

PT-14 Tracer

USER MANUAL



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This is the user manual for tracer PT-14 (hereinafter referred to as Tracer). It contains all of the information a new user will need to operate the Tracer effectively as well as safety conditions while using the Tracer.

Note that all illustrations at this document are just for user's consideration. The actual design of the Tracer may be different.

The manufacturer can make changes into the Tracer construction, which will not affect its operation, without special announcement.

GENERAL SAFETY SUMMARY

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified. Only qualified personnel should perform service procedures.

- **Do not operate with suspected failures. If you suspect the product has been damaged, have it inspected by qualified service personnel;**
- **Do not operate in wet/damp conditions;**
- **Do not operate in an explosive atmosphere. Keep product surfaces clean and dry.**

SAFETY TERMS AND SYMBOLS



These terms may appear on the Tracer or in the user manual:

WARNING. Warning statement identifies conditions or practices that could result in injury or death.

CAUTION. Caution statement identifies conditions or practices that could result in damage to the Tester or equipment to which it is connected.

1 INTRODUCTION

1.1 Application

The Tracer paired with the GT-75 and GT-15 Transmitters is designed to locate and trace cable and pipe lines (hereinafter referred to as Utilities).

1.2 Description

The Tracer:

- locates the planimetric position, orientation and misalignment of utilities with simultaneous indication of a target line depth and intensity of current through the line in the TRACE mode;
- finds and traces the areas of faulty insulation of the utility line and locates the position and depth of the line in the «TRACE/ SONDE» mode;
- picks the cable conductors and detects the short-circuited areas or wire break (using the MD-01 mini-sensor);
- logs readings with positional data received from external GPS module; transmits these data to a PC.

Without the aid of the Transmitter the Tracer:

- on the «50Hz» and «550Hz» frequencies locates cables by detection Power signals naturally occurred on the utilities;
- on the «100Hz» and «300Hz» frequencies locates utilities and finds areas of damaged insulation of pipes by detecting Electrochemical protection signals;
- on the «55Hz» and «1450Hz» frequencies locates the areas of ground fault of overhead lines by detection Power current harmonics;
- in the «AIR» mode locates utilities by re-radiated broadcasting and telephone signals within the frequency band from 48Hz to 14kHz;
- in the «RADIO» modes locates utilities by re-radiated broadcasting signals within the frequency band from 10kHz to 36kHz.

2 SPECIFICATIONS

2.1 Main technical data

The main technical data of the Tracer are shown in Table 1.

Table 1 – Main technical data of Tracer

Parameter	Value	
	Frequency, Hz	Sensitivity, min, $\mu\text{A/m}^*$
Rated values of operating frequencies (with Transmitter); sensitivity on the selected frequency	273	500
	526	300
	1024	150
	8928	25
	32768 (33k)	5
Rated values of operating frequencies (with Transmitter), Hz	50, 100, 300, 550 and 1450	
Dynamic range of input signals, dB, min	102	
Bandwidth for each operating frequency, max, Hz	at the level of minus 3dB	at the level of minus 60 dB
	9	24
Utility depth, m	from 0.10 to 6.00	
Operating frequency current in the utility	from 10mA to 10.0A	
Admissible error of the depth of single extended utility line, max	$\pm \{[4+0.3h(h+1)]\%+0.1\text{m}\}$, where h is a measured depth	
Admissible error of planimetric location of a single line at the depth of 2 m, min	± 0.1	
Operating frequency voltage at the SONDE jack input	from 0.01mV to 1.70V	
Sensitivity at the SONDE jack input at the signal-noise ratio of 6dB, mV, min	0.05	
Limits of admissible main error of voltage measurement, max, % + dgt	$\pm (3 + 3)$	
Input resistance at the SONDE jack input, MOhm	1	
Overall dimensions, max, mm	700 × 300 × 140	
Continuous operation under the normal conditions with full battery, min, h	5	
Weight, max, kg	1.8	
* Note. Rated for the “Broad peak” method. The signal-noise ratio is 6 dB		

The Tracer provides signal gain adjustment with the step of 6 dB (each step provides doubled gain).

Power supply voltage is from 7.5V to 5.2V. The Tracer is powered from a rechargeable Ni-Mh battery with the rated voltage of 6 V and capacity of 2000mA·h. The Tracer may be powered from the pack of five replacement batteries of the AA type put into the battery compartment. You may also use five AA - type batteries with the voltage of 1.2V.

The batteries may be replaced without breaking a seal.

The Tracer has a battery level indicator, and it goes off automatically to avoid excessive discharge when the battery is low.

The Tracer is switched to a battery charging mode when the power supply unit is connected. The Tracer secures the battery against overcharge when the battery is on its place.

The Tracer provides wireless Bluetooth communication with external GPS Bluetooth module and PC.

2.2 Environmental condition

Ordinary values of the environment climatic factors for operating the Tracer are specified in Table 2.

Table 2 – Tracer environment conditions

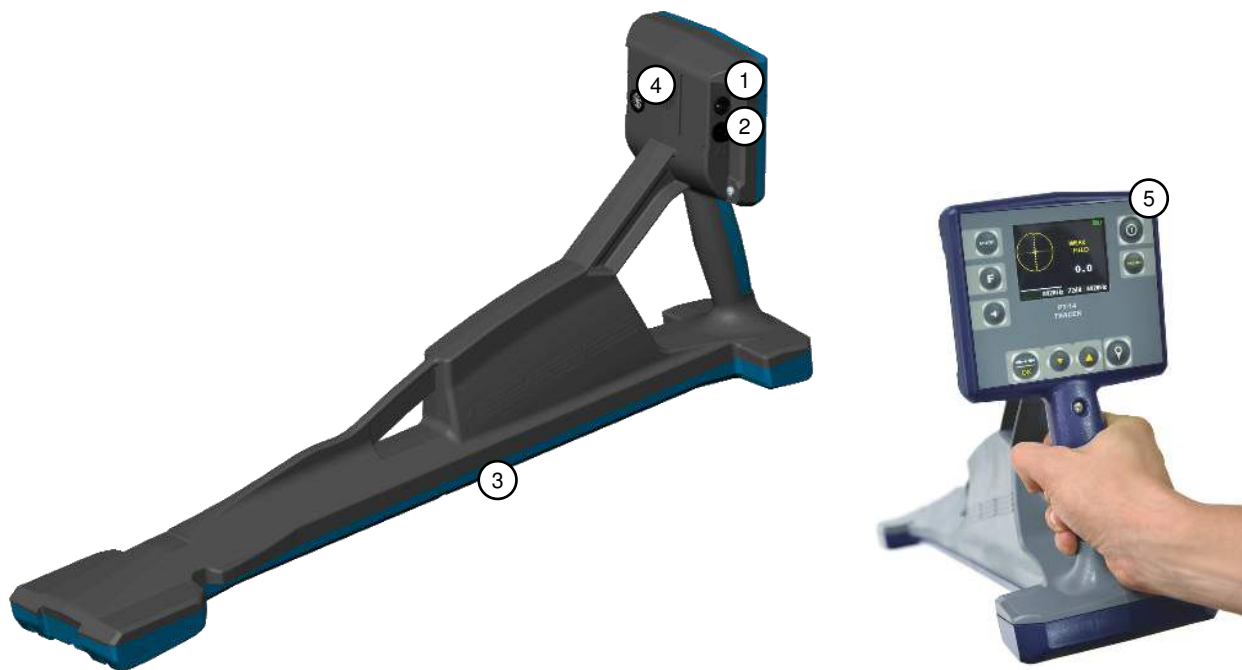
Factors	Storage and transportation	Operating
Ambient temperature, °C	- 50 ... + 70	- 20 ... + 55
Atmospheric pressure, mm Hg	460 to 800	
Relative humidity, %	90 (at 30 °C / non-condensing)	

The Tracer can only be transported in proper packaging, in accordance with section 3.2 of this user manual. When transporting the Tracer, avoid vibrations and other physical impact on the Tracer.

3 DESIGN

3.1 Appearance

The exterior of the Tracer is shown in Figure 1.



- 1 Jack for the power supply unit;
- 2 Jack for headphones;
- 3 Battery compartment cover;
- 4 SONDE jack for replacement sensors;
- 5 Front panel.

Figure 1 – Exterior of Tracer

The Tracer is supplied with the sun-protective cover. The cover is fixed in the handle area with a Velcro tape.

The exterior of the front panel of the Tracer is shown in Figure 2.



- 1 "ⓘ" button. ON/OFF Tracer;
- 2 "MENU" button. Navigation key – enters/exits the menu;
- 3 Display;
- 4 "📍" button. Stores displayed parameters and GPS coordinates for further transmission to a PC;
- 5, 6 "▲", "▼" buttons. Adjusts signal gain; scrolls through the MENU options;
- 7 "➡️⬅️ / OK" button. Sets optimum signal gain in the TRACE or SONDE channels (depending on actual control area). Measures the utility depth and intensity of current. Switches on/off the selected option in the MENU mode;
- 8 "🔊" button. Adjusts the sound volume;
- 9 "F" button. Switches the available operating frequencies;
- 10 "MODE" button. Selects available locating modes. Switches the control areas to change operating frequencies and amplify signal between the TRACE and SONDE channels in the TRACE-SONDE mode.

Figure 2 – Front panel

3.2 Packing

Tracer and the operating documentation are wrapped with packaging film in a way preventing dust and moisture from getting in and placed in a packing crate.

The crates are supplied with labels containing the name of the Tracer as well as shipping and storage instruction signs.

4 OPERATION PROCEDURES

4.1 First use

If the Tracer was stored at low temperatures, it shall be kept at the operating temperature for no less than 1 hour before use.

Take the Tracer out of its case and examine protective covers and fasteners. Check the Tracer body and external power supply unit for the mechanical damage.



WARNING!

Always observe safety rules when you work with live cables.
Do not apply voltage of more than 42V to the open metal parts or jacks of the Tracer.

The Tracer locates utilities and cable faults by the induction method.

Replacement sensors facilitate finding damaged insulation by the voltage of current bleeding via the ground.

The alternating magnetic field induced by the utility and/or the voltage generated in the replacement sensors are transformed into a signal form. This signal is amplified and processed by the digital signal processor. Then the signal levels are displayed in a form of line bars and digital values in dB or Volts. The indication may be supported with the audible signal.

4.2 Battery charging

The Ni-Mh batteries of the 5H-AA 2000B-1 type with the rated capacity of 2000mA·h are used to supply the device.



WARNING!

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

The ambient temperature shall be from plus 10 °C to plus 30 °C when charging. Charging at other temperatures may reduce battery life.

Charging rate is displayed as a battery icon.

If you want to charge the battery, connect a power supply unit plug (included in the delivery set) to the corresponding jack of the Tracer. Plug the power supply in. Full battery is shown with completely highlighted BATTERY bar graph indicator.

Charging time is from 6 to 8 hours. If the Tracer is out of use for a long time, recharge the batteries quarterly.

Note. Charging of standard battery is with the current from 400mA to 500mA. When charging the batteries with other rated capacity, always check the temperature. If it rises quickly, stop charging.

4.3 Selection and setting the main parameters via the MENU options

Press the "MENU" button to enter or exit the menu. The menu is navigated with the signal gain buttons or sound volume buttons. The options may be selected and changed with the «H» button.

4.3.1 In the INDICATION submenu (see Figure 3b)

- the TRACE option (see Figure 3c) is used to select the signal peak type (see Figure 3d) and to switch on/off the peak or null indication;
- the SONDE option (see Figure 3e) is used to expand the scale 1:4 and to select signal level at the of the SONDE jack input in dB or Volts.

4.3.2 In the SOUND submenu (see Figure 3f) you may select an auditory accompaniment of the indication:

- as a single-frequency tone when the volume is proportional to the signal level;
- as a crack sound like in GM counter when the frequency of cracks is proportional to the signal level;
- as a direct audible signal from antenna on the frequencies of «50 Hz» and «AIR». This function provides operation by ear.

In the TRACE mode the sound backs up the peak signal intensity. When Peak mode is OFF, the sound level corresponds to the null signal. In the TRACE-SONDE mode, the sound backs up the signal at the SONDE jack input.

>

Indication...
Sound...
Measurements...
GPS
Exit

a)

Indication

> TRACE scale...
SONDE scale...
Back

b)

TRACE scale

> Peak type...
COMPASS
Peak scale
Null scale
Back

☒
☒
☒

c)

Maximum type

> Sharp
Broad
Expansion 1:4
Back

☒
☐
☒




d)

SONDE scale

> Scale in Volts
Scale in dB
Expansion 1:4
Back

☒
☐
☐

e)

Sound

> Tone
Dosimeter
Live
Back

☒
☐
☐

f)

Measurements

> Auto measurement H,I
Frequency set
Back

☒

g)

☒ 273Hz
☒ 526Hz
☒ 1024Hz
☒ 8928Hz
☒ φ 8928
☒ AIR
☒ 50HZ

☒ 100Hz
☐ 300Hz
☐ 550Hz
☐ 1450Hz
☒ RADIO
☒ 33kHz

h)

Figure 3 – Menus

4.3.3 In the MEASUREMENTS submenu you may use the following options (see Figure 3g):

- the AUTO, H and I options – to switch ON/OFF the continuous indication of utility depth («H») and the current flowing through the utility line («I»);
- FREQUENCY SET option – to set the frequency levels for further shortcut selection with the «F» button (see Figure 3h). You may enter the frequency levels into the list of available values or delete them with the “H” button. You may exit with the MENU button.

4.4 Operating Modes

4.4.1 The Tracer operates in two modes:

- TRACE – to locate the utility and detect its depth and operating frequency current flowing through it. The display of this mode is shown in Figure 4a;
- TRACE-SONDE – to locate the utility insulation damage and detect the depth of damaged area; to detect the short-circuited areas or wire break and select the conductors in the multi-core cables. The display of this mode is shown in Figure 4c;
- with the COMPASS option switched on, the direction of the located cable relative to the Tracer will be displayed. The display of the TRACE mode with COMPASS.

feature is shown in Figure 4b; in the TRACE-SONDE mode – in Figure 4d.

To exit the TRACE mode and enter the TRACE-SONDE mode (and vice versa), press the MODE key and hold it pressed for more than two seconds.



WARNING!

For the correct operation of the Tracer in the TRACE-SONDE mode, use the A-frame of new version with insulation joint.

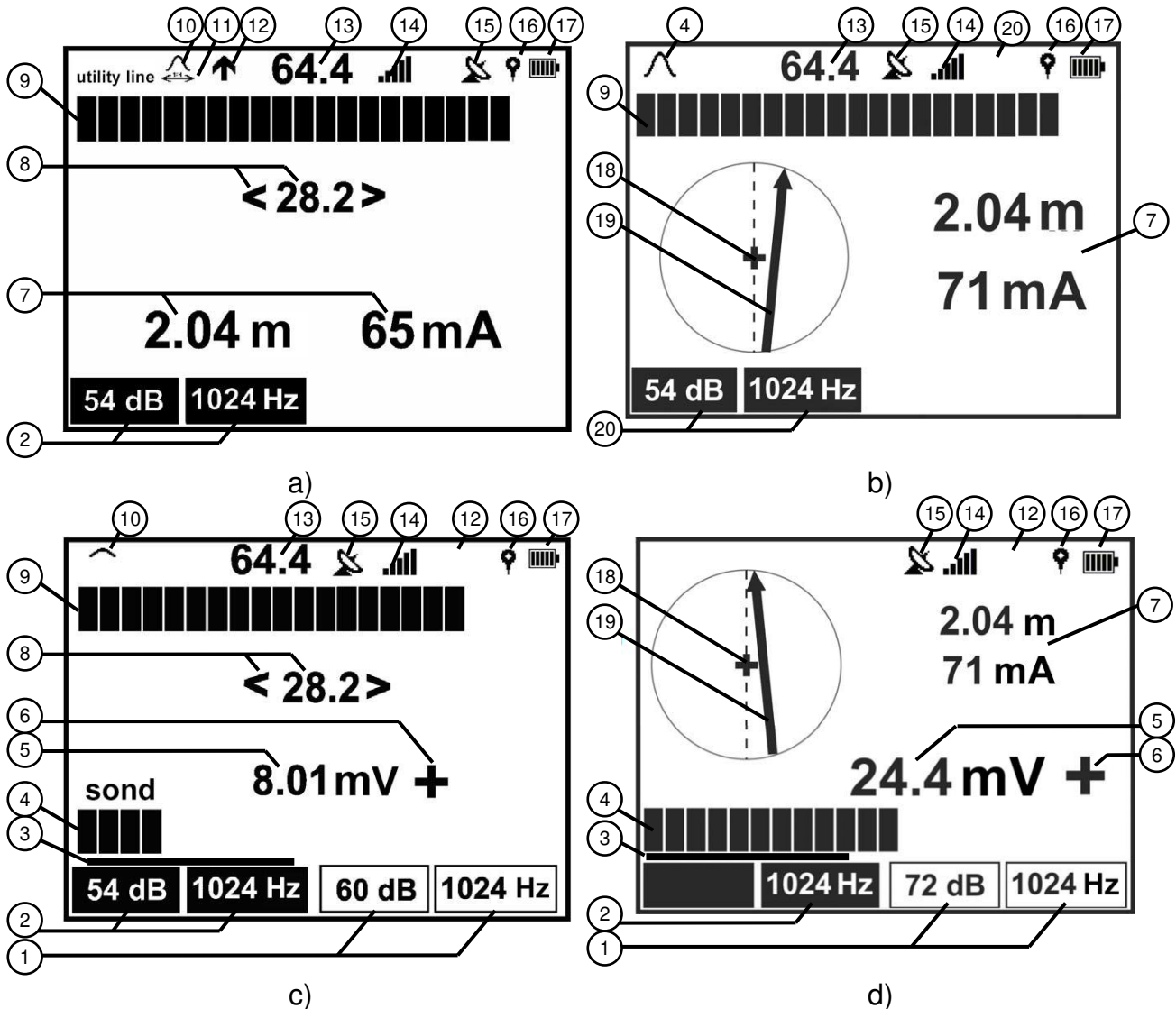


Figure 4 – Mode displays

- 1 Gain and operating frequency of the SONDE channel;
- 2 Gain and operating frequency of the TRACE channel;
- Indicator of effective area for selected gain and/or operating frequency for the
- 3 TRACE and SONDE channels. To change the effective area, press the MODE key shortly;
- 4 Barograph showing the relative signal strength at the SONDE jack input;
- 5 Voltage at the SONDE jack input – In Volts or dB;
- 6 Relative polarity caused by the leakage currents at the SONDE jack input;
- 7 Indication of the utility depth and the intensity of current via the utility;
- 8 Input signal from the magnetic antenna in dB and relative strength of input signal (null bargraph). Locating is by null method with the preset direction of the utility;

- 9 Relative strength of the input signal (peak bargraph). Locating is performed by the peak method;
- 10 Indication of sharp peak («») or broad peak («»);
- 11 Indication of scale extension «»;
- 12 Direction of current: «» - from Transmitter; «» - to Transmitter;
- 13 Input signal from the lower magnetic antenna in dB. Locating is by the peak method;
- 14 Volume indicator;
- 15 GPS state, «» or «»;
- 16 Logging to the «» track, displayed at the moment of recording;
- 17 BATTERY state icon;
- 18 Tracer axis;
- 19 Utility position arrow;
- 20 Linear distance from the point logged by last pressing of «» button to present position. Calculated according to the GPS readings.



CAUTION!

The indicator of the input signal strength in dB (for locating by peak and null) turns red when the corresponding input channels are overloaded (see Figure 4, Pos. 13 and 8).

4.5 Locating Methods

4.5.1 Selection of operating frequency

Frequency selection shall be performed depending on operating conditions, targets and locating method. The operator shall have corresponding qualification and practical skills.

We recommend you to start location at low frequencies both by direct connection and induction methods. If the necessary signal strength fails to be reached, you may operate the device at higher frequencies.

Low-frequency location provides maximum range of search, especially in the wet soil, and it reduces interferences to other utilities. At the same time, the interferences of power signals and adjacent utilities are stronger at lower frequencies.

At higher frequencies, the range of search is greater in dry or frozen soil, and interferences of power signals and adjacent utilities are lower. Moreover, signal losses caused by insulated joints are much lower. At the same time, the Transmitter induces much noise to adjacent utilities, and this may result in false trails.

You may locate the utilities and damaged insulation without Transmitter at the operating frequencies as follows:

- «50Hz» - according to power cable signals (main frequency or harmonics);
- «100Hz», «300Hz» - according to electrochemical protection signals;
- «AIR», «RADIO» - according to telephone and/or broadcasting signals.

This method may cause false trails since the tracing of the utility may be complicated by branching, and direction of the target utility may not be detected by “own signal”. The operator shall have corresponding qualification and practical skills for this method.

4.5.2 Peak, null and current direction modes.

The Tracer contains four magnetic antennas. The Tracer shall be arranged vertically (see Figures 5 and 9). The «broad peak» tracing requires a lower horizontal antenna only; two horizontal antennas operate during «sharp peak» tracing; one lower horizontal and one vertical antennas operate for tracing in the null mode. The COMPASS mode requires all 4 antennas of the Tracer.

4.5.2.1. Peak mode

The Tracer is equipped with sharp peak («») and broad peak («») functions, which facilitate high accuracy of tracing depending on the depth and density of utilities in the target zone.

In Figure 5 shows the relationship between the signal level and antenna displacement from the utility.

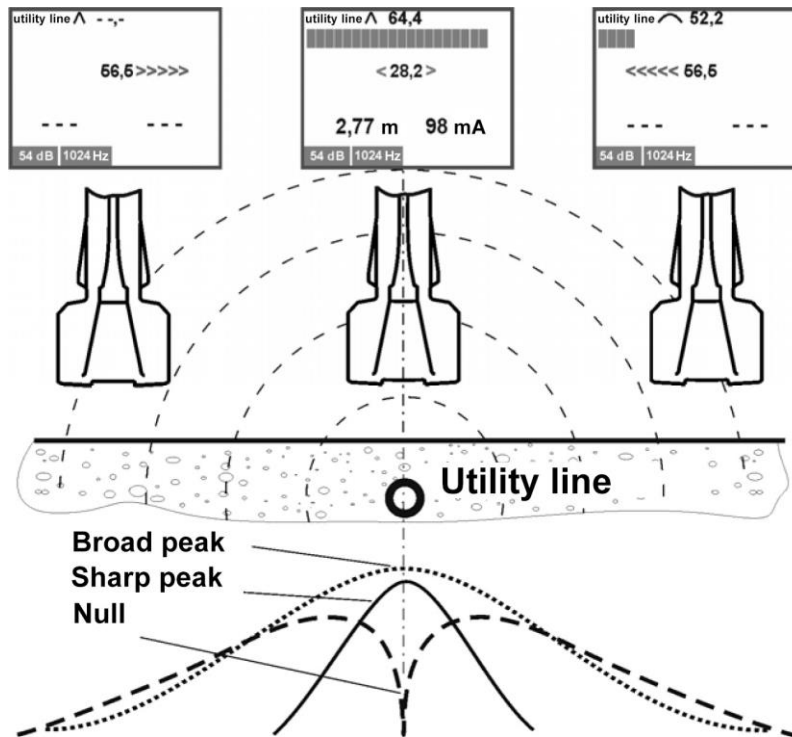


Figure 5 – The level of the responding signal depending on the Tracer displacement from the utility axis

The «sharp peak» method provides high accuracy of the utility tracing since the signal peak near the line axis is on the abrupt area of the graph (see Figure 5, left display). When the antenna is arranged right over the axis of the utility, the responding signal will be on its peak. The signal gain in this point shall be set so that $\frac{3}{4}$ of the scale were lighted; the sound volume shall be adjusted at the level, comfortable for the operator. The « $\rightarrow \bullet \leftarrow$ / OK» button may be used to adjust the optimum gain of each specific signal automatically. The indicator barograph will grow down when the Tracer moves away from the axis. Further displacement of the Tracer will result in disappearing of the linear scale. The «--.-» icon will appear instead of the signal level indication.

If the signal is weak or the depth of utility is sufficient, the indication on the Peak scale may be unstable or missing. In this case you shall use the «broad peak» method which demonstrates higher sensibility to weak signals.

The indicator scale readings do not depend directly on the location of the Tracer towards the utility at the «broad peak» method since the signal peak is within the broadarea of the graph (see Figure 5, right display). However, this method provides maximum sensitivity of the Tracer.

As far as you move along the line, the Tracer gain and the sound volume shall be adjusted depending on the strength of the received signal. Along the route the signal strength may change depending on the cable core twists. The strength of signal may also drop considerably in the areas where the cables are laid under pipelines or near connecting sleeves, or in the areas where they are shielded with metal pipes.

In some cases, the peak scale is not sufficient, e.g. when the pipeline branch of smaller diameter is traced deeply under the ground. At that, some portion of tracing current leaks through the branch, and the peak signal strength over the main pipeline drops slightly, and this may go unnoticed.

The «peak scale expansion 1:4» option reduces the scale divisions to increase its resolution. The «» icon (Pos. 11 in Figure 4) will be displayed, a yellow strip will appear under the «peak» scale to show the expansion bar graph relative to the normal (unexpanded) scale.

Using the gain up/down buttons, place the end of the extended «peak» bar graph within the visible area of the display. The gain-up button expands the scale. The gain-down button makes the scale shorter.

The optimum gain and scale for a specific signal intensity may be obtained by pressing the « / OK» button.

The option of the peak scale extension may be selected by scrolling the MENU options as follows: *Menu > Indication > TRACE scale > Peak type > Extension 1:4.*

4.5.2.2. The null method

The method of null provides precise tracing of single utilities. The null signal is within the abrupt area of the characteristic curve.

In Figure 5 shows relationship between the null signal intensity and the displacement of the antenna away from the target utility. When the antenna is exactly over the axis of the utility, the signal will be on its minimum. When you move the antenna away from the utility, you will get the signal gain, and there will be more lighted segments of the barograph towards the utility. Subsequent disposal of the antenna will result in smooth signal attenuation.

When you use the null method you should maintain the optimum gain level of the Tracer. If the gain is too low, the barograph drift from the center will be minor or unnoticeable. If the gain is too high, the barograph drift may be drastic. This may give the impression of chaotic operation of the Tracer.

When you move along the route of the utility, the signal may rise sharply. This means that the bending (or branching) of utility takes place. The indicator will show its direction.

When you locate the utilities surrounded with other lines and cables, use the method of sharp peak since the interferences of adjacent lines is too high during peak tracing.

4.5.3 Locating with COMPASS option

The COMPASS mode is used to facilitate location of single long-distance utility lines with bends and turns. This COMPASS shows the orientation of the located utility relative to the Tracer. This facilitates the user operation.

The COMPASS option is selected via Menu as follows: *Menu > Indication> TRACE scale > COMPASS*.

The COMPASS arrow will show the direction of the utility (see Figure 4, Pos.19). In the TRACE mode, the Tracer displays the peak scale and input signal strength; in the TRACE-SONDE mode, the Tracer displays the scale, strength and polarity of signal at the SONDE input.

Locating with the COMPASS feature is shown in Figure 6.

Moving along the target line, try to arrange the Tracer relative to the utility so that the Utility position arrow (Figure 4 Pos.19) turned to be aligned with the Tracer axis (Figure 4 Pos.18).



CAUTION!

The utility position arrow shall be used for visual presentation of utility location only. It shall not be used for precise localization of the target cable. If the signal is weak, the target line environment is crowded and noisy, use the peak method as specified in 4.5.2.1.

The utility position arrow may become fuzzy during location. This may occur when the Tracer is perpendicular to the path of the utility line or the Tracer and target utility are distant, or locating signal is too weak.

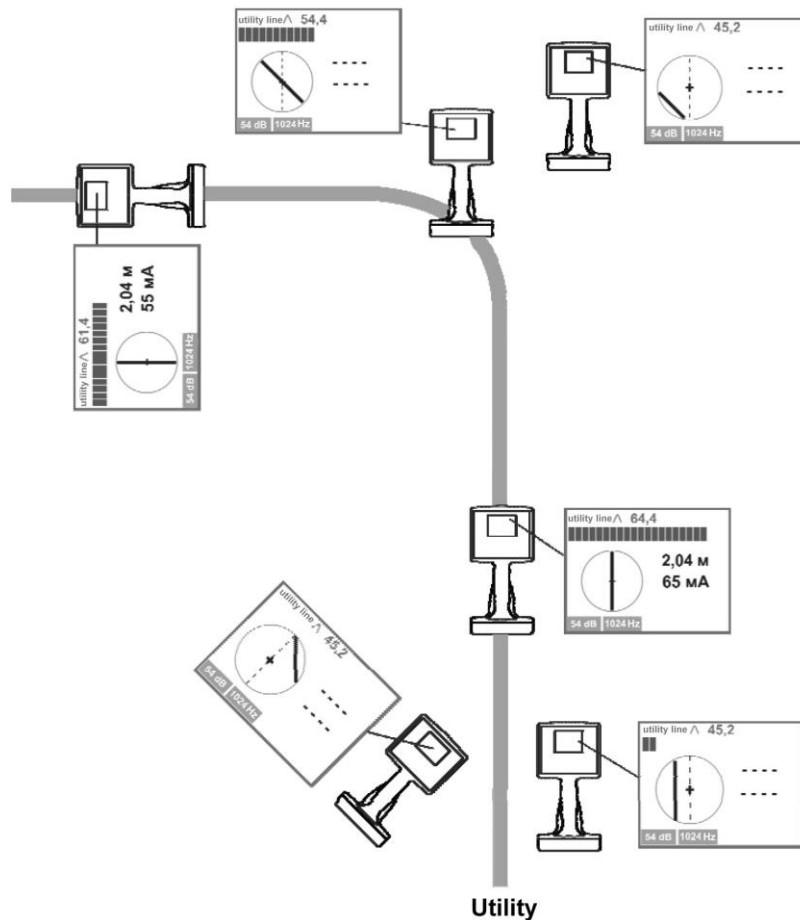


Figure 6 – Locating with COMPASS

4.5.4 Locating by current direction

The method of current direction may be used to locate target line in the areas with high concentration of utilities. Select the mode of double-frequency signal of «1024Hz» on the Transmitter, and set the operating frequency of the Tracer on the level of «1042Hz». If the double-frequency signal strength is sufficient, the indication of current direction (Figure 4, Pos. 12) will be active automatically.

If the COMPASS feature is used, the current direction will be shown with the Utility position arrow direction (Figure 4, Pos. 19).

The Transmitter shall be connected directly to the target line for this technique. The adjacent utilities shall be galvanically separated from the target line in the point of connection (see Figure 7).

The «direct current» will go via the target utility line from the Transmitter, and it will be displayed as the «↑» icon. The so-called «return current» will flow back to the Transmitter via the adjacent lines. This current is generated due to the distant galvanic or capacitance coupling with the target line, and It will be indicated as the «↓» icon.

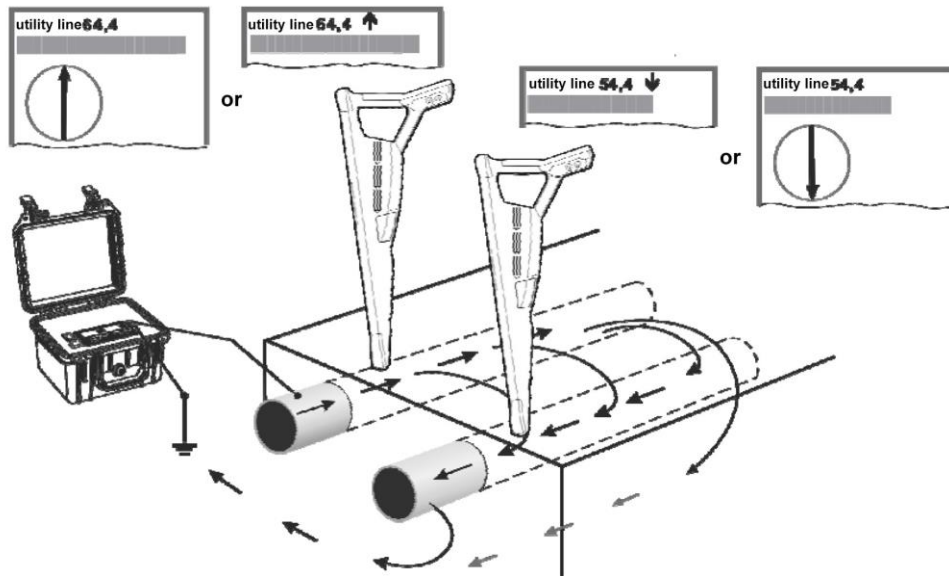


Figure 7 – The direction of current in the galvanically separated adjacent lines

In case the adjacent utility lines are galvanically coupled with the target line, all these lines will have the signals of equal direction (see Figure 8). Signal amplitudes of the adjacent lines may differ depending on the search current spreading.

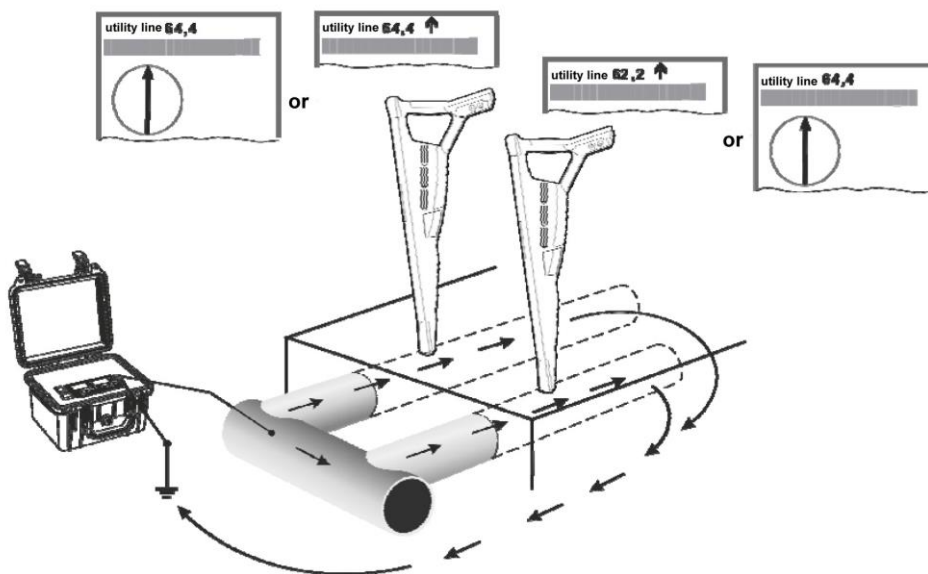


Figure 8 – The direction of current in the galvanically coupled adjacent lines

4.6 Depth and current intensity of the utilities



WARNING!

The errors of depth measurements may be caused by the magnetic field distortion produced by adjacent utilities or metal objects, bends or branches, or in high-noise areas. Always observe the rules of operation of the Tracer before operation to ensure against errors.

The utility line depth and current strength are not displayed on the «RADIO» and «AIR» frequencies. The error of depth is not rated on the «50Hz» frequency.

Using the above techniques, keep the Tracer over the target utility axis, as shown in Figure 9. The arrows on the Tracer body and antenna plain shall be perpendicular to the utility line axis.

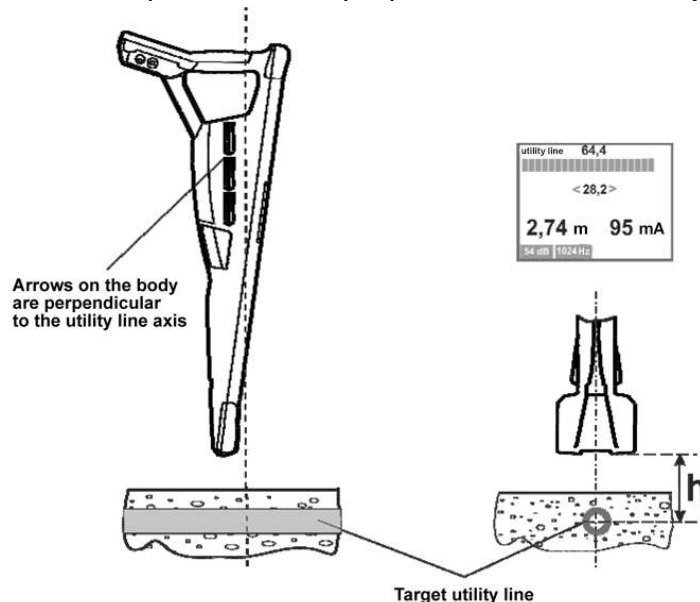


Figure 9 – Direct location of the utility depth

The Tracer displays the depth and current of target line by default. You may switch this function off, and display these data by pressing the «••» / **OK**» button.



CAUTION!

The depth is measured from the lower surface of the Tracer to the center of the utility line.

The line depth value is measured from the lower surface of the antenna to the center of utility.

When the Tracer moves away from the utility axis the depth readings will increase as the distance to the utility increases. Thus, the most significant readout is the minimum value of the utility depth.

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.

To check the results of measurement you may perform the following: lift the Tracer 1.3 meters up and repeat measurements, making sure that you hold the Tracer evenly. The readings shall increase by the height of lifting. You may perform measurements at various frequencies.

The «LOW FIELD» indication means that the obtained result are certainly wrong since the received signal is too weak or the Tracer is moved away from the target line or the utility field is distorted by the adjacent line currents. In this case, use “the 6dB method” (see Figure 10).

4.6.1 The indirect method of 6dB

When the Tracer fails to measure the depth of the utility line or the depth shall be located on the passive frequencies, you may use the indirect method of 6dB.

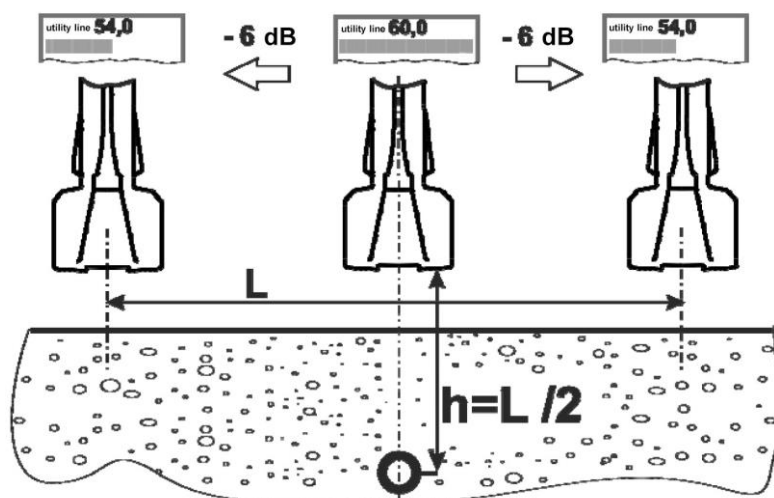


Figure 10 – Depth measurement by the 6dB method

Pinpoint the utility axis and store the readings of the input signal strength on the peak scale in dB. Moving to the left and to the right of the utility axis, find the positions in which the readings will be 6dB less (this means that the signal strength is two times less). The distance between these two points will be equal to double distance from the Tracer to the utility line axis.

4.6.2 Locating by the utility current

When several utilities are running close together within the traced area, return signals from wrong lines may cause false retrieval. The problem sometimes occurs when the target line is deeper than the wrong line carrying the return signal, and the return signal from the wrong line is stronger than one from the target line.

The current intensity does not depend on the utility depth, and maximum current will be detectable in the target line. The same level of current will be detected in the target line, and the target line will be identified easily.

When you use this technique, please be sure that the current strength in the target line is much higher than in the adjacent utilities. To achieve this, connect the Transmitter directly to the target line, or use the current-control clamps. Connection through the transmitting RP-02 frame gives less evident results.

The abrupt current change may represent branches or tie-in connections of the utilities (if they are made of current-conducting materials), since some current will leak through the branches. The first Kirchhoff's law says that the total current inflowing in a junction is equal to the total outflowing current. You should note, however, that values of the current intensity near the branches will differ from the actual values. Accurate and true measurements may be performed within long-distance and uniform areas only.

4.7 Testing of ground plots

In order to avoid damage, the ground plots shall be tested to locate and trace the current-conducting utilities before excavating.

4.7.1 Passive locating without Transmitter

The territory may be located in response to re-radiated power, telephone, broadcasting signals or signals of electrochemical protection. Make tracing on the «50Hz», «100Hz», «AIR» and «RADIO» frequencies consecutively.

Set the Tracer gain so that a half of the peak bar graph is illuminated. Move in zigzags with the zigzag step of from 1m to 5m in one direction, and then – in perpendicular direction.

Increased signal strength on the peak scale shows the presence of the utility line. To validate a target line location, perform steps specified. Find the direction of the located utility rotating the Tracer on vertical axis. The peak signal is generated when the Tracer plane

is perpendicular to the utility line, the minimum one – when it is parallel.

4.7.2 Testing of ground plots with the RP-02 frame and transmitting antenna AP-01

When the location on the passive frequencies is impossible because of the weak signal, and when you need more accurate location of the utility, you may perform tracing according to the Transmitter signals induced by the Transmitting frame RP-02 or Transmitting antenna AP-01 hereinafter referred to as the inductors).

Please note that:

- high Transmitter power and small distance from the inductors to the Tracer cause strong direct connection, that will drown the utility signals;
- the strength of current induced in the utility line by means of the inductors will be much lower than that at the direct connection;
- the strength of current induced in the utility line by means of the inductors will be high at high operating frequencies of the Transmitter and close location of the inductor to the utility line;
- the utility current strength depends on the grounding on the ends of the utility line. If one of the ground contacts is missed, the location will be difficult, so the Transmitter shall be set on the maximum frequency to increase the currents via the capacity between the utility and ground.

The testing shall be made by the following methods:

The first method

Split a studied territory into the plots with the size from 30×30m to 100×100m. Put the RP-02 frame on the ground horizontally, in the center of the studied plot (see Figure 11). Place and fix the antenna vertically. Set the Transmitter frequency on its maximum. Adjust the Transmitter power to achieve minimum direct connection between inductor and Tracer. In order to test the narrow plots, i.e. for a trench, put the inductor apart from the tested plot (at the distance from 15m to 20m).

Go along the perimeter of the plot. Peak signal will be at the crossing of the plot bounds with the utility lines.

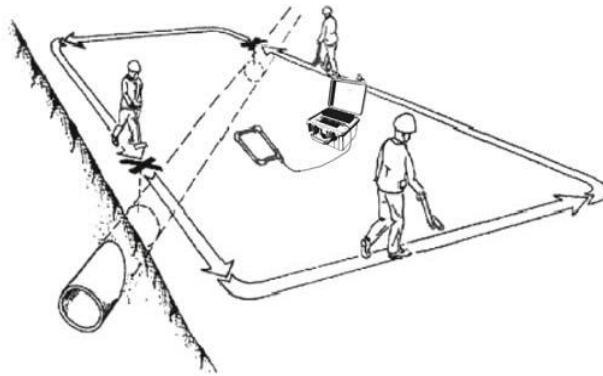


Figure 11 – Ground plot location with the RP-02 frame

The inductors placed as above fail to induce signals onto the utilities arranged right below. These utilities may be left undetected. Move the inductor some meters aside and repeat tracing.

To verify the utility location, place the RP-02 frame vertically over the supposed utility axis, and put the AP-01 antenna across the utility axis. Trace the utility line in both directions.

The second method

Connect the AP-01 antenna to the GT-15 Transmitter. Do not take this equipment out of the carrying case. Select the «33k» frequency. Set the optimum power.

Two operators go at the distance of 20m or 30m from each other. The first operator goes along one edge of the testing plot, pointing the antenna straight forward. The second operator goes along the opposite edge of the testing plot and registers the changes of the signal strength according to the peak scale (see Figure 12). The signal peaks will appear in the areas of utilities.

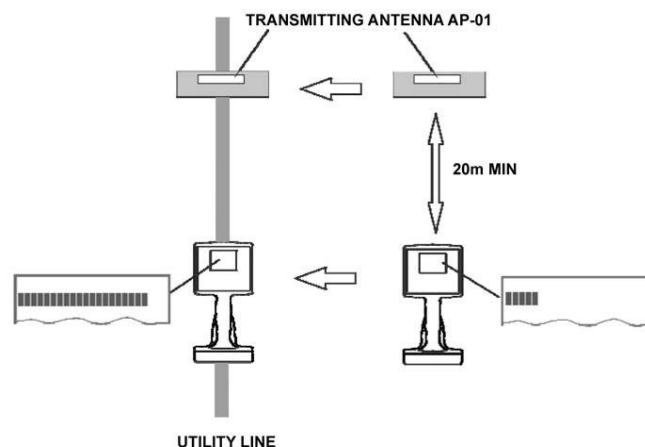


Figure 12 – Tracing the plots with the AP-01 transmitting antenna

Repeat the above steps moving in perpendicular direction

5 METHODS OF LOCATING DAMAGED PIPELINES AND UTILITIES

The methods below are based on identification of relative distortions of signals within the damaged areas. Sometimes these distortions are unobservable so all the readings obtained during measurement shall be stored in the PC memory for further analysis.

5.1 Method of locating by current

This method should be used to locate broken insulation of pipelines or utilities with considerable leakage to ground.

If a sudden drop of the current strength is revealed in the areas without tie-in connections and branches, this will mean that a considerable damage of the line insulation takes place. This method is true for high initial current (of more than 0.5A) and considerable drop of current strength after the damaged area. We recommend you to make tracing on the frequencies of 273Hz or 526Hz.

5.2 Fault finding with insulation control

Both contact sensors of insulation control DKI-02 and A-frame, and non-contact sensors DKI-E and DKI-P are used for location. Turn the Tracer into the TRACE-SONDE mode. The sensors shall be connected to the SONDE jack (Pos. 4 in Figure 1). The broken areas are detected according to the strength of the signal from the sensors on the SONDE scale.

At that, the utility planimetric position control shall be performed with the «peak» and «null» methods (see Figure 4c). If the COMPASS function is activated, locating will be performed by the position of the utility pointer relative to the Tracer (see Figure 4d). Always control the depth of the utility and the strength and direction of current to avoid false trials. The current direction shall be controlled when two-frequency signal of «1024Hz» is set on the Transmitter.

To adjust the line scale of the signal strength from the insulation control sensors, set the pointer (Pos.3 in Figure 4) to the SONDE position by pressing the MODE button. The gain may be selected with the gain up/down arrows. For the automatic gain selection use the   / OK button.



CAUTION!

Do not supply the voltage of more than 42V to the SONDE jack inputs.

5.2.1 Insulation fault finding by signal drop.

The technique is the same for all types of sensors.

Both operators shall stand in trail over the axis of the target line (for the DKI-E sensor) or both pins of the sensor shall be put into the soil for survey as shown in Figure 13.

The point of insulation failure may be defined by the signal peaks when one pin/operator is directly over the place of break. The signal drops to its minimum when the point of insulation failure gets between the pins/operators. When you work near the area of failure, move the pins closer to each other (to make their coordinate positions more clear) and reduce the steps.

When the long-distance insulation failure takes place, the signal peaks are located distantly from each other, on the bounds of failure. The signal null is between the bounds of insulation damage.

To make a precise tracing you may define the polarity of signal at the SONDE input. For this, switch the mode of double-frequency signal of «1024 and 512Hz» and set the operating frequency of the Tracer to the level of «1042» at the SONDE input. The indication of current direction becomes active automatically, if the two-frequency signal strength is sufficient (Figure 4, Pos. 6).

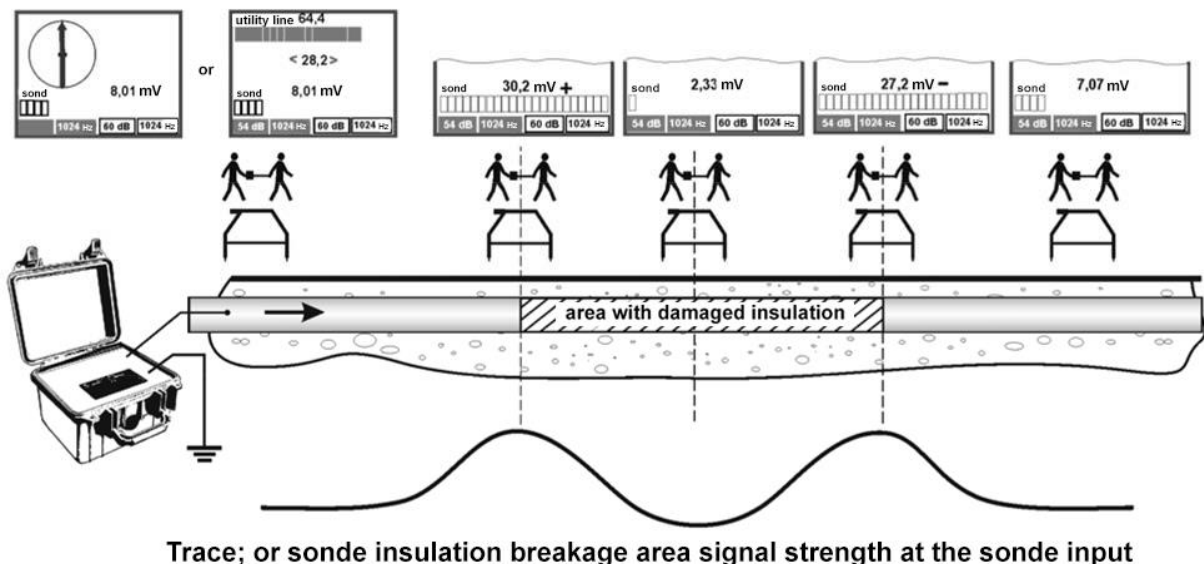


Figure 13 – Insulation fault finding by signal drop

When the operator moves along the undamaged part of the utility, and then moves directly over the damaged area, the chaotic change (or missing) of polarity at the SONDE input may occur because of weak signal (see Figure 13).

As far as the operator approaches the bound of the damaged area, and the signal increases, the polarity becomes stable. When the operator passes the border of the damages area, the polarity will change. In case the insulation is damaged in one point only, the signal level over the damaged point will have a sharp null.



CAUTION!

The polarity inversion without a specific signal fluctuation may not be considered as a sign of fault.

5.2.2 The search of the insulation failure by the signal rise

The technique of search is the same for all types of sensors (see Figure 14).

One of the operators with the Tracer shall move along the target line with the certain step (for the DKI-E sensor) or one of the pins shall be embedded into the soil with a certain step for fault finding. The second pin/ operator shall be away from the target line.

The area of the insulation failure shall be determined by the signal peak.

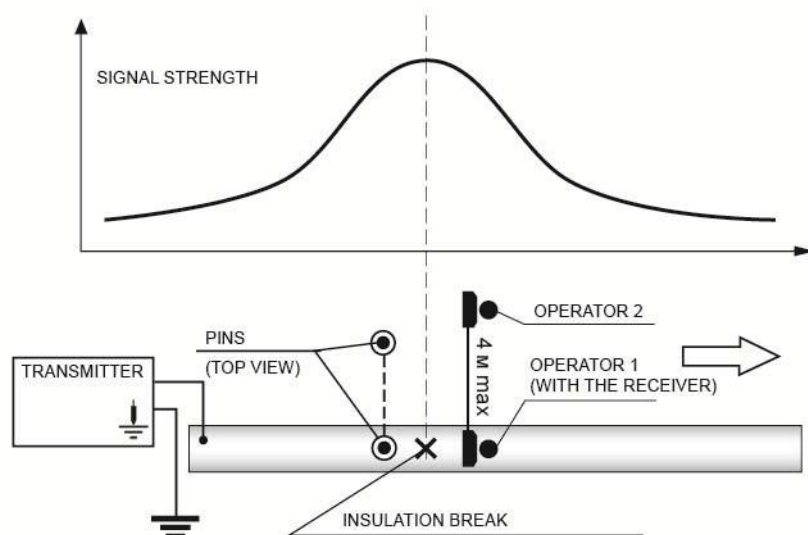


Figure 14 – Connection diagram and search of the insulation failure by the signal rise

5.2.3 Use of sensors



CAUTION!

Do not supply the voltage of more than 42V to the sensors inputs.

The DKI-02 sensor

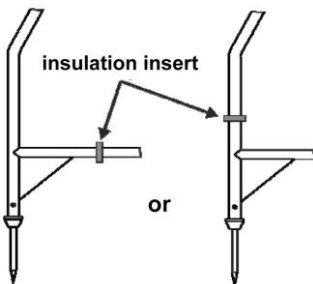
This sensor facilitates operation in congested areas. The pins shall be arranged or rearranged over the axis of the utility at the distance from each other not exceeding the depth of line.

The “A-frame” sensor



WARNING!

For correct readings of depth and direction during fault finding always use the A-frame of a new type supplied with insulating insert, as shown in Fig. Old A-frame may cause false readings of depth.



As compared with the DKI-02 sensor, the “A-frame” provides more accurate readings from measurement to measurement, since the fixed distance between the pins

eliminates signal fluctuation error caused by different distances. Measurements with this sensor, however, require the pins to be embedded into the soil, that may be inconvenient in some cases.

Keep the insulator surface of the A-frame clean. Soiling may cause signal drop or loss of sensitivity.

The DKI-E sensor

This sensor accelerates tracing of single expanded utilities. The sensor operability does not depend on the type of soil or paving. The sensor, however, has lower sensitivity, particularly at low frequencies. Each operator holds a contact electrode of the sensor during operation. If tracing is performed close to the fault, the distance between the operators shall be reduced to clarify the position of cable failure.

The DKI-P sensor

This sensor is an electric antenna fixed to the magnetic antenna module. The operation of this sensor is similar to the operation of the DKI-E sensor, but it requires only one operator. This sensor, however, has lower sensitivity. Strong wind or contact with grass may cause instable readings.

5.3 Cable breakdown location



CAUTION!

The ferromagnetic armature over the cable conductor may reduce the detected signal strength so the search shall be made at maximum possible current

5.3.1 Finding of short-circuited conductors

In Figure 15 shows the diagram of tracing the short-circuited cables.

The Receiver shall be brought along the target utility, and the signal strength shall be controlled on the peak scale. The signal strength may change before the shorted area depending to the cable lay pitch. The signal fluctuation stops behind the short-circuited area, and signal strength may drop (case 1) or rise (case 2).

In the first case, the «dead short» takes place, when only the cable conductors are shorted. In the second case, the cable conductors are shorted to each other and to the armature.

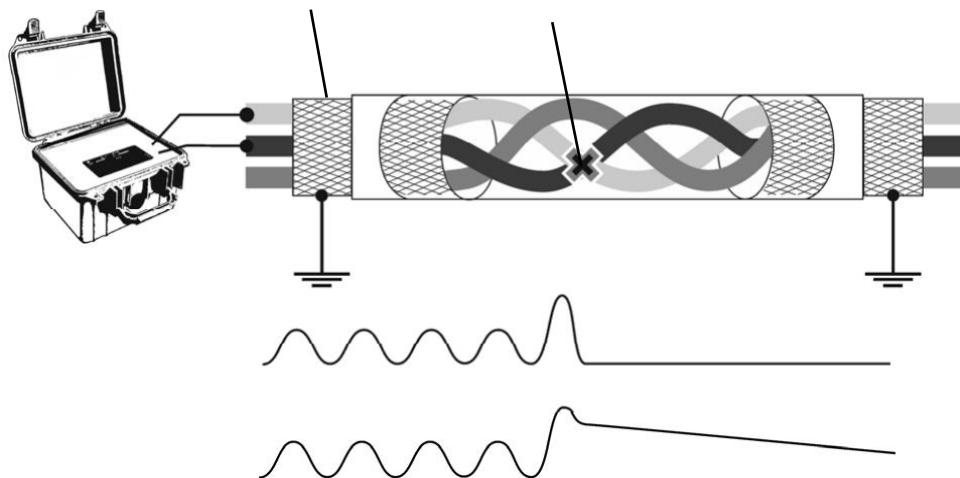


Figure 15 – Layout and signal diagram at the method of search of short-circuited wires

5.3.2 Location of shorted conductor-armature areas

The layout of location of conductor-armature shorted area is shown in Figure 16.

The signal strength may change before the shorted area depending to the cable lay pitch. The signal fluctuation behind the short-circuited area remains the same, and signal strength rise abruptly.

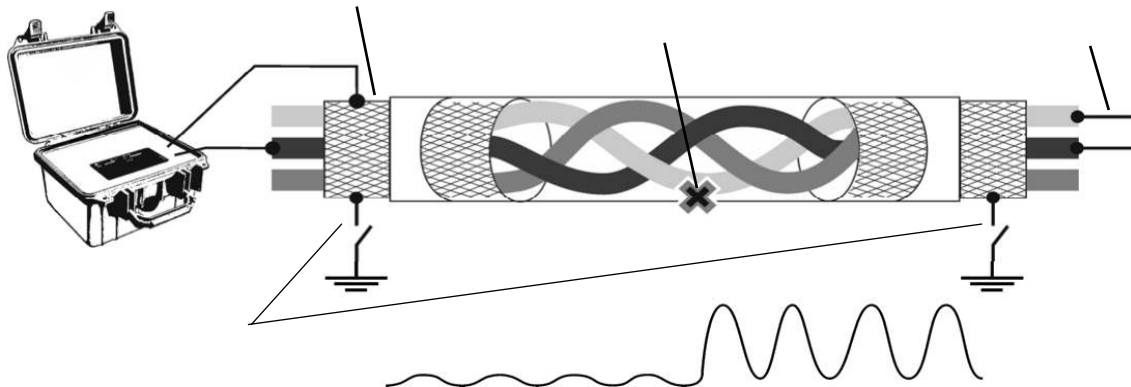


Figure 16 – Layout and signal strength of tracing of conductor-armature short-circuit

5.3.3 Tracing of damaged insulation and grounding areas

Cable insulation failure relative to the ground with the resistance of hundreds Ohm may be located with insulation control sensors – DKI-02, A-frame and DKI-E or DKI-P. Connect the Transmitter in accordance with Figure 17. The grounding wire shall be connected to the Transmitter jack with the « $\perp$ » marking. The methods of locating are generally the same.

In case the cable insulation resistance relative to the ground does not allow the use of the insulation control, the method of phase tracing may be applied. The phase technique provides location of both low-resistance and high-resistance insulation failures with the leakage to ground of up to 0.5MΩ. The area of damaged insulation shall be determined initially with a reflection-coefficient meter. One operator only locates by this method, and no additional sensors are required.

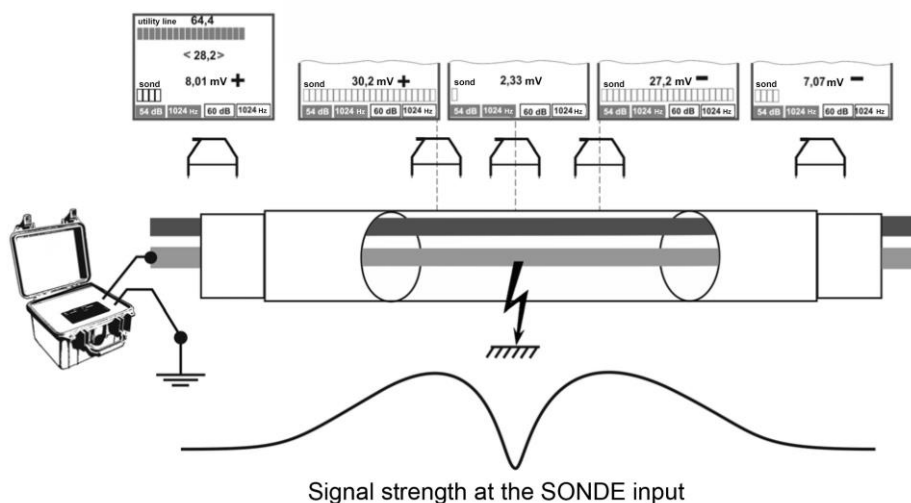


Figure 17 – Connecting diagram and signal strength for the method of insulation damage tracing with insulation control sensors

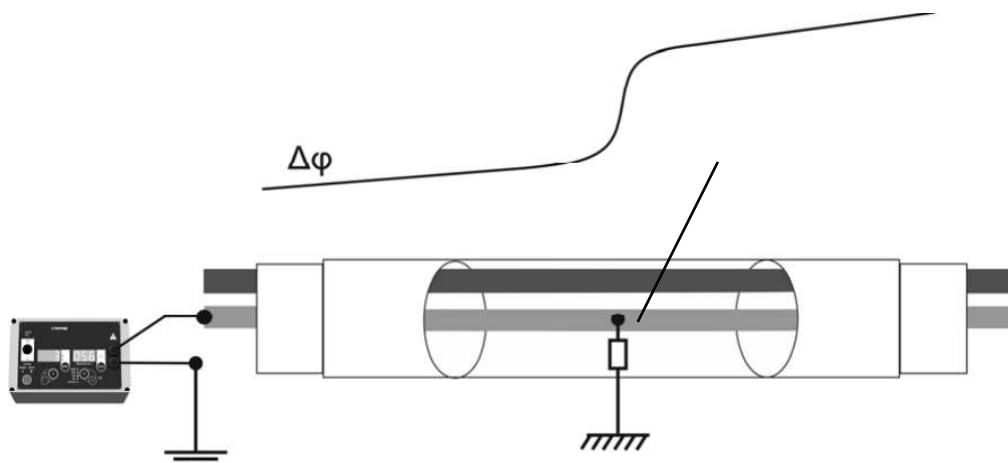


Figure 18 – Connecting diagram and phase shift at the phase method of cable insulation failure locating

Connect one lead of the GT-15 Transmitter to a damaged conductor (see Figure 18). The opposite end shall be protected. The second lead of the Transmitter shall be grounded with a pin placed at the distance of no less than 5m from the cable. Preset the double frequency « Φ ».

Select the TRACE mode and frequency of the « Φ 8928» on the Receiver. Stand directly over the utility line at the beginning of the tested plot. Make sure that you are not closer than 20m to the point of connection of the Transmitter. Press the « $\rightarrow \leftarrow$ / OK» button on the Receiver to reset the phase indications. Move along the target line, directly over it, and control the position with the null scale; take phase readings carefully. The phase may change smoothly. The phase readings will rise abruptly by several scale units behind the area of insulation failure. When you pass the area with damaged insulation, the phase readings will change smoothly.

The failures of this method are as follows:

- phase fluctuation within the areas of damaged insulation is less obvious than signal fluctuation by the insulation control sensor tracing method;
- interferences from adjacent utilities.

5.3.4 Tracing the area of wire break

In case the cable is inaccessible or protected with metal armature, perform a high-voltage burn-down of the cable to achieve stable short-circuit of the broken conductor to the adjacent wire or armature. To make further search follow the steps.

If the cable has not armature, and it is easy-to-reach, the area of conductor break may be found with mini-sensor of the MD-01 model.

The mini-sensor MD-01 is shown in Figure 19. Connect the mini-sensor to the SONDE jack.

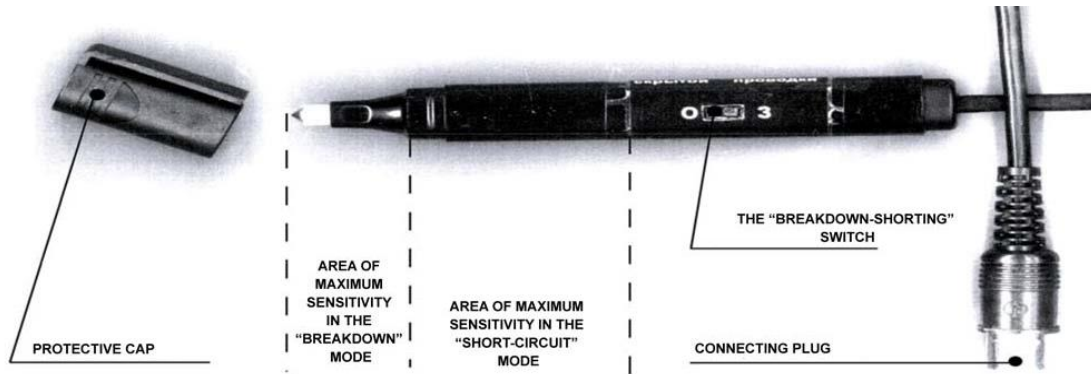


Figure 19 – Mini-sensor MD-01

The sensor is compact, and it provides more accurate tracing in case of close location of wires.

When you use the MD-01 sensor, switch the Transmitter to the mode of limitation of the input voltage to the level of 30V.



WARNING!

Do not supply the voltage of more than 42V to the current-collecting nozzle of the mini-sensor probe

If the cable is easy-to-reach and unshielded, the area of conductor break may be found with the MD-01 mini-sensor. Set the switch of the mini-sensor into the “O” position. The mini-sensor registers an electric field near the conductors.

In Figure 20 shows the conductor break locating diagram.

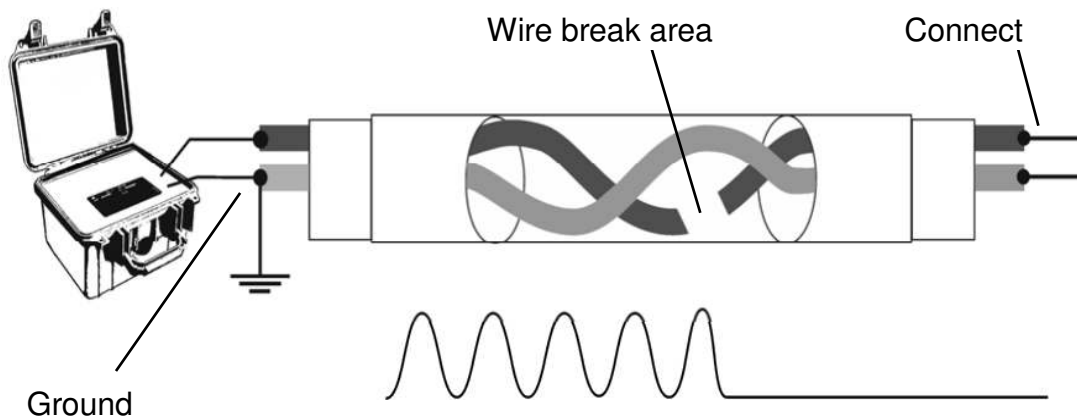


Figure 20 – Connection diagram and signal strength for conductor break locating on the unshielded lines

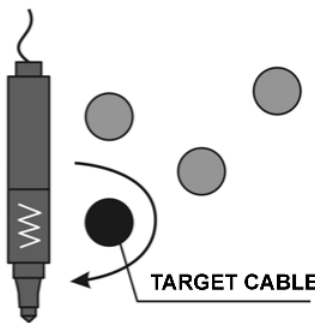
5.4 Picking-up cables and conductors

To pick the cables and wires up, set the mini-sensor switch into the «3» position. The mini-sensor registers magnetic field near the live conductors. The signal strength will be controlled with the SONDE scale.

When you locate the de-energized cables, connect one Transmitter output to the target cable (conductor) at the frequency of 273Hz or 526Hz. The Receiver shall be set to the operating frequency of 273Hz or 526Hz correspondingly or to the «AIR» frequency in the TRACE-SONDE mode.

Below find the technique of picking-up of the cable from the bundle. The picking-up of the wires from the multi-wire cable shall be the same.

5.4.1 Finding the conductor in the multi-core cable by signal peak

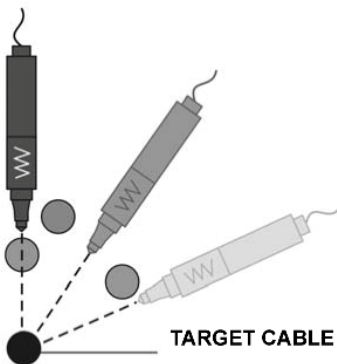


One output of the Transmitter shall be connected to the target cable; the other one shall be grounded.

With this method the maximum sensitivity zone of the mini-sensor in the “SHORTING” mode is applied consecutively to the different cables of the group of cables. Then the results of measurements are compared. The target cable which is connected to the Transmitter will have the signal of maximum strength.

Move the sensitive zone of the mini-sensor around the target cable in the plane perpendicular to the cable axis. The signal strength will be constant. When the sensitive zone of the mini-sensor is moved around the other cables, the signal strength will vary according to the position of the mini-sensor in regard to the target cable (cable with maximum signal strength).

5.4.2 Locating the conductor in the multi-core cable by the method of signal minimum



One output of the Transmitter shall be connected to the target conductor; the other one shall be grounded.

If the mini-sensor end touches the target cable, the current flowing through the cable will not induce the signal to the coil of the mini-sensor. The signal strength will depend on the signals induced by adjacent cables of the group.

As far as the mini-sensor axis is displaced from the cable axis, the signal generated by the target cable will amplify considerably.

In other words, when the mini-sensor is moved over the target cable and with the axis of sensor crossing the axis of the cable, the abrupt drop of signal over the cable may be observed. Other cables will not cause so evident signal drop or they will not cause a signal drop depending on the strength of the signal via the cables.

Put the mini-sensor at different angles for testing in order to avoid false trials (you may detect a cable which goes over the sought one).

5.4.3 Check by the method of depth measurement

To check the results and eliminate errors of the measurement, apply the module of magnetic antenna to the target cable and perform the depth measurements. The depth readings shall be zero, other readings mean the false trials.

5.5 Locating the line-to-ground faults of the overhead lines in the networks of 6 ~ 10 kW with isolated neutral

The search of line-to-ground faults is performed on the high-harmonic level of zero- sequence current at the frequency of 550Hz or 1450Hz. The faulty overhead line, which splits off from the station, is detected according to the signal peak. The signal strength will be much higher on the faulty line than on non-faulty one in the points where the branches of the overhead line take place. The signal strength behind the short-circuited area drops abruptly.

6 TROUBLESHOOTING AND REMEDIES

The possible faults and remedies are listed in Table 3.

Table 3 – Possible faults and remedies

Fault	Possible cause	Remedies
The Receiver fails to be switched- on or it is switched off spontaneously	Battery is defective or discharged	Charge or replace batteries
When power supply is on the Receiver fails to respond to the Transmitter signal	No contact in antenna plug connector	Check and restore contacts
The headphones fail to deliver sound whereas the sound is good through the internal speakers	No contact in headphone connector	
	Break in headphone circuit	Repair or replace headphones
The error of measurement of the depth of single long utility exceeds its allowable value	Drift of parameters of the measuring channel	Adjustment at the manufacturer is recommended