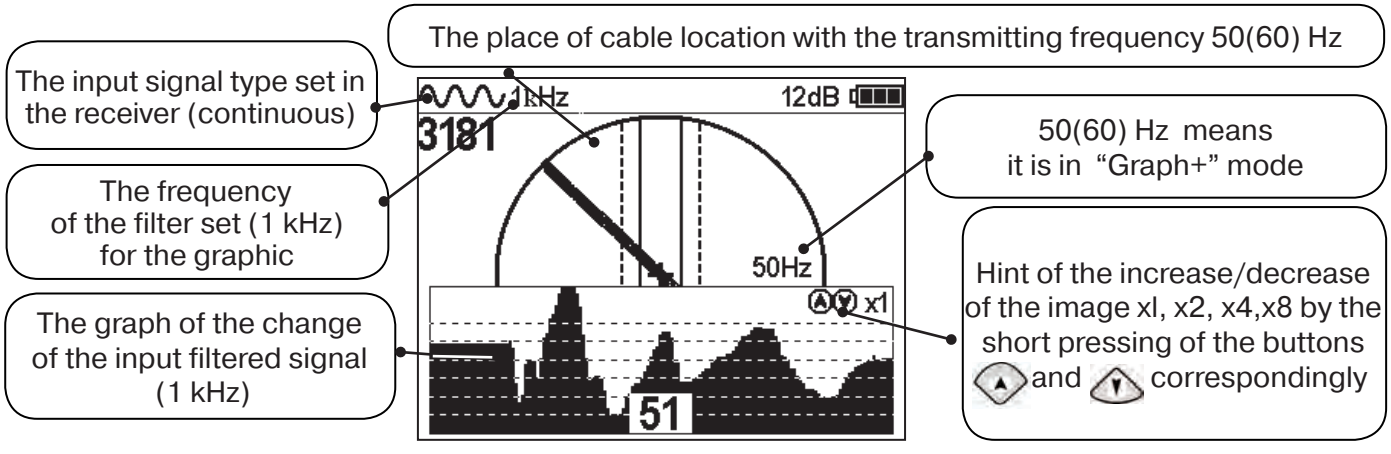
## 7.1 Setting of the Receiver for Work in the “Graph+” Mode

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. |

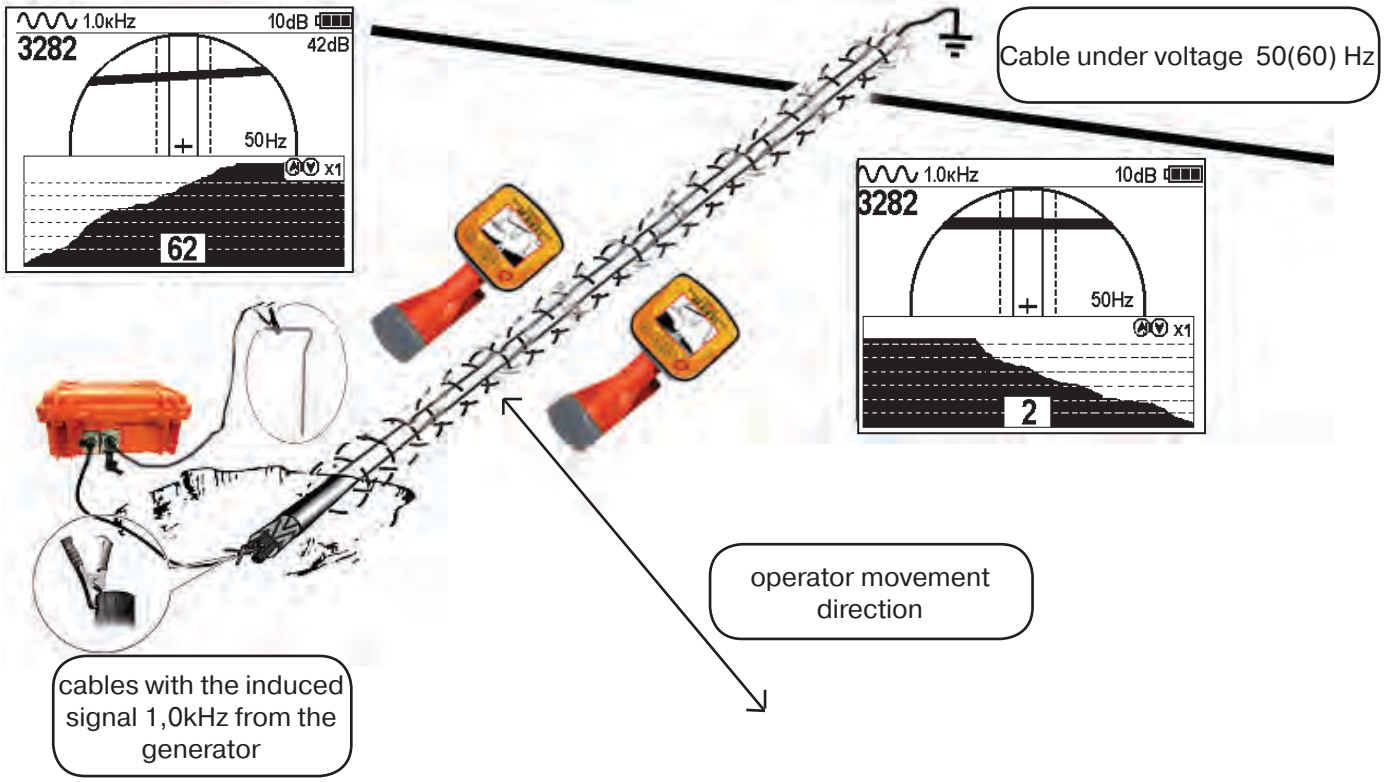
## View of the Receiver Screen for Route Location in the Active Mode



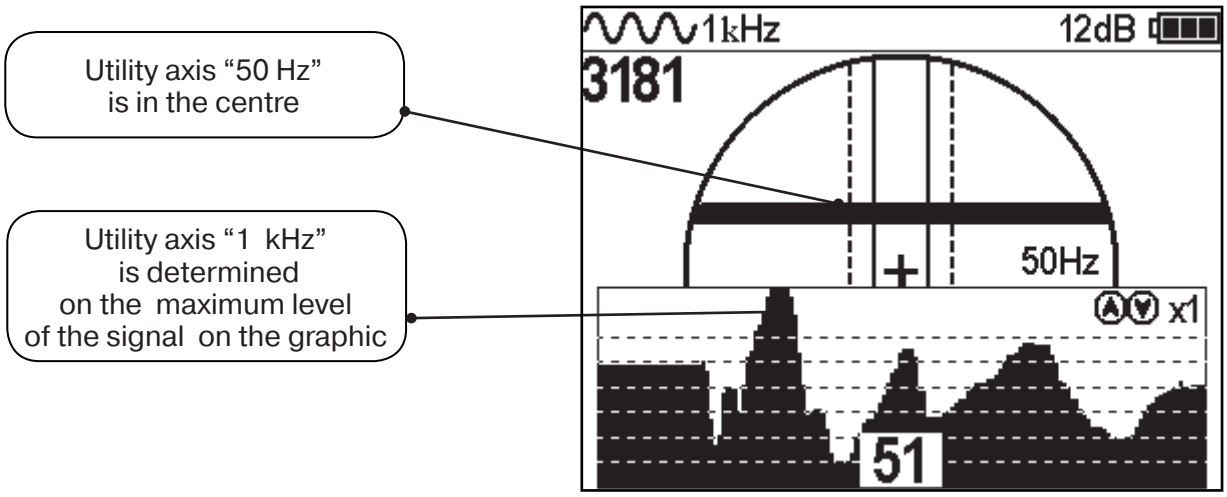
5. Approach the supposed place of cable route, on which the signal from the generator was transmitted. Locate the receiver axis in parallel to the utility axis.

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.

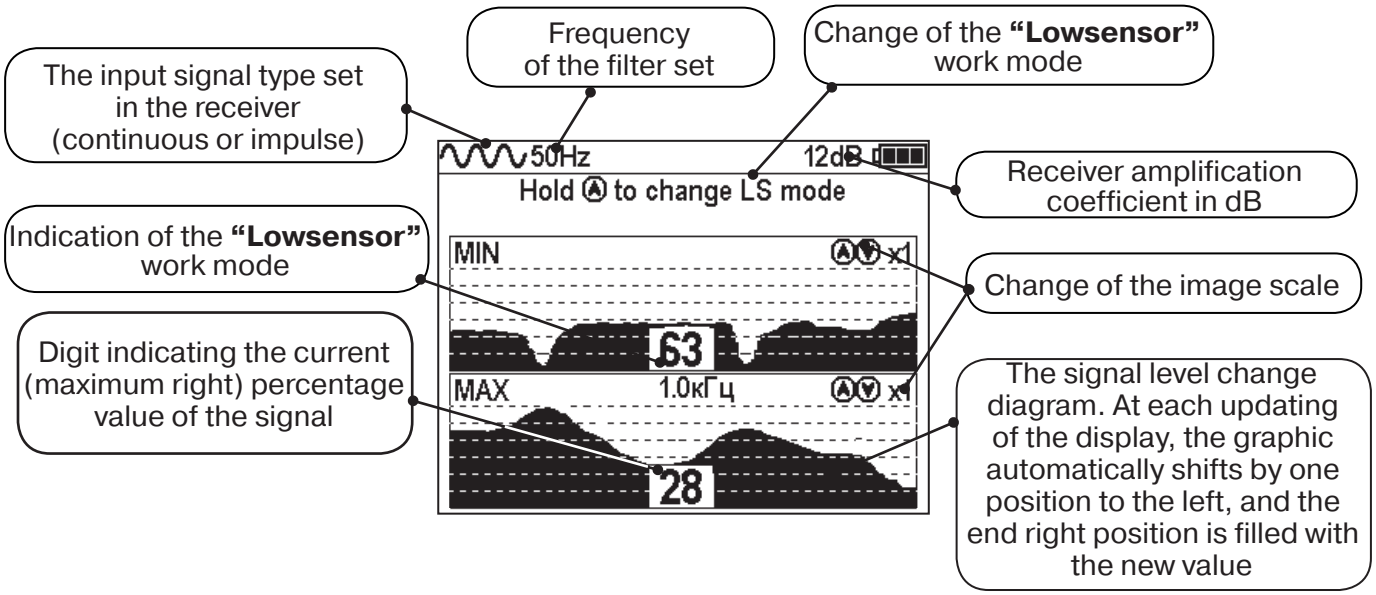


# 8. Performing a Cable Location in the Mode “MIN & MAX”

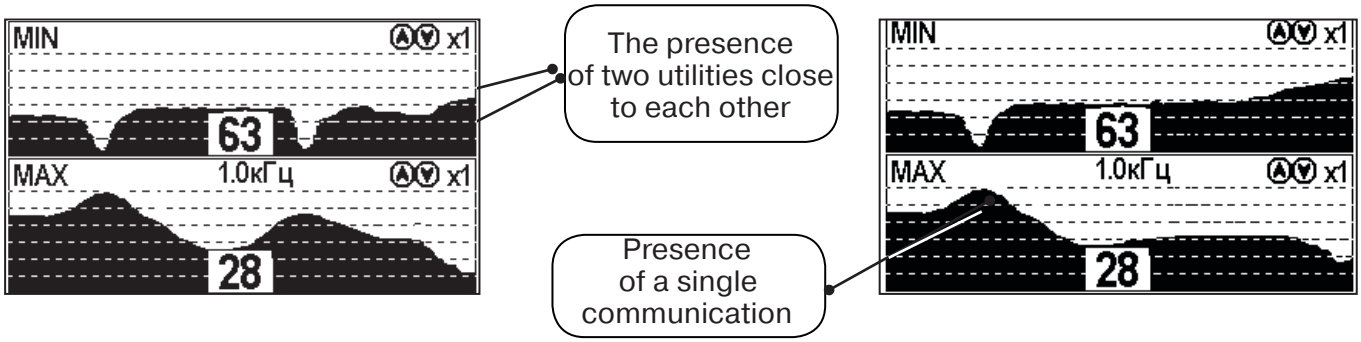
In the mode **“MIN & MAX”**, the device works simultaneously both on the method “maximum” and the method “minimum”. This mode is used in the conditions of distorted field, in the presence of nearby utilities and at the low induced signal. It allows the user to perform location and to determine the presence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



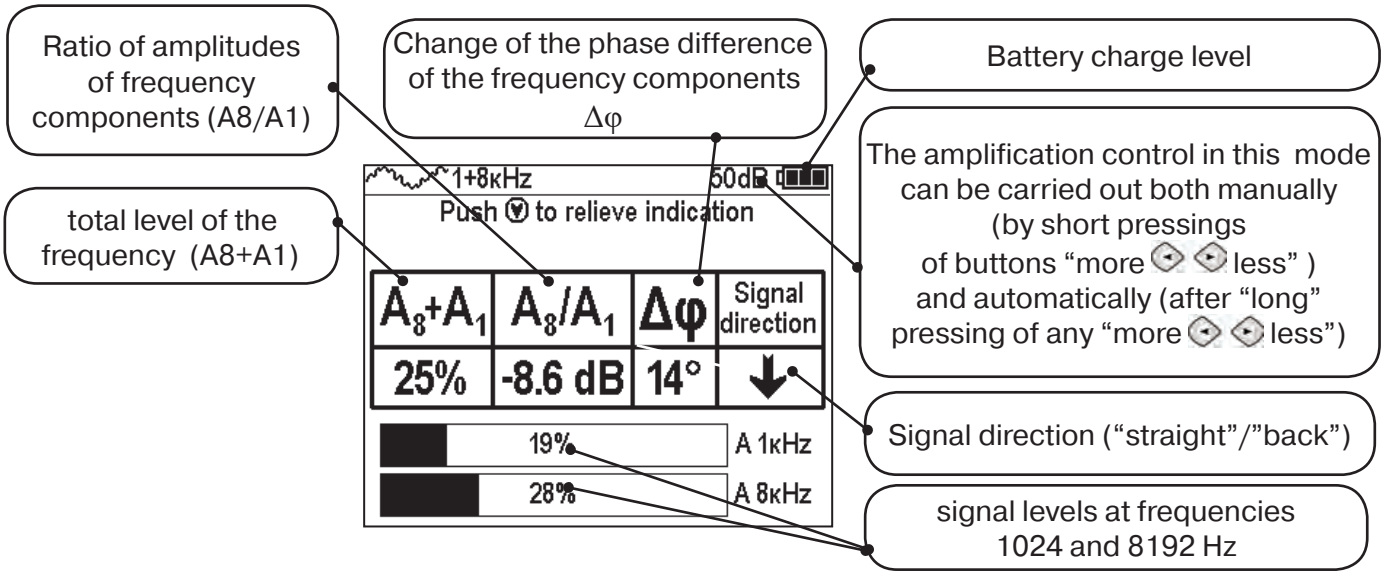

The cable route location is performed similarly to route location in the “Graph” mode, orienting on the maximum level of the signal on the lower scale of the graphic and the minimum level of the signal on the upper scale. To determine the number of the nearby utilities, you should step aside from the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



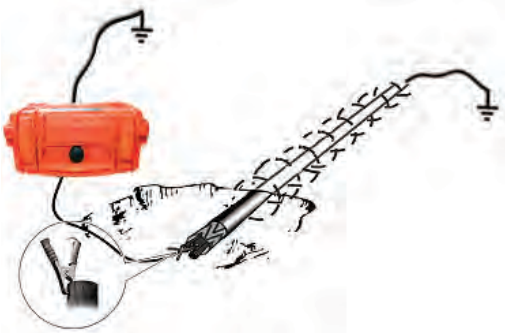
# 9. Performing Cable Route Location in “2 Frequencies” Mode

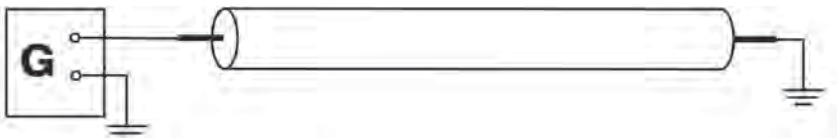
The mode “2 frequencies” was added so the user could determine the signal direction in cables.
**Additional possibilities of the mode are described in App. 2:**
Append. 2 p.3 Amplitude “two-frequency” method “ΔA”;
Append. 2 p.4 Phase “two-frequency” “Δφ”

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



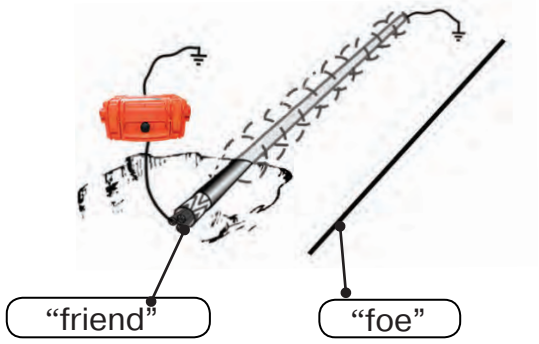

1. One output of the transmitter should be connected to the point of the utility that is more distant from the supposed place of the defect (start of the diagnostic site). The other output of the generator is grounded on the maximum possible distance from the utility from the other side (end of the diagnostics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



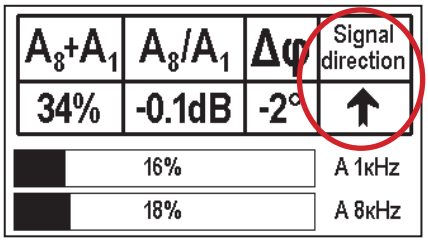



2. The transmitter in the mode “2F” sends to the utility the signals of two frequencies (1024Hz and 8192Hz) simultaneously.

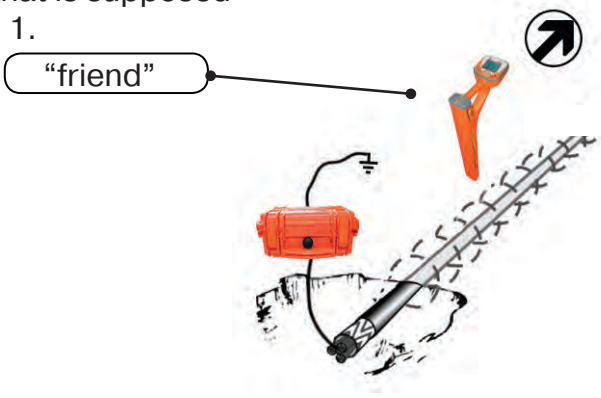
3. The signal from the utility, to which the route locating transmitter is directly connected, is conventionally named - “friend”. The “parasitic” signal from the nearest utility, on which the generator signal is transferred, in conventionally named as “somebody else’s”.

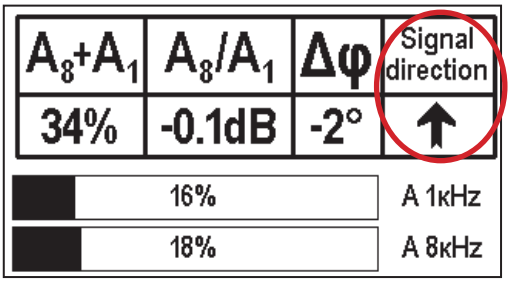



4. Based on the direction of the “arrow”, it is possible to distinct a “friend” signal from a “foe” one, since the current direction in “friend” utilities is opposite the “transferred” currents flowing through “foe” utilities.

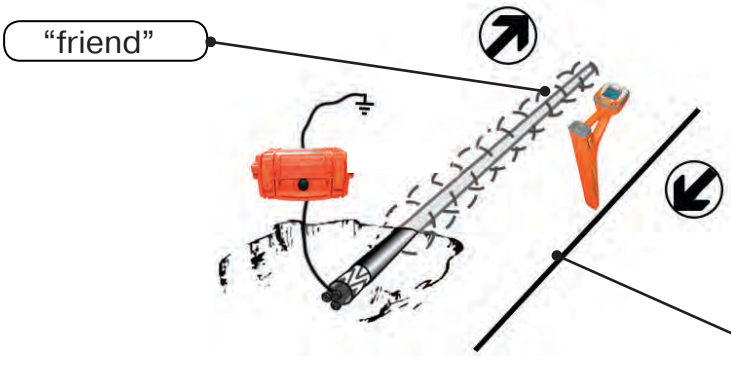


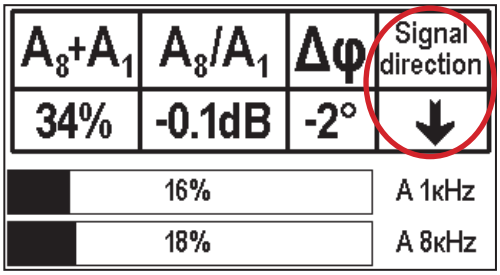

5. “Signal direction - forward” is the conventional concept and “assigned” by the operator, for this position of the sensor relative to the route. The “assignment” is performed by the pressing of the button “ ”; when the sensor is located exactly over the “allocated” utility that is supposed to be a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

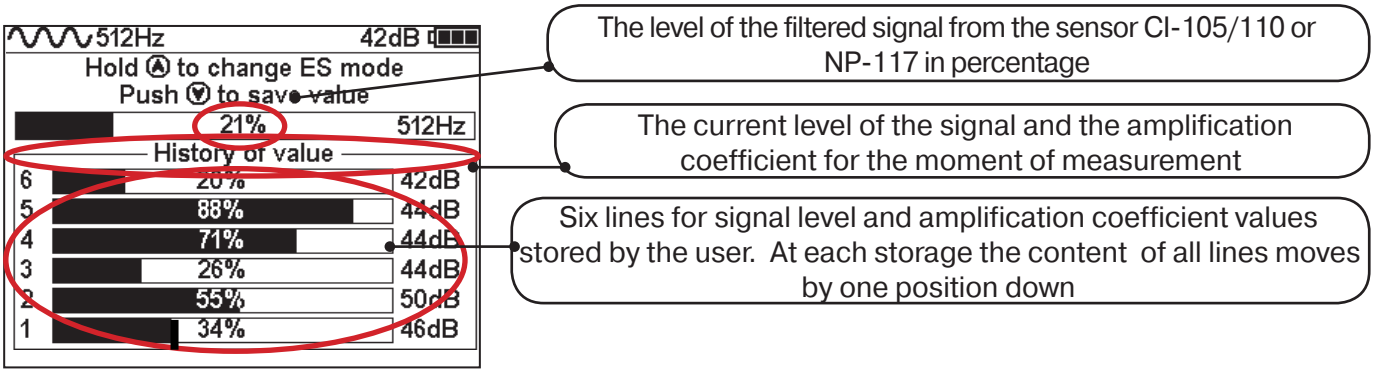


# 10. The work mode «Cable selection from a bunch»

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.



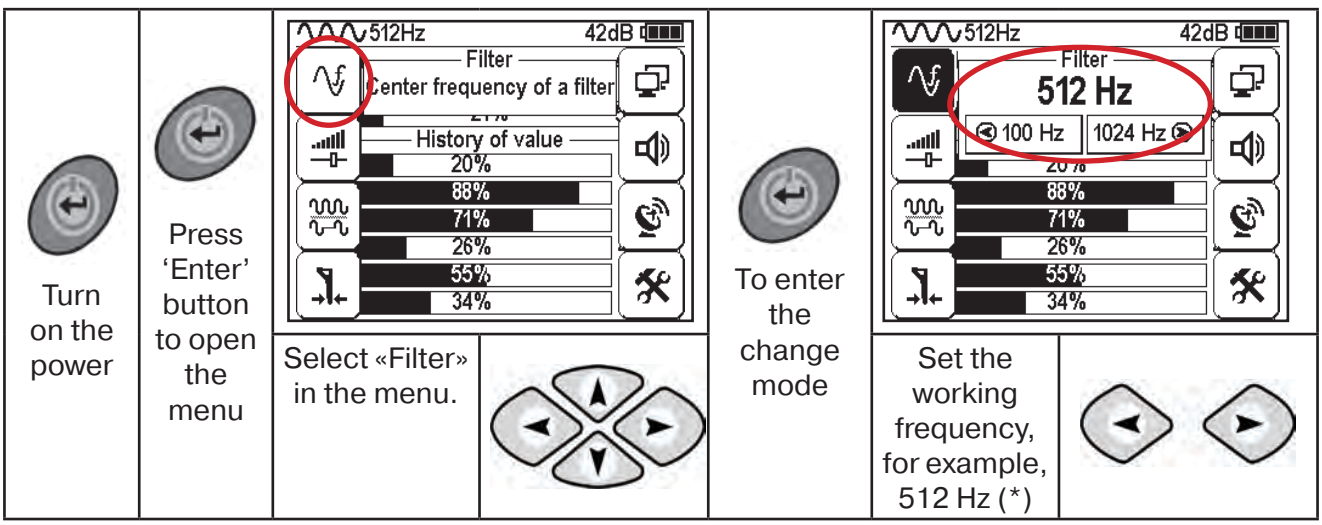

## 10.1. The work with the receiver in the mode «Selection of the cable from a bunch»

**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**

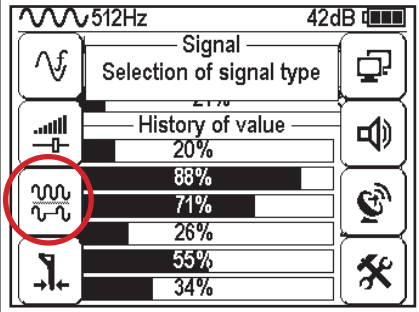
**Fig 10.2**

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



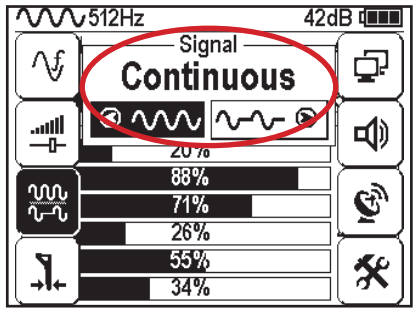

**(*) at that the signal should be sent into the cable from the transmitter with the same frequency 512Hz**

Press 'Enter' again to return to main menu.



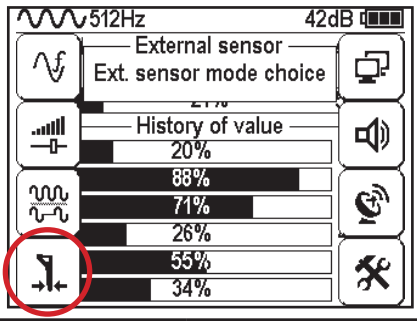

Select «Signal» in the menu.

To confirm your selection press 'Enter' button.



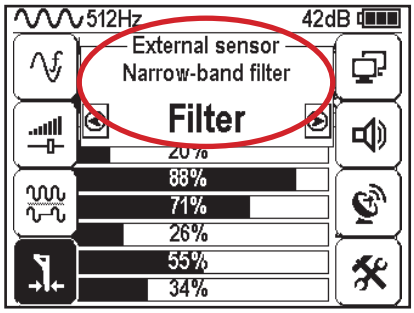

Select the signal type corresponding to the signal type from the transmitter, for example, continuous.

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.

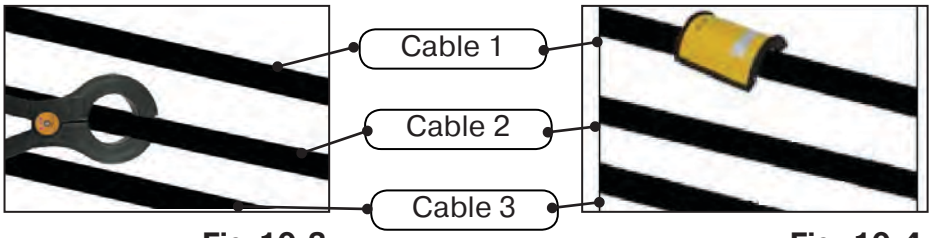
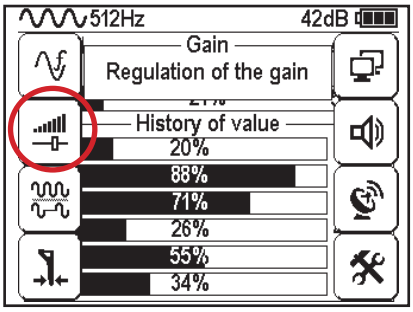


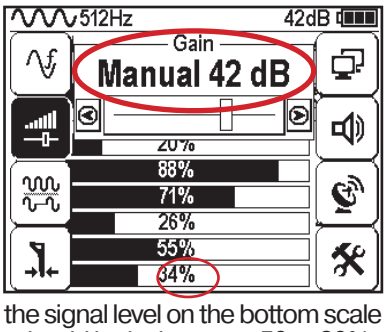

**Fig.10.3** **Fig. 10.4**

Press 'Enter' again to return to main menu.




Select «Amplification» in the menu.

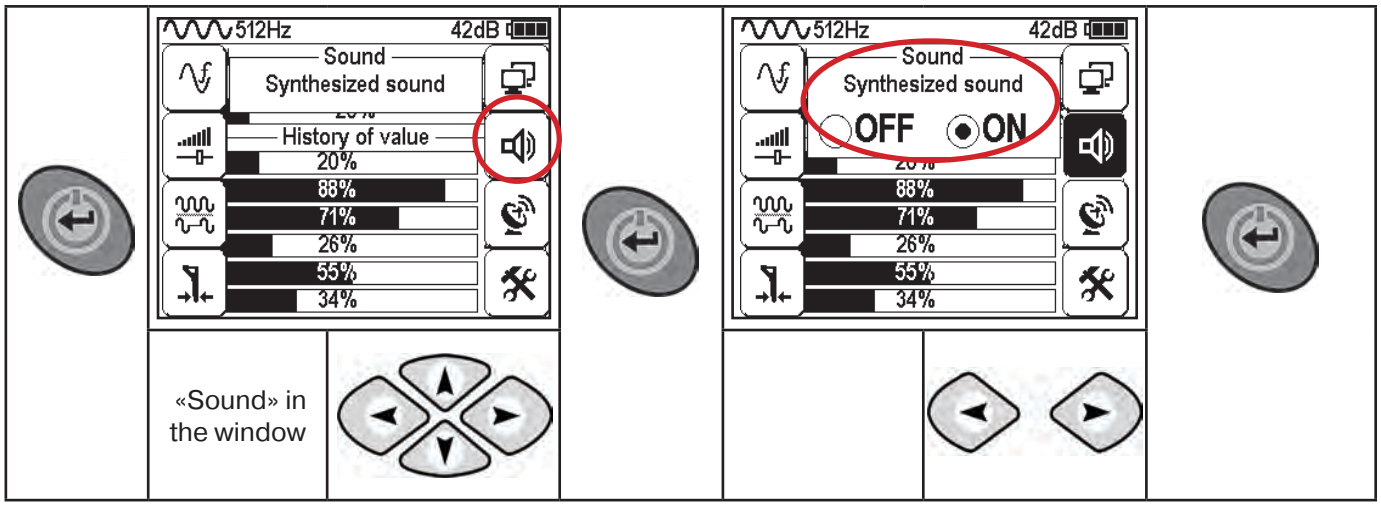
To confirm your selection press 'Enter' button.




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

Set the amplification coefficient, for example, 40 dB

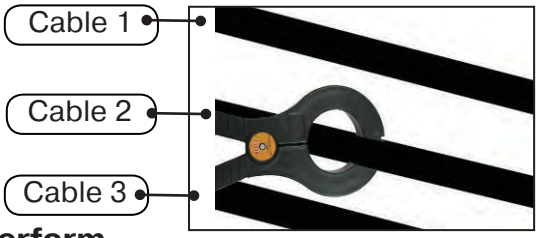
Press 'Enter' again to return to main menu




**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).

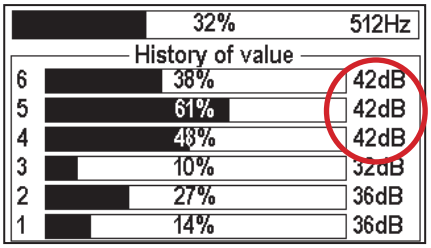
The tone pitch of the synthesised sound correspond to the signal value (including and «impulse» amplitude)




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.**



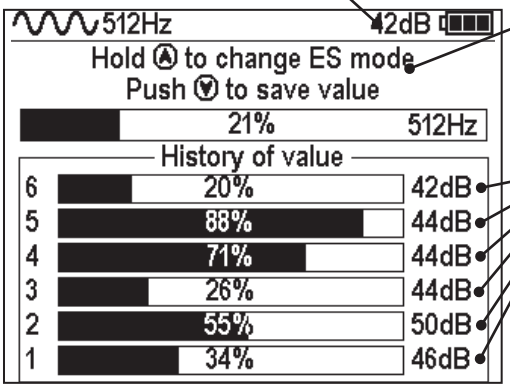

**The maximum signal 80% (42 dB) corresponds to the cable No.2**

**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)

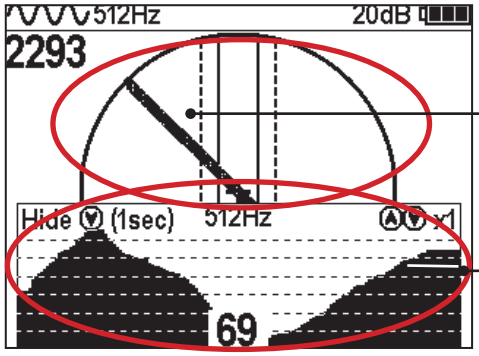
Note

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.



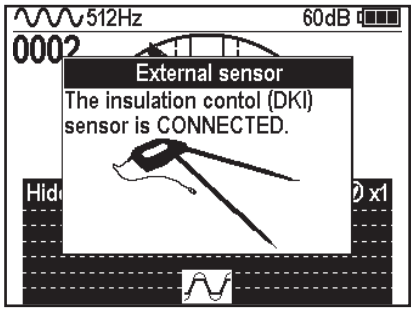

2D display of the route location

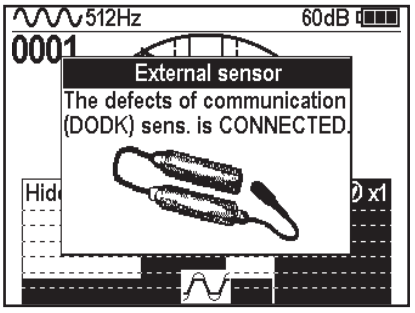
2 The graphic of time change of the external sensor signal level
The graphic can be hidden by long pressing of the button and appears at the short holding of the button.

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

Fig.11.1

Fig.11.2

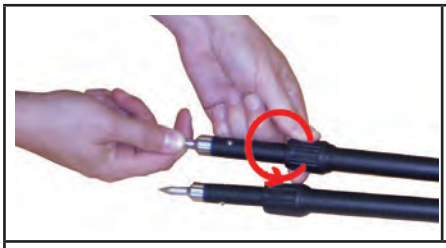
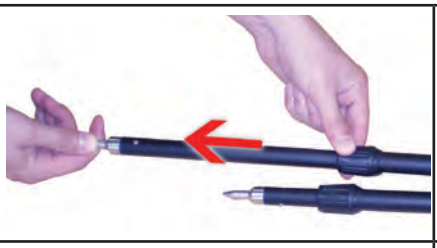
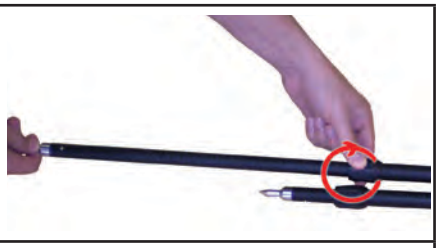
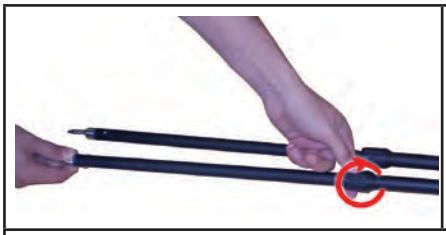
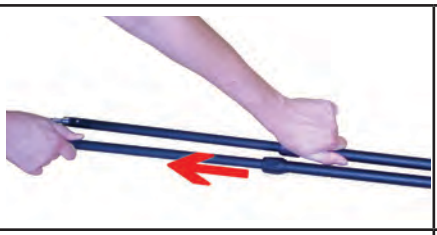
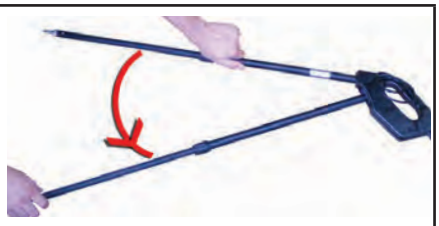



- Connect to the sensor to the receiver of the insulation control DKI-117 (fig. 11.1) or DODK-117 (fig. 11.2).

# 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.

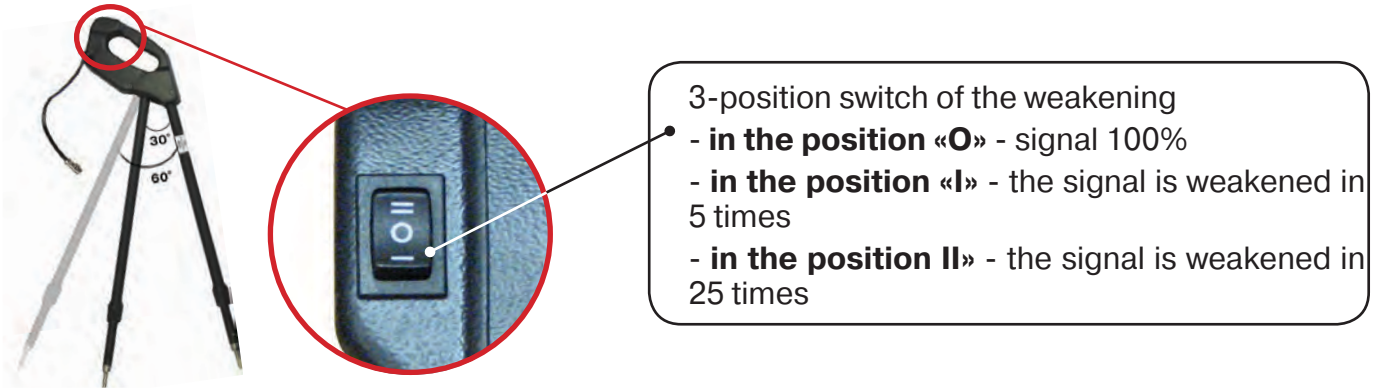



**Fig. 11. 3.**

**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)**

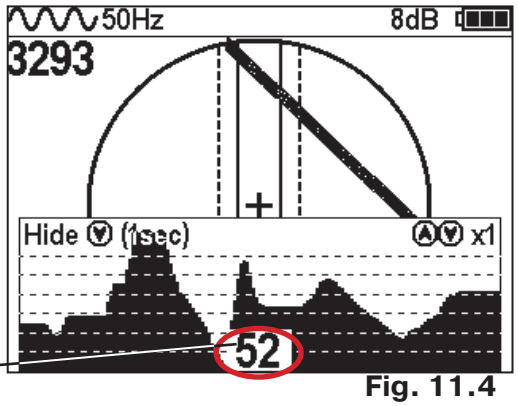



**Fig. 11.4**

## 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**

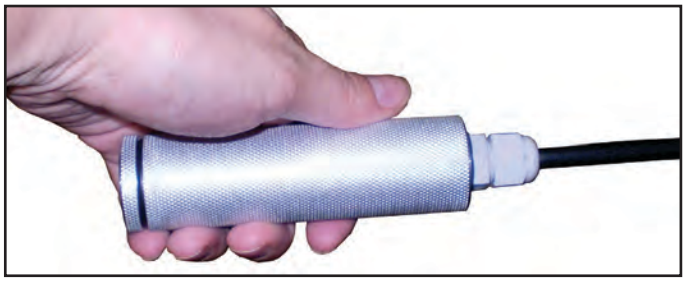


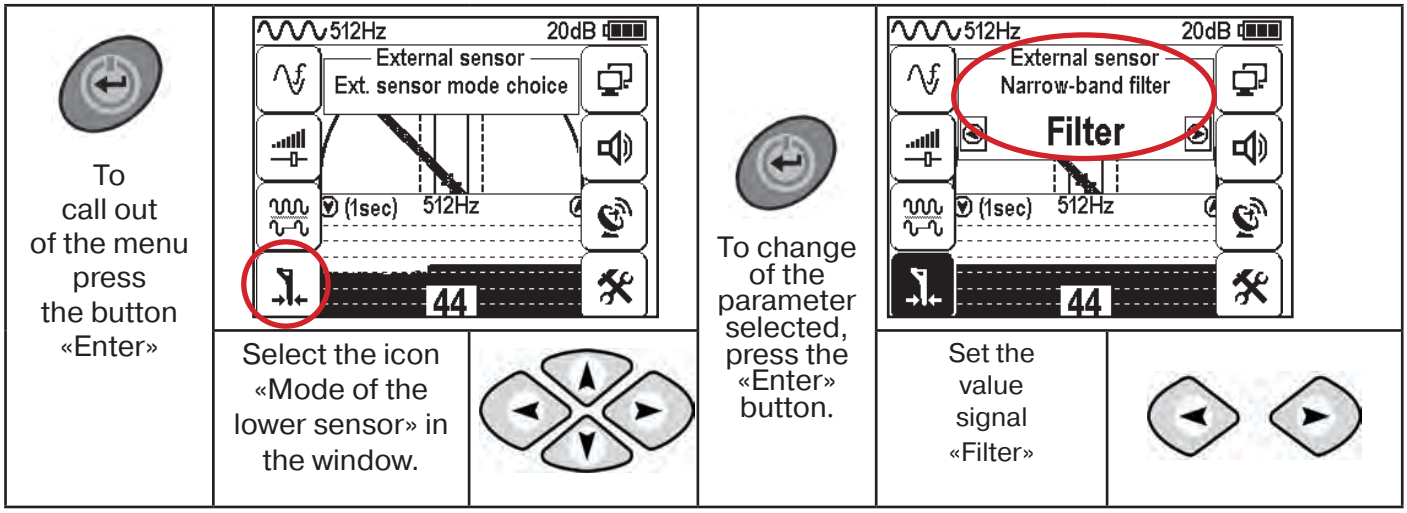
**Fig. 11.6**

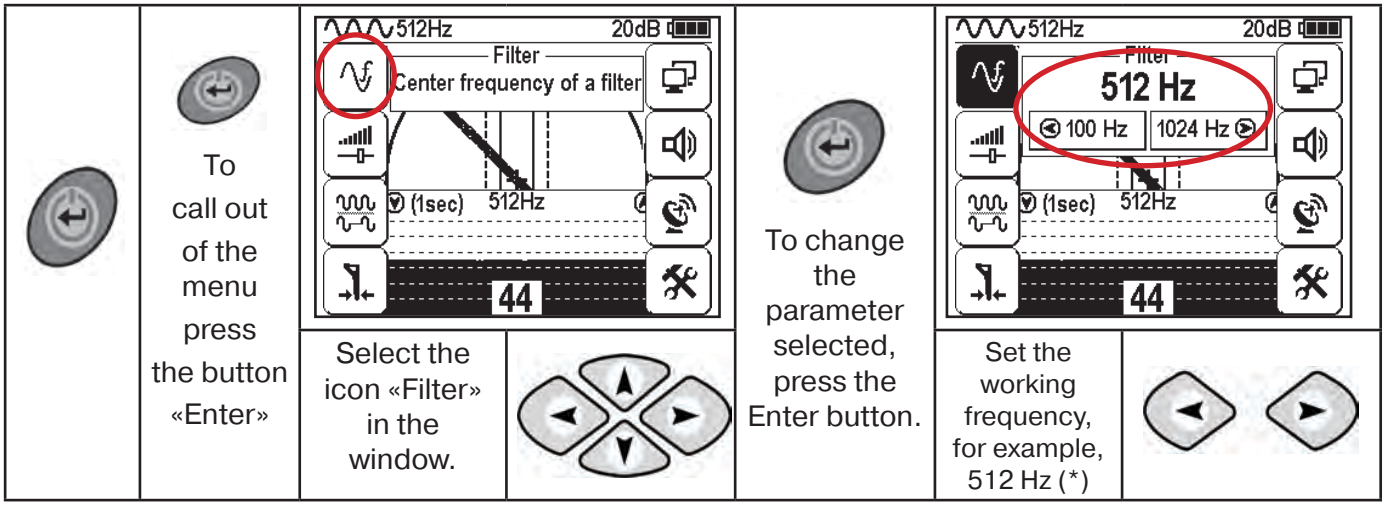
### Receiver setting

1.Turn on the receiver

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

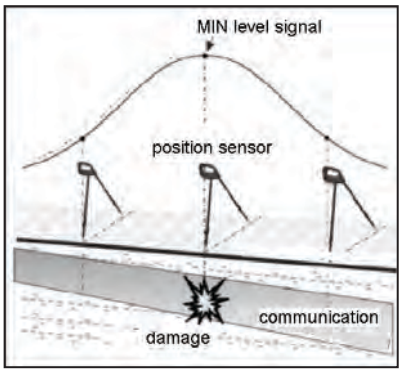
3. Set the working frequency and type of the signal:



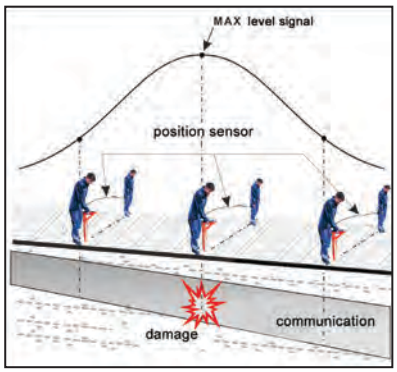



**Wait for several seconds till menu icons disappear**

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).

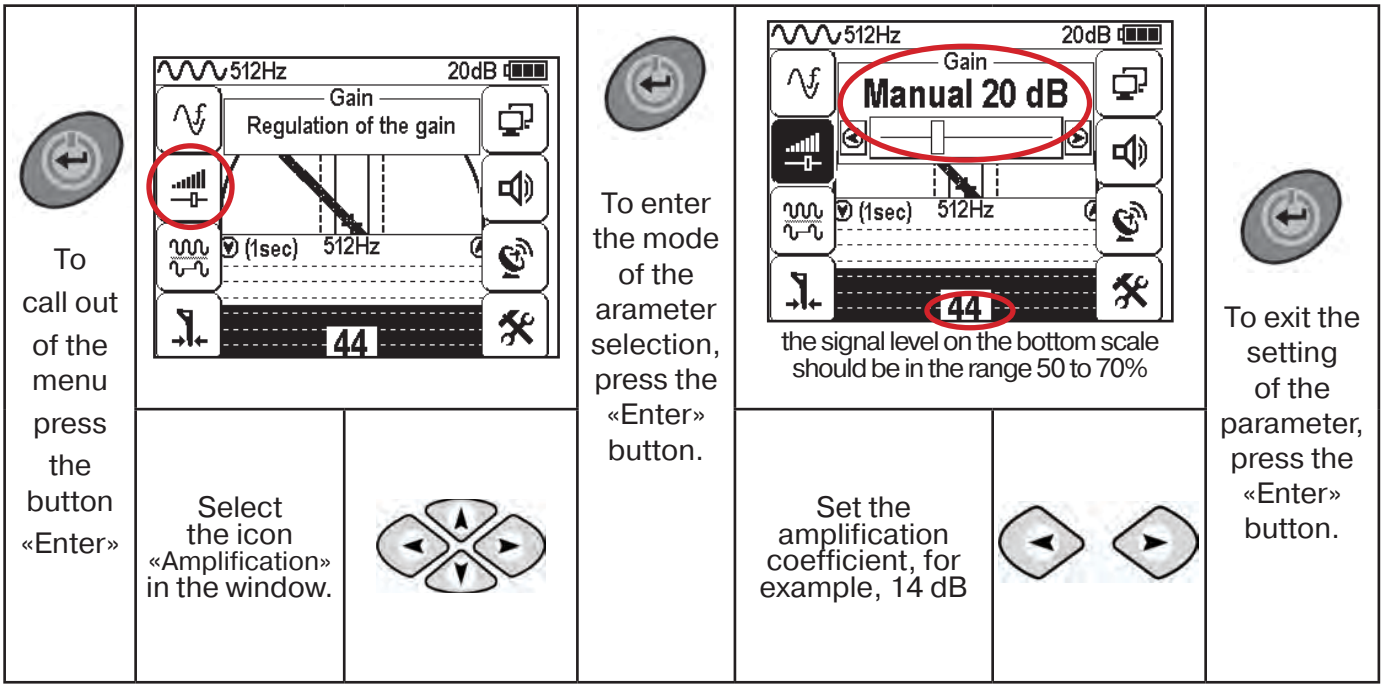



**(fig. 11.7.)**

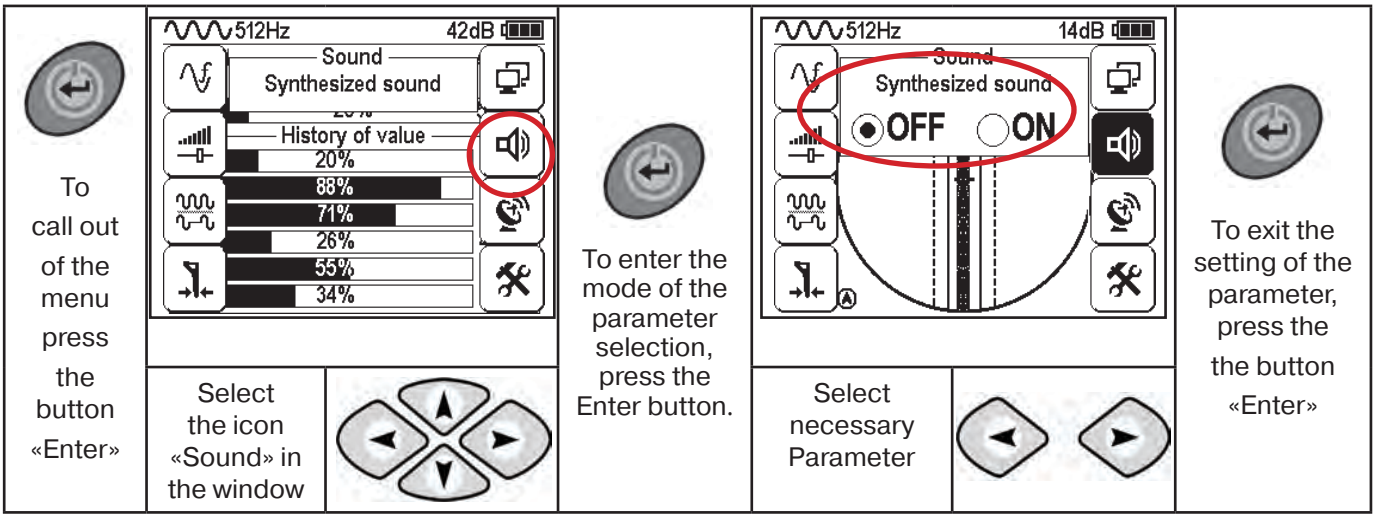



**(fig. 11.8.)**

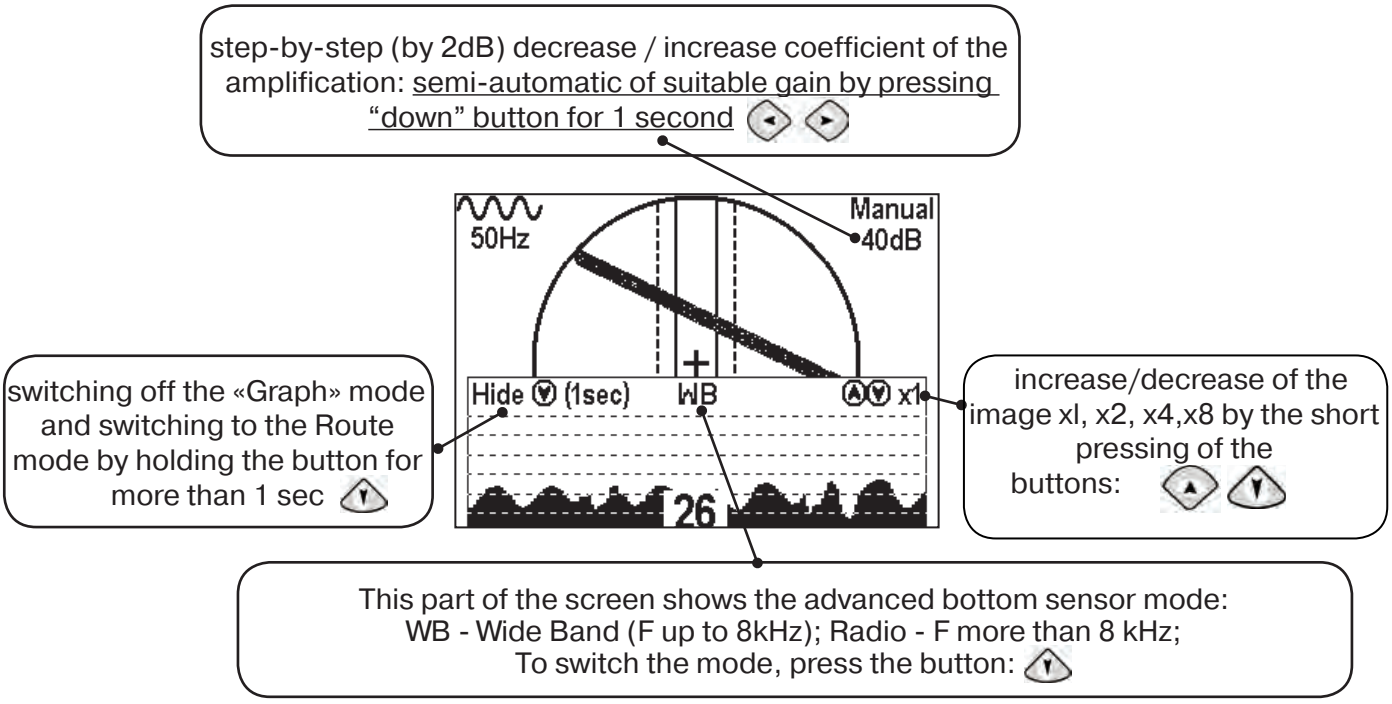
When working with sensors you should regulate the receiver amplification coefficient so that the signal level was in the rang 50 to 90 %.



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 ty the 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 it's 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 existance of damage, however, has a low accuracy of localization of the exact place due to the blurred indication of signal curve maximum.

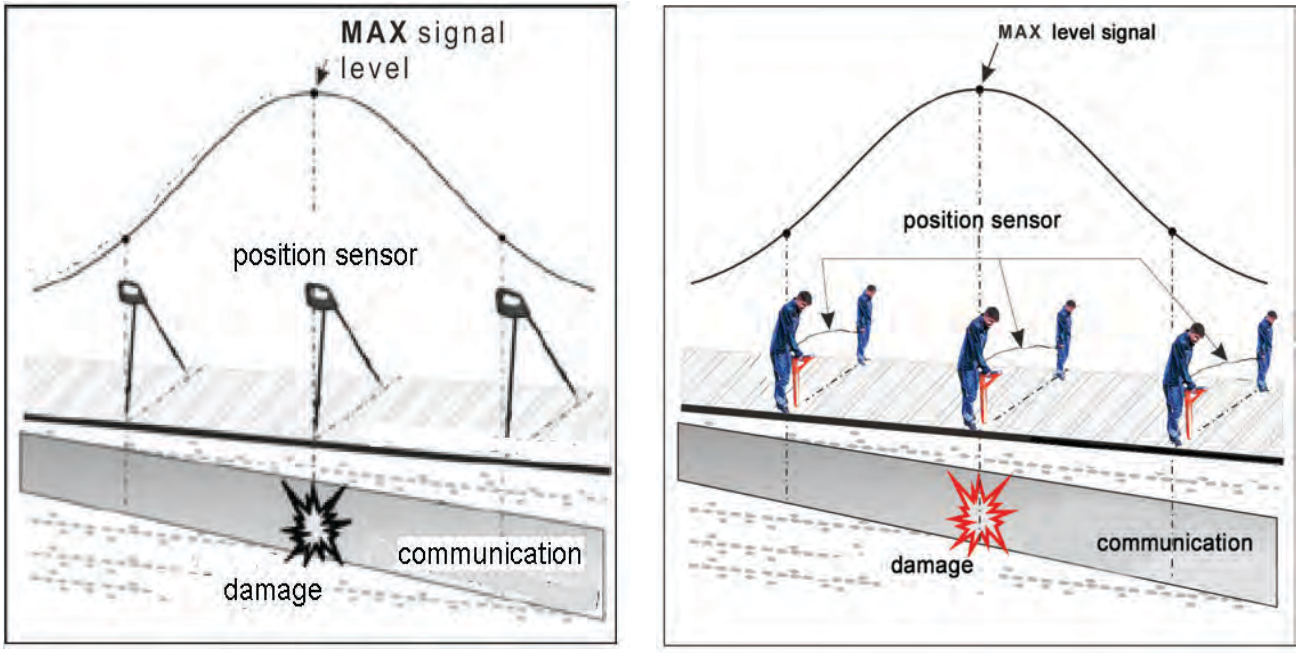



**Fig. A.1**

## 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.

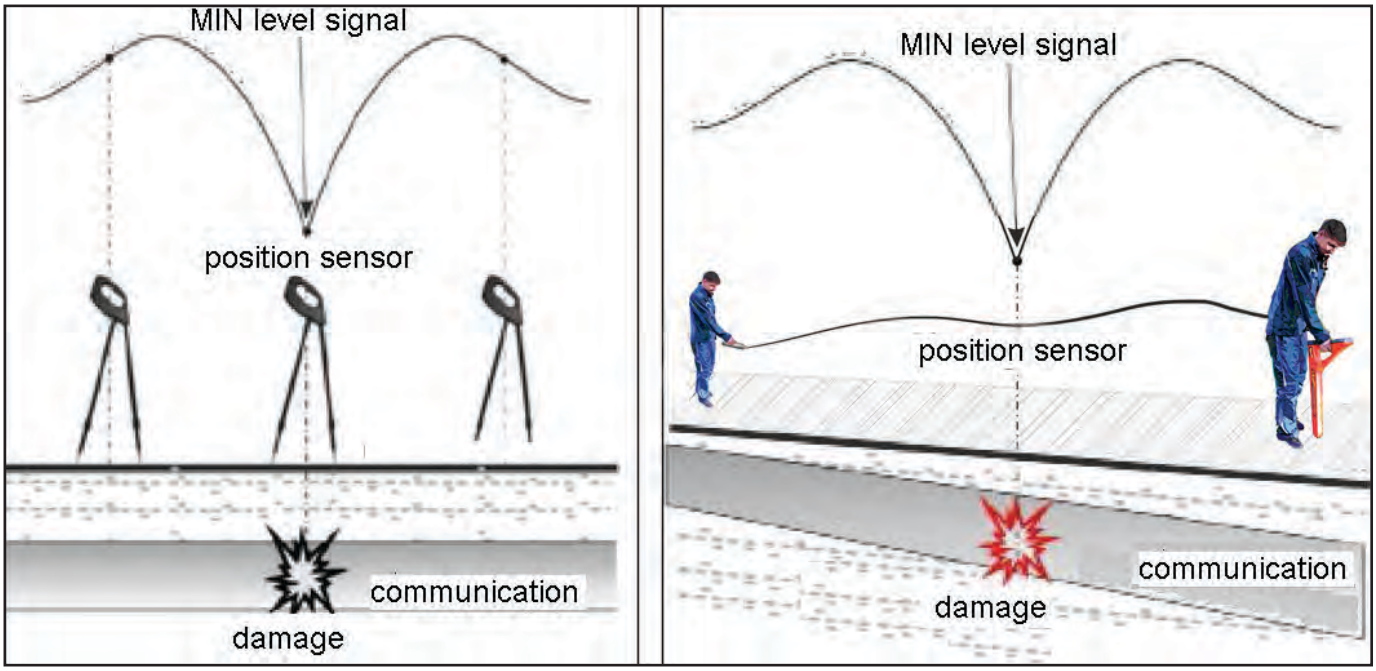


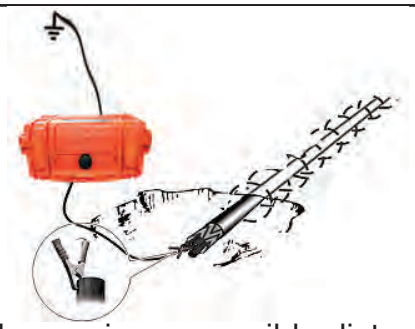

**Fig. A.2**

### 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**

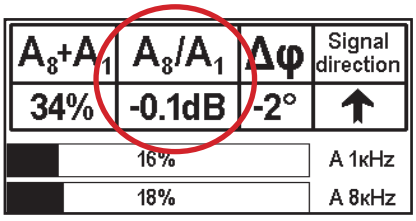


1. Exit output of the generator should be connected to the «start» of communication (more distant from the supposed place of the defect). The other output of the generator is grounded on the maximum possible distance from the communication. The «end» of the communication is not grounded.

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

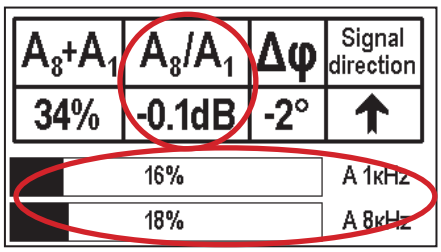

3. The defect localisation is performed in direction «from generator».

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




***Note***

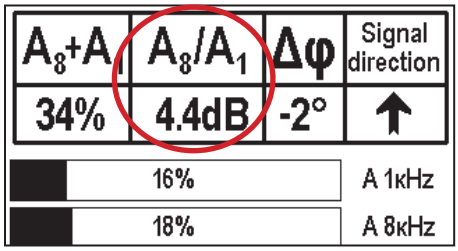
A8/A1 indication can have negative value. In such cases it recommended to reset indication periodically, using the button «◇».




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.

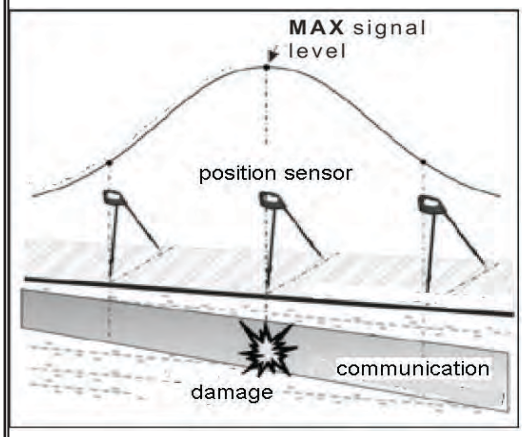
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, A8/A1 did not changed, it means that there are no damages on the surveyed site.

7. The sharp positive overfall of the «A8/A1» 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.

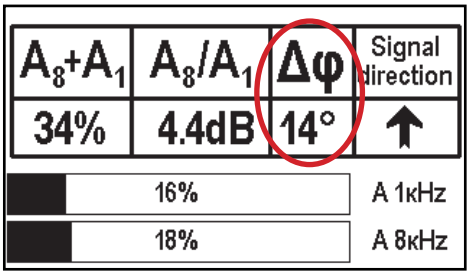
8. To validate the existance of the damage, use 2contact method, using. (the methodology in app. 2 of p.1.2)




## 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.

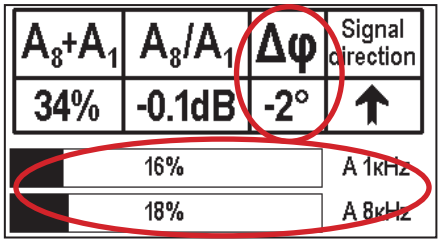
Steps 1-3 are similar to those in p.3.




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***

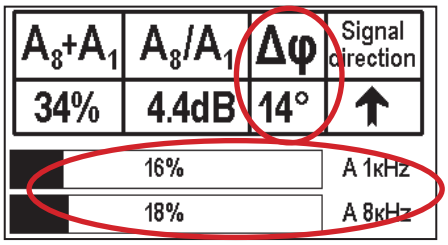
Δφ indication can be negative, «running» in the process of increase of distance from the generator. It is recommended to periodically reset such indications (exactly over the route), using the button «▼».




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 A8/A1, the inscriptions A8kHz and A1kHz are correspondingly «darkening», and the value «X0» disappears.

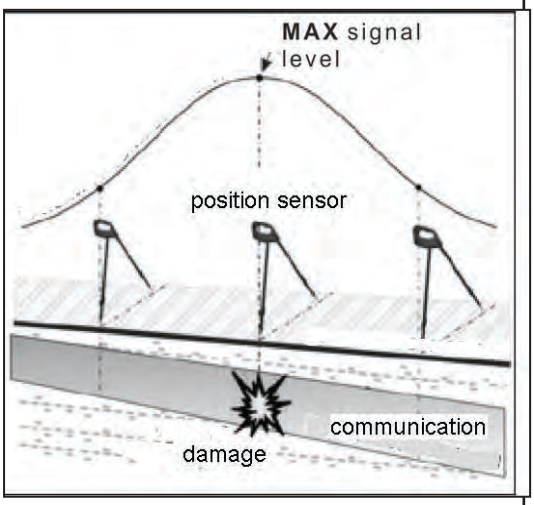
6. There is no need to continuously move along the route, controlling the signal. You can walk around the place which is hard to reach. If, while returning to the route, A8/A1 did not changed, it means that there are no damages on the surveyed site.

The sharp positive overfall of the A8/A1 value by 3dB and more indicates the possibility of defect existance (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 50) will mean that there is damage in the cable.

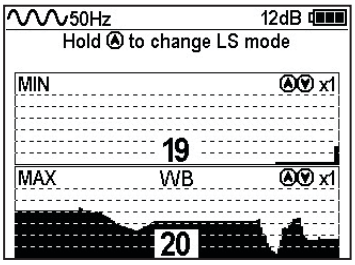
To validate the existance of the damage, use contact method, using. Append. 2 p.1,2)

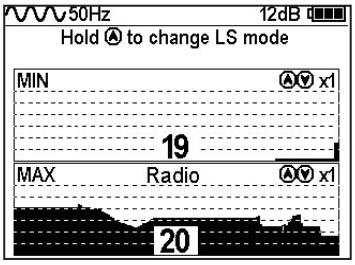


## Appendix 3

## Area survey before excavation works

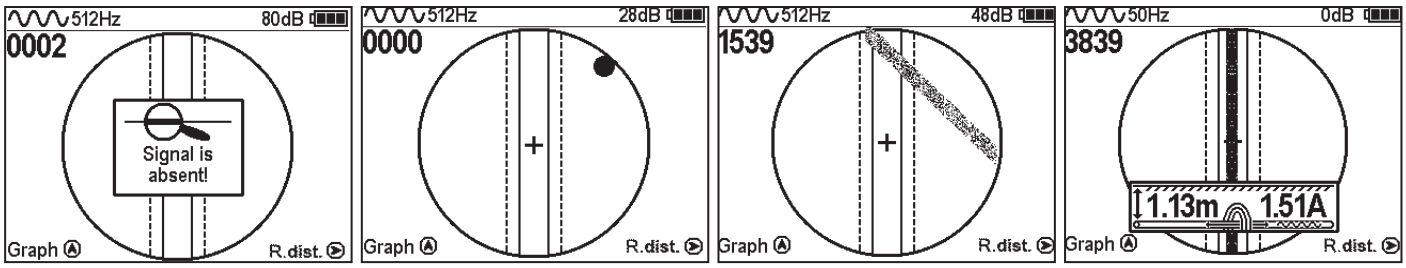
First of all the area should be surveyed with the receiver in passive mode, in order to locate the signal from energized power cables, pipes with cathodic protection or any other current providing utility. To do that, use the following frequencies consequently: 50 Hz, 100 Hz , Radio and Broadband mode.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



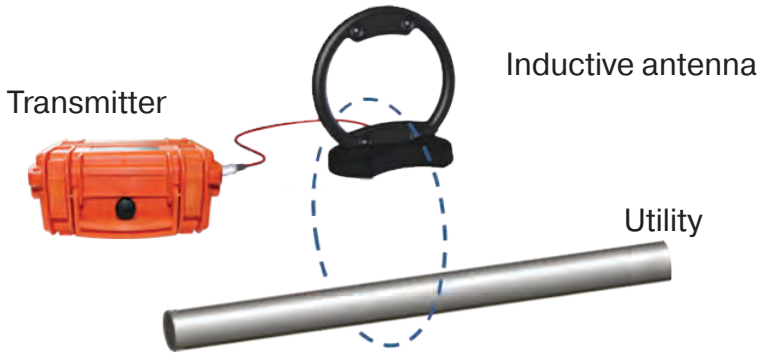




In this case the operator should rely on “MAX” scale.

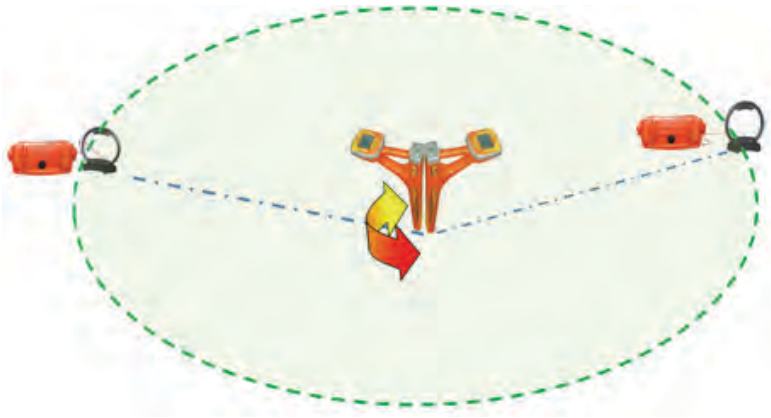
At 50 a 100Hz frequencies in Route mode the signal strength will increase as you are moving to the utility. Following indication should appear on the screen while performing these actions:




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




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

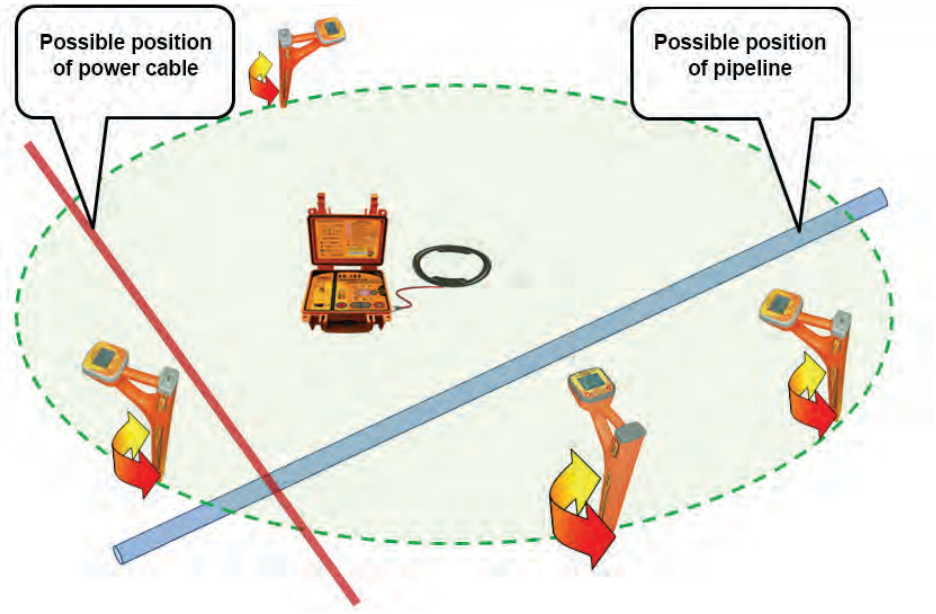


If there is no utility in center point of the area, then start the general location routine described below.

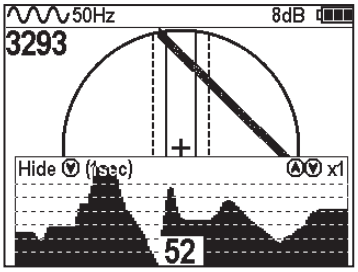
When surveying the area in active mode, it is necessary to place. IEM antenna horizontally in the center of the plot (you can remove the antenna from its stand). In this position the antenna will be in the flatness parallel to all surrounding utilities in the area.

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

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




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



# Appendix 4
# Operational features of the set

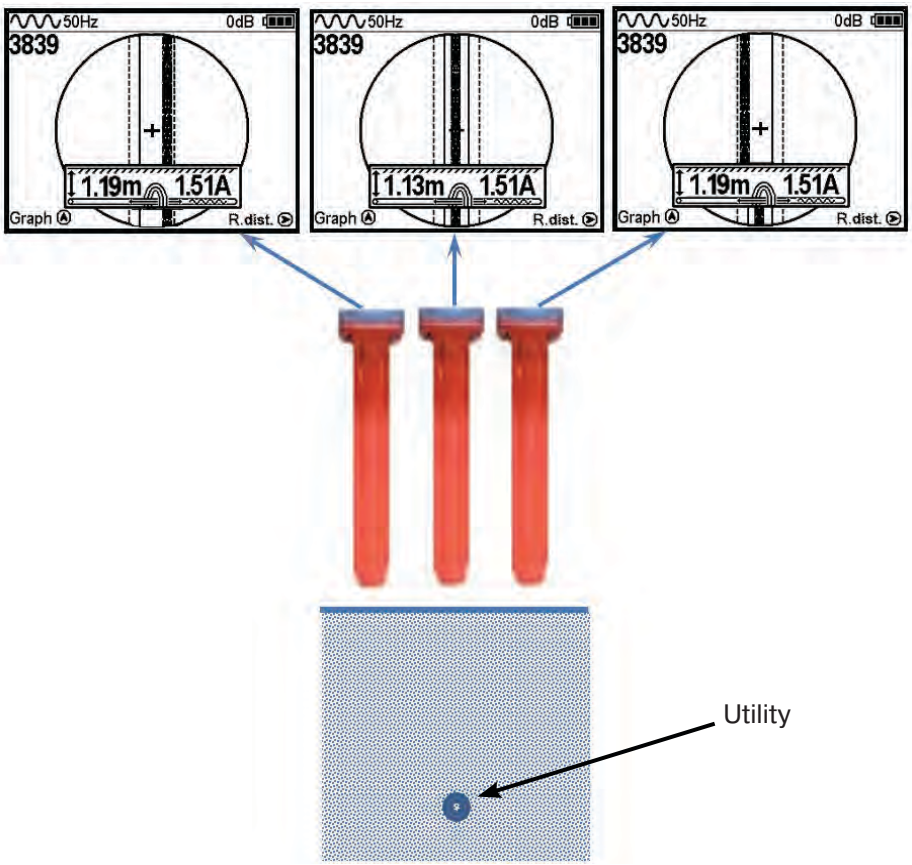
***External influence during receiver operation***

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

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

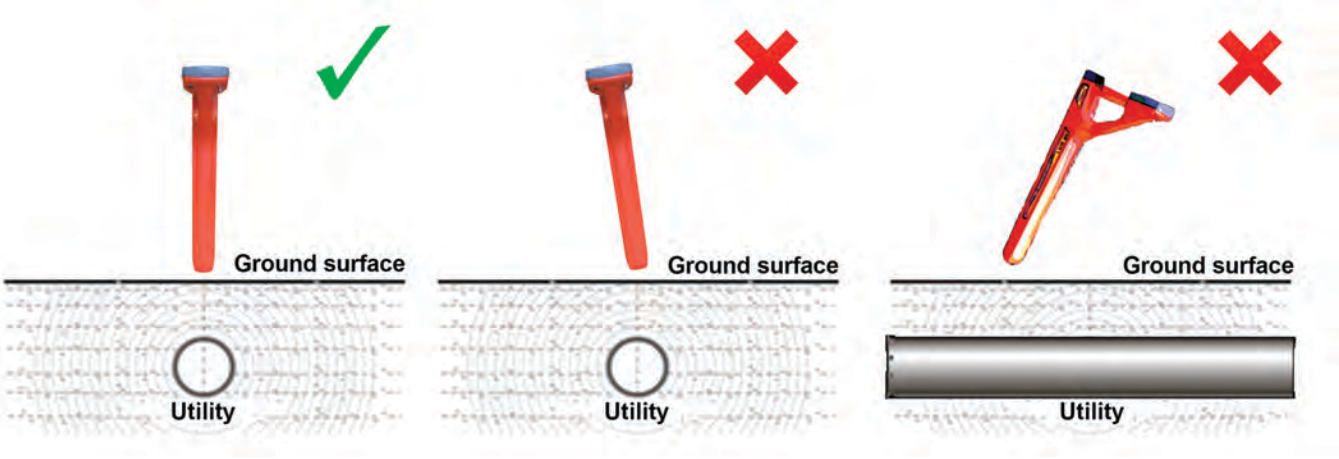
***Specialties of utility depth measurements***

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



***Receiver position during depth measurement***

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




***Operation via external power supply***

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

***Specialties of utility location at 50Hz***

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

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

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

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

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

# 12. The transmitter AG-120
## 12.2. Appearance. Controls

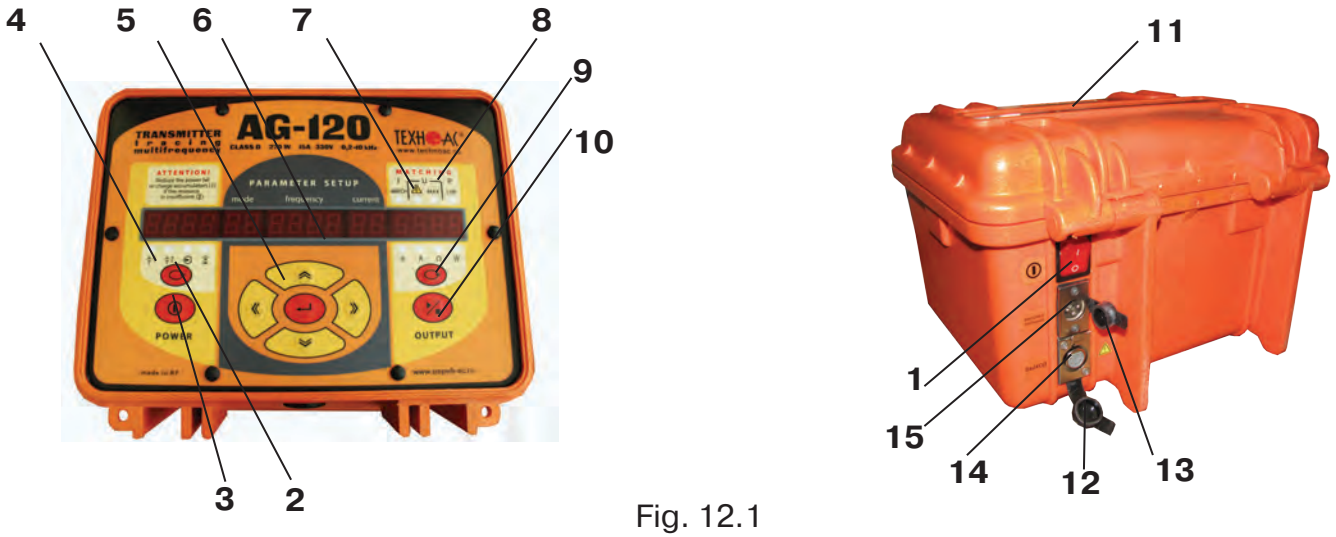



Fig. 12.1

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

## 12.2 Procedure of work with the transmitter

***SAFETY REQUIREMENTS***

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

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

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

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

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

**ATTENTION!**

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

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

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

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

## 12.3 Transmitter connection

1) Contact mode of transmitter connection

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

The connection to buried utility is done by mating of the output connector of the transmitter to the buried utility and grounding rod **figure 12.2.**

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

**Rules for grounding:**

- To achieve the maximum tracing distance when the transmitter is connected to the buried utility the grounding shall be arranged at an angle close to $90^0$ and **as far as possible** from the route in the assumed search direction.

Fig. 12.2

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

### Methods of transmitter connection to the route

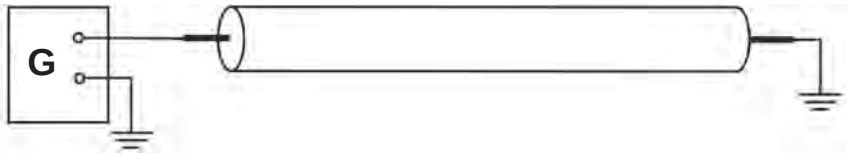
To achieve quality in route position detection the following rules should be observed:

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

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

1) The ground is a return conductor

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

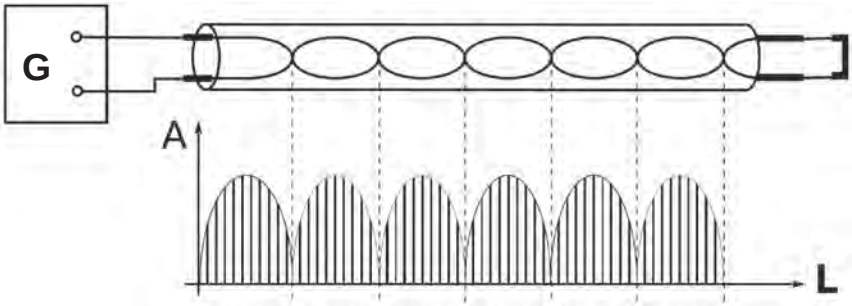



2) The cable armor is a return conductor

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


3) The cable cord is a return conductor

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



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

Connecting to the utility is carried out by induction method.

To do this: remove the antenna from it package and insert active part of the antenna in the foundation body. Connect the antenna to the transmitter output connector (**pos. 14 figure 11.3**) and install over assumed place of route. The antenna and route must lay in the same plane.

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

Allows tracing of the selected buried utilities, energized and de-energized cables. The clamp shall be put around the conductor to be traced **figure 11.4.**

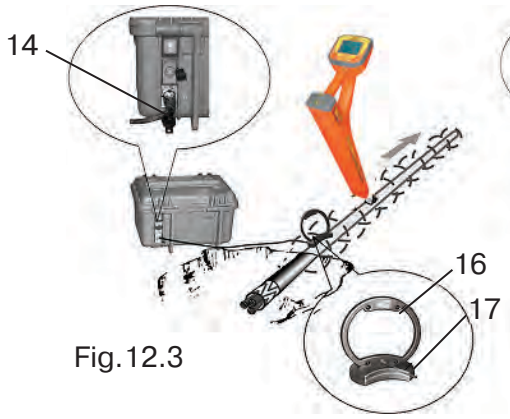


Fig.12.3

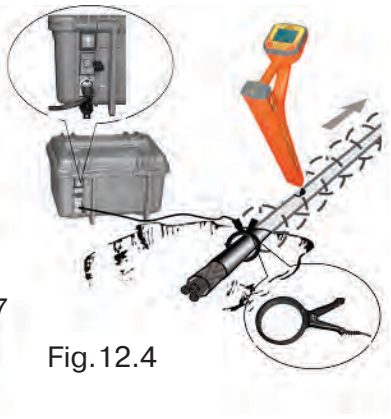


Fig.12.4

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

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

### 12.4 Turning on the transmitter power

Connect the load to the lowest connector on the transmitter rear panel in accordance with the tracing procedure (pos.14 **figure 12.5**). The examined route (pipeline, cable), inductive antenna or transmitting clamp can be used as a load.

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

Turn on the power with external mechanical switch «I/O» on the rear panel by setting it into the «I» position pos.1. Open the cover. Turn on the power with the button **pos.2 figure 12.6.** The indicators on fields «POWER» and «PARAMETER SETUP» will start indicating.

Fig.12.5

Fig.12.6

## 12.5 Parameter setup

The field «PARAMETER SETUP» **figure 12.7** is used for selection of one of three generation frequencies f1, f2, f3, one of three modes of sine generation (continuous «CO», one frequency transmission «PU», two frequencies transmission «2F» or charging mode «CH») and of four current loads. If necessary the "banks" of currents and frequencies can be modified quickly. The use of the transmitting antenna as a load is possible only if a generation frequency of 8192 Hz which is set automatically when the antenna is connected to the output.


Fig.12.7

1) To enter the setup mode depress the button of entering into parameters setup « ↵ » pos.5 while staying in the "stop" mode (no generation, yellow LEDs on the "OUTPUT" field **figure11.7**. are not on). Will begin to blink field of the indicator «MODE».

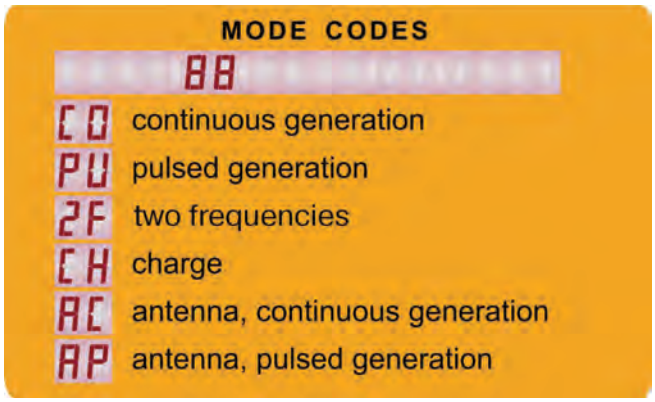



Fig.12.8

2) Depending on the task, to set the mode the buttons « ⩔ » or « ⩖ » (cycle) pos.5 **figure11.7** are used to select on the field "MODE" the symbol depicting the required generation mode or mode of internal accumulators charging. The mode codes are shown on figure 4.8. If the transmitting antenna is connected to the output, the signal «AC» is indicated (mode «antenna, continuous»). The selection in this case is possible only between modes «AC» and «AP» (mode «antenna, pulsed») directly by the buttons « ⩖ » or « ⩔ ».

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

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

It is possible to work with the specified frequency temporarily before power is switched off, if the generation (automatic matching) is activated immediately with the button « ⏻ » pos.10 **figure12.9.**

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


Fig.12.9

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

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

-the lower is the power – the higher is power supply life

-the lower is the current, the lower is the frequency – the lower «induction» on the neighboring elements

-the higher is the frequency – the higher is sensitivity of receiver, the less current (power) is enough, energy saving is possible, recommended for high-resistance buried utilities, on the other hand, the higher level of signal penetration into the neighboring objects and, as a result of higher attenuation, the signal is spread at the less distance.

-the higher is the current, the lower is the frequency – the range of transmission and route detection is higher, but the power required is higher.

## 12.6 Modification of the set parameters

To modify the set parameters, stop the generation with the button « » pos.10 **figure 12.9** at the field «OUTPUT» by one or two depressions and proceed to the parameters setup. The first depression of the button « » pos.10 results in stop of the automatic matching process at the achieved level (the indicator readings are “frozen”, no generation, yellow LEDs on the field «OUTPUT» are not on), second depression on the button « » results in the stop of generation (the indicator is off).

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

## 12.7 Indication of parameters

1) Indication on the field «POWER» figure 12.10.

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

⏚1- voltage on the “base” internal accumulator №1

⏚2 -voltage on the «superstructure» internal accumulator №2

⊕ -voltage on the external power supply input

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

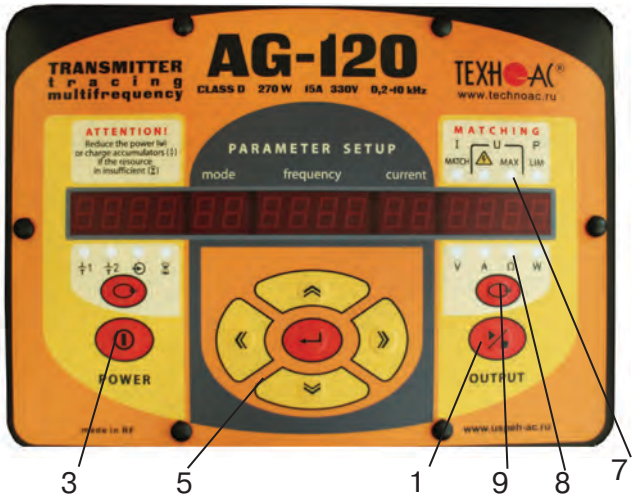



Fig. 12.10

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

If two or three first LEDs are illuminated at the same time, that means that the digital field «POWER» indicates the resulting voltage, supplying the terminal power amplifier. In this the first (left) seven-segment indicator on the field «POWER» symbolically depicts the configuration of mutual connection of the power supplies. The list of possible power supply configurations and codes is given on the transmitter cover (figure 12.11).

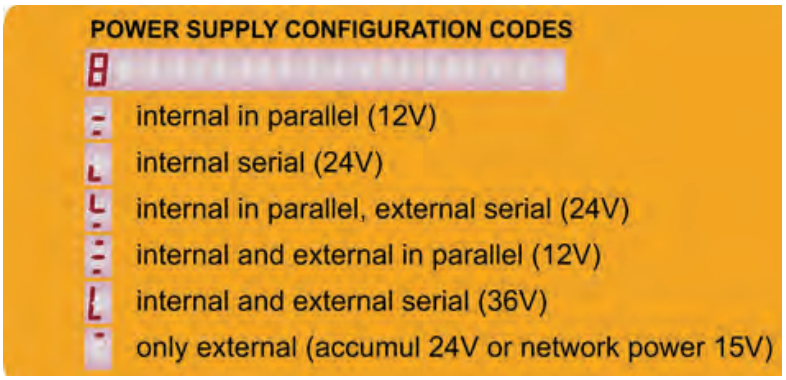



Fig. 12.11

2) Indication on the field «PARAMETER SETUP»

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

3) Indication on the field «OUTPUT»

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

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

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

During the generation the estimated values of output parameters are indicated on the digital field «OUTPUT»: load voltage «V», load current «A», load resistance «Ω», load power «W». The accuracy of measurement (±5 % for «V» and «A» and ±10 % for «Ω» and «W») is sufficient for situation evaluation and decision making. The indicated parameter is selected by the button «⁄■» pos.9 the LED corresponding to the selected parameter is illuminated pos.8 figure 12.10.

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

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

After complete attempt of automatic matching (not aborted) the field «MATCHING» pos.7 figure 4.10 reveals the result:

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

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

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

## 12.8 Start and stop of generation

If after power is turned on the button «» pos.10 is depressed shortly in the standby mode («stop»), the generation and automatic matching – step-by-step increase of voltage at the output until the specified current is reached shall be started. It is recommended to monitor the power life indicator (« » on the field «POWER»). If the output voltage («V») exceeds «24.0» the automatic matching shall stop anyway. If the specified current is not reached, the indicator “Umax” shall be on in the field «MATCHING». This is a **safe mode** set by default when the power is on.


Fig. 12.12

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

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

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

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

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

**ATTENTION! ENERGY SAVING!**

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

**Long-term storage of accumulators in discharged condition results in complete loss of their serviceability. Before long term storage charge the accumulators and recharge them at least every 6 months. The temperature during storage shall be +20…25ºC.**

## 12.9 Operation with inductive antenna

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


Fig. 12.13

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

The following is indicated: mode «AC», frequency «8192», current «0,2». After transmission is activated with the button « » pos.10 the automatic matching results in automatic setting with optimum specified parameters. After that if necessary the output voltage can be reduced or increased with the buttons « » and « ». To continue transmission after power interruption restart with the button « » is required.

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


Fig. 12.14

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

## 12.10 Operation with the transmitting clamp

If there are several closely located buried utilities it is recommended to use the transmitting clamp figure 12.14 to induce the current specifically in one of them contact-free. The power consumed by the clamp is reverse proportional to the signal frequency if the voltage is constant. It is not recommended to apply the power more than 60W in the continuous generation mode (CO).

## 12.11 Operations under precipitations

The waterproof instrument **(IP54)** allows operation under precipitations when the cover is closed providing the on-line adjustment of parameters is not required. The power is turned on/off with external waterproof power switch «I/O» pos. 1 figure 12.15. The readings are monitored through the transparent window in the cover pos. 11 figure 12.15. Make sure the required mode is selected and start the transmission before closing the cover. Every time the power is turned on with the closed cover the system shall restart this mode (except for «AC» and «AP») with automatic matching. The transmission is indicated by highlighting of the external switch. The free connectors on the rear panel are protected by rubber plugs.

## 12.12 External power connection

The additional accumulator (12/24V) or power adapter output (15 V) can be connected to the upper connector of the rear panel pos.15 figure12.15.

**ATTENTION!**

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

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

## 12.13. Internal accumulators charge

Necessary instruments for charge is given on a figure:

Transmitter
AG-120TM

Charger
AG120.02.100

Charger connection scheme is given on a figure:

EXTERNAL POWER
SOCKET

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

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

1. Connect power cable to the charger AG120.02.100;

2. Connect the charger to «EXTERNAL POWER» socket of the transmitter and connect it to 220v power supply;

3. Select «CH» mode in transmitter menu:

- in «STANDBY» (yellow indicators are not glowing, transmission is off), press «  » (ENTER) button. Indicator “MODE” will start to block;

- using arrow keys «⩔» / «⩒» («MORE» / «LESS” select «CH» mode;

4. Press« ⏯» (START/ STOP).

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

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

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

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

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

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

- Transmitter grounding selection (refer to p.11.3);
- Definition of transmitter connection type (refer to p. 11.3);
- Setting of transmitter parameters (refer to p.11.5);
- Adjustment of receiver (refer to p.11.3).

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

TECHNO-AC

**Thank you for choosing Techno-AC equipment!**

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

**We will solve your problem in no time.**

## Appendix 5
## Specifications of AG-120

| Frequency of generated signal | |
|---|---|
| Frequency of generated signal<br>Frequencies f1, f2, f3 (three frequencies fixed in memory), Hz | Range 200…9999<br>(selected in the range with a resolution of 1 Hz and accuracy of ±0,05% Hz and input in the power-independent memory) |
| Frequency f4 (one «temporary»), Hz | Range 200…9999<br>(selected instead of one of the «fixed», not input to the memory, exists while the power is on) |
| Output parameters | |
| Output current | |
| Maximum in manual mode:<br>- continuous and two frequencies generation, A<br>- pulse generation, A | <br>10<br>15 |
| Maximum output voltage | |
| - when working in safe mode, V<br>- under internal power supply, V<br>- with added external accumulator 12V, V<br>- when supplied from power adapter, V | 24<br>220 (170 when «2F»)<br>330 (260 when «2F»)<br>140 (110 when «2F») |

| Maximum output power when accumulators are fully charged | |
|---|---|
| - under internal power supply or from external accumulator 24V, W | 120 continuous at a load of 1,2…300 Ohm / 180 pulsed at a load of 0,8…200 Ohm |
| - with added external accumulator 12V, W | 180 continuous at a load of 1,8…450 Ohm / 270 pulsed at a load of 1,2…300 Ohm |
| - from power adapter, W | 70 at a load of 0,7…200 Ohm |
| NOTE. When incompletely charged or (and) frequencies above the “logarithmic middle point” of the range (1,4kHz) the reduction of the maximum power with an increase of frequency and load resistance is possible at no more than 3dB. | |
| Resistance range for matched loads, broader than | |
| For minimum specified current (0,1A)<br>- for internal power, Ohm<br>-with external accumulator 12V added, Ohm | <br>4…2200 (4…1700 when «2F»)<br>4…3300 (4…2600 when «2F») |
| For maximum continuous current (10A)<br>- for internal power, Ohm<br>-with external accumulator 12V added, Ohm | <br>0…1,2<br>0…1,8 |
| For maximum pulsed current (15A)<br>- for internal power, Ohm<br>-with external accumulator 12V added, Ohm | <br>0…0,8<br>0…1,2 |
| **Matching with the load** | |
| | - automatic, providing achieving of the specified current in the load<br>- manual (buttons « » or « ») |

| Design parameters | |
|---|---|
| Output power amplifier | Pulsed, technology CLASS D(BD), Efficiency factor > 80% |
| LED-based superbright digital indicators of high temperature range | - all supply voltages<br>- modes and settings<br>- power resource<br>- «OUTPUT MULTIMETER»:<br>«output voltage», «current in load», «load resistance», «power in load» |
| Control | Nine-button keyboard and external power switch with generation indicator providing work under rain with closed cover (due to parameter setup “memorizing”). Intuitive interface |
| Dimensions of electronic block (case), maximum, mm | 305x270x194 |
| Weight of electronic block, maximum, kg | 12 |
| Operating temperature range, $^0$C | -30 ...+50 |
| | |

## Appendix 6
## Symbols displaying the power supply configuration of the AG-120 transmitter


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


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


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


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


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


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

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

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

**Symbolic depiction of the AG-120 multifrequency transmitter operation modes**

continuous generation

pulsed generation (short transmissions)

two frequencies (frequencies sent in turn)

charging of internal accumulators

transmitting antenna connected, continuous generation

transmitting antenna connected, pulsed generation

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

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