RESEARCH AND PRODUCTION COMPANY "RADIO-SERVICE" JSC

Locator "Stalker" PT-14

Operation Manual

RAPM.464333.007OM

This Operation Manual describes components and operating principle of locator "Stalker" PT-14 (hereinafter referred to as locator) and contains the data relevant for proper operation, safety precautions and checking procedure.

Operating conditions:

- operating temperatures of minus 20 to plus 55 ºC;
- relative humidity of 90 % at the temperature of plus 30°C;
- atmospheric pressure of 60 to 106.7 kPa (460 to 800 mm Hg).

Normal operating conditions:

- ambient air temperature of plus 15 to plus 25 ºC;
- relative air humidity of 30 to 80%;
- atmospheric pressure of 84 to 106 kPa (630 to 795 mm Hg).

Protection grade of the casing is IP54 in accordance with GOST 14254.

In terms of safety the locator complies with requirements of GOST IEC 61010-1-2014

In terms of electromagnetic compatibility, the locator complies with requirements of GOST R 51522.1

Protection against mechanical impacts is IK08 in accordance with IEC 62262.

Due to permanent upgrade of the locator, design changes improving its reliability and operation conditions, the items produced and the design described in this Operation Manual may differ to some extent.

⚠ ***ATTENTION! Please read this Operation Manual before switching on the locator.***

All the survey procedures of underground utilities are based on analysis of **relative *variations*** of signal values to be determined.

1 Description and Operation

1.1 Purpose of the Locator

1.1.1 The locator together with transmitters GT-75 or GT-15 is used survey of cable lines and pipelines (hereinafter referred to as utilities):

- determination of the horizontal position and direction of a utility, with deviation from its axis specified, along with indication of utility depth and the current of operating frequency flowing therein ("TRACE" mode);

- locating of utility damaged spots along with determination of utility's horizontal position and depth ("TRACE-SENSOR" mode);

- selecting of cable cores, locating of short circuits or ruptures in cable or wiring (when used with mini sensor MD-01);

1.1.2 The locator without the use of the transmitter ensures the following on operating frequencies:

- "50 Hz" and "550 Hz" - search for utilities (cable lines), basing on signals of power currents;

- "100 Hz" and "300 Hz" - search for utilities and damaged spots of the pipeline insulation, basing on signals of cathodic protection;

- "550 Hz" and "1450 Hz" - search for fault to earth in overhead lines (OHL), basing on power current harmonics;

- "SB" - search for utilities by telephone or broadcasting signals within range of 48 Hz to 14 kHz.

- "RADIO" - search for utilities by telephone or broadcasting signals within range f 10 Hz to 36 kHz.

1.1.3 The locator records displayed values, as well as their reference to coordinates obtained from an external GPS logger. The locator provides data transmission to PC or Android device for further analysis.

1.2 General Specification

1.2.1 General specification is given in table 1.2.1.

Table 1.2.1 – General specification

<table>
<tr><th>Parameter</th><th colspan="2">Value</th></tr>
<tr><td rowspan="2">Operating frequencies during operation with the transmitter, and sensitivity on this frequency</td><td>Frequency, Hz</td><td>Sensitivity, min., µA/m*</td></tr>
<tr><td>273
526
1024
8928
32768 (33k)</td><td>500
300
150
25
5</td></tr>
<tr><td>Auxiliary operating frequencies during operation with transmitters of other manufacturers</td><td colspan="2">491, 512, 982, 2000, 2048, 8440, 9828, 10000</td></tr>
<tr><td>Operating frequencies during operation without use of transmitter, Hz</td><td colspan="2">50, 60,100, 300, 550 and 1450</td></tr>
<tr><td>Dynamic range of input signals, min., dB</td><td colspan="2">102</td></tr>
<tr><td rowspan="2">Pass bandwidths for each operating frequencies, Hz, max</td><td>at the minus 3 dB level</td><td>at the minus 60 dB level</td></tr>
<tr><td>9</td><td>24</td></tr>
<tr><td>Determination of the utility depth, m</td><td colspan="2">0.10 to 10.00</td></tr>
<tr><td>Determination of the power current in a utility</td><td colspan="2">10 mA to 10,0 A</td></tr>
<tr><td>Depth accuracy for stand-alone extended and direct utility, max</td><td colspan="2">±{[4+0.2h(h+1)]%+0.1 m}, where h is measured depth</td></tr>
<tr><td>Indication of signals voltages on operating frequencies at the input of "SENSOR" jack</td><td colspan="2">0.01 mV to 1.70 V</td></tr>
<tr><td>Voltage accuracy</td><td colspan="2">± (3% + 3 digits)</td></tr>
<tr><td>Sensitivity at the input of "SENSOR" jack at 6 dB signal-to-noise ratio, min., mV</td><td colspan="2">0.05</td></tr>
<tr><td>Input resistance at the "SENSOR" input, MΩ</td><td colspan="2">1</td></tr>
<tr><td>Power consumption, W, max</td><td colspan="2">2</td></tr>
<tr><td>Duration of continuous operation in normal conditions with a charged battery, min., h</td><td colspan="2">5</td></tr>
<tr><td>Overall dimensions, max., mm</td><td colspan="2">700×300×140</td></tr>
<tr><td>Weight, max., kg</td><td colspan="2">1.8</td></tr>
</table>

Note*. Standardizes for the "flat maximum" method. Signal-to-noise ratio - 6 dB

1.2.2 The locator has step-by-step regulation of input signal amplification with a 6 dB step (each step doubles the amplification).

1.2.3 The supply voltage range is from 7.5 to 5.2 V.

The power supply is provided with a nickel metal hydride (Ni-Mh) rechargeable battery of 6 V rated voltage and 2000 mA/h capacity, or with five replaceable AA batteries placed in a battery compartment. It is allowed to use five AA batteries of 1.2 V rated voltage.

The locator design allows battery replacement without damaging seal.

1.2.4 The locator provides indication of battery status and switches off automatically when battery is discharged.

1.2.5 With the power unit connected, the locator allows charging and ensures overcharge protection of the battery without taking out from the locator.

1.2.6 The locator can communicate with external GPS Bluetooth module and PC via Bluetooth connection.

1.2.7 Life time of the locator is no less than 6 years.

1.3 The delivery set is given in Table 1.3.

Table 1.3 – Delivery set

Item	**Q-ty**
Locator "Stalker" PT-14	1
Headphones	1
Power unit	1
5 x AA battery compartment	1
Operation Manual RAPM.464333.007OM	1
Bluetooth-USB adapter	1
Locator bag	1
Sun cover	1
Package RAPM.323229.015	1 (if the locator is supplied as a separate item)
Mini sensor MD-01 RLPA.411519.001	1*
Insulation sensor DKI-E RLPA.411129.001	1*
"A-frame" sensor with mount RAPM.418114.001	1*
Insulation sensor DKI-P1 RAPM.411129.002	1*
Insulation sensor DKI-02 RAPM.411129.001	1*
External GPS “Bluetooth” module	1*
Note. Positions marked with * are delivered against a separate order.	

1.4 Design and Operation

1.4.1 Locator appearance is shown in Figure 1.4.1.

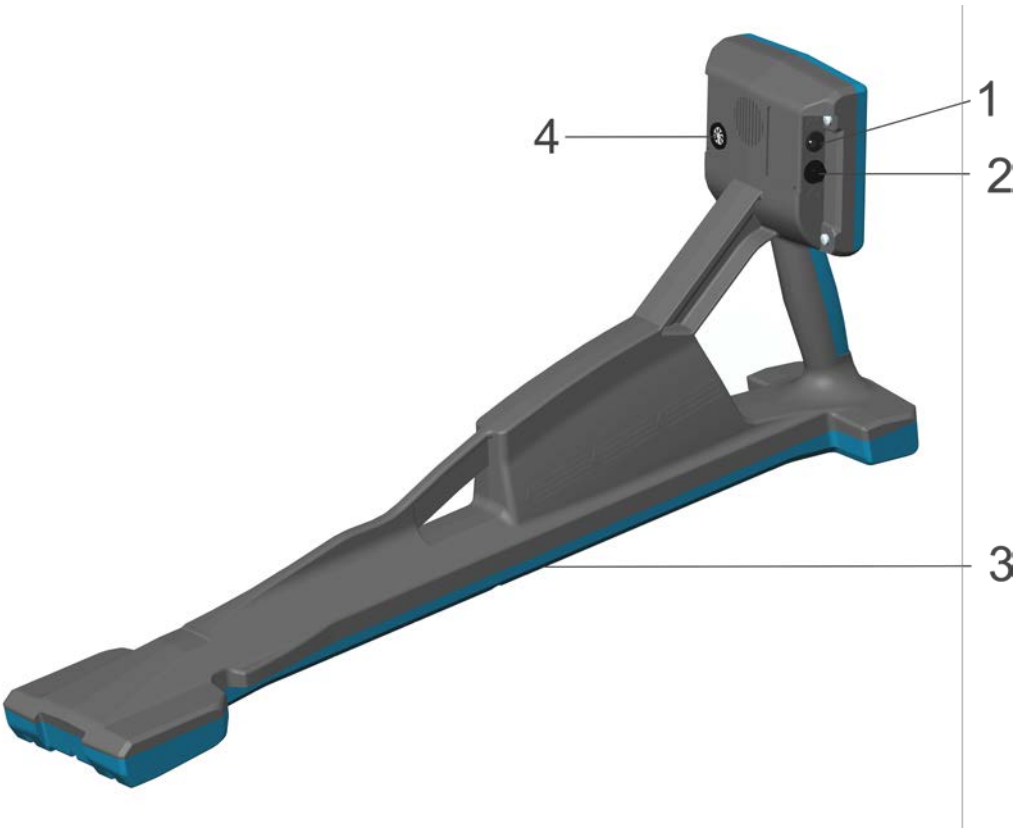


Figure 1.4.1 – Locator appearance.

On figure:

1 – power unit socket, 12 V / 0,5 A (central pin has a negative polarity ⊖—⊙—⊕);

2 – headphones jack;

3 – battery compartment cover;

4 – "SENSOR" jack for replaceable sensors.

The locator could be equipped with sun-protective cover to facilitate operation in sunny weather. The cover is attached with two touch fasteners to the locator handle. The locator equipped with cover is shown in the figure.

1.4.2 The front panel of the locator is shown in Figure 1.4.2.

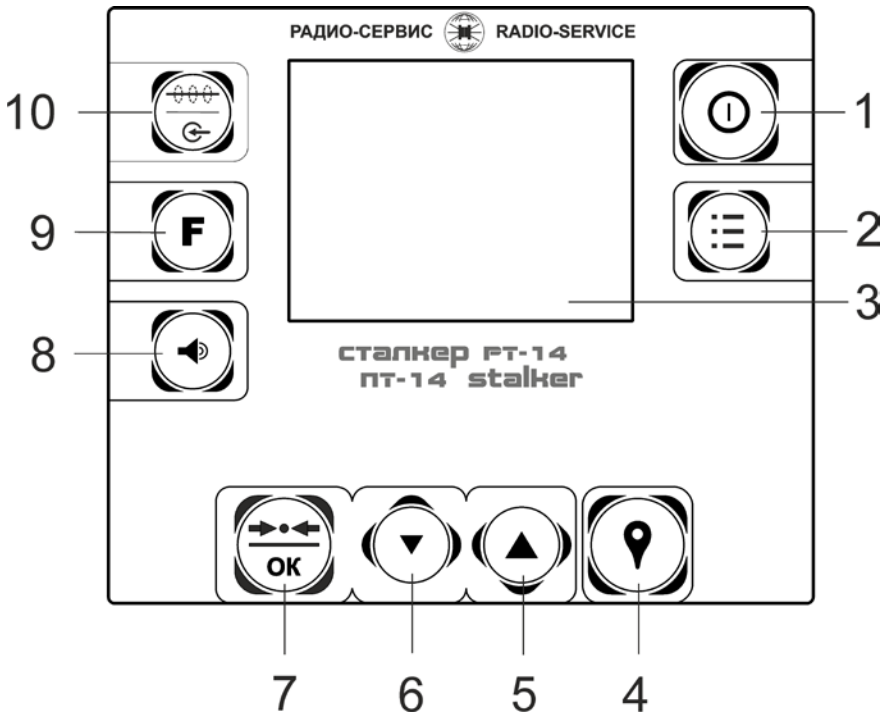


Figure 1.4.2 - Front panel of the locator

On Figure:

1 - "⏻" key to switch the locator on and off;

2 - "MENU" key to enter and exit the MENU;

3 - display;

4 - key to store displayed parameters and GPS coordinates displayed on the screen for their further transmission to PC;

5, 6 - keys to increase/decrease the amplification and to travel over the MENU;

7 - "→•← / OK" key to set the adequate amplification for this signal strength in "TRACE" or "SENSOR" channel (depending on the current control zone). The key allows measuring the depth and current, with "Automatic measurement" disabled. In the "MENU" the key enables/disables selected option.

8 - volume key;

9 - "F" key to switch between operating frequencies;

10 - "MODE" key to select search mode. In "TRACE-SENSOR" mode, the key is used for switching control zones to change operating frequencies and amplification between "TRACE" and "SENSOR" channels.

1.4.3 Operating Principle

The locator locates utilities and cable faults by induction method. Connection of replaceable sensors allows locating spots of damaged insulation by voltage caused by current to the ground.

The current induced in antennas by utility's alternating magnetic and/or the voltage induced in replaceable sensors are transformed into electrical signals which are amplified and processed by digital signal processor. Then signal levels are displayed on the screen as bars and digital values in "dB" or "Volts". Indication on the display may be duplicated with the audio signal.

2 Intended Use of the Locator

2.1 Electrical Safety Measures

During operation with alive cable observe requirements of "Occupational safety rules during operation of electrical installations" and use the means of protection against electric shock as per "Instruction on use and testing of protection means used in electrical installations".

Avoid the voltage over 42 V on exposed metal parts and jacks of the locator.

2.2 Preliminary Procedures

If the locator was exposed to a temperature differing from the operating one, first it shall be held at working operating temperature for not less than 1 hour before operation.

Take the locator out from the bag and check for serviceability of protective covers, fasteners, absence of mechanical damages on the locator body and on the power unit.

2.2.1 Charging the Rechargeable battery

The power supply of the instrument is provided with a nickel metal hydride rechargeable battery RAPM.436244.006, 6 V / 2000 mA/h.

Note. Before charging, make sure that a rechargeable battery is put into the battery compartment. If the battery covert contains non-rechargeable batteries when charging, this may cause damage to the locator.

Note. The rechargeable battery is charged at an ambient air temperature of +10 to +30 ºC. Failure to comply with this rule may reduce the rechargeable battery life.

Battery level is displayed as battery symbol.

In order to charge rechargeable battery, connect plug of power unit to corresponding jack of locator. Then connect power unit to 220V mains. Charging progress is shown by filling the icon . When the battery is fully charged, the icon is full.

Charging a dead rechargeable battery requires 6-8 hours.

If the instrument has not been in use for a long time, recharging a rechargeable battery every three months is recommended.

Note. While charging an extremely discharged rechargeable battery the charging indication may not appear on the display for some time.

Note. A standard rechargeable battery is charged with 400 mA to 500 mA current. When charging rechargeable battery with other capacity, check its temperature regularly, e.g. by touch. If the temperature rises rapidly, stop charging immediately.

3 Menu Settings, Description and Indication of Operation Modes

3.1 Menu

To enter and/or exit the menu (figure 3.1.a) press the «MENU» key. To scroll the menu use signal amplification increase/decrease keys. Use the «→•← / OK» key to select item, edit or confirm an action.

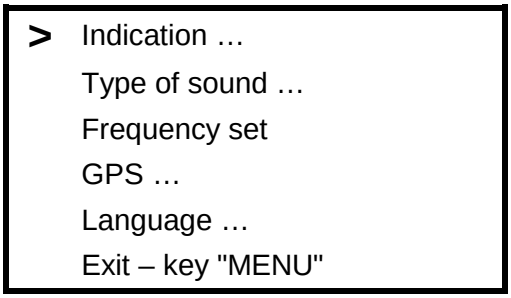


Figure 3.1.a

Indication

In the Indication submenu (Figure 3.1.b) the following may be set:

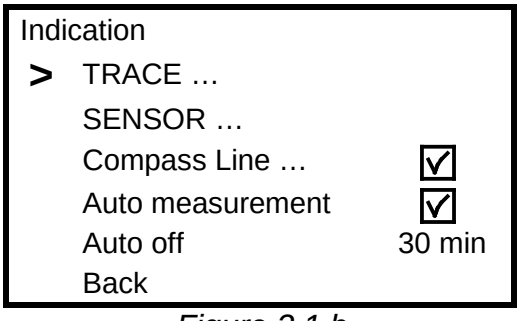


Figure 3.1.b

- TRACE submenu (*Figure 3.1.c*):

- enabling/disabling indication of peak and null scales on the display;

- selection of peak modes

- zoom 1:4;

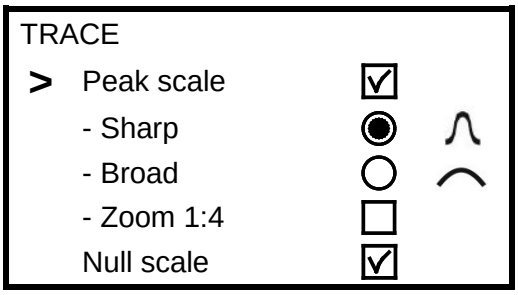


Figure 3.1.c

- SENSOR submenu (*Figure 3.1.d)*:

- selection of indication of signal strength at the "SENSOR" jack input either in "dB" or in "Volts";

- zoom of sensor scale 1:4;

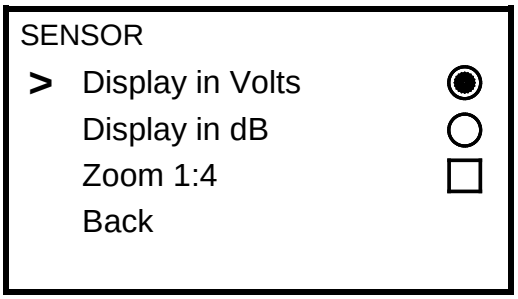


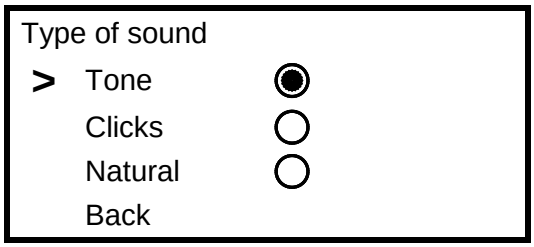
Figure3.1.d

- Menu item “Compass line” allows enabling/disabling the "Compass line" option;
- Menu item “Auto measurement” allows enabling/disabling permanent indication of the utility depth ("H") and utility current ("I").

Menu item «Auto off» allows setting the time of automatic shutdown. Available time: off (automatic switching off is disabled) → 10→ 20→ …90 min. → off. The auto-off is set to 30 min by default.

Type of sound

In the "Type of sound" submenu the type of sound accompaniment of indication may be selected:



- Tone is a tone of one frequency, the volume is proportional to the signal strength;

- Clicks sound is similar to clicks of Geiger counter (dosimeter); frequency of clicks is proportional to the signal strength;

- Natural sound allows listening directly to the signal from the antenna for "50 Hz", "60 Hz" and "SB" frequencies, which provides operation "by ear".

In "TRACE" mode, the sound duplicates the signal strength from the peak scale. With the “peak” scale disabled, the sound duplicates the signal strength of the null scale. In "TRACE-SENSOR" mode, the sound duplicates the signal strength at the "SENSOR" jack input.

Frequency Set

Frequency set submenu allows (Figure 3.1.e) selection of frequencies available for further operation.

To add the frequency to the list of available ones and to delete it use "→•← / OK" key

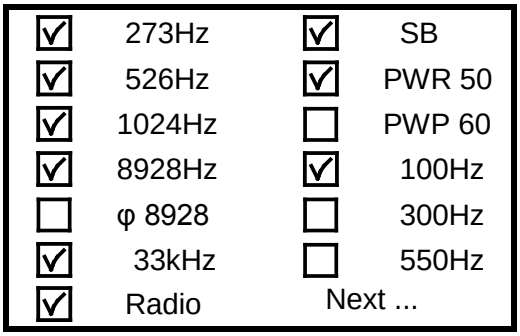


Figure 3.1.e

GPS

GPS submenu allows the following (Figure 3.1.f):

- setting of connection and operation of the locator with external GPS “Bluetooth” logger.
- Enabling PC connection
- setting of track record and details;
- operation with track list saved in locator memory.

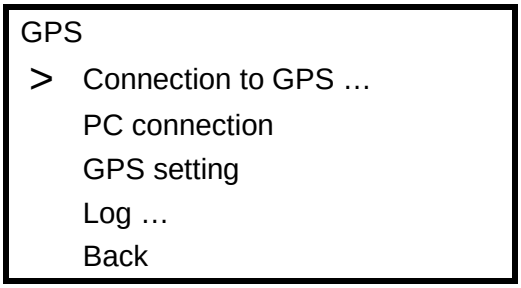
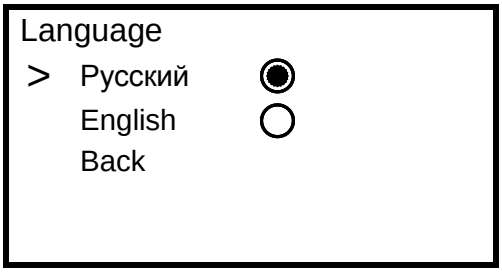


Figure 3.1.f

Language

In language submenu an interface language may be chosen.

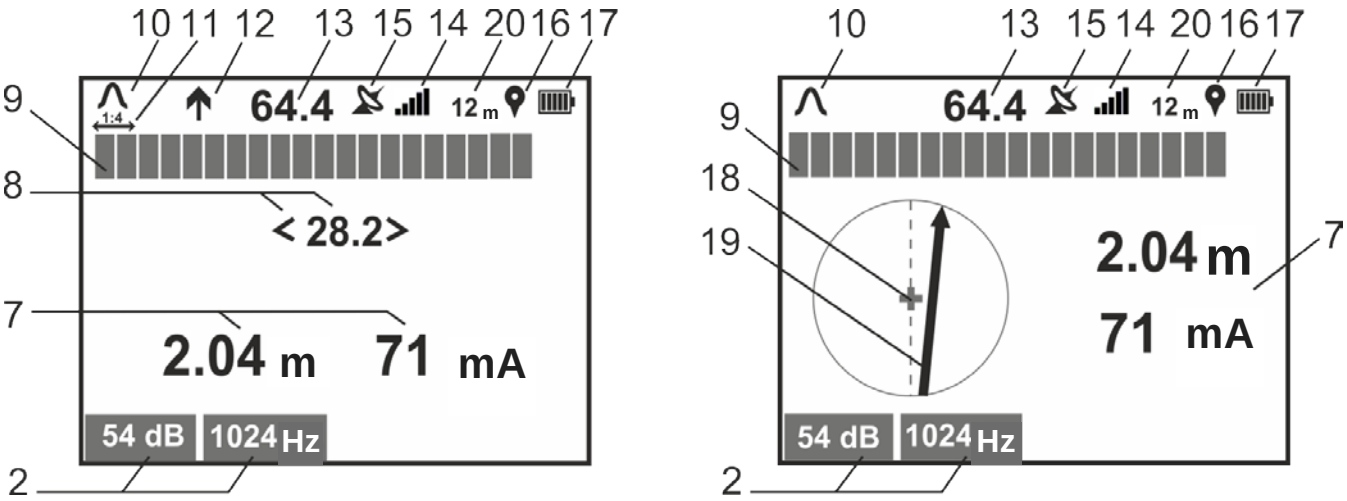


3.2 Indication and Operation Modes of the Locator

To switch from one mode to another, press the "MODE" key and hold it for more than 2 seconds.

The locator has two operation modes:

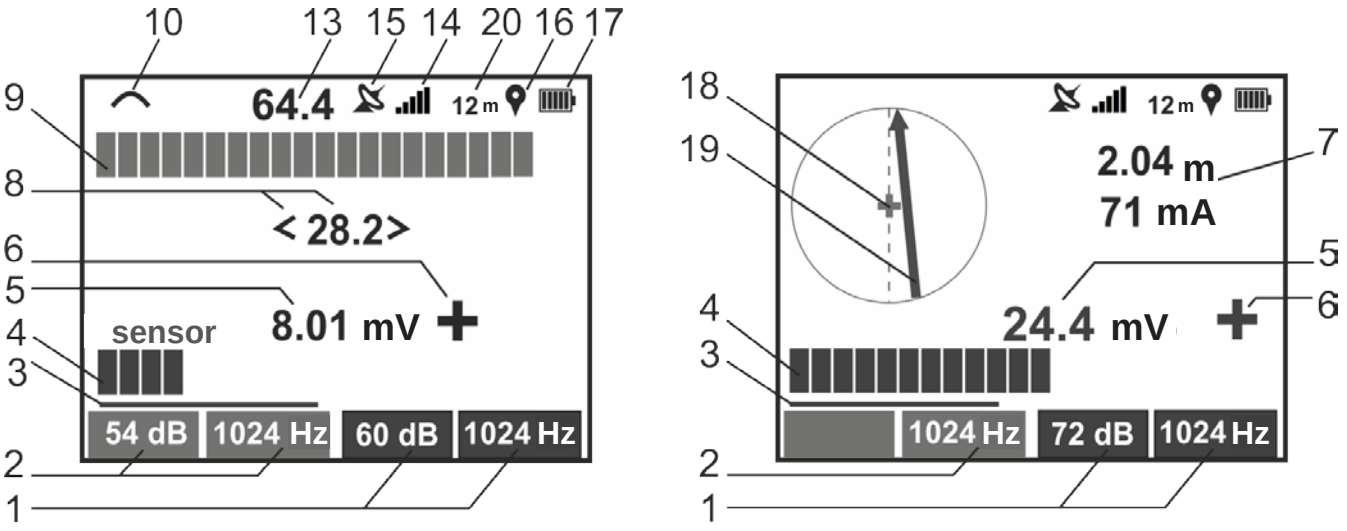
- TRACE mode is intended for locating utilities along with measurement of the utility depth and current (Figure 3.2a). With the "Compass line" option on, the utility position and direction relative to the locator are additionally displayed (Figure 3.2b).



a) b)

Figure 3.2 – Locator indication in TRACE mode

- TRACE-SENSOR mode is intended for locating damaged spots of utility insulation and measurement of damaged area depth. It also may be used to search for cable rupture, short circuit, or to select cores in a multicore cable (Figure 3.3a). With the "Compass line" option enabled, the utility position and direction relative to the locator are additionally displayed (Figure 3.2b).



a) b)

Figure 3.3 – Locator indication in TRACE-SENSOR mode

In Figures 3.2, 3.3 and 3.4:

1 – amplification and operating frequency of the SENSOR channel;

2 – amplification and operating frequency of TRACE channel;

3 – indicator of an active zone for the change of amplification or operating frequency for "TRACE" and "SENSOR" channels. The active zone is changed by short pressing of "MODE" key.

4 – bar graph of relative signal strength at the "SENSOR" jack input;

5 - voltage at the "SENSOR" jack input - in "Volts" or "dB";

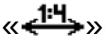
6 – relative polarity of potential difference at the "SENSOR" jack input caused by leakage currents (item 5.2.1);

7 – indication of utility depth and current;

8 – input signal from the magnetic antenna in "dB" and the scale of input signal relative level (null scale) during tracing by null method with indication of the direction towards the utility (item 4.2.2)

9 – bar graph of input relative signal strength (peak bar graph) during tracing by peak method (item 4.2.1);

10 – icon of sharp ("  ") or board ("  ") peak mode (item 4.2.1);

11 – icon of zoomed scale «  »(item. 4.2.1);

12 – utility current direction icon: «  » – from the transmitter, «  » – to the transmitter (item 4.2.4);

13 – input signal from the lower magnetic antenna in "dB" during tracing by peak method (item 4.2.1);

14 – volume indicator;

15 – icon of the state of connection to the GPS logger, "  " or "  " (item 6.2);

16 – icon of recording to track "  ", displayed during recording (item 6.2);

17 – icon of battery level;

18 – locator position and axis;

19 – in "TRACE" and "TRACE-SENSOR" mode - the indicator of utility position;

20 – distance covered (item 6.4).

4. Methods of Utility Search

4.1 Selection of the Operating Frequency

The frequency selection shall depend on operation conditions, nature of the task to accomplish, method of utility search, and requires certain skills from the operator.

In order to switch between operating frequencies, press F key.

It is recommended to start searching for utilities at the low frequency, both in case of inductive locating and direct connection. If the lower frequency does not ensure the required signal strength, you may increase searching frequency. The search at low frequencies allows reaching the maximum range in wet soils and reduces signal noises to other utilities. However, noises of power signal and nearby utilities are stronger at low frequencies.

At high frequencies the range of search for utilities in the dry or frozen soil increases, while noises of power signals and adjacent utilities are lower. Also high-frequency search reduce signal looses caused by any insulated joints in target utility. However, the transmitter induces much noise to adjacent utilities, and this may result in false trails.

The search for utilities and damaged spots is available without use of the transmitter at the operating frequencies (basic frequency or harmonics) – locator operating frequency "PWR50" (PWR60), or by signals of cathodic protection - locator operating frequency "100 Hz", "300 Hz", or by telephone or broadcasting signals - locator operating frequency "SB" or "Radio". However, this method may cause false trails because direction of target utility may not be found by “own signal” if it has any brunches. This method requires certain skills from the operator.

4.2 Methods of Search by Peak, Null and Current Direction

The locator has four magnetic antennas. The working position of the locator is upright (Figures 4.2.1 and 4.3). The search in “broad peak" mode employs the lower antenna positioned horizontally, the search in “sharp peak” mode employs two horizontal antennas, the search in “null” mode employs the lower horizontal and lower upright antennas, the "Compass line" option, when enabled, employs all 4 antennas of the locator.

4.2.1 Peak Modes

The locator has sharp peak and broad peak modes used for precise tracing of target utility depending on the depth and density of utilities in searching zone. In order to select one of these modes press MODE button. Dependence of signal strength indication on locator position relative to the utility is shown in Figure 4.2.1.

Peak modes are switched between through the main menu: Menu > Indication > TRACE > Peak scale > Sharp<> Broad (Fig.3.1c).

The search in sharp peak mode provides high accuracy of locating the utility since the signal peak near utility axis is on the abrupt area of the bar graph (Fig. 4.2.1, left display). When antenna is held directly over the utility axis, the signal will be on its peak. At this point set the amplification to fill 3/4 of the bar graph, and the most comfortable volume for the operator. The optimum amplification for this signal strength may be set automatically by pressing "→•← / OK" button. Upon moving locator away from utility axis bar graph indication will be reducing until it will disappear.

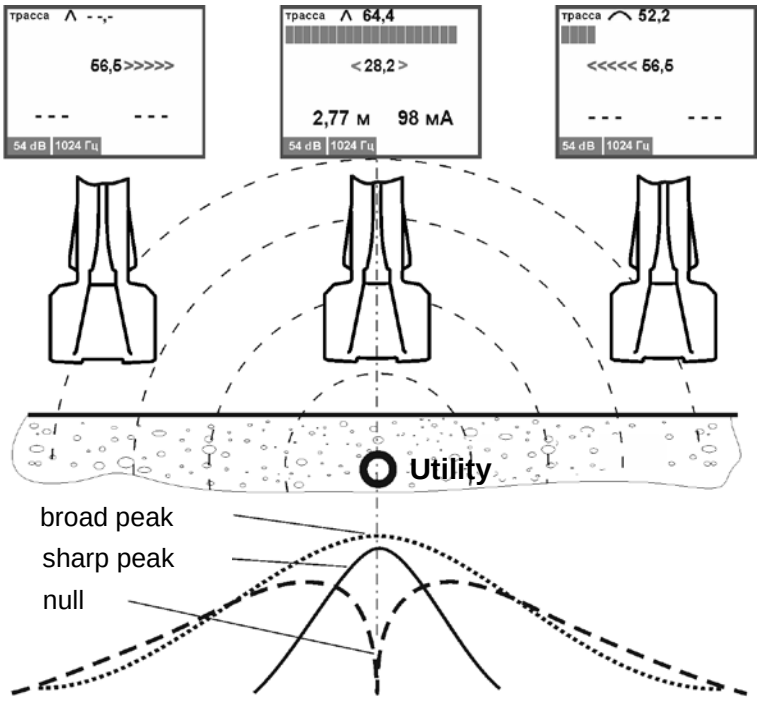


Figure 4.2.1 – Changing of signal strength while the locator is shifting relative to the utility axis.

In sharp peak mode readings may be unstable or missing if input signal strength is low or the target utility is laid too deep. In this case we recommend switching locator in broad peak mode, which is more sensitive to weak signals.

In broad mode peak readings do not depends directly on locator position relative to the utility axis since the signal peak can be found on the broad part of bar graph (Fig. 4.2.1, right display). However, only this mode provides the maximum sensitivity of the locator.

Upon approaching the utility, locator amplification and volume are adjusted depending on the level of the signal received. The signal strength may change periodically when locator is held right above cable cores twist, or may drop down significantly in spots

where the utility laid under the pipeline, shield with metal pipes, or where couplings are fitted.

Note. Indication of the input signal strength in "dB" during the tracing by peak method or null method (item 13 and 8 in Figure 3.2,) changes its color to red when corresponding input channels are overloaded.

Zoom

In some cases, the peak bar graph resolution is insufficient, e.g. when searching for pipeline branch of smaller diameter which is laid deep under the ground. In this s case the search current partially leaks to the bend, and the peak signal strength above the main pipeline drops down slightly, which may remain unnoticed.

If the "zoom 1:4" option is enabled, the division value becomes four times smaller, thus increase the scale resolution. The "1:4" icon (item 11 in Figure 3.2) will appear on the display and yellow line will be displayed under peak bar graph to show the expansion bar graph relative to the original (not zoomed) scale.

Enabling/disabling the "zoom 1:4" option is available from the main menu: Menu > Indication > TRACE > zoom 1:4 (Figure 3.1c).

Use amplification increase/decrease keys to bring the end of the zoomed peak scale within the visible area. The amplification increase key moves the zoom range to the left and increases the zoomed scale. Amplification decrease key makes the scale shorter.

Press "→•← / OK" key to get optimum signal amplification and zoom for specific signal strength.

4.2.2 Null Mode

The search in null mode allows locating a stand-alone utility more precisely, because the signal null is on the abrupt part of the graph. Figure 4.2.1 shows dependence of null signal strength on displacement of antenna away from the utility. When the antenna is directly over the utility axis, the signal will be on its minimum level. Upon shifting locator away from utility’s axis signal strength will growswell as bar graph readings. Further shifting will smoothly reduce signal strength.

The locator amplification needs maintaining at optimal level. If the amplification is too low, null scale response may be unnoticeable. If the amplification is too high, null scale response may be sharp or even chaotic.

During search the signal level may increase significantly. This may occur when locator is over the spot of utility bent. Bar graph drift will indicate direction of utility turn.

At the same time the search in null mode is more vulnerable to interference of currents in neighboring utilities. Therefore, it is recommended to switch the locator in sharp peak mode if there are any other utilities on the territory under survey.

4.2.3 "Compass Line”

Compass line option is used to facilitate tracing of single long utilities with bends. It displays position of target utility relative to the locator.

The "Compass line" option is enabled from the main menu: "Indication" > "Compass line".

The utility is schematically displayed as a line - an indicator of utility position (pos. 19, Figure 3.2 and 3.3). In the "TRACE" mode the locator displays the peak bar graph and the input signal strength; in the "TRACE-SENSOR" mode locator displays the bar graph, strength and polarity of input signal at the "SENSOR" input.

Tracing with the "Compass line" option enabled is shown in Figure 4.2.3.

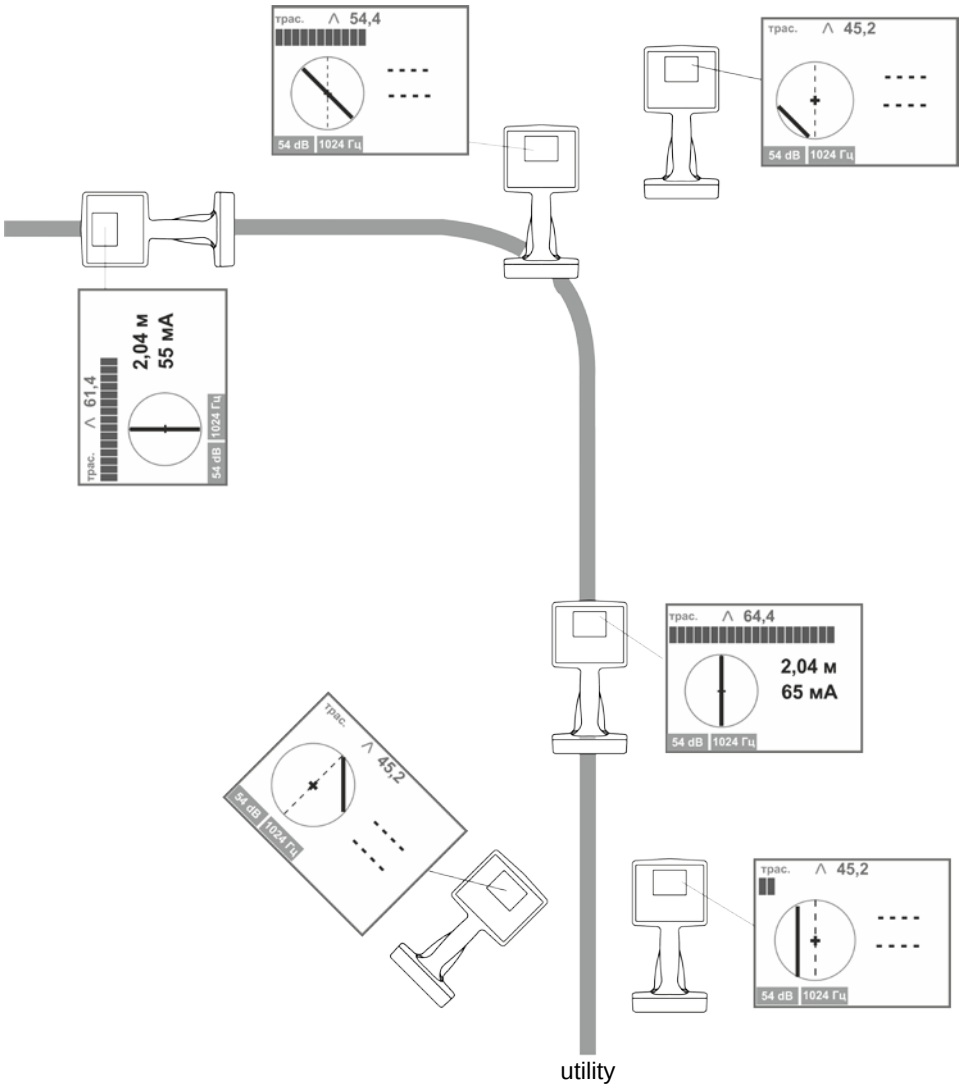


Figure 4.2.3 – Tracing with the "Compass line" option enabled

While moving along the utility, position the locator relative to the utility so the utility position indicator (item 19, Figure 3.2) turned to be aligned with the locator axis (item 18 Figure 3.2)

Note. Indicator of utility location only visualizes the utility direction and cannot be used for precise utility location. Apply peak mode (p. 4.2.1.) for precise utility axis search if the signal is weak, or there are any other utilities nearby the target one.

During the search the utility position indicator may become "blurred". It occurs when the locator is perpendicular to the target utility or it is far from the utility axis, or the search signal strength is too low at the noise background.

4.2.4. Search by Current Direction

The method of search by current direction is used for locating the target lone in zone with high concentration of utilities. On transmitter select mode of double-frequency signal of

"1024 Hz» and select “1024 Hz” operating frequency on the locator. If the double-frequency signal strength is sufficient, the indication of current direction (item 12 in Figure 3.2) will switch on automatically. With "Compass line" enabled the current direction is shown with the utility position line (item 19 in Figure 3.2).

It is important to connect the target utility directly to the transmitter. Neighboring utilities shall be galvanically separated from the target one at the point of connection (Figure 4.2.4.1).

The "forward current" will flow from the transmitter through the target utility and will be displayed as "↑" icon. The so-called "reverse current" will flow back to the transmitter through neighboring utilities and will be displayed as the "↓" icon. The “reverse current” appears due to the capacitance coupling or distant galvanic coupling with the target utility.

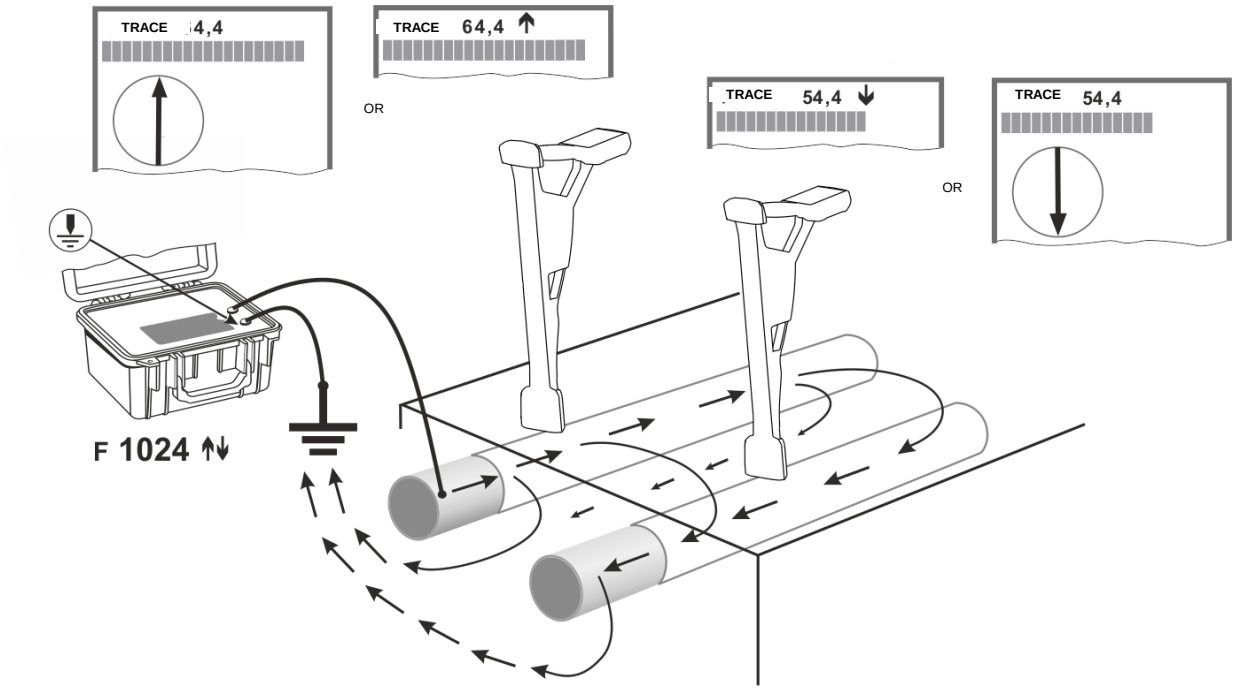


Figure 4.2.4.1 – Current direction and locator’s readings in galvanically separated utilities

If neighboring utilities are galvanically coupled to the target utilities, the signal direction will be the same on all of them (Figure 4.2.4.2). The signal amplitude in neighboring utilities may differ depending on search current spreading.

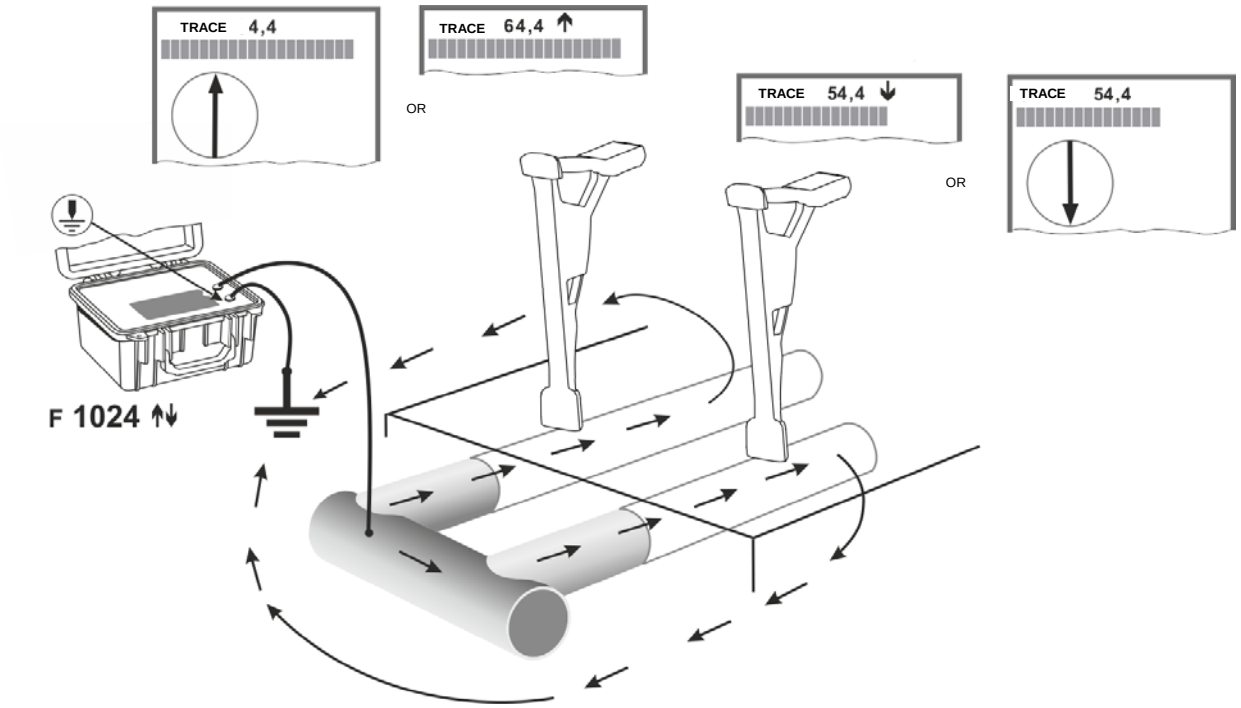


Figure 4.2.4.2 – Current direction and locator's readings in galvanically coupled utilities

4.3 Methods of Utility Depth and Current Measurement

To measure utility depth and the current flowing through it place the locator over the utility axis, as Figure 4.3 shows. Pointers on the locator body and the antenna plane should be perpendicular to the target utility axis.

The option of automatic depth and current display is enabled in the locator by default. However, it may be disabled (p. 3.1), in which case the depth and current are displayed upon pressing the «→•← / OK» key.

At "Radio" and "SB" frequencies the utility depth and current are not displayed. At "50 Hz" and "60 Hz" frequencies the error of depth measurement indication is not rated.

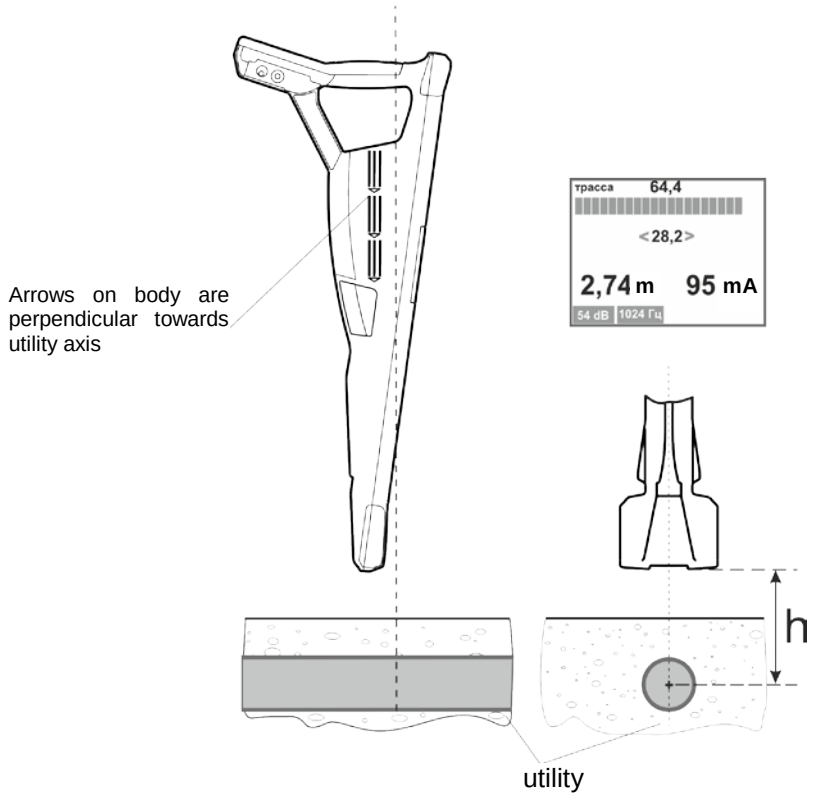


Figure 4.3 – Readings of the depth and current

Depth Measurement

ATTENTION! The locator measures depth distance from locator´s bottom to utility´s centre.

Perform two or three measurements of the depth in one point. The depth level shall be calculated as the average value of the obtained results.

Raise the locator to the height of 0.3 m, holding it straight, and find the depth value again. Depth readings shall increase to the height value. If it is possible, perform depth measurements at different operating frequencies.

Upon increasing distance between the locator and utility axis depth readings will be increasing as well. Therefore, the minimum depth value is the most accurate.

Current Measurement

When there is more than one utility in search zone the locator may sometimes detect a stronger signal from an adjacent line to which the signal has coupled or shares common grounding because it is nearer the surface. However, the target utility will always have the

highest current, because current value does not depend on depth. Therefore, current measurements facilitate tracing of target utility.

For search of target utility by current measurements, make sure that it has a higher current than neighboring utilities. Therefore, it is recommended to apply searching current directly from transmitter to target utility (item 2.3.1 of transmitters GT-75 and GT-15 Operation Manuals) or indirectly using current clamp.

Sharp change of utility current may appear in spots of intersections or tie-in points, because part of applied current may leak trough utility's branch. According to the Kirchhoff first law, the current flowing into a junction must be equal to current flowing out of it. However, current measurement at points near to branches may be inaccurate. Accurate current measurement may be performed only at long part of utility.

⚠ *ATTENTION! Errors in the depth and current measurements may be caused by magnetic field distortion from the neighboring utilities and close metal objects, in bends and branches, high noise level, or failure to following the below rules of handling the instrument.*

when current and depth measurements are certainly inaccurate since the received signal is too week or locator is moved away from searching utility or utility magnetic field is distorted by current of other utilities nearby. In these cases, we recommend to find utility depth by "-6dB" method (see item 4.3.1).

4.3.1 Depth Measurements by Indirect-6dB Method

When locator cannot find utility depth or locating on passive signals, you can calculate utility depth applying indirect -6dB depth measurement method.

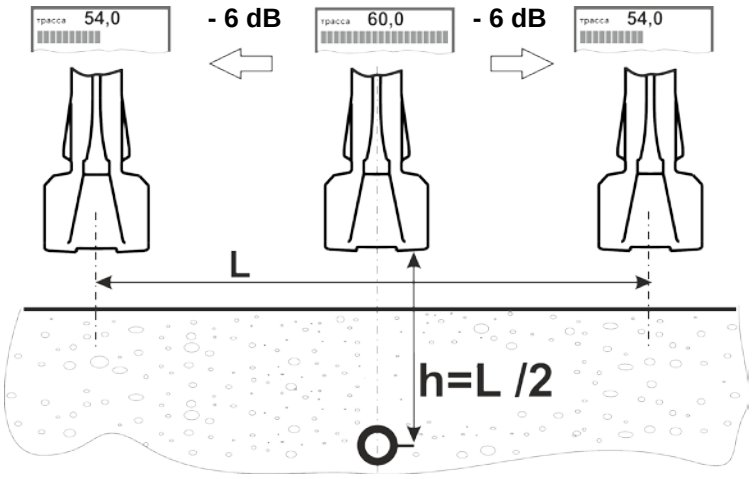


Figure 4.3.1 – Depth measurement by "-6dB" method

Hold the locator right above utility axis and store the readings of the input signal strength on peak scale in dB. Move at first to one side and then to the opposite side away from the utility´s axis and find the positions in which readings will be 6 dB less (this means that signal strength is twice less). Distance between this two spots will be equal to double distance between utility axis and locator.

4.4 Territory Survey

The main purpose of territory survey is to find conductive utilities and to prevent them from being damaged during earthworks.

4.4.1 Territory Survey without Transmitter

Territory may be surveyed by induced power frequency signals, signals of cathodic protection, telephone and translation signals. Perform searching on passive signals “50 Hz”, “100 Hz”, “SB” and “Radio”.

Set amplification to bring bar graph indication to approximately 50%. Move in zigzags with zigzag step of 1-5 m in one direction, and then in a perpendicular one (Figure 4.4.1). Where the utility is located, the signal strength will be at maximum level. Perform searching as described in item 3.2.1 in order to confirm utility location. Find utility direction by turning locator around vertical axis. When locator is perpendicular to utility axis the signal strength will be at minimum level and vice versa.

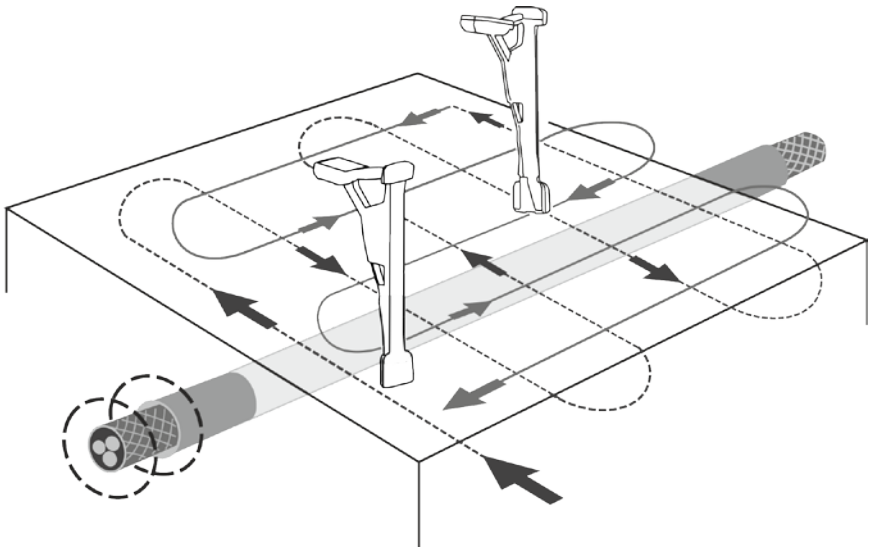


Figure 4.4.1 – Survey of territory plots without use of the transmitter

When locating stand-alone utility and utility's signal strength is high, it is recommended to apply "Compass line" option in order to facilitate utility tracing (item 4.2.3.).

4.4.2 Territory Survey with Use of Transmitting Frame RP 02 or Transmitting Antenna AP-01

When tracing on passive frequencies is impossible, it is recommended to perform searching by transmitter signals, induced in utility bi transmitting frame RP-02 or transmitting antenna AP-01 (hereinafter referred as inductors)

Consider the following when applying search current in target utility:

- The higher transmitter power of the transmitter and the shorter the distance from inductors to the locator is, the stronger direct connection between them, which will make utility signal almost indistinguishable;

- current induced by inductors is far lower than current induced by direct connection to utility;

- the higher transmitter operating frequency and the closer inductors to target utility, the greater applied search current,

- level of induced current depends on whether there are groundings on utility's ends. The search for utility is getting more difficult If at least one grounding is missing. In this case it is recommended to use the maximum transmitter frequency in order to increase current through capacitance between utility and ground.

Territory survey may be performed as follows.

Method 1

Divide the territory under survey into plots sized 50x50 to 100x100 m. Lay RP-02 frame horizontally on the ground in the centre of surveyed territory (Figure 4.4.2.1) and put and fasten AP-01 antenna in vertical position. Select the maximum operating frequency of transmitter. Select transmitter output power so the direct connection between locator and inductor is minimal. When surveying narrow plots, e.g. during trench excavations, place inductors away from the plot under survey at the distance of 20 to 25 meters.

Search the territory perimeter. The maximum signal strength will appear in intersections of utility and plot boundaries.

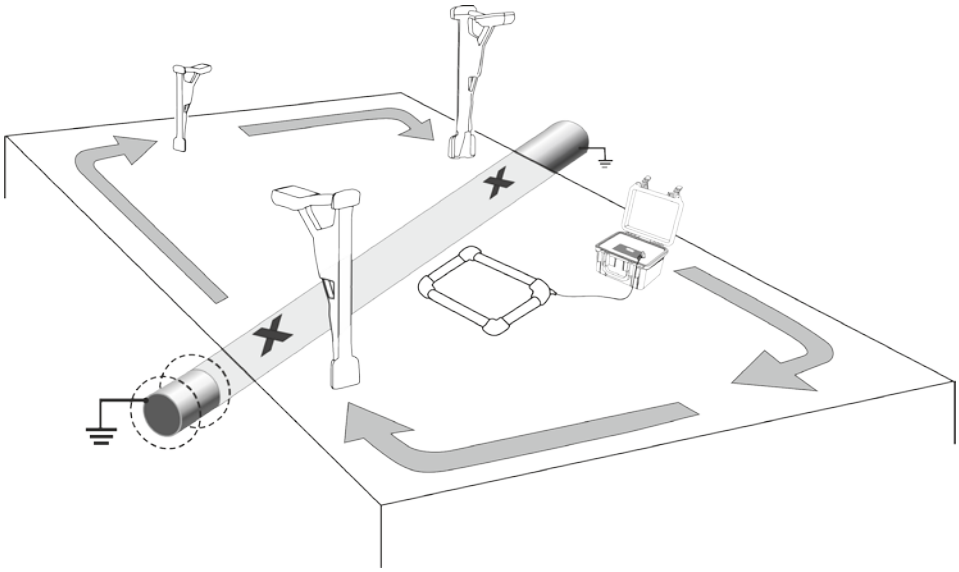


Figure 4.4.2.1 – Survey of territory plots using frame RP-02

However, inductors' signals cannot be induced in utilities located directly below them. Such utilities may be undetected. In order to locate them, move inductor to the side at distance of few meters and repeat search.

For more precise utility location place RP-02 in vertical position above utility axis and lay AP-01 antenna across utility axis. Trace the line in both directions.

When locating stand-alone utility and utility's signal strength is high, it is recommended to apply "Compass line" option in order to facilitate utility tracing (item 4.2.3.).

Method 2

Connect AP-01 antenna to transmitter GT-15 without taking it out of bag. On transmitter, select frequency of "33k". Set the optimal power.

Then two operators should walk parallel in the same direction keeping the distance between them from 20 to 30 m. One operator should move along plot boundary holding transmitter bag so the axis of transmitting antenna was towards his direction. Another operator must move along the opposite plot boundary holding locator and record signal changes by bar graph (Figure 4.4.2.2.). The maximum signal will appear in spots where locator is directly above the target utility. Enable "Compass line" option in order to facilitate utility tracing when the input signal strength is high (item 4.2.3).

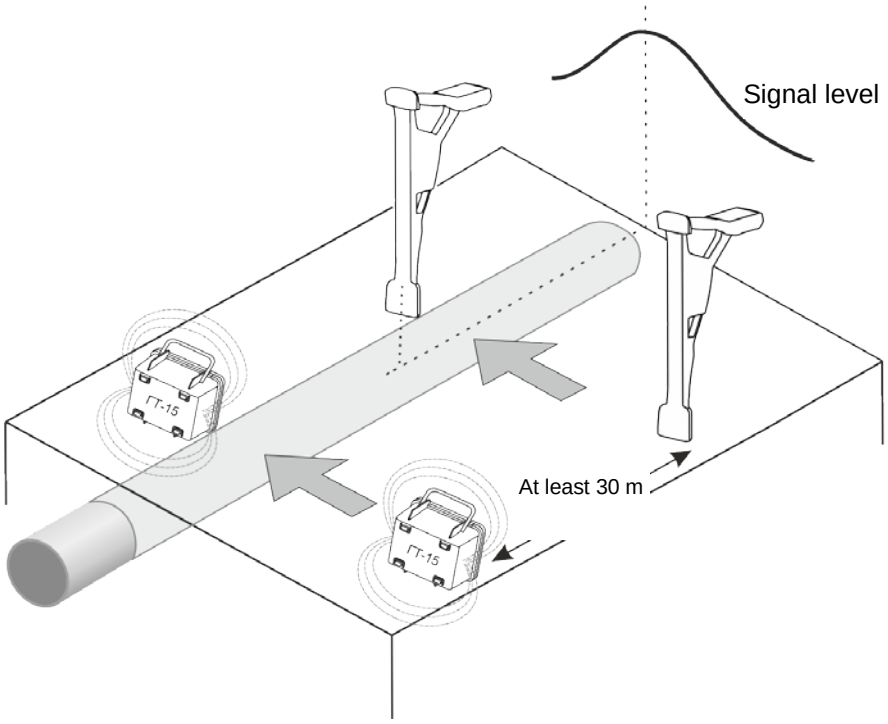


Figure 4.4.2.2 – Survey of territory plots with the use of GT-15

Repeat the search in the same way moving in direction perpendicular the previous one.

5 Search for Damages of Pipelines and Cable Lines

The methods described below are based on registration of signal changes in fault spots. Since in some cases these changes may be unnoticed by operator, all readings shall be saved in the instrument memory for further analysis on PC (item 6).

5.1 Search for Insulation Fault to Ground by Current

This method should be applied in order to locate insulation faults of pipelines and cables with considerable leakage current to earth in damaged spots.

Sudden current drop during tracing in spots where there are no branches or ties-in may be a sign of significant insulation damage. However, considering search current accuracy, this method may be applied only when initial current is high (0.5 A and more) and it drops significantly in spot of insulation damage. It is recommended to apply this method of search on 273 or 526 Hz frequencies.

5.2 Methods of Search for Pipeline Insulation Damages Using DKI-02, "A-frame", DKI-E, DKI-P1 Insulation Sensors.

⚠ *ATTENTION! The voltage over 42 V shall be avoided at inputs of the "SENSOR" jack.*

Both insulation contact sensors - DKI-02, "A-frame", and non-contact sensors - DKI-E, DKI-P1, are used in search for insulation faults.

Switch the locator into "TRACE-SENSOR" mode by pressing and holding "MODE" for more than 2 seconds. Sensors shall be connected to "SENSOR" jack (item 4 in Fig. 1.4.1).

Insulation damages are detected according to the signal strength from insulation inspection sensors on the SENSOR bar graph. At the same time utility position shall be verified by readings of peak or null bar graph (Figure 3.3a), or by compass arrow if “Compass line” option is enabled (Figure 3.3 b). During operation monitor utility depth and search current strength and direction to avoid false trails (current direction can be observed when two-frequency signal of “1024 Hz” is set on the Transmitter).

To adjust the amplification of signal strength from sensors, set the indicator (item 3 in Figure 3.3.) to "SENSOR" position by pressing "MODE" key. The required amplification is selected by amplification increase/decrease keys, the optimum amplification level is set automatically by pressing "→•← / OK" key.

The signal strength indication in "dB" or in "Volts", as well as zoom option may be selected from the main menu: Menu > Indication > "Sensor" scale (Fig. 3.1c).

.

5.2.1 Search for Insulation Damages by Signal Drop

The search method is similar for all types of sensors.

Both spikes of contact sensors shall be put into soil, or both operators (for sensor DKI-E) shall move along the utility axis, one after another (Figure 5.2.1). The utility signal drops to minimum when the insulation fault gets between operators or spikes of “A-frame”. Reduce distance between operators / sensor spikes in order to precisely locate spot of insulation fault.

The signal null will be between two boundaries of the damaged area and signal peak will appear when one of boundaries is directly below sensor spike / operators.

For more precise search for the insulation damage, you may define signal polarity at "SENSOR" input. On transmitter, set double-frequency signal "1024 Hz» and set"1024 Hz" operating frequency on the locator. If the double-frequency signal strength is sufficient, signal polarity indication is switched on automatically (item 6, Figure 3.2).

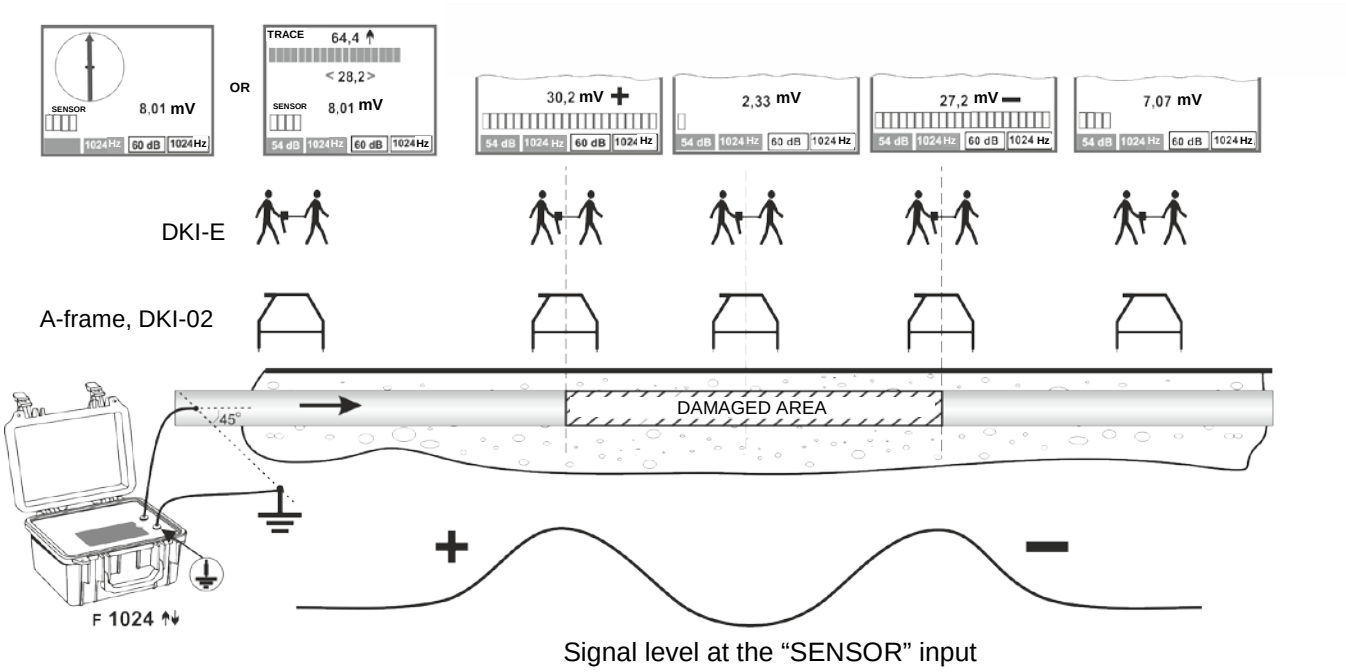


Figure 5.2.1 – Connection diagram and signal strength during the search for insulation damage by signal drop with polarity sign change

When operator moves along the undamaged part of the utility and then moves right above damage area the signal polarity at the "SENSOR" input (Figure 5.2.1) may change chaotically or missing due to weak signal strength. Upon approaching to the bound of insulation fault area, the signal strength will be growing and the polarity sign will get stable. When operator passes the bound of insulation fault area, the sign will change to the opposite one. If insulation damage area is short, the signal strength above the damaged spot will be at minimum level.

ATTENTION! Change of polarity sign without specific change of signal strength shall not be considered as assign of insulation fault.

5.2.2 Search for Insulation Damages by Signal Rise

This method of search can be used with all types of sensors (Figure 5.2.2). One of sensor spikes shall be put in the soil, or one of operators (for sensor DKI-E) shall move along the utility axis at a certain interval. Another spike shall be put in the soil, or another operator shall be away from the utility. The area insulation damage is located by signal peak.

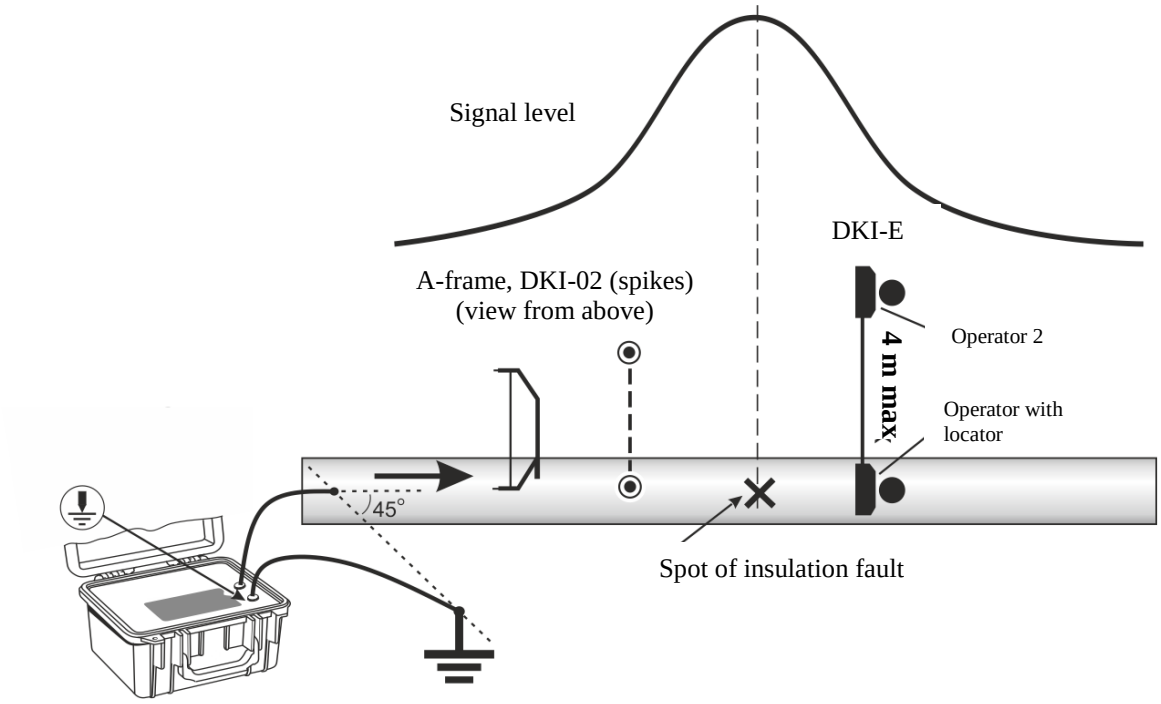


Figure 5.2.2 – Connection diagram and signal strength during the search for insulation damages by signal growth

5.2.3 Specific Features of Sensors

ATTENTION! The voltage over 42 V shall be avoided at inputs of sensor

Sensor DKI- 02

Use of this sensor allows locating damages in places with high density of utilities. The spacing between sensor spikes and interval of changing spikes pins positions between locating operations shall not exceed the depth value.

"A-frame" sensor

Unlike sensor DKI-02, the "A-frame" sensor allows to determine the signal strength more precisely from one measurement to another because the fixed distance between spikes excludes the error of signal strength growth/drop due to change of the distance between them. However, use of this sensor requires burying spikes in the ground, which is not always possible.

ATTENTION! Using A-frame with locator attached do not thrust it in the ground sharply - that may lead to locator's failure.

When the "A-frame" is used, the insulator surface shall be kept clean because the dirt on them may attenuate the signal or result in complete loss of sensor's sensitivity

Sensor DKI-E

This sensor allows searching for damages in stand-alone long utilities at a relatively high speed and does not depend on the coating type. However, this sensor has a slightly lower sensitivity, especially on low frequencies. Each operator shall hold a contact electrode of the sensor in his hand during the operation. For precise detection of damaged area, the distance between operators shall be decreased.

Sensor DKI-P1

Sensor DKI-P1 is an electrical antenna mounted on the magnetic antenna module. Use of this sensor is similar to that of DKI-E but it allows performing the search by one operator, as is described in the above methods. However, this sensor has a lower sensitivity. Besides, touching the grass with the sensor or rushes of wind during the operation may lead to unstable indications of the signal strength.

5.3 Search for Damages of Cable Lines

Note. Cable armor made of ferromagnetic material reduce the level of a detectable signal, therefore the maximum possible search current shall be maintained during the search.

5.3.1 Search for Location of Short-Circuit of Cores to Each Other

A diagram of searching for short-circuit between cores is shown in Figure 5.3.1. During the search the locator receiver shall be brought along the route, and the signal strength is monitored on the peak scale. The signal strength upstream the short-circuit location may change at a core lay interval. Downstream of the short-circuit location even signal beating at a core interval disappears, and the signal strength may both drop (case 1) and grow (case 2).

As a rule, the first case is caused by solid short circuit of cores to each other. In the second case cores are shorted not only to each other but also to the cable armor.

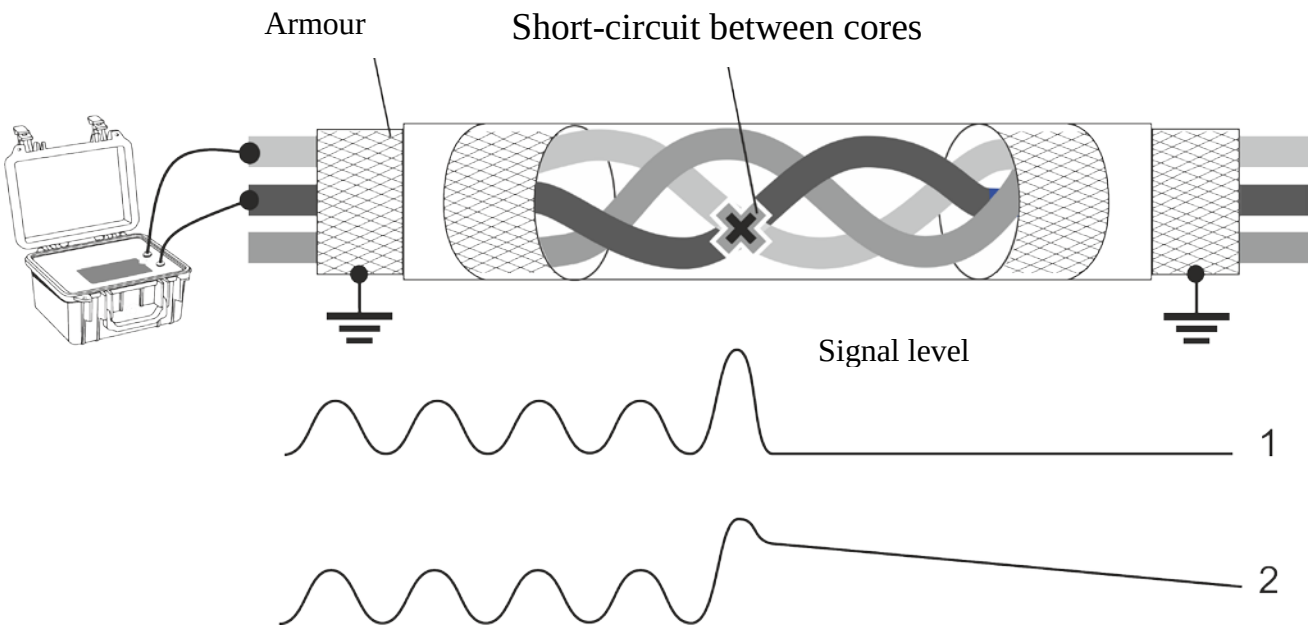


Figure 5.3.1 – Connection diagram and signal strength during the search for a short-circuit of cores to each other

5.3.2 Search for Location of Short-Circuit of a Core to an Armor

A diagram of searching for short-circuit of a core to an armor is shown in Figure 5.3.2. The signal strength upstream the short-circuit location changes at a core lay interval. Behind the short-circuit location the signal strength grows sharply while beating at the lay interval remains.

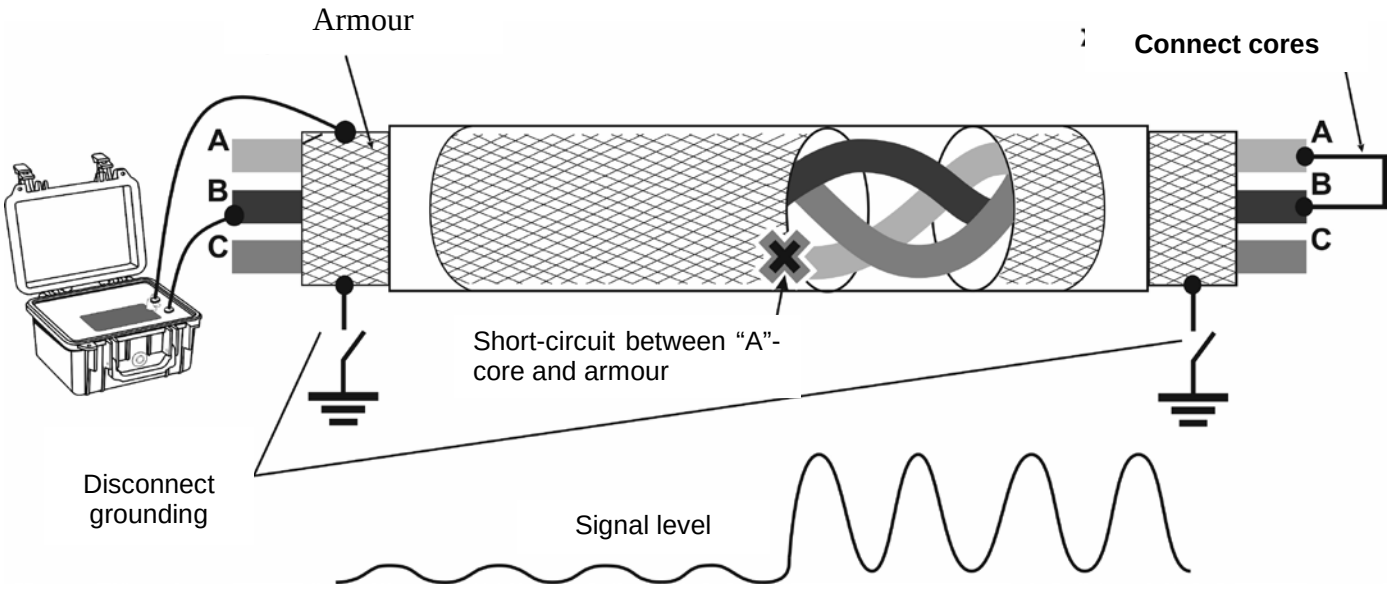


Figure 5.3.2 – Connection diagram and signal strength during the search for a short-circuit of a core to an amour

5.3.3 Search for Insulation Damages and Locations of Ground Faults

Insulation of the cable damage relative to the ground with the resistance of up to hundreds Ohm may be detected with insulation control sensors DKI-02, "A-frame" and DKI-E, DKI-P1. The transmitter shall be connected according to Figure 5.3.3.1. The grounding conductor connected to the transmitter jack marked with "⏚". This method of searching is similar to those described in items 5.2.1 and 5.2.2.

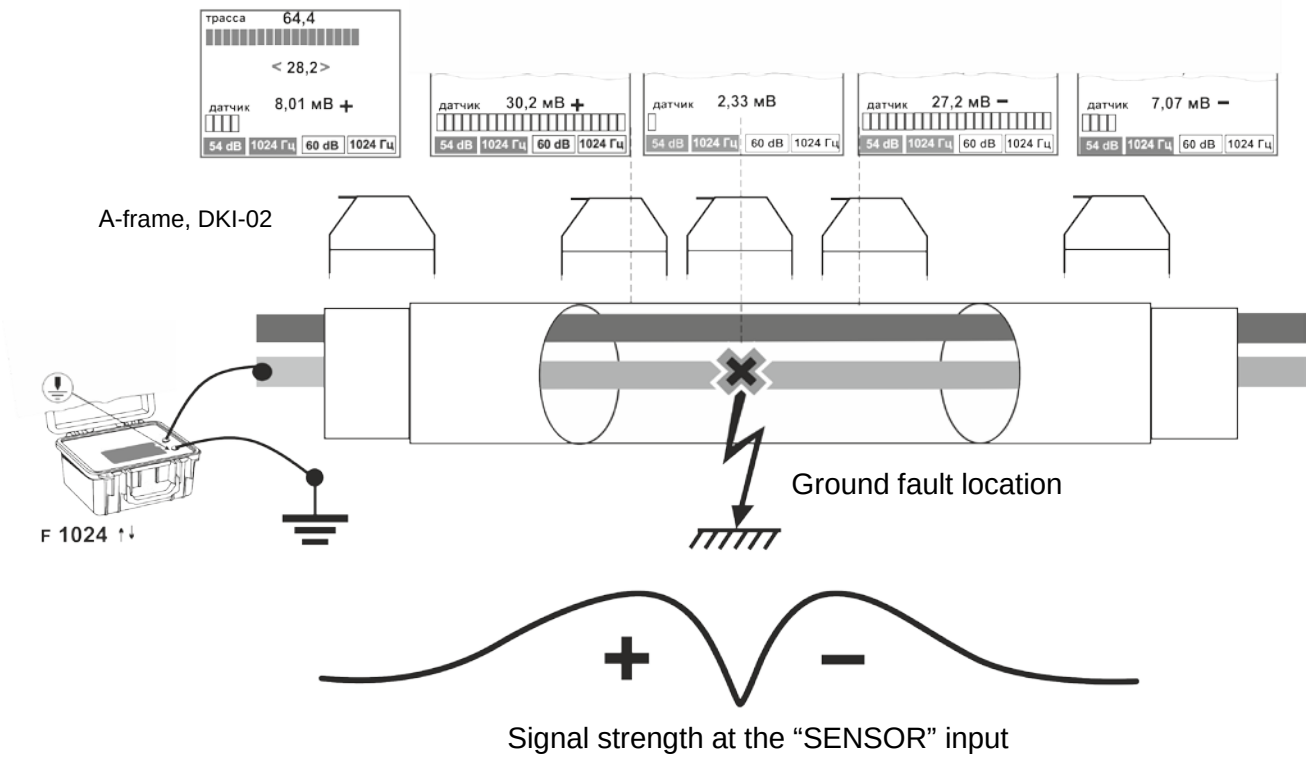


Figure 5.3.3.1 – Connection diagram and signal strength during the search for insulation damage with the use of insulation inspection sensors

If the cable insulation resistance to ground does not allows searching with the use of insulation control sensors, the phase method may be applied. The phase method of searching for cable insulation damages allows locating both low and high-resistance insulation damages with the leakage to ground of up to 0.5 MΩ. The area of damaged insulation shall be located with a reflectometer. The search is performed by one operator without using any additional sensors.

Connect transmitter GT-15 with its one lead to the core of the cable with damaged insulation (Fig. 5.3.3.2). The opposite end of the core shall be insulated. Another lead of the transmitter shall be grounded with it’s a pin placed ad the distance of no less than 5 m from the cable. Set the double frequency "**φ**".

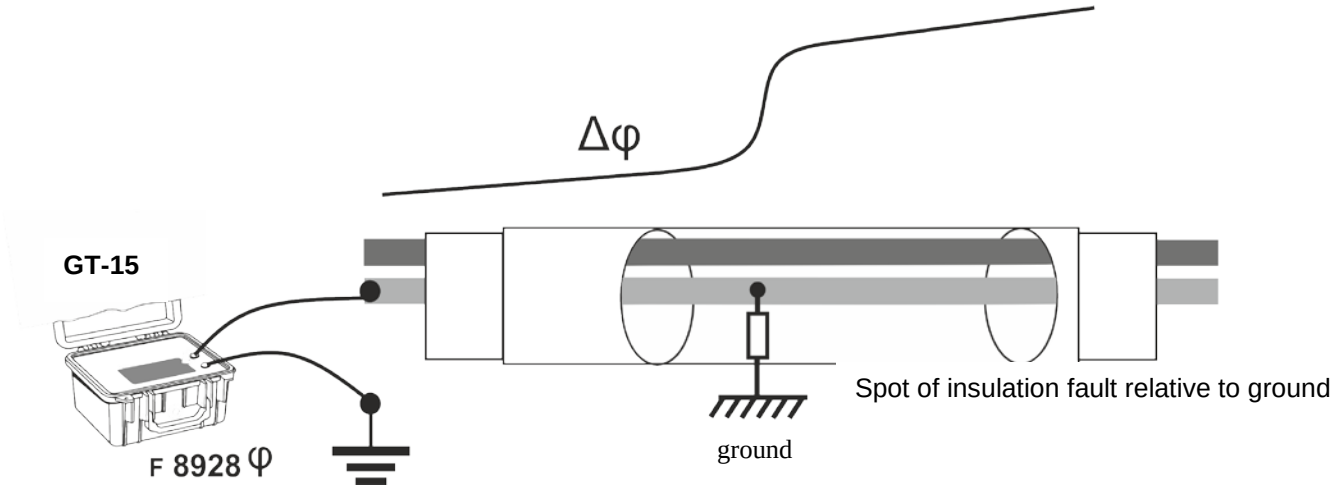


Figure 5.3.3.2 – Connection diagram and phase shift during the search for insulation damage by phase method

Select "TRACE" mode and "**φ** 8928" frequency on the locator. Stand at the beginning of the plot under survey right above the utility but not closer than 20 m from the transmitter connection point. Press "→•← / OK" key on the locator to reset phase readings. Move along the utility´s axis monitoring its position with the null bar graph and take phase readings. Phase shall change smoothly. When the insulation fault is directly under the locator, the phase shall grow sharply. When the damaged spot is passed, the phase reading will continue to change smoothly

This method has the following disadvantages:

- phase change at insulation damaged spots is less sharp than signal strength change during search with insulation control sensors;

- phase change may be caused by movements relative to the cable axis;

- interferences from adjacent utilities.

5.3.4 Search for Cable Breakdown

If the direct access to the damaged core of cable is not available, or the cable is metal-armored, make the short-circuit of the core to the adjacent core or to the armor by burning down of insulation with a high-voltage unit. The method of searching for the damaged spot is similar to cases described in items 5.3.1, 5.3.2.

Mini-sensor MD-01 can be applied for searching of rupture in cable without metal armor when direct access to it is unavailable. Due to small size this sensor allows the more accurate search when it is difficult to space individual cores.

Appearance and working zones of the mini-sensor are shown in Figure 5.3.4.1.

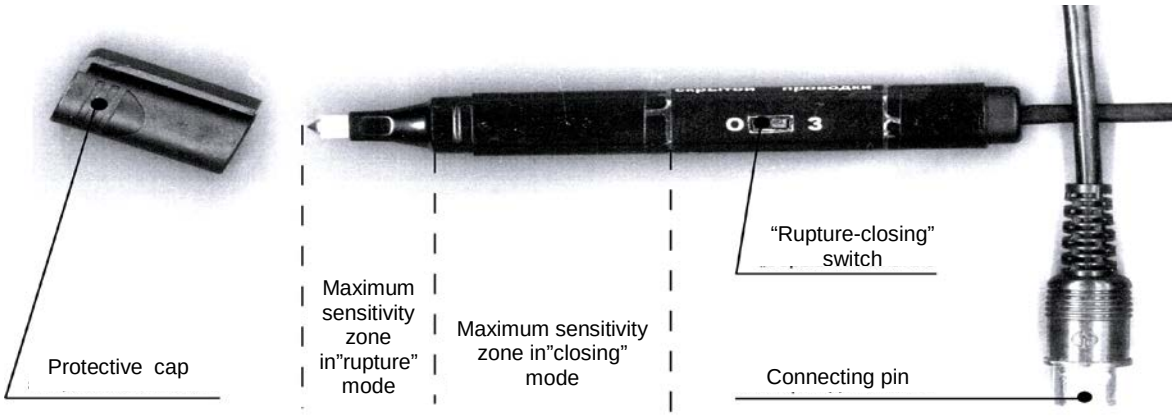


Figure 5.3.4.1 – Mini-sensor MD-01

Connect the transmitter and close cable cores, according to Figure 5.3.4.2. During operation with use of MD-01 mini sensor, it is recommended to set transmitter output voltage of 30 V (Operation Manual for transmitters GT-15 and GT-15). In order to reduce interferences from neighboring cores or cables, the rupture search should be started from a low frequency, for example, 273 or 1024 Hz, moving on to the higher frequency if the sensitivity is insufficient.

ATTENTION! The voltage over 42 V shall be avoided on the current-collecting metal tip of the mini-sensor probe.

Connect the mini-sensor to "SENSOR" jack of the locator (item 7 Figure 1.4.1). Set the mini-sensor switch to position "O" (breakdown); in this mode mini-sensor detects changes of electric field. Move the mini-sensor along the cable while monitoring the signal strength by readings "SENSOR" scale of the locator. The signal strength the short-circuit location may pulsate at a core lay interval. When the damaged area is passed the signal strength shall drop sharply, signal pulsating at the lay interval disappears

.

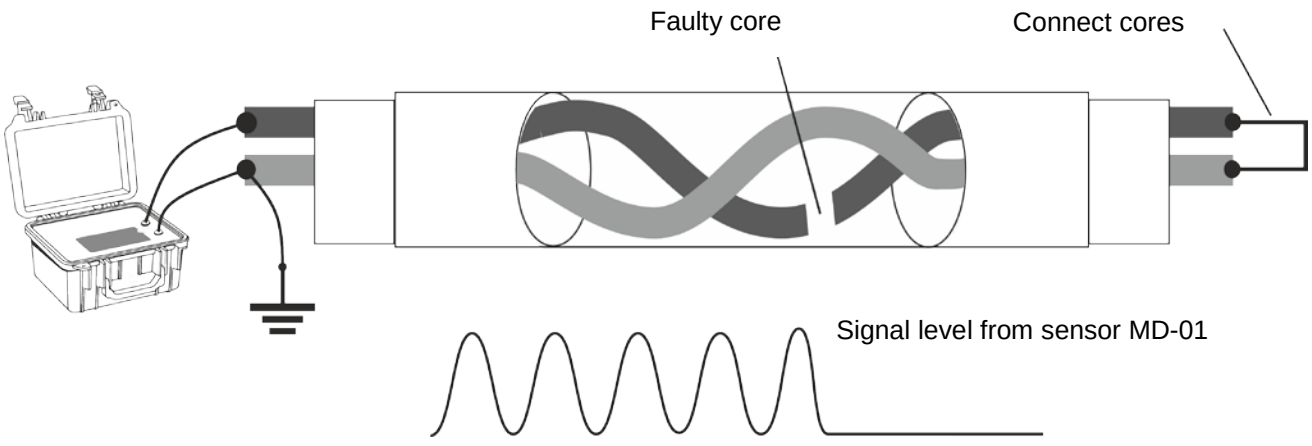
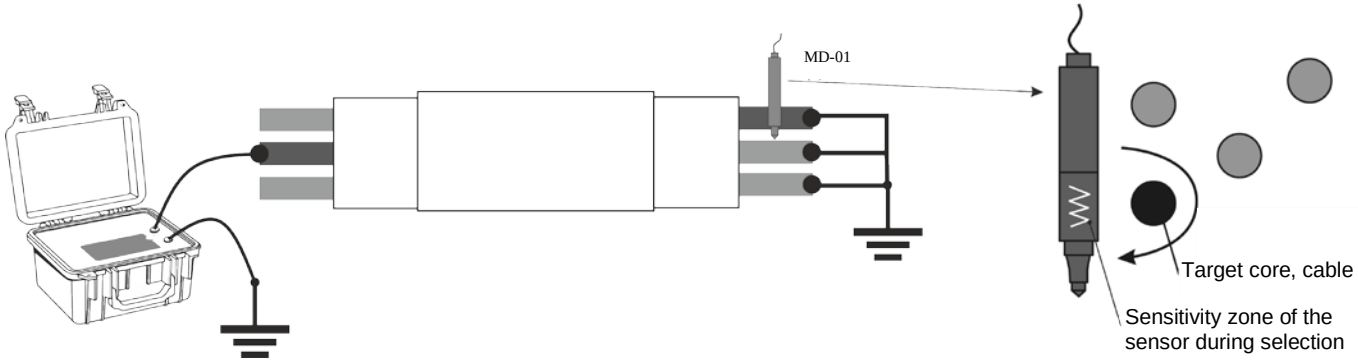


Figure 5.3.4.2 – Connection diagram and signal strength during the search for rupture in a cable without a screen or armor

5.4 Selection of Cores and Cables

To select cores in a multi-core cable, connect the transmitter and close all cores, as shown in Figure 5.4.1a. During operation with use of MD-01 mini sensor, it is recommended to set transmitter output voltage of 30 V (Operation Manual for transmitters GT-15 and GT-15). In order to reduce interferences from neighboring cores or cables, the rupture search should be started from a low frequency, for example, 273 or 1024 Hz, moving on to the higher frequency if the sensitivity is insufficient.

Connect the mini-sensor to locator's "SENSOR" jack. Set the mini-sensor switch to position "3" (circuit); in this mode mini-sensor detects to change of the magnetic field around the alive conductor.



a) b)

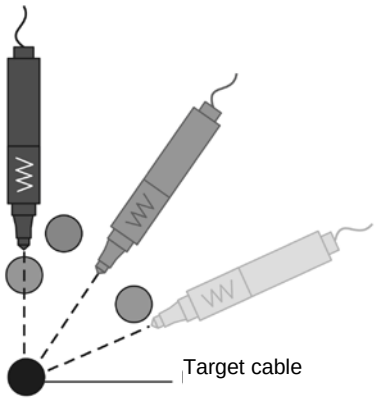
Figure 5.4.1 – Connection diagram for selection of cable cores

Then apply the mini-sensor with its tip to each core, as shown in Figure 5.4.1, and check the signal strength by "SENSOR" scale. The target core connected to the transmitter shall have the peak signal.

Selection of cores may be verified by turning the mini-sensor with its sensitive area around the target core (Fig. 5.4.1b) - the signal strength shall remain unchanged. With the mini-sensor turned around any other core, the signal strength will be changing depending on the mini-sensor position relative to the target core, where the current from the transmitter

flows.

The selection of cores can be also verified by signal null. Apply the mini-sensor with to the target core as shown in Figure 5.4.2. The current flowing in the core will not induce the signal to the mini-sensor core. The signal strength will be determined by interferences from neighboring cores and will be null. The shift of mini-sensor axis away from the core axis will increase signal strength.



When axis of mini-sensor crosses the axis of target core the signal strength will drop significantly. When the mini sensor is hold above other cores, the signal strength will drop slightly or remain the same.

Apply mini-sensor to core at different angles in order to avoid false trails.

The selection of target cable from a bundle shall be performed in the similar way.

Verification of Core Selection by “Depth Measurement”

After excavation works the target cable may still lay under the ground while another one that lies above is selected by error. In order to verify cable selection and avoid errors, apply locator closely to the selected cable and take depth measurement. The readings of depth measurement shall approach zero.

5.5 Search for Line-to-Earth Faults in Overhead Lines (OHL) in 6-10 kV Isolated-Neutral System.

Search for spots of earth faults is performed by level of upper harmonics of the flowing zero-sequence current at frequency of 550 or 1450 Hz. The signal peak will appear when tracing the damaged OHL coming from the substation. At OHL junctions the signal strength on a damaged line will be much higher than on an undamaged one. When the damaged area is passed, the signal strength shall drop sharply.

6 Data Storage and GPS

The locator stores readings in a non-volatile memory, including GPS time coordinates values received from an external GPS/GLONNAS – Bluetooth logger (hereinafter referred to as GPS logger) or from smartphone built-in GPS module. Communication with an external GPS "Bluetooth" module is performed via Bluetooth version 2.0, 2.1 or 3.0 (support of SPP

profile).

The following parameters may be stored in internal memory of the locator both with GPS coordinated or without:

- strength of signals from magnetic antennas and at the SENSOR input (item 4.2.1);
- direction to the utility (item 4.2.2);
- utility depth and current (item 4.3);
- direction of search current (item 4.2.2);
- relative polarity of potential difference at the "SENSOR" input (item 5.2);
- signal phase at the "TRACE" input (item 5.3);
- operating frequency;
- local date and time of readings through GPS;
- coordinates of target point obtained by the GPS.

Accuracy of GPS positioning depends on specifications of GPS receiver (external GPS logger or smartphone built in GPS module), quantity of satellites within the line-of-sight coverage, arrangement of satellites, reflected signals, ionosphere influence, error of satellites chronometers, etc.

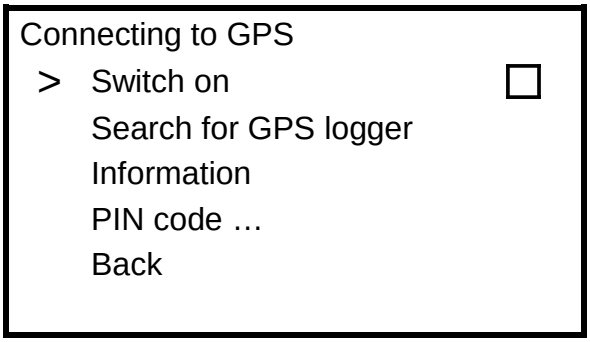
Note! Upon using a GPS-Bluetooth logger that, e.g. ensures more accurate GPS positioning, make sure that the GPS logger transmits the data in NMEA-0183 RMC and GGA formats with data renewal rate of 1 second.

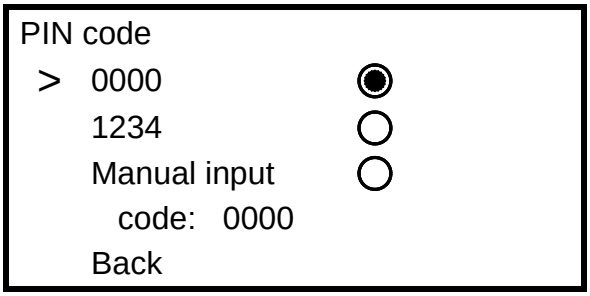
6.1 Locator Settings for Operating with External GPS Devices

6.1.1. Communication with External GPS-Bluetooth Logger

The GPS logger shall be placed next to the locator, e.g. in the pocket of sunscreen cover.

Connect the locator to the GPS logger. In "Menu" select "GPS" > "Connecting to GPS" > "PIN code". Set PIN code of GPS logger. The most frequently used codes are "0000" or "1234". If the code differs and includes a random combination of four figures, enter the digits with amplification increase/decrease keys.





Then switch on the GPS logger. On the locator, enter the "Menu" and select "GPS" > "Connecting to GPS" > "Search for GPS logger". On completing the search, select the GPS logger from the list of identified devices with amplification increase/decrease keys. Confirm the selection with "→•← / OK" key.

Connection to the selected GPS logger will be performed through "Menu" > "GPS" > "Connecting to GPS" > "Switch on", or automatically after the track number is selected (item 6.2).

Name and address of the GPS logger, number of satellites it sees, coordinates and times it finds are available through "Menu" > "GPS" > "Connecting to GPS" > "Information".

Status of connection with the GPS logger is indicated with "" or "" icons (item 15 in Figure 3.2).

Table 6.1 – Status of connection with the GPS logger

Icon	Description
- none	No connection to the GPS logger

yellow	Connecting to the GPS logger 1 minute max.
yellow	Connection to the GPS logger is established but there are no GPS coordinates (cold start of the GPS logger, bad conditions of GPS signals reception)
green	Connection to the GPS logger is established, receiving the coordinates...
red	Connection to the GPS logger is lost

Next connection with previously selected GPS-Bluetooth logger will be established automatically by pressing button and selecting track (item 6.2.) or manually via Menu > GPS > GPS connection > On

Note. Cold start period (for example, first start after being not used for a long time), depends on the GPS logger model and quantity of visible satellites and may last up to 20 minutes. In this case "" icon will be displayed in yellow. Next hot starts will take only a few seconds.

6.1.2 Communication with Smartphone Built-in GPS-module

Instead of external Bluetooth-GPS logger, the locator can communicate with smartphone that has a built-in GPS module in order to receive GPS coordinates.

Smartphone shall run Android 6.0 or higher.

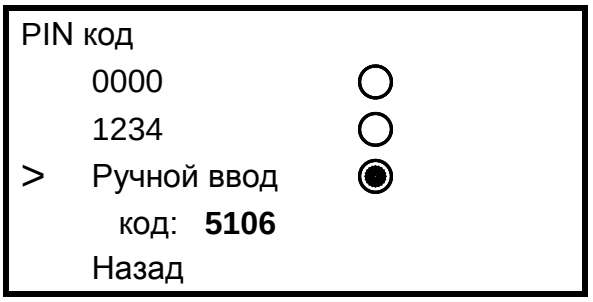
Download Stalker-terminal App from our official website www.radio-service.ru/en and install it on your smartphone. Make sure that you have allowed your smartphone to install Apps downloaded from unknown sources.

Keep the smartphone near to the locator, so it could receive signals from maximum available satellites.

During first pairing between locator and smartphone enter Menu on the locator and select GPS > GPS connection > PIN code > Enter. Enter the code 5106 by keys.

After that proceed as follows:

- run Stalker terminal App on smartphone;
- On App main window select "Transmit GPS coordinates". Wait until the number of available satellites appears on the display and select "Establish connection";



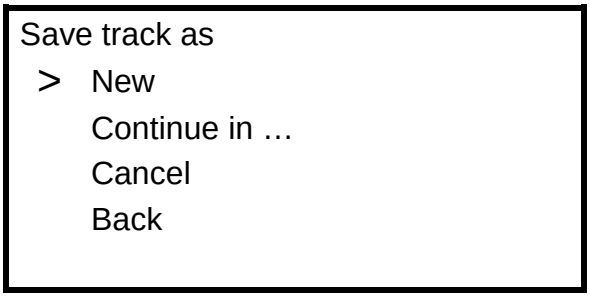
- During the first pairing between smartphone and locator, enter the Maine Menu of the locator and select "GPS" > "GPS connection" > "Search of GPS module". When the searching is over select your phone from the list of available GPS modules. Next connection between paired locator and smartphone will be established automatically by pressing key on the locator and selecting track record (item 6.2).
- Enter the PIN code 5106 in query window that will appear on smartphone display

If the smartphone is connected to the Internet it will display your current position on Google Maps. Otherwise the map will not be displayed.

The indication of the status of communication with the GPS module is similar to clause 6.1.1

6.2 Recording tracks

First pressing of "" key after the locator is switched on carries over to "Menu" > "GPS" > "GPS settings" > "Save track as" section where the operator can create a new track or to continue recording in the existing track.



After that the locator establishes connection to the GPS logger.

Data may be stored both by pressing "" key and automatically with the preset time intervals (autotracking).

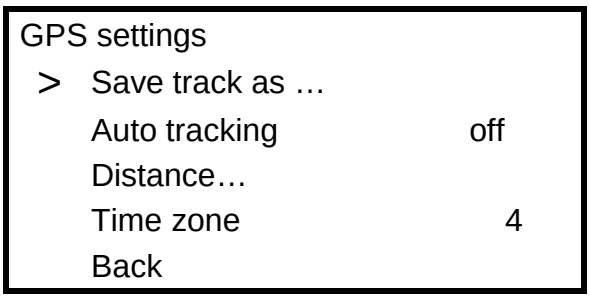
At the moment the point is being stored, the "" icon will appear shortly on the display (item 16 in Fig. 3.2). The icon is green if the point stored in the track with GPS coordinates and red if no GPS data has been saved.

6.2.1 Manual Recording

When you press the "📍" key, the locator stores the information displayed at the moment of pressing to the selected track. In "Stalker-terminal" software, this point will be tagged with " ⚑ " icon.

To create specifically points marked points, e.g. to mark areas of damaged insulation or tap-off, press "📍" key and hold for 2 seconds (a long sound will be heard). In "Stalker-terminal" this point will be tagged with " ! "icon on PC version or with green 📍icon on Android version.

6.2.2 Autotracking

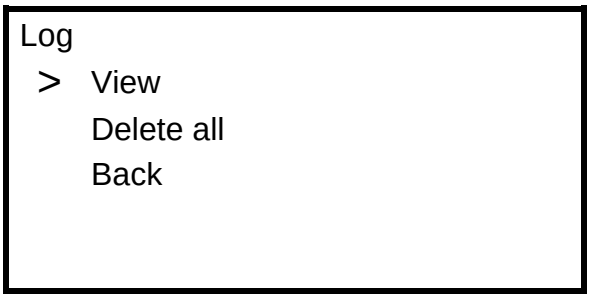


The locator stores the readings to the track with preset time intervals automatically. Autotracking interval from 1 to 60 seconds is set via "Menu" > "GPS" > "GPS settings" > "Auto tracking". To start or stop autotracking press the "📍" key. When autotracking is stopped, the "✕" icon appears on the display. This mode also allows storing specifically marked points by pressing "📍" and holding it pressed for 2 seconds (a long sound will be heard). In "Stalker-terminal" software, this point will be tagged with " ! " icon.

The locator does not store the parameter of autotracking interval in the autonomous memory. This interval shall be set each time the autotracking option is enabled.

6.3 Log

List of tracks saved in the locator memory may be viewed via "Menu" > "GPS" > "Log" > "View". The following information may be viewed for each track: number, date and time of the first saved point of the track and number of points per track. Select the track increase/decrease keys. Press the "📍" key to delete the track. Press " →•← / OK " key to confirm the selected track for data storage, exit from menu and establish the connection with the GPS logger.

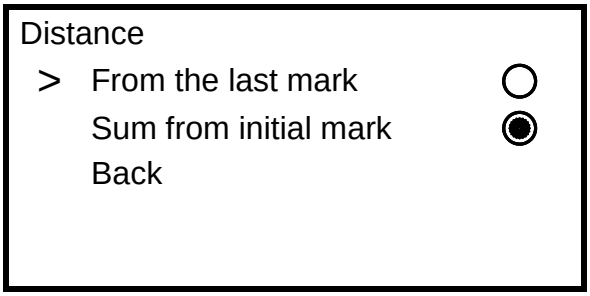


6.4 Distance

The locator calculates and displays the distance covered, basing on coordinates received from the external GPS logger, (item 20 Fig. 3.2):

- as the distance of the straight line from the last point marked by pressing "📍" key to the current location;

- as a sum of distances between points marked with "📍" key, starting from the first point, plus the distance from the last point to the current location. It displays distance covered not only for straight lines but also for parts consisting of broken lines. Press the "📍" key each time the direction of movement is changed.



You can select the proper option through "Menu" > "GPS"> "GPS settings" > "Distance".

The distance readings are not stored in autonomous memory of the locator - it is set to zero every time the locator is switched on.

6.5 View and Transmission of Tracks to PC or Smartphone

The locator can transmit the data to PC or smartphone. The data is transmitted over Bluetooth connection and save as files containing information on tracks.

In order to receive data from locator memory, use a special software program “Stalker-terminal” that also allows editing, viewing and saving tracks on your device.

6.5.1. Viewing Tracks on PC

Make sure that PC run Microsoft Windows OS (XP SP2/SP3, Vista, 7, 8). The PC shall be fitted with a Bluetooth device, or an external Bluetooth-USB adapter shall be used. In the latter case make sure that adapter drivers are properly installed,

Download from manufacturer’s official website www.radio-service.ru/en “Stalker-terminal” software (ver. 2.4 or higher) and install it. Prior to downloading check with your system administrators that your computer is allowed to download and install third-party programs.

Proceed as follows to transmit the data to the computer:

- run "Stalker-terminal";

- place the locator close to the PC;

- on the locator, switch on the connection with PC: "Menu" > "GPS" > "Connection to PC";

- On “Stalker-terminal” in “File” tab select “Load track from locator”;

- Select track or tracks from the list appeared in “Select tack” window and click OK.

The program allows viewing tracks, making graphs and importing tracks into "Yandex. Maps", “Google Maps” and "OpenStreetMap". Importing GPS data on maps requires internet connection. If the Internet is accessed via proxy server, set its parameters in "Stalker-terminal" settings. When Internet connection is not available, the map will not be displayed but the program will work in all other aspects.

Track data can be saved in .khm format for uploading into Google Earth or in .csv format for uploading into others applications. Select “Export table to …” from File tab and select track name, format and save pass in appeared window.

In certain cases, operating system of your PC may fail to establish connection with some Bluetooth-USB adapters. In this case make sure that:

- there is a Bluetooth symbol on task panel and that the Bluetooth-USB adapter is identified as Bluetooth devise.
- the locator is shown in list of available Bluetooth devices.

Otherwise:

- connect Bluetooth-USB adapter to another USB-port of PC;
- Install drivers for Bluetooth-USB adapter;
- Replace Bluetooth-USB adapter and try again.

6.5.2 Transmission of Tracks to Smartphone

For viewing tracks received from marker locators your smartphone must run with Android ver. 6.0 or higher.

Download and install Stalker-terminal application from official website www.radio-service.ru/en . Make sure that you have allowed installation of application downloaded from third-party sources.

Proceed as follows in order to transmit data:

- On marker locator, activate PC connection via Menu > GPS > PC Connection;
- On smartphone, run Stalker-terminal application;

- On application window select "Download and view track", then select "Download track from locator";
- Enter PIN code 5106;
- Select track / tracks from the list and press Download. Wait for the download to finish;
- In the appeared "Saved tracks" window select the required track and press Open.

Stalker-terminal application allows viewing tracks on Google Maps when the smartphone has internet connection. If connection to the Internet is not available, the map will not be displayed but the software will work in all other aspects.

Also tracks can be save in .track format for uploading into Stalker-terminal on PC. In “Saved tracks” windows select the required track and press “Export for PC”. The track will be saved in smartphone internal memory in “Stalker Terminal” folder.

Program options in details are shown in training films that placed on official website www.radio-service.ru/en .

7 Potential Failures and Troubleshooting

Potential failures and troubleshooting procedure are provided in Table 7.

Table 7 - Possible failures and troubleshooting procedures

Failure symptoms	Probable cause	Troubleshooting procedure
The locator does not switch on or switches off spontaneously.	The rechargeable battery has either run down or failed.	Charge or replace the rechargeable battery or install batteries
Charging does not indicated on the display (rechargeable battery does not charge)	Power unit failure	Check of power unit
	Storage batter failure	Replace storage batter (item 8.3).
	Rechargeable battery is extremely discharged	Connect power unit at least for 4 hours.
No sound can be heard in headphones though the sound can be heard normally from a built-in speaker.	No contact in the headphones connector	Check and restore connector contacts
	Rupture in headphones	Repair or replace headphones
Error of finding the depth of a stand-alone long utility exceeds the maximum permissible one	Failure in signal processing	Setting by the manufacturer is required.

8 Maintenance and Repair

8.1 Maintenance includes compliance with the rules of rechargeable battery operation, storage, charging, regular checks and troubleshooting.

8.2 Repair of the locator is only allowed at the manufacturer’s site or in special repair agencies.

8.3 Replacement of a rechargeable battery or power components

Proceed as follows to replace power components:

- take out rechargeable battery cover screws;
- remove the cover and take the storage batter (battery compartment) out;
- decouple the connector running to the storage batter (battery compartment);
- replace to rechargeable battery or power components, restore the connection;
- assemble the instrument in a reverse order;
- charge the rechargeable battery.

8.4 If the instrument is exposed to negative temperatures, it is recommended to regularly treat contacts of "SENSOR" connector and its counter-parts on replaceable sensors with a dehumidifying lubricant of "WD-40" type to protect against sweating. Such treatment is also recommended before long-term storage in an unheated room.

9 Transportation and Storage

The locator packed in a standard package allows transportation by all transport means, excluding unpressurized aircraft compartments.

Transportation conditions shall be as follows:

- ambient air temperature of plus 50 to plus 70 ºC;
- relative humidity of 95 % at the temperature of plus 30°C;
- transportation vibration up to 120 impacts per minute with 30 m/s^2 acceleration, for not loner than 1 hour;
- atmospheric pressure of 60 to 106.7 kPa (460 to 800 mm Hg).

10 Disposal

Disposal shall be performed by the customer in compliance with the national standards and law.

The locator does not include any environmentally hazardous elements.

11 Acceptance Certificate

Locator PT -14 No. _____
Reg. No.

corresponds to specifications RAPM.464333.002ТУ, and has been found fit for operation.

QCD Head

Stamp here _____ _____
personal signature **print full name**

_____
day, month, year

12 Manufacturer's Warranty

The manufacturer guarantees that the locator meets the specification requirements provided that operation, transportation and storage rules are observed.

The guaranteed service life of the locator is 18 months from the date of manufacture or sate of sale (if a note on sale is available), but not more than 24 months from the date of manufacture.

The guaranteed service life is prolonged through the period from claim presentation till elimination of failures.

The guaranteed service life does not cover the rechargeable battery.

Manufacturer's details:

268, Pushkinskaya Street, 426000 Izhevsk, Russia, Radio-Service, JSC

Phone: (3412) 43-91-44. Fax: (3412) 43-92-63.

E-mail: office@radio-service.ru Website: www.radio-service.ru

To be filled in by the seller:

Date of sale _____

Seller _____

Seller’s address _____

Seller’s phone _____

Stamp here

13 Regular Verification

13.1 The locator verification is recommended to be performed once every two years and after the repair. Verification steps are given in Table 13.1.

Table 13.1 – Verification steps

Verification steps	Verification step number
Visual inspection	13.5.1
Testing	13.5.2
Test of locator sensitivity	13.5.3
Check of error of determining the operating frequency voltage at the "SENSOR" jack input	13.5.4

13.2 Verification means

Verification means shall be operable and calibrated by authorities of state or departmental metrological service.

List of measurement means is presented in Table 13.2.

Table 13.2 – Verification means

Description and type of measurement means, equipment	Specifications of verification means	
	Measurement range	Accuracy
G3-110 transmitter	0.01 Hz – 2 MHz	$\pm 3 \times 10^{-7}$
Multifunctional voltmeter GDM-8245	10 µV - 1000 V, 10 nA – 20 A at 20 Hz - 20 kHz	0,03%

13.3 Verification conditions

The verification shall be performed in normal conditions.

13.4 Preparation for verification

13.4.1 The locator shall be prepared for operation in accordance with the operation manual. The rechargeable battery shall be charged to the full.

13.4.2 Measurement means and equipment required for the verification shall be brought to operating condition in accordance with their operational and engineering documentation.

13.5 Verification Procedure

The locator shall be handled in accordance with electrical safety rules by qualified personnel who have studied this Operation Manual and been granted with the relevant permit category.

13.5.1 Visual inspection

Visual inspection of the locator shall verify the following:

- compliance of the completer set;
- good visibility of all captions (marking);
- absence of the following failures and defects:
    - poor fastening of parts, electrical connectors;
    - cracks, scratches, dirt preventing from taking off readings;
    - severe mechanical damages of external parts.

13.5.2 Testing

Switch the locator on and make sure that all keys work:

- operating frequencies are changed between;
- the amplification factor is changed and displayed on the screen;
- the volume is adjusted.

13.5.3 Check of locator sensitivity

Set the mode to "TRACE" mode, disable the "Compass line" option. Wrap one turn of wire around the locator antenna and secure according to Figure 13.5.3. Connect the transmitter to the wire via an AC ammeter. The locator shall be at least 1.5 m from the transmitter, electrical appliances and mains cables.

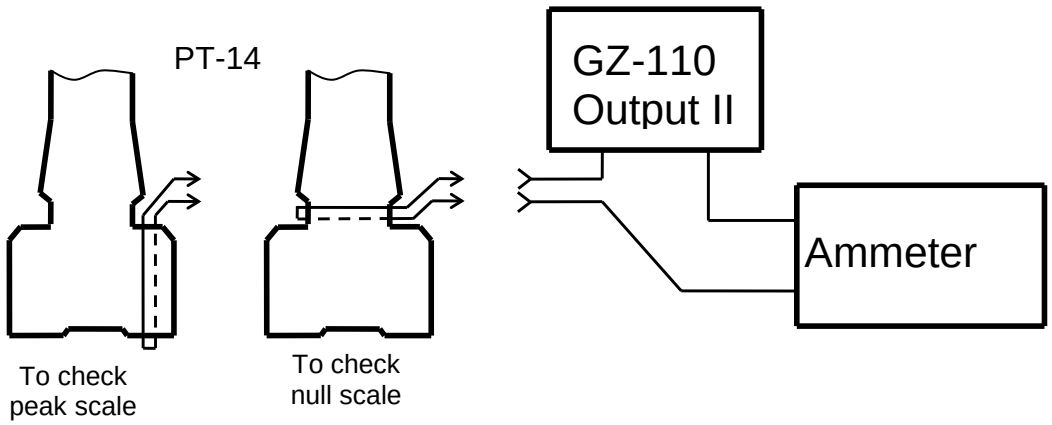


Figure 13.5.3 - Diagram of the workstation for sensitivity check

Set the frequency and current via the wire on the transmitter according to Table 13.5.3. Set the same frequency on the locator. Readings of input signal strength corresponding to peak scale and null scale shall be within the limits stated in Table 13.5.3.

Table 13.5.3

Frequency	Current, mA (setting accuracy ±10%)	Signal strength for null and peak scale, dB
"1024Hz"	4.0	87 ± 8
"33к" (32768Hz)	0.5	98 ± 8

13.5.4 Check of error of determining the operating frequency voltage at the "SENSOR" jack input

Set the locator to the mode of voltage measurement at the "SENSOR" input in "Volts", operating frequency of 1024 Hz. Set the "0 dB" signal attenuation on G3-110 transmitter. Send the test signal with the effective voltage value of 500 mV (check with the voltmeter), frequency of 1024 Hz from the transmitter to "SENSOR" connector, contacts 2 and 3 (common) (Figure 13.5.4). Locator readings shall be within the range of 475 mV to 525 mV. Using "ATTENNUATON dB" keys, set the "80 dB" signal attenuation on the transmitter (40+20+10+8+2).Locator readings shall be within the range of 0.03 to 0.07 mV.

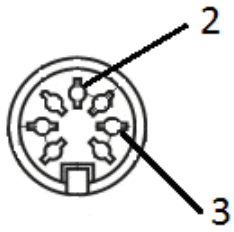


Figure 13.5.4 - Numbering scheme of "SENSOR" jack

13.6 Verification results

13.6.1 The locator passed verification with a positive result is found to be fit for operation.

14 Instrument In-Service Transfer Record

14.1 The instrument in-service transfer record is given in Table 14.1.

Table 14.1 - Instrument in-service transfer record

Date of installation	Where installed	Date of removal	Operating time		Cause of removal	Signature of person in charge of installation (removal)
			since operation beginning	after last repair		

14.2 Data on instrument acceptance and handover is given in Table 14.2.

Table 14.2 - Data on instrument acceptance and handover

Date	Status of the instrument	Basis (document title, number and date)	Enterprise, position and signature of person in charge of		Note
			handover	acceptance	

Record of changes

ed.	Numbers of sheets (pages)				Total sheets (pages) in the document	No. of the document	Incoming No. of accompanying document and date	Signature	Date
	Revised	Replaced	New	Cancelled					