TECHNOAC

Cable fault locator

TDR-TA1M

USER MANUAL

Contents

Introduction

This user manual is a document certifying the main parameters and technical characteristics of the cable fault locator TDR-TA1M (hereinafter TDR-TA1M) guaranteed by the manufacturer.

The user manual allows you to become acquainted with the device and the operation principle of TDR-TA1M and establishes operating rules, the observance of which ensures device maintenance in a constant readiness for action.

Personnel with a secondary technical education who has working experience with electrical measuring instruments is admitted to work with the device.

1 PURPOSES

1.1 TDR-TA1M is designed for measurements on balanced, asymmetric and power cables. The device consists of a reflectometer unit and a measuring bridge block.

The reflectometer unit is designed for the following measurements on symmetrical and asymmetrical cables with wave resistance from 30 to 500 Ω:

- Cable length measurement;
- Measurement of distances to wave impedance or damage heterogeneities;
- Measurement of the line shortening coefficient with a known length;
- Determining the damage degree;
- Recording and playback of up to 100 reflectograms for subsequent processing in stationary conditions;
- Display of measurement results on the LCD screen with a resolution of 320x240 pixels.

The measuring bridge unit (hereinafter the bridge unit) is designed for the following measurements on balanced, unbalanced and power cables:

- Stub resistance measurement;
- Insulation resistance measurement;
- Electrical capacitance measurement;
- DC and AC voltage measurement;
- Ohmic asymmetry of cores determination;
- Distance to the place of lowering the insulation resistance determination;
- Distance to the cable conductor break determination;
- Distance to the short-circuit of the cable conductor determination;

1.2 TDR-TA1M is a compact device designed for operation both in the field and stationary conditions.

Type of climatic performance TDR-TA1M

- Operating temperature range from -20 to +40 °C;
- Relative air humidity 98% at +25 °C;

- Transportation and storage conditions from -50 to +50 °C.

1.3 TDR-TA1M is stable and resistant to the effect of sinusoidal vibration in accordance with Group 4 State Standard 22261 in the frequency range from 10 to 55 Hz.

1.4 TDR-TA1M power supply is an integrated maintenance-free battery voltage 7.4 V (battery type CV610D 1.9A*h). TDR-TA1M is equipped with battery discharge control and automatic shutdown of the device after 10 minutes of standby.

1.5 TDR-TA1M is not a sound noise source.

2 MAIN TECHNICAL DATA AND CHARACTERISTICS

2.1 Cable fault locator unit

2.1.1 Distance measurement range (time delay) from 0 to 50000 m (from 0 to 500 μs)

Measurement subbands:

0 - 250 m (0 - 2.5 μs); 0 - 500 m (0 -5 μs); 0 - 1000 m (0 - 10 μs); 0 - 2500 m (0 - 25 μs);
0 - 5000 m (0 - 50 μs); 0 - 12500 m (0 - 125 μs); 0 - 25000 m (0 - 250 μs);
0 - 50000 m (0 - 500 μs).

2.1.2 Basic reduced error limits allowed in measuring of the distance (time delay) in the subbands are ± 0.4% of the final subband value.

2.1.3 Additional reduced error limits allowed in measuring of the distance (time delay) in the operating temperature range from -20 to +40 °C are ± 0.8% of the final value of the subband.

2.1.4 The probing pulse parameters of positive polarity see in Table 1.

Table 1

The probing pulse parameters	Measuring distances range, m							
	250	500	1000	2500	5000	12500	25000	50000
τ_u, μs	≤ 0,04	≤ 0,05	≤ 0,06	0,2 ± 0,02	0,5 ± 0,05	2 ± 0,2	5 ± 0,5	10 ± 1,0
$\tau_{фр}$, ns, not more than	20	20	25	25	30	30	30	30
T, ms	10 ± 1	10 ± 1	10 ± 1	10 ± 1	10 ± 1	10 ± 1	10 ± 1	10 ± 1
U, B, not more than	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0

Note: additional possibilities for changing the duration of the probe pulse at different ranges by distance see in Table 3 of Section 4.

2.1.5 Permissible relative error limits of measurement of the shortening factor are in the range from 1 to 3 ± 0.8%.

2.1.6 The sensitivity of the receiving path when the signal exceeds the noise level twice on all subbands is not worse than 1 mV.

2.1.7 Range of matched resistances from 30 to 500 Ω.

2.2 Bridge unit

2.2.1 Permissible absolute error limits of measuring the resistance of the loop in the range from 1.0 to 9 900 Ω are ± (0.005R + 0.2) Ω.

2.2.2 Permissible absolute error limits of measuring the insulation resistance are: in the range from 10 to 999 kΩ ± 0.01R; From 1 to 999 MΩ ± 0.02R; From 1000 to 10,000 MΩ ± 0,1R, at the measuring voltage of direct current (180 ± 10) V.

2.2.3 Permissible absolute error limits of measuring the electrical capacity in the range from 1 to 3000 nF are ± (0.1C + 1) nF.

2.2.4 Permissible absolute error limits of measuring the DC voltage in the range from 1 to 200 V are ± (0.01 U + 1) V and the AC voltage frequency (50 ± 5) Hz in the range from 10 to 250 V ± (0.02U +2) V.

2.3 TDR-TA1M provides the following work types:

a) " Cable fault locator" mode:
- Determining the nature of the damage;
- Saving reflectograms in the internal storage;
- Output of stored records from internal storage to the screen.

b) «Bridge» mode:
- Determination of the cores ohmic asymmetry;
- Determination of the distance to the place of the insulation resistance lowering;
- Determination of the distance to the place of cable conductor break;
- Determination of the distance to the place of cable conductor short-circuit.

2.4 Time for setting the operating mode no more than 30 seconds.

2.5 The time of continuous operation of TDR-TA1M from the battery is not less than 8 hours and depends on the state of the battery, the time of continuous operation through the charger is unlimited.

2.6 Maximum electrical power consumed by TDR-TA1M when the battery is charged, no more than 30 VA.

2.7 Overall dimensions of TDR-TA1M, not more than:

length - 240 mm
width - 200 mm
height - 115 mm

2.8 Weight of TDR-TA1M with a battery is not more than 1.9 kg.

2.9 Reliability

2.9.1 Mean time to failure (T_f) at least 6000 hours;

2.9.2 The established service life (T_{sl}) is not less than 5 years.

3 DELIVERY SET

TDR-TA1M delivery set:

- Cable fault locator TDR-TA1M -1 item.
- Power supply (charger) GSU15E-3 - 1 item.
- Connecting cable - 4 items.
- User manual - 1 item.

4 STRUCTURE AND OPERATING PRINCIPLE OF TDR-TA1M

4.1 Operating principle of TDR-TA1M

4.1.1 TDR operating principle

The device implements the method of pulse reflectometry, which is based on the phenomenon of partial reflection of electromagnetic waves at the places of the circuit wave impedance variation. Using pulse measurement method, a rectangular probe pulse sent to the line, which, partially reflected from the inhomogeneities, returns back. Probe and reflected pulses are observed on a screen that is scaled by range and amplitude, and by their type you can draw a conclusion about the nature of the line inhomogeneity (see Table 2). The reflected pulses return to the device after a certain time from the sending of the probe pulse. Knowing the speed of the electromagnetic wave propagation along the line and the time delay of the reflected signal, it is possible to calculate the distance to the inhomogeneity of the wave resistance.

$$X = v\frac{t_3}{2} = \frac{C}{2 \cdot PF} \cdot t_3$$

where: X – distance to inhomogeneity, m;

v – propagation velocity in the electromagnetic wave line, m/ μs;

t_3 – reflected signal delay time, μs;

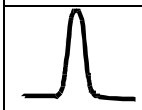
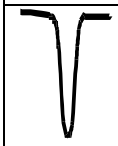
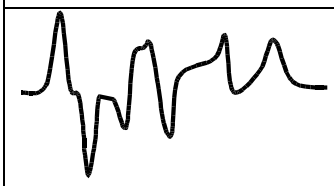
v = c / PF

c – velocity of light, equal to 300 m/ μs;

PF – propagation factor (shortening coefficient).

Inhomogeneities of wave resistance is a consequence of the cable production technology violation, as well as due to mechanical and electrical damage of circuits during the construction and operation of the lines. Inhomogeneity occurs in the places of connection to the line of any devices (coupling, tap, cable splice, Pupin's coil, broken pairs, etc.), or in the fault points (breakage, short circuit, cable core wetting, leakage to ground, leakage on an adjacent wire, etc.). The method of pulse reflectometry makes it possible to detect multiple inhomogeneities, both discrete and extended, depending on the ratio of their length and the minimum wavelength of the probing pulse spectrum.

Table 2

Appearance	Description
	Cable breakage
	Complex resistance is greater than the wave impedance of the cable
	Short circuit
	Complex resistance is less than the wave impedance of the cable
	Broken pairs or parasitic coupling between pairs. Status of the lines: "L1 - output, L2 - input". One line is connected to the socket "L1", the other - to the socket "L2"

NOTE The pulse amplitudes are given in the appropriate proportions with the same gain.

As a probe, a pulse of positive polarity with an amplitude of more than 10 V is used. The duration of the probe pulse automatically changes with a change in the scale of the measurement subband and is between 10 ns and 20 μs. However, it can be additionally changed by the user within certain limits, in accordance with Table 3.

Table 3

Additional possibilities for changing the probe pulse at different ranges of distance

Measurement subband	Pulse width options				
250 m		10 ns	**20** ns	40 ns	60 ns
500 m	10 ns	20 ns	**30** ns	60 ns	90 ns
1000 m	20 ns	30 ns	**50** ns	100 ns	150 ns
2,5 km	50 ns	100 ns	**200** ns	400 ns	600 ns
5 km	100 ns	250 ns	**500** ns	1 μs	1.5 μs
12,5 km	500 ns	1 μs	**2** μs	4 μs	6 μs
25 km	1 μs	2.5 μs	**5** μs	10 μs	15 μs
50 km	2.5 μs	5 μs	**10** μs	20 μs	

Note - the default pulse durations for each measurement sub-range are marked in bold.

The value of the propagation factor is individual for each type of cable. It is related to the type of cable sheath by the following relation:

$$PF = \sqrt{\varepsilon_0} \ ,$$

where ε_0 – dielectric constant of cable sheath.

The value of the propagation factor can be determined experimentally from the known cable length.

The inaccuracy in determining the distance to the inhomogeneity is determined by the discreteness of the indicator (320 samples / scale) and by the inaccuracy in setting the line shortening coefficient. Also additional inaccuracies can take place due to shape distortion of the reflected signal in the lines with frequency-dependent losses.

The measurement inaccuracy is also can be affected by the nature of the inhomogeneity, its magnitude, the presence of several inhomogeneities in the line. The measurement inaccuracy can be reduced by matching the device with the line using BALANCE handle.

In the TDR-TA1M device the distance is determined automatically (depending on the selected propagation factor) and corresponds to the position of the cursor on the screen and is displayed digitally at the bottom of the screen (Cursor).

4.1.2 Operating principle of the measuring bridge

The device is a universal measuring device, which includes a set of measurement schemes implemented on the basis of DC bridges and ballistic measurement method. Using the proposed measurement schemes, it is possible to determine the cable parameters (loop resistance, insulation resistance, ohmic asymmetry, electrical capacitance) and calculate the distance to the fault location (break, reduced insulation resistance, short circuit). Microprocessor allows you to automate the execution of calculations, and automatically selects a measurements range.

4.1.2.1 Insulation resistance measurement

The insulation resistance is measured by a DC bridge with a variable ratio of the bridge arms. The sensor, included in the diagonal of the bridge, fixes the current change, which allows to give a quantitative estimate of the connected resistance.

4.1.2.2 Measurement of the resistance of the loop is similar to measuring the insulation resistance. At the far end of the cable, the cores are short-circuited.

4.1.2.3 Electrical capacitance measurement

The method of the capacitance measuring is based on the ballistic method. The device discharges the cable connected to it, and then charges it for a short time interval through a stabilized current source to a certain voltage. Obtained capacitance value is determined by the formula:

$$C = \frac{I \cdot t}{U},$$

where: C – Electrical capacitance, nF.
I – Current intensity, mA.
U – Measured voltage, V.
t – Measuring time, μs.

4.1.2.4 Measurement of DC and AC voltage

The DC voltage is measured by direct voltage supply to the measuring path at the input of the device. The AC voltage is measured by converting it to a DC voltage and calculating the RMS value of this voltage.

4.1.2.5 The ohmic asymmetry is determined by an unbalanced DC bridge. At the far end, the cores are short-circuited to the screen. The sensor included in the diagonal of the bridge will give a quantitative estimate of the ohmic asymmetry.

4.1.2.6 Determination of the distance to the place with a reduced insulation resistance in relation to the cable sheath or in relation to the adjacent core is carried out according to the Murray method. Live and damaged wires are short-circuited at the far end of the cable and connected to the terminals of the device. The third terminal connects the cable braid or core, in relation to which there is a reduced resistance. Knowing the cable resistance value (see "cable table" in the "Settings" mode) or the total cable length, you can calculate the distance to the fault location. To determine the location of the fault, measurements should be taken from both ends of the cable.

4.1.2.7 Determination of the distance to the point where the cable core is broken is carried out according to the method of capacitances comparison. The capacitance of a live core of the cable is compared with the capacitance of the damaged core. Knowing the value of the cable's linear capacitance (see "cable table" in the "Settings" mode) or the total length of the cable, you can calculate the distance to the point where the cable breaks. To determine the location of the break, measurements should be taken from both ends of the cable.

4.2 Exterior

Exterior of the device is shown in Figure 4-1.

Figure 4-1 TDR-TA1M exterior

4.3 Controls

4.3.1 Power supply

The device is powered by a built-in 7.4 V battery with a capacity of 1.9 Ah. The device can be switched on by pressing the ON/OFF button. A charger can be connected to the DC IN 12V connector, allowing you to work with the device while simultaneously recharging the built-in battery. The procedure for charging the battery is described in section 8.2.

4.3.2 The RESET button is used to forced device turn off (see section 8 note).

4.3.3 Connector "COM" is intended for computer connection.

4.3.4 The "BACKLIGHT" button is used when necessary to turn on the screen illumination. However, the current consumption increases somewhat.

4.3.5 Buttons « ▼ » and « ▲ » are used to select the operating mode of the device ("Bridge" or "Reflectometer")..

4.3.6 The ENTER button is used to switch to the selected operating mode.

4.3.7 In the "Reflectometer" mode controls perform the following functions:

a) Buttons « ▼ » and « ▲ » in the MEASUREMENT mode are used to adjust the signals amplitude on the screen, shift the image vertically and adjust the ratio of the shortening coefficient. Button « ▼ » allows to reduce the gain continuously (displacement, shortening coefficient), button « ▲ » allows to increase the gain continuously (displacement, shortening coefficient). The current parameter values are displayed on the screen. The determined parameter value is assigned to the reflectogram when it is written to the device internal storage. In the MENU mode buttons « ▼ » and « ▲ » are used to select a menu item;
b) Buttons « ▼ » and « ▲ » in the MEASUREMENT mode are used to move the measuring cursor to the left and to the right; In MENU mode - to change the value of the selected parameter;
c) Coordination handle is only used in the MEASUREMENT mode to match the output impedance of the TDR-TA1M to the impedance of the testing cable. The criteria of the best matching is the minimum amplitude value of multiple re-reflected signals. For maximum image clarity, it is recommended that you simultaneously use the BALANCE handle to adjust the gain with the buttons « ▼ » and « ▲ ». The exposed matching (in conventional units) is displayed in the second position in the upper right corner of the screen and assigned to the reflectogram when it is written to the device internal storage;
d) The ORIGIN button is used only in the REFLECTOMETER mode and is used to assign the zero position to the current position of the cursor;
e) The "L1 L2" button in the MEASUREMENT mode is used to select the "L1", "L2" sockets when the test cable is connected. At the same time, it is possible equivalent connection of the tested cable to another socket group, or connection of two cables to two sockets at the same time. By choosing the "L1 L2" button, you can also display the corresponding reflectogram on the screen. Sequentially pressing the "L1 L2" buttons, you can visually compare two reflectograms, which is useful if one of them is a reference reflectogram (the line is faultless

and parallel to the one being examined). The status of the inputs is displayed in the lower right corner. The mode is used to determine faults such as "split pairs" and "parasitic coupling between pairs";

f) Sockets "L1", "L2" are intended for connection of cables in the MEASUREMENT mode. The investigated two-wire line should be connected to the corresponding sockets. When working on cable lines it is convenient to use the connecting cables included in the device kit (in case of short line length the connecting cables can cause an inaccuracy in the measurements);

g) The ZOOM button is used only in the REFLECTOMETER mode and serves to stretch the image near the selected cursor position;

h) the MENU button is used for calling up a list of menu options that can be changed by the user or for returning to the MEASUREMENT mode;

i) The ENTER button in the MEASUREMENT mode selects a parameter, by sequential pressing of this button you can select the following parameters to change: "Gain", "Offset" or "Shortening Coefficient"; In MENU mode - allows you to select a parameter that requires changing its value, to remove a parameter or to save (load) into the device storage the desired reflectogram when the marker is placed in front of the "Save" ("Load").

j) The screen view of the TDR-TA1M in TDR MEASUREMENT mode

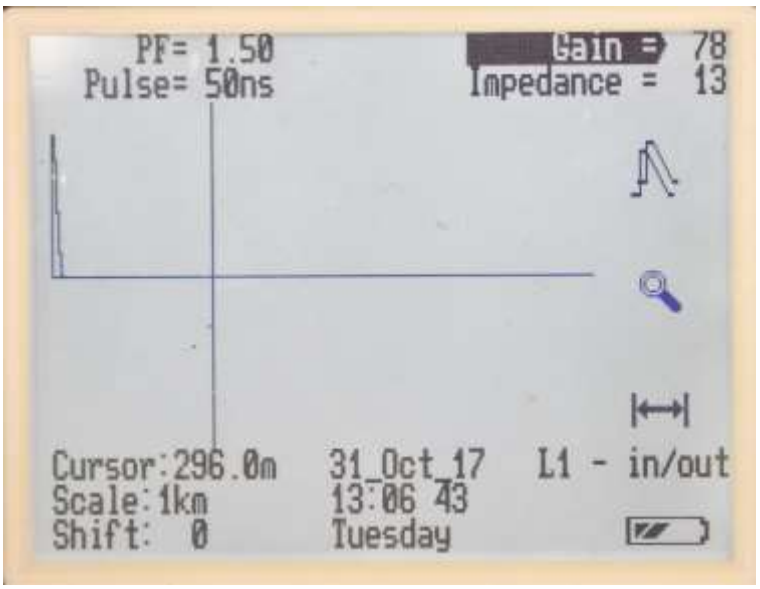


Figure 4-2 The screen view of the TDR-TA1M in TDR MEASUREMENT mode

Central part:

- Reflectogram

Top part:

- selected shortening coefficient (sign – Short. Coeff.);
- selected pulse width (sign - Pulse);
- selected gain (from 0 to 155 units) (sign - Gain);
- selected balance (from 0 to 60...63 units) (sign - Balance).

Bottom part:

- distance (in m) from the probe pulse to the cursor (sign - Cursor);
- selected distance measurement subband (sign - Scale);
- selected shift (from -48 to +48 units) (sign - Shift);
- current date and time;
- L1, L2 conditions.

In the right part (from top to bottom):

- The comparison mode of the reflectograms (symbol -);
- Activation of the ZOOM mode (symbol -);
- The mode of assigning the zero position to the current position of the cursor (symbol -);
- Charge indicator of the built-in battery (symbol -).

l) The screen view of the TDR-TA1M in the MENU Mode

Figure 4-3 The screen view of the TDR-TA1M in the MENU Mode

- «Scale» - distance measurement subband selection.
- «Pulse» - probing pulse width selection.
- «Shortening» - shortening coefficient selection.
- "Accumulation" - the number of accumulated reflectograms (to prevent asynchronous interference) selection.
- «Date» - current time and date settings.
- «Save» - saving to the internal non-volatile internal storage of the current reflectogram.
- «Load» - loading reflectogram from the internal non-volatile internal storage.
- «Cable Library» - reading and editing propagation factors for different cable types.
- «Contrast» - Display contrast setting.
- «Bridge» - switch to measuring BRIDGE mode.
- "Reset " – reset the device to factory settings.

4.3.8 In BRIDGE mode controls perform the following functions:

a) Buttons « ▼ », « ▲ » and « ◄ », « ► » are used to select a parameter in the "Measuring bridge modes" menu, and also to change some parameters during the measurement (linear capacity, line resistance, etc.);

b) the ENTER button allows to change the selected parameter, to start the measurement process and exit from it;

c) terminals "A", "B", "C" are intended for cable connection. The cable to be tested is connected to the corresponding terminals. When working on cable lines, it is convenient to use the connecting cables provided with the device.

d) button «L1L2» allows to select the switching method between the terminals "A", "B", "C" in the manual mode of the bridge.

e) BRIDGE mode main menu

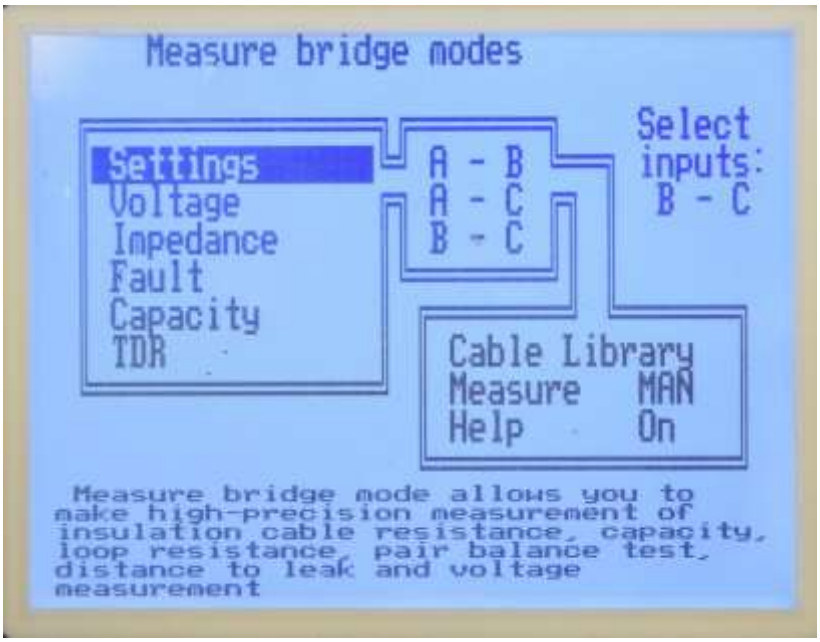


Figure 4-4 BRIDGE mode main menu

The "Settings" mode provides:

- The choice of switching the terminals "A", "B", "C", between which measurements will be taken;
- Enter the "Cable Library" menu to enter or edit the values of the linear resistance and the linear capacity of the cable;

- "Measure" - automatic or manual start of the measurement process (except for the "Asymmetry of cores", "Checking", "Break", "Leakage" modes, these modes can be performed only in manual mode);
- “Help” - Enable (disable) hints in all the Help menu items.

The "Voltage" mode allows you to select the type of measured voltage between terminals (constant, alternating).

The "Resistance" mode selects the DC measurement of:

- Insulation resistance;
- Loop resistance;
- Cores asymmetry;

The "Fault" mode allows you to determine the distance to the cable fault:

- The item "Testing" allows complex measurement of insulation resistance and electric capacitance between all cores or between cores and braid;
- The "Break" item allows to measure the distance to the cable break point by comparing the electrical capacitances of intact and damaged cores;
- "Leakage" item allows you to measure the distance to the place of lowering the insulation resistance of the cable.

The "Capacity" mode allows to measure the electrical capacitance of the cable.

The "Reflectometer" mode switches the instrument to the REFLECTOMETER mode

e) Screen view in "Fault - Leakage " mode

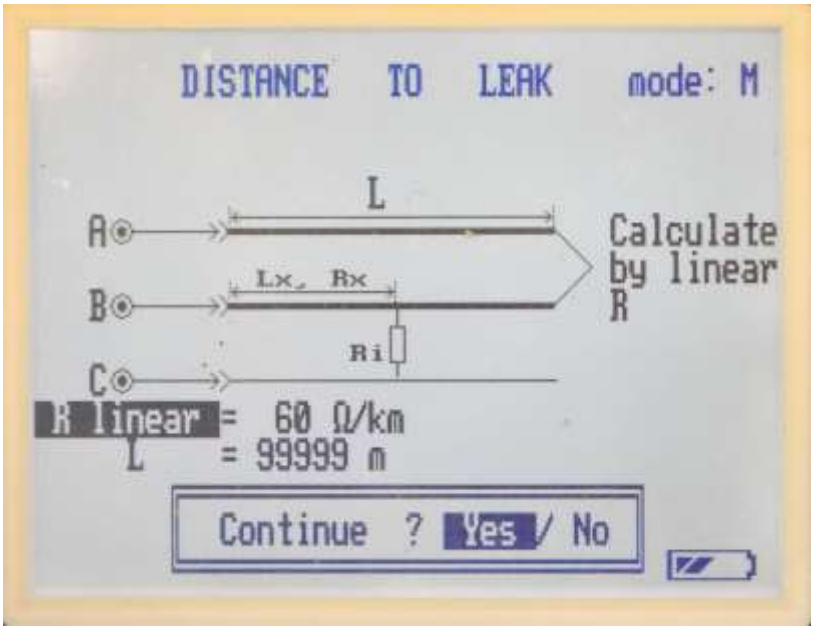


Figure 4-5 Screen view in "Fault- Leakage" mode

Central part:

- Graphical display of the measurement method;
- The value of the linear resistance (from 0 to 10 kΩ) (only in the "Leakage" mode) (sign - Linear resistance: 0 Ω/km) or the value of the linear capacitance (from 0 to 99 nF) (only in the "Break" mode) (sign - Capacity: 0 nF / km);
- hint;
- measurement results.

Top part:

- Parameter and measurement mode (A - automatic, M - manual);
- A creeping line, filled with the measurement information being carried out.

Bottom part:

- Continue (stop) measurements (sign - Continue? Yes / No);
- Charge indicator of the built-in battery (symbol – ▬).

5 SAFETY PRECAUTIONS

5.1 Working with TDR-TA1M is allowed only for people who have read the present User Manual.

5.2 TDR-TA1M does not operates with life-threatening voltages.

5.3 When operating the TDR-TA1M with the simultaneous charge of the battery through the charger, do not open the device body.

5.4 When working on different routes, personnel must comply with safety regulations for working on this type of route.

6 PREPARATION AND OPERATION PROCEDURES

6.1 Before operation, TDR-TA1M is inspected visually. In this case, special attention should be paid to the marking of the controls, the absence of visible damage.

6.2 Switching the device on

The device is switched on by pressing the ON-OFF button. At the same time, the window of the current version of the device lights up on the screen, which is replaced by the window for selecting the operating mode of the device. To switch to MEASURING BRIDGE mode, select "Bridge", select "Reflectometer" to enter REFLECTOMETER mode. To navigate the menu, use the navigation buttons « ▼ » and « ▲ »; Use the ENTER button to select a mode.

6.3 Operating in the REFLECTOMETER mode

Device setup

Figure 6-1 Date & time setting

6.3.1 Setting the time and date of the device internal clock is carried out in the main menu of the "Reflectometer" mode. To switch from the measurement mode to the main menu, press the MENU button. Using the navigation buttons « ▼ » and « ▲ » Set the marker to the "Date" item and press the ENTER button, an arrow will appear below the number. Change the parameter with the buttons « ▼ » and « ▲ ». To edit the next parameter, press the ENTER button.

6.3.2 To set the display contrast using the navigation buttons « ▼ » and « ▲ », Set the marker opposite to "Contrast" and press the ENTER button. Change the parameter with the buttons « ◄ » and « ► » in the range from 0 to 40 units. To quit press the ENTER button.

6.3.3 Return to the factory settings by selecting the item "Reset".

6.4 Connecting the device to the testing line

Attention! Before starting work, make sure that there is no line voltage.

6.4.1 To operate in the REFLECTOMETER mode, it is necessary to connect the cable to the "L1", "L2" connectors, using the connecting cables included if necessary. Select the cable connecting method by pressing the button "L1 L2".

6.5 Cable length measurement

6.5.1 The device operating parameters can be set in the menu mode. To enter the menu mode, press the MENU button. Entering the measurement mode is done by pressing the MENU button again.

6.5.2 To set the distance measuring sub-band, use the « ▼ » and « ▲ » buttons, set the marker next to "Scale" and press the ENTER button. Select the sub-band (250 m, 500 m, 1 km, 2.5 km, 5 km, 12.5 km, 25 km, 50 km) using the navigation buttons «◄» & «►». To quit press the ENTER button.

6.5.3 To set the duration of the probe pulse, set the marker next to "Pulse" and press the ENTER button. Select the probe pulse duration (see Table 3) using «◄» & «►» navigation buttons. To quit press ENTER button.

6.5.4 To set the value of the shortening coefficient, set the marker next to "Shortening Coeff." and press the ENTER button. Choose the shortening coefficient (from 1 to 3) with the navigation buttons «◄» & «►». To quit press ENTER button.

6.5.5 The value of the shortening coefficient can be taken from the table "Shortening Coeff." in the device menu. For selection set the marker next to " Shortening Coeff. Table" and press the ENTER button. From the available cable types in the device internal storage select your cable type with the « ▼ » and « ▲ » navigation buttons and press the ENTER button. The following menu offers to set the selected shortening coefficient ("Set"), change the selected shortening coefficient ("Change"), add a new coefficient and cable type ("Add") or remove this cable type from the table ("Delete"). Use the «◄» & «►» buttons to scroll through the table pages. To quit press ENTER button.

Cable	PF	Cable	PF
РК-50-2-11	1.52	3D-2V	1.49
РК-100-7-11	1.20	5D-2V	1.49
П-270	3.00	8D-2V	1.49
П274М	1.39	10D-2V	1.49
П296М	1.60	20D-2V	1.49
ПВС 5х2,5	1.84	Belden 9913	1.19
резин. изол.	2.00	Flexi-4XL	1.19
СБ,АБ	1.87	АВВГ	1.59
СБП3АВпШп	1.61	АПВБбШП	1.51
СИП 3х95+1,95	1.43	АПВБбШП 4х25	1.51
КСПП (130 Ом)	1.52	АПВБбШП 4х95	1.51
КСПП (115 Ом)	1.52	АПВВНГ 1х95/35	1.87
1.5D-2V	1.49	АПВПГ 1х95	1.87

Figure 6-2 Selecting shortening coeffictient value from the table

6.5.6 To set the accumulation filter value from asynchronous noise, set the marker next to the "Accumulation" item and press the ENTER button. Select the number of reflectograms (from 1 to 128) to be accumulated by the navigation buttons «◄» & «►». To quit press ENTER button.

6.5.7 To enter the measurement mode, press the MENU button. In this mode the following parameters can be selected on the screen using the ENTER button: "Gain" (top right corner of the screen), "Shift" (bottom left corner of the screen), "Shortening Coeff." (top left corner of the screen). Change the values of these parameters using the buttons «▼» and «▲».

6.5.8 To match the output impedance of the TDR-TA1M to the wave impedance of the cable under test, use the BALANCE knob. The criterion of the best matching is the minimum magnitude of the multiple re-repeated signals amplitude. For maximum image clarity, it is recommended that you use the «▼» and «▲» buttons in a couple with BALANCE knob to adjust the gain. The displayed matching (in conventional units) is displayed at the second position in the upper right corner of the screen and assigned to the reflectogram when it is saved to the device's storage.

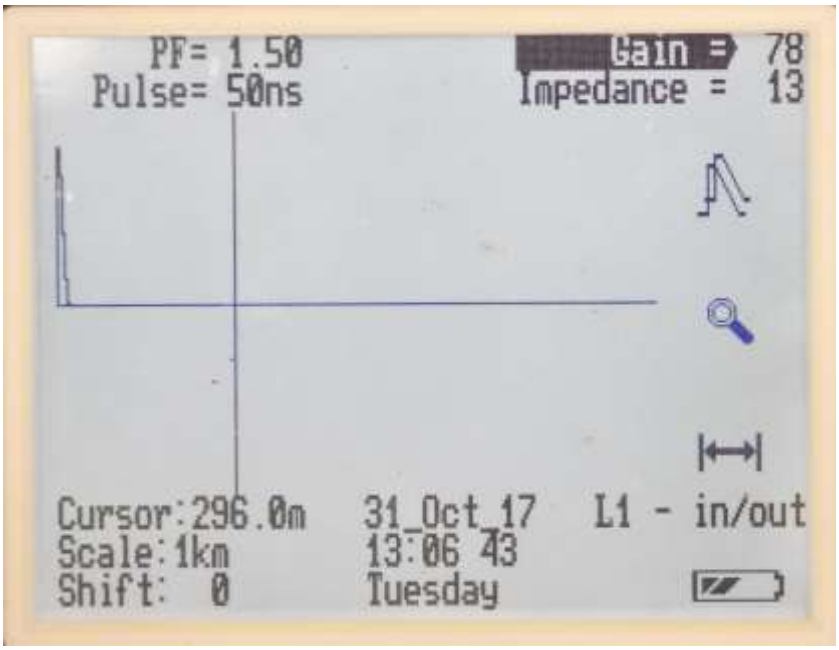


Figure 6-3 Reflectogram

6.5.9 Analyze the received cable reflectogram in the measurement mode. An echo pulse of positive polarity defines a cable break. Place the cursor on the pulse front. In the TDR-TA1M, the distance is determined automatically (depending on the selected shortening coefficient), corresponds to the position of the cursor on the screen and is displayed at the bottom of the screen ("Cursor").

6.6 Measurement of the line shortening coefficient with a known length.

6.6.1 Repeat operations described in 6.4; 6.5.1…6.5.3 & 6.5.6…6.5.8

6.6.2 Analyze the received reflectogram in the measurement mode. Place the cursor on the pulse front. Select the "Shortening Coefficient" parameter by pressing the ENTER button sequentially and, changing the value of the shortening factor with the « ▼ » and « ▲ » buttons, set the "Cursor" parameter value equal to the line length. Fix the obtained value of the shortening coefficient in the upper left part of the screen ("PF").

6.7 Determination of the distance to the cable fault location in the REFLECTOMETER mode

Determination of the distance to the cable fault location is performed according to the procedure described in section 6.5. By analyzing the received reflectogram, it is possible not only to determine the distance to the fault, but also to recognize the damage type.

6.7.1 Reflectogram analysis

Note. Figures 6-4 ... 6-8 in the upper part show the cable line schematically, in the lower part - the reflectogram of this line.

a) Determination of distances to couplings, twists, breakages

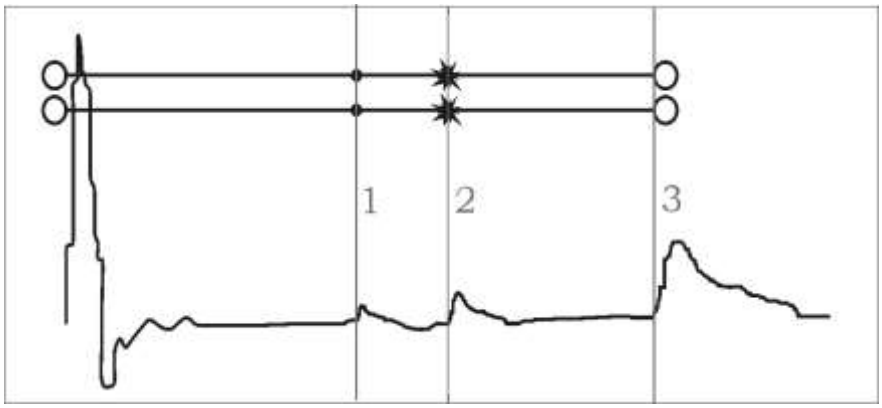


Figure 6-4 Couplings, twists & breakages

Reflection from the inhomogeneity characterizing the cable splice, is expressed in the presence of a pulse of positive polarity. The magnitude of the reflected pulse can be used to evaluate the quality of the cable splice. The reflectometer makes it possible to distinguish between several discrete inhomogeneities. At the position of cursor 1 there is a reflected pulse of positive polarity, indicating the presence of a connection in the cable line. The connection at the cursor 2 position is worse than the previous connection. The reflected pulse at the position of the cursor 3 indicates the breakage (end) of the cable line.

b) Determination of the distance to short-circuit between the cores

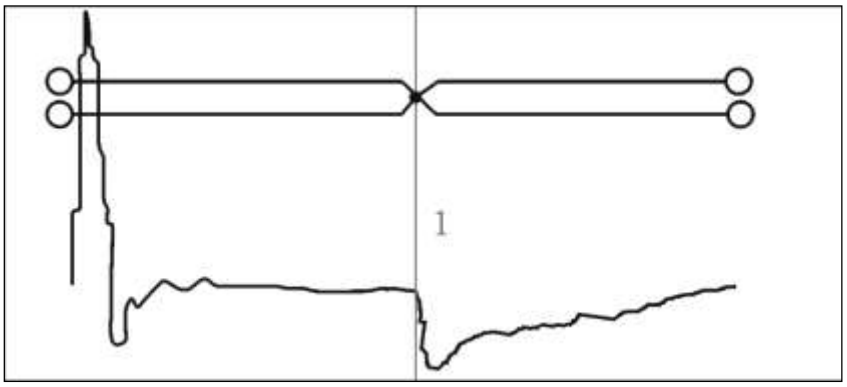


Figure 6-5 Short-circuit

The reflection from the inhomogeneity characterizing the short-circuit of the cable cores is expressed in the presence of a pulse of negative polarity, and is a particular case of a lower insulation resistance. The magnitude of the reflected pulse is approximately equal to the pulse reflected from the end of the cable. At the position of cursor 1 there is a reflected pulse of negative polarity, indicating a short circuit in the cable line. The reflected pulse from the end of the cable line is missing.

c) Determination of the distance to the soaked section of the cable

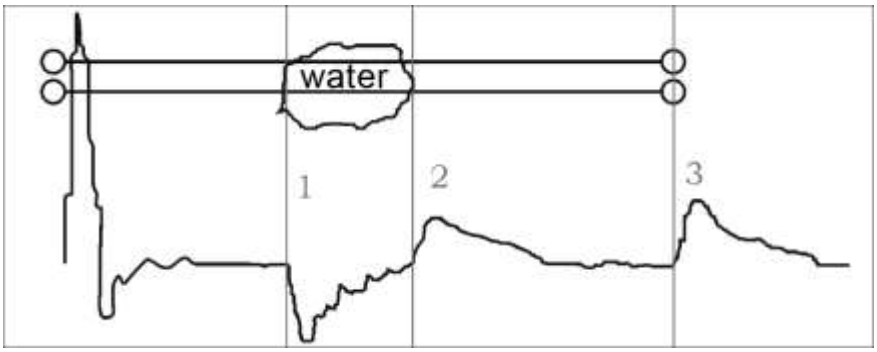


Figure 6-6 Soaked section of the cable

The inhomogeneity associated with the appearance of moisture in the cable core is, by its nature, extended. A soaked area is characterized by a reduced resistance and a random value of the dielectric permittivity of the insulation. To estimate the length of the soaked section, you should place the cursor on the beginning of the soaked section, and then set the Origin to the end of the cable and calculate the length of the non-soaked area from the end of the cable. On the reflectogram the soaked section starts at the cursor position 1 and ends at the cursor position 2.

d) Determination of the distance to the parallel tap

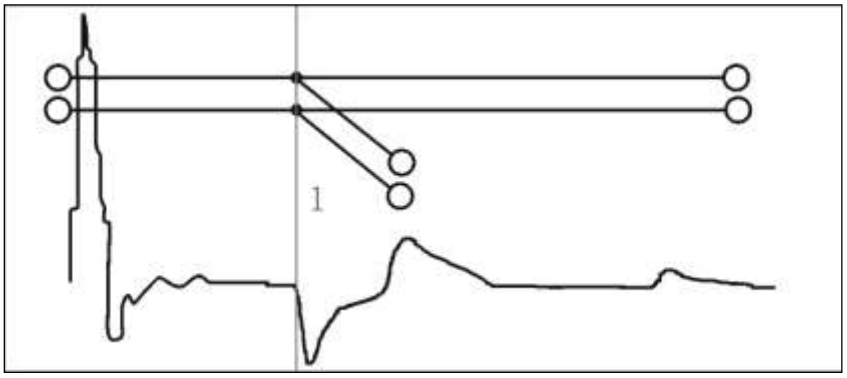


Figure 6-7 The parallel tap

The heterogeneity associated with the presence of taps is extensive. According to the type of the reflectogram, the tap reminds the soaked cable. The difference is that the tap is a uniform section. To determine the distance to the tap point, you should set the cursor to the beginning of the inhomogeneity. If the length of the tap exceeds the length of the remaining portion of the cable, it is possible that the reflected pulse from the end of the cable will completely disappear. At the position of cursor 1 there is a reflected pulse, indicating the presence of a parallel tap in the cable line.

e) "Broken pairs" definition

"Broken pairs" is the installation technology violation of paired twisted cables in joint and distributor boxes. To determine the distance to the joint box in which the pairs are entangled, it is necessary to connect one pair to the output of the device, and the other to its input. On the screen there will be almost complete disappearance of the input pulse, and in the place of the paits entanglement - a response of positive polarity. Switching of the inputs to the "Broken pairs" mode can be done by pressing the button "L1 L2". At the same time in the lower right corner of the display appears the designation "L1 - output, L2 - input" (or "L1 - input, L2 - output").

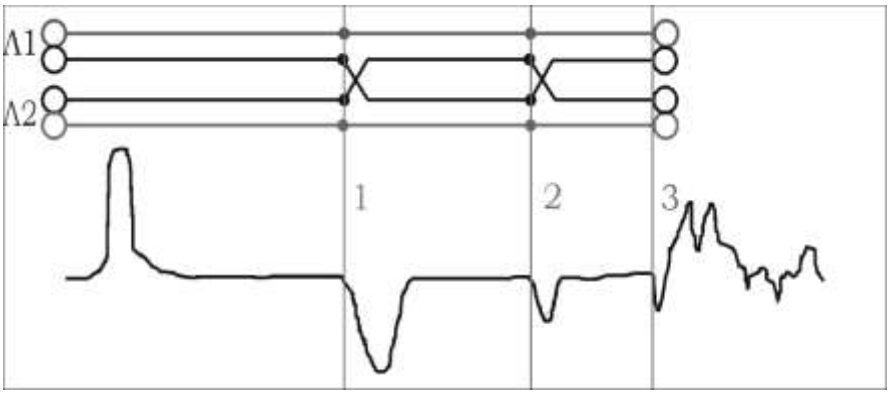


Figure 6-8 "Broken pairs"

The notion of "broken pairs" refers to multi-pair cables of communication, alert and control cables. At the position of the cursor 1 there is a reflected pulse, typical for the “broken pairs”. In the position of the cursor 2 there is a reflected pulse, where the “broken pairs” repeat. The reflected pulse at the cursor position 3 indicates cable break or cable end.

6.8 TDR-TA1M internal storage

6.8.1 For operation convenience, there is a table with a list of different brands of cables and their characteristics in the device's inner storage. The device can store up to 200 marks of cables with indication of their shortening coefficients. To go to the menu with cable marks, it is necessary to set the marker in the main menu of the device opposite the "Shortening Coeff. Table" item, using the navigation buttons and the ENTER button. Navigating through the table with the navigation buttons « ▲ », «► », « ▼ », «◄ » set the marker on the cable of interest and press the ENTER button. To quit, use the MENU button.

Moving through the selection menu you can:

- "Set" - select the current cable brand and use its shortening coefficients;
- "Edit" - edit the brand of the cable, the value of its shortening coefficient;
- "Add" - add cable brand, the value of its shortening coefficient;
- "Delete" - delete the current cable from the inner storage.

Editing cable parameters:

- select "Edit" or "Add" and press the ENTER button;
- At the top of the screen is the field of the cable being edited;
- at the bottom of the screen - a set of characters and the item "Record";
- use the navigation buttons **« ▲ », «► », « ▼ », «◄ »** to set the marker to the corresponding character, the ENTER button performs character input;
- to delete the last character press the ORIGIN button;
- To save changes, select the "Save" item and press the ENTER button;
- to exit the editorial board, press the MENU button.

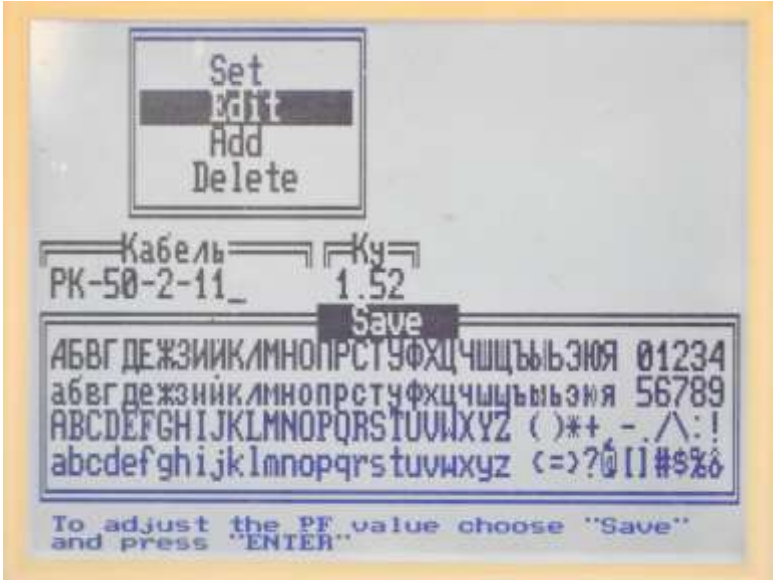


Figure 6-9 Editing cable parameters

6.8.2 Reflectograms storage

The device can store up to 100 waveforms (if this number is exceeded, the first ones are erased from the storage).

a) To save the current reflectogram:

- In main menu, set the marker opposite the "Save" item, using the navigation buttons and the ENTER button, the number of the storage location where the reflectogram will be recorded will appear to the right of the item;
- press ENTER;
- At the bottom of the screen, you will see a set of characters and the item "Notes" with which you can add comments to the recorded waveform;
- use the navigation buttons **«▲», «►», «▼», «◄»** to set the marker to the corresponding character, the ENTER button performs character input;
- to delete the last character press the ORIGIN button;
- To save changes, select the "Save" item and press the ENTER button, the device will enter the measurement mode.

Figure 6-10 Saving reflectogram

b) To load reflectogram from the inner storage:

- In main menu, set the marker in front of the "Load" item, using the navigation buttons and the ENTER button, the number of the storage location with saved reflectogram will appear to the right, at the bottom of the screen the reflectogram preview with the comment is shown, the "Date" line contents the reflectogram recording date.

- use navigation buttons «➢» & «◄» to move through reflectograms storage items;

- After pressing the ENTER button, the reflectogram will be displayed on the screen in the measurement mode.

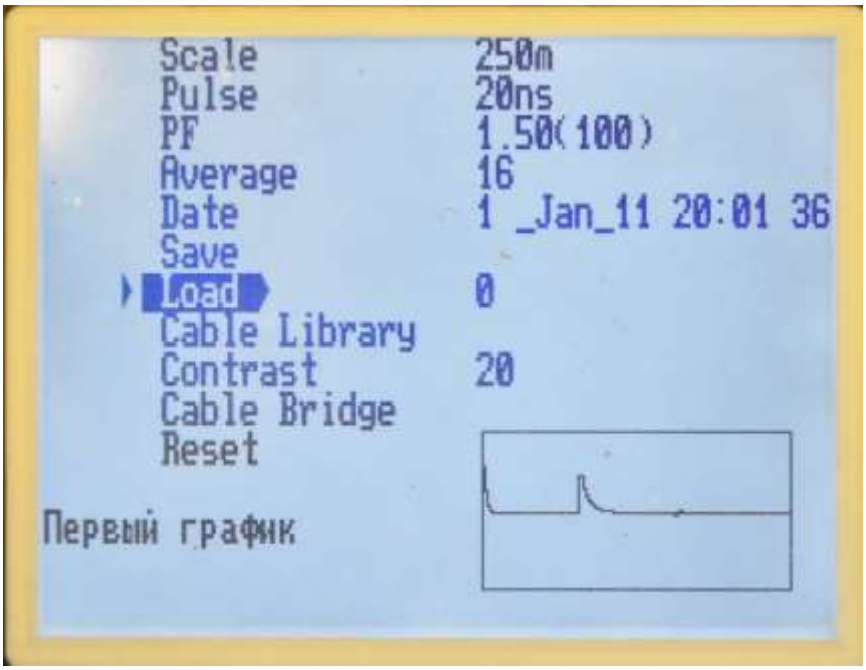


Figure 6-11 Loading a reflectogram

c) Comparing the reflectograms with stored ones

This mode is convenient for the cable condition comparison during the regular inspection, for troubleshooting on cable lines when comparing a healthy cable core with a faulty one.

To call the comparison mode, you need:

- load reflectogram from the inner storage (6.8.2b);
- press the ENTER button, the «⅄» symbol is displayed inversely;
- carry out continuous sounding until the matching from the inner storage and from the line are equal (the probing parameters are taken equal to the parameters of the trace from the memory, with the exception of the matching, which should be adjusted with the Balance knob), and the result is displayed on the screen along with the reflectogram from the inner storage;
- the reflectogram received from the inner storage is allocated with a flicker;
- vertical offset of the trace can be adjusted by the buttons «►» & «◄»;
- return to the MEASUREMENT mode by pressing the ENTER button again.

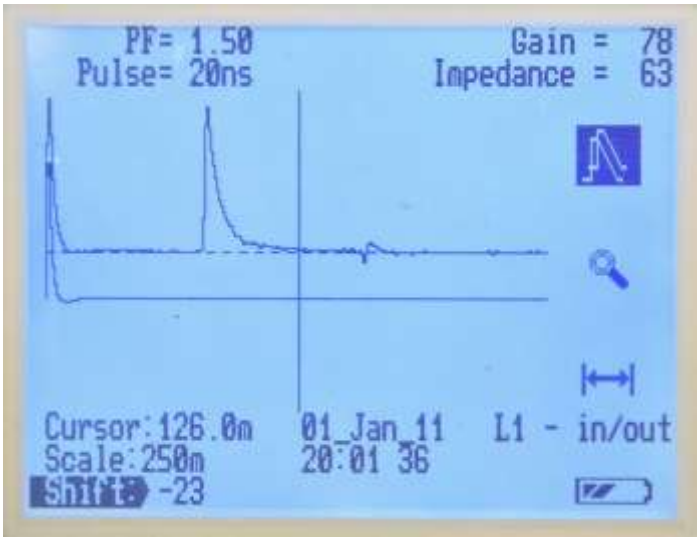


Figure 6-12 Comparing the reflectograms with stored ones

6.9 Microplan mode

Switch to the microplan mode by pressing the ZOOM button in the measuring mode. In this case, stretching of the image near the selected cursor position to a scale of 250 m occurs on the 500, 1000, 2500 m distance subbands, and on the remaining subbands to a scale of 0.1 from the subband value. This mode allows you to identify the features of reflected signals at large distances and thereby determine the nature of the inhomogeneity. To return back to measuring mode press the ZOOM button again.

6.10 Operation of the TDR-TA1M in the measuring bridge mode

For operation in the measuring bridge mode, it is necessary to connect the cable to the terminals "A", "B", "C", using the connecting cables included in the delivery, if necessary.

6.10.1 Measuring bridge settings

Select the "Settings" mode in the menu and use the navigation buttons «▲», «►», «▼», «◄» to select "MANUAL measurement" item. Manual mode is used to determine the state of the line and economically consumes the resources of the battery. Transfer of the device to the automatic mode of measurement is carried out by pressing the ENTER button, thus the inscription "AUTO Measurement" appears. This mode is used to measure the main parameters of the line and allows you to visually observe the drift of the readings (if takes place) and to evaluate the measured value after the transient processes in the cable line are ended (indications do not change), transient processes can take an indefinite time.

To select the device inputs ("AB", "A-C" or "B-C"), between which the line will be checked in manual mode, use the button "L1L2". In automatic mode, the selection of inputs (" AB "," A-C "or" B-C ") is carried out in the menu in the "Settings" mode using the navigation buttons «▲», «►», «▼», «◄» and the ENTER button.

To select the option to display hints in all menu items of the measuring bridge operation, use the navigation buttons to select "Help ON". To switch off this option press the ENTER button, thus the word "Help OFF" appears.

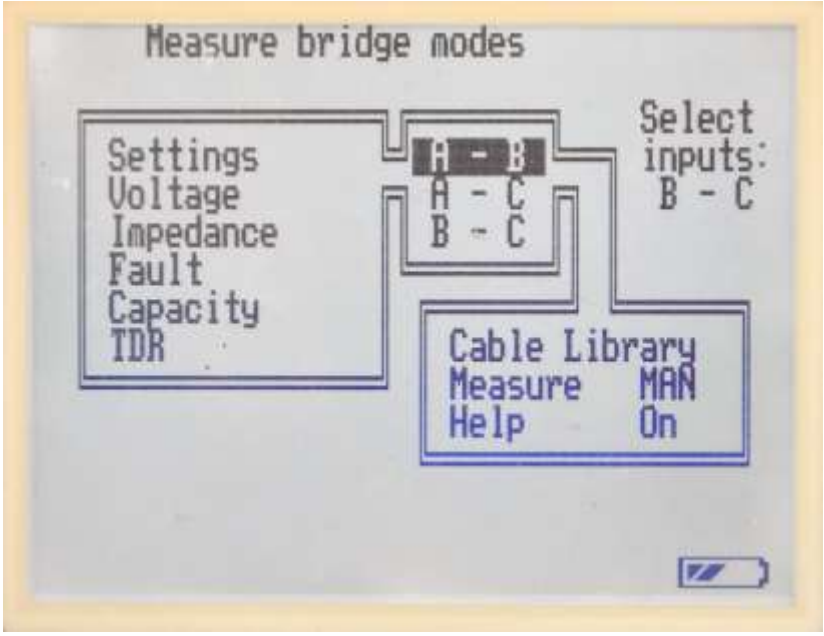


Figure 6-13 Selecting the device inputs

6.11 Line voltage measurement

Select the "Voltage" mode and the type of the measured voltage ("Constant" or "Variable") in the menu using the navigation buttons **«▲», «►», «▼», «◄»** and the ENTER button. To measure the voltage, connect the line to the terminals "AB", "A-C" or "B-C", selecting the option to connect the inputs. The screen shows the voltage value in the line corresponding to this connection method. To return to the menu, select "No" in the "Continue? Yes / No" and press the ENTER button.

6.12 **Resistance measurement**

Caution: Before starting work, make sure that there is no voltage in the line under test!

6.12.1 Measurement of insulation resistance between cable cores

Choose the "Resistance" mode and the item "Insulation resistance" in the menu using the navigation buttons **« ▲ », «➢ », « ▼ », «◄ »** and the ENTER button. Connect the wires of the cable to the terminals "A-B", "A-C" or "B-C". The screen displays the insulation resistance value corresponding to switched method. Press the ENTER button and analyze the results. Switch the state of the inputs to measure the insulation resistance between the other cores. To exit the menu, select "No" in the "Continue?" Yes / No" and press the ENTER button.

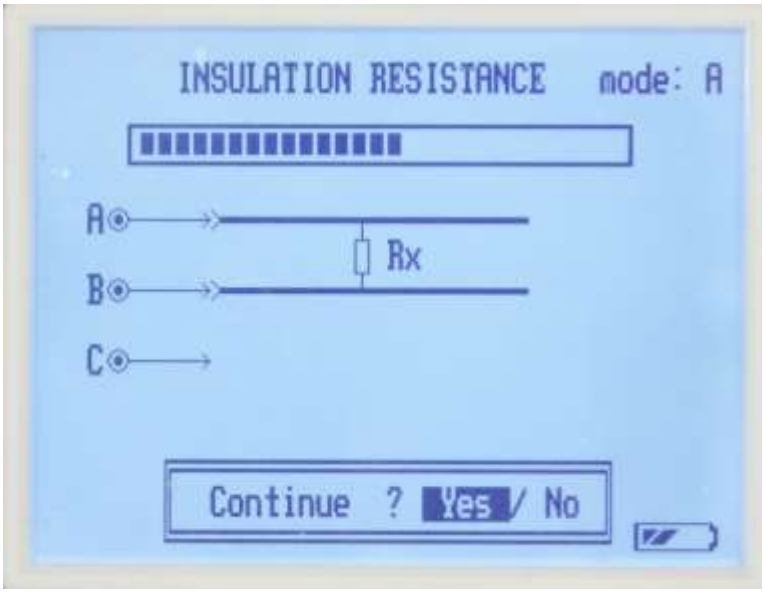


Figure 6-14 Insulation resistance measurement

6.12.2 Measurement of loop resistance

Choose the "Resistance" mode and the item "Loop resistance" in the menu using the navigation buttons **« ▲ », « ► », « ▼ », « ◄ »** and the ENTER button. Connect the cable to the terminals "A-B", "A-C" or "B-C". Close the wires at the far end of the cable. The display shows the resistance value of the loop corresponding to switched method. Press the ENTER button and analyze the results. Switch the state of the inputs to measure the resistance of the other conductors. To exit the menu, select "No" in the "Continue?" Yes / No" and press the ENTER button.

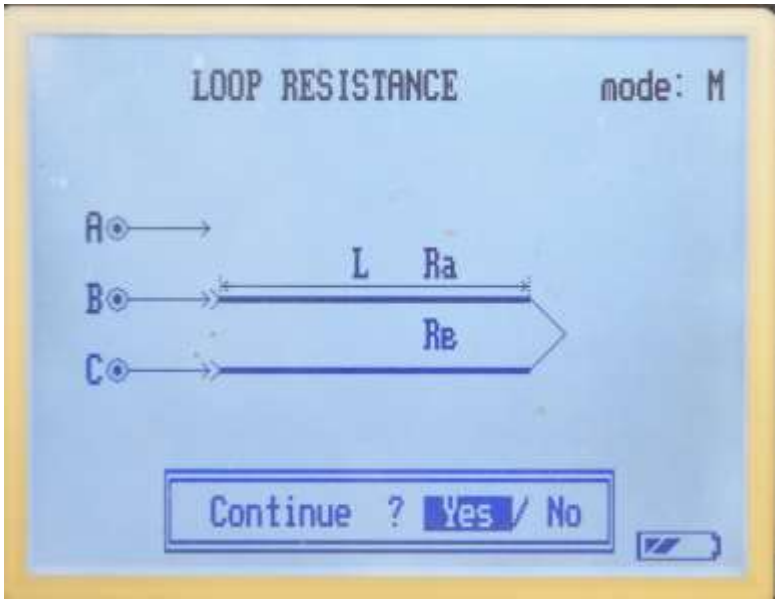


Figure 6-15 Loop resistance measurement

6.12.3 Determination of ohmic asymmetry

Select the "Resistance" and "Asymmetric wires" item in the menu using the **«▲», «►», «▼», «◄»** navigation buttons and the ENTER button. Connect the cable to the terminals "A", "B", and the cable braid to the "C" terminal. Close the wires and braid at the far end of the cable.

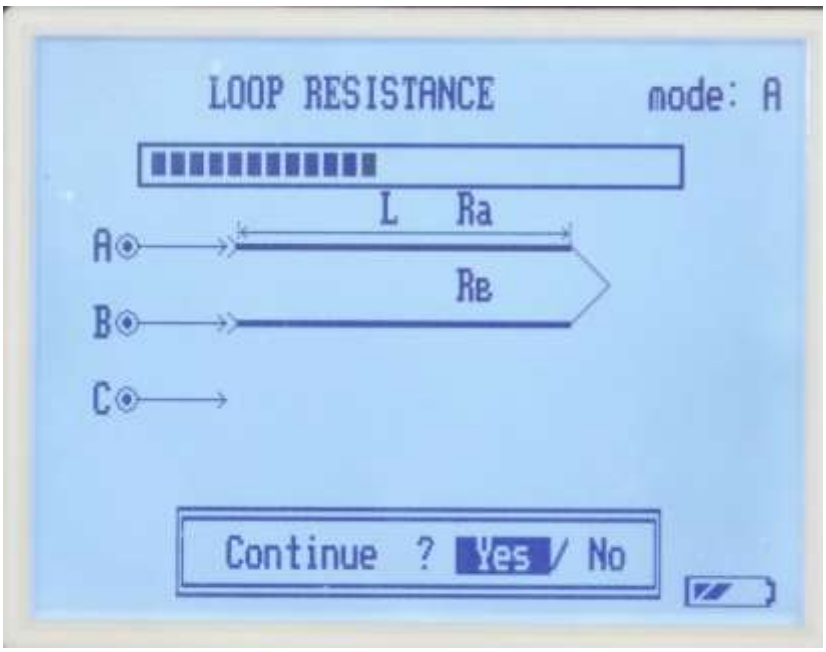


Figure 6-16 Determination of ohmic asymmetry

The screen displays the ohmic asymmetry value corresponding to this switched method. Press the ENTER button and analyze the results. To exit the menu, select "No" in the "Continue?" Yes / No " and press the ENTER button.

6.13 Measuring the electrical capacity of the cable

Select the "Capacity" mode from the menu using the «▽», «△» **«▲», «▼»** navigation buttons and the ENTER button. Connect the cable to the terminals "A-B", "A-C" or "B-C". Leave the wires at the far end of the cable ***not closed***. The display shows the electrical capacity of the cable that corresponds to this switched method. Press the ENTER button and analyze the results. Switch the state of the inputs to measure the electrical capacity of other cores. To exit the menu, select "No" in the "Continue?" Yes / No "and press the ENTER button.

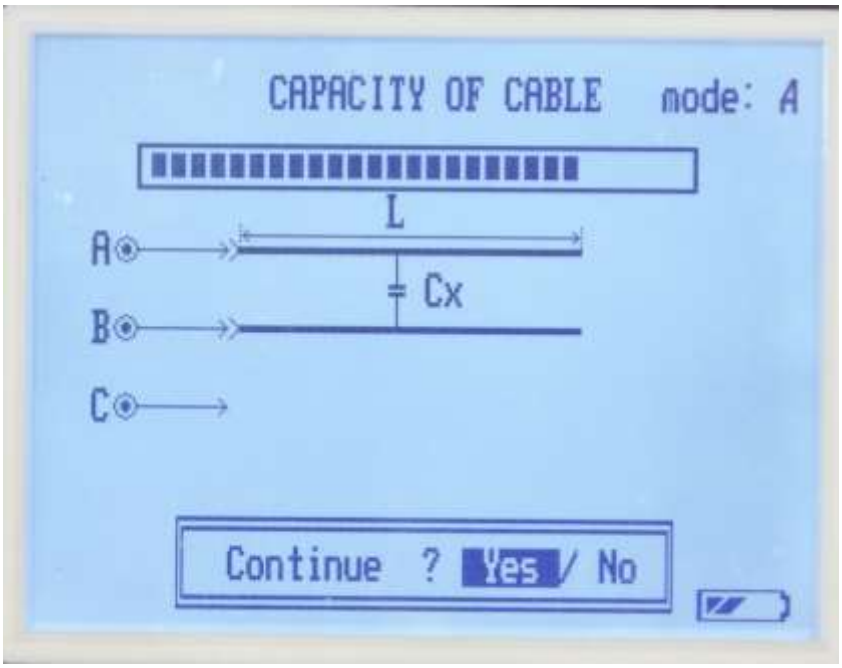


Figure 6-17 Measuring the electrical capacity

6.14 Cable length measurement by a measuring bridge

a) With the known loop resistance value, obtained in 6.12.2, is possible to calculate the cable length using the table values. The main condition is the homogeneity of the cable line.
b) The value of the electrical capacity obtained in 6.13 allows the calculation of the cable length using the table values of the line capacitance for this type of cable. The main condition is the homogeneity of the cable line.

6.15 **Determination of the distance to cable damage by a measuring bridge**

a) The determination of the distance to a reduced insulation resistance is carried out by the Murray method. To perform measurements, select the "Damage" mode and the "Leakage" option in the menu using the « **▲** », «**►** », « **▼** », «**◄** » navigation buttons and the ENTER button. Conditionally healthy core is connected to the "A" terminal. The damaged core is connected to the "B" terminal. Potentially damaged cable sheath, or core is connected to the "C" terminal. At the far end, the wires connected to terminals "A" and "B" are closed. By setting the cable resistance values (see "Cables table" in the bridge menu) or the total length of the cable, you can calculate the distance to the fault location. To determine the location of the fault, measurements should be taken from both ends of the cable. If there are multiple faults on the line, the measuring bridge identifies them as one, by estimating the weighted average distance to the fault.

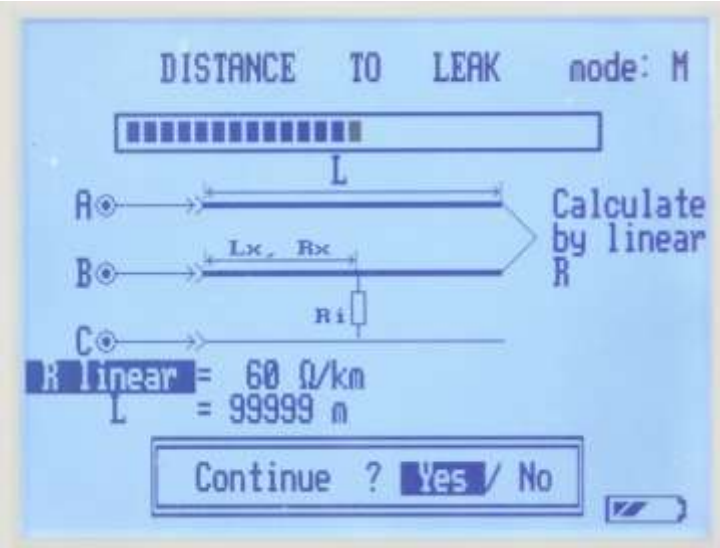


Figure 6-18 Murray method

The screen displays the distance to the reduced insulation resistance of the cable, corresponding to this switching method.

To determine the distance to the point of leakage by the value of the linear resistance, select the item "Linear resistance" on the screen, then use the «**►** » and «**◄** » navigation buttons to set the desired value and press the ENTER button. Select "Yes" in the "Continue?" Menu. Yes / No" and press the ENTER button. Analyze the result in the column "Lx".

To determine the distance to the point of leakage along a known length, select "L =" on the screen, then use the **«►»** and **«◄»** navigation buttons to set the desired value and press the ENTER button. Select "Yes" in the "Continue?" Yes / No" and press the ENTER button. Analyze the result in the column "Lx".

To exit the menu, select "No" in the "Continue?" Yes / No" and press the ENTER button.

b) The determination of the distance to wire breakage is carried out by the method of measuring the capacity of a damaged and healthy core. Select the mode "Damage" and the item "Break" in the menu using the navigation buttons **«▲», «►», «▼», «◄»** and the ENTER button.

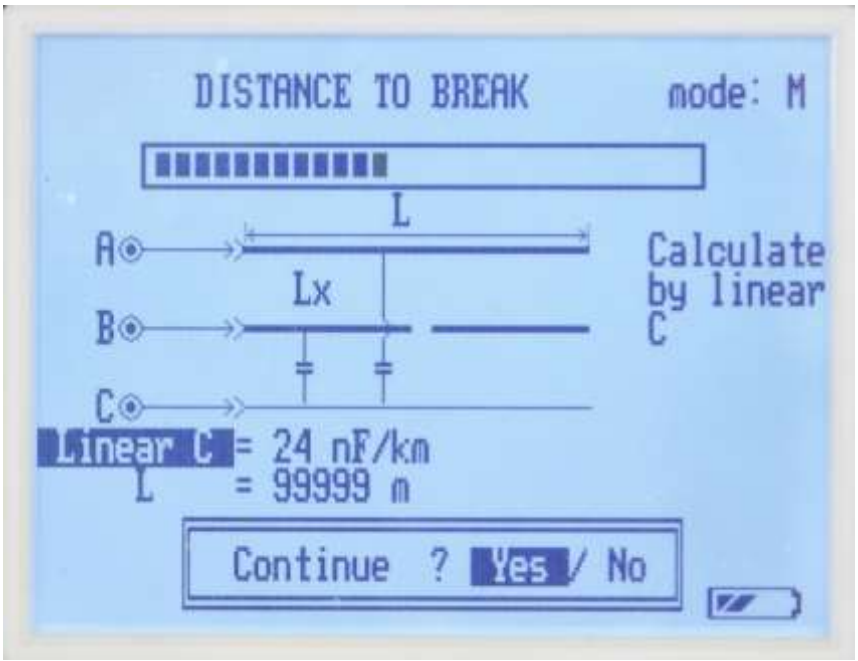


Figure 6-19 The determination of the distance to wire breakage

Conditionally healthy core is connected to the "A" terminal. The damaged core is connected to the "B" terminal. The potentially damaged cable sheath or core is connected to the "C" terminal. At the far end, the wires connected to terminals "A" and "B" ***are open***. By setting the cable capacitance values (see "Cable table" in the bridge menu) or the total length of the cable, you can calculate the distance to the fault location. To determine the location of the damage, measurements should be taken from both ends of the cable.

The screen displays the value of the distance to the point where the cable core terminates, which corresponds to this switching method.

To determine the distance to the breakpoint by the size of the line capacity, select "Capacity:" on the screen, then use the «➢ » and «◄ » buttons to set the desired value and press the ENTER button. Select "Yes" in the "Continue?" Menu. Yes / No" and press the "ENTER" button. Analyze the result in the column "Lx".

To determine the distance to the break at a known length, select "L =" on the screen, then use the **«➢ »** and **«◄ »** navigation buttons to set the desired value and press the ENTER button. Select "Yes" in the "Continue?" Menu. Yes / No" and press the ENTER button. Analyze the result in the column "Lx".

To exit the menu, select "No" in the "Continue?" Yes / No" and press the ENTER button.

c) the device provides for a comprehensive check of the cable condition: measurements of the insulation resistance and the electrical capacitance between the three cores of the cable.

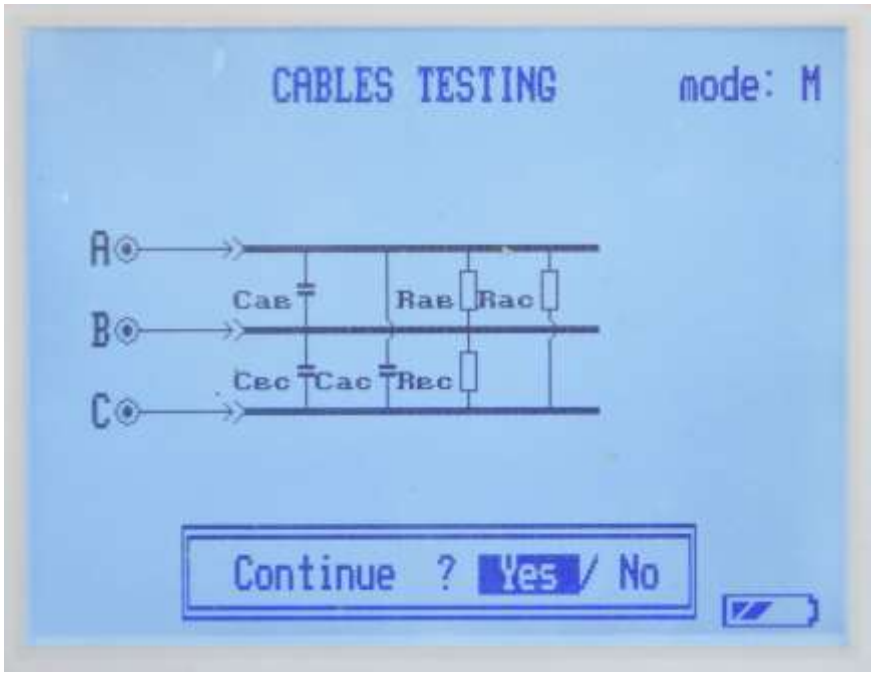


Figure 6-20 Comprehensive check

Select the "Fault" mode and the "Check" item in the menu using the **«▲ », «➢ », «▼ », «◄ »**navigation buttons and the ENTER button. For measurements connect the test cores to the terminals "A", "B", "C». The screen will display the value of the insulation resistance and the electrical capacity between the three cores of the cable. Press the ENTER button and analyze the results. To exit the menu, select "No" in the "Continue?" Yes / No" and press the ENTER button.

6.16 Storage for cable brands in the measuring bridge mode

The device can store up to 100 brands of cables with indication of their length, loop resistance and electrical capacitance. To go to the menu with cable marks select in the main menu of the measuring bridge the "Settings" mode, the "Cables table" item using the navigation buttons **«▲», «►», «▼», «◄»** and the ENTER button. Navigating through the table with the navigation buttons «▲» and «▼» select the cable type of interest and press the ENTER button.

Moving through the selection menu, you can:

- "Set" - select the current cable brand and use its parameters when determining the distance to the fault location using the Murray method, or by comparing the electrical capacitances;
- "Edit" - change the cable brand, the value of its electrical capacitance, loop resistance, length;

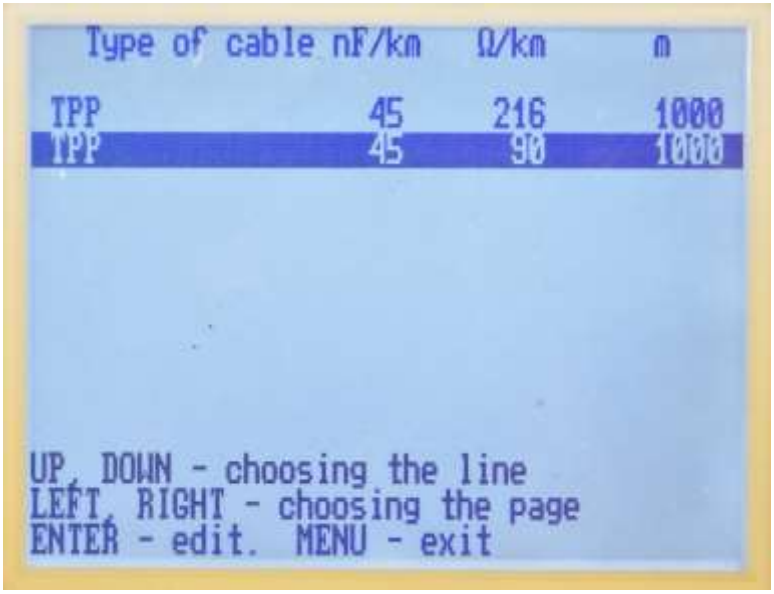


Figure 6-21 Storage for cable brands in the measuring bridge mode

- "Add" - add another brand of cable, the value of its electrical capacitance, loop resistance, cable length;
- "Clear" - delete the current cable from the storage;

Editing cable parameters:

- Select "Edit" or "Add" and press the ENTER button;
- At the top of the screen is the field of the edited cable;
- At the bottom of the screen - a set of symbols and the item "SAVE";

Figure 6-22 Editing cable parameters

- Using the **«▲», «►», «▼», «◄»** navigation buttons set the marker to the corresponding character, the ENTER button enters this character;
- Moving the marker with the **«►»** and **«◄»**buttons on the editing line is possible with the highlighted "Save";
- To save the edition, select the "SAVE" item and press the ENTER button;
- To exit the editorial board, press the MENU button.

6.17 Switching device off.

The device is equipped with the function of autosave of user settings when the power is turned off by pressing the ON-OFF button. To restore the device to its factory settings, select "Reset settings" in the MENU, press the ENTER button and turn off the device with the ON-OFF button

7 POSSIBLE MALFUNCTIONS AND REMEDIES

7.1 If there are any violations in the operation of the TDR-TA1M, please contact with the manufacturer.

8 MAINTENANCE

TDR-TA1M does not require any special maintenance. To remove dirt on the surface of the device, you can use a soap solution or alcohol. Usage of aggressive chemicals (gasoline, acetone, solvents for paints) is strictly prohibited.

The TDR-TA1M uses the CV-610D battery as the built-in power source. Batteries of this type are lithium-ionic, sealed, unattended for the entire service life.
The battery CV-610D provides the output voltage of 7.4 V at a capacity of 1.9 Ah. When the temperature decreases, the battery capacity decreases (60% at -20 ° C).
It is recommended to check the battery before starting work. The battery status can be estimated by the indicator in the lower right corner of the screen in the MEASURE mode. The results of the monitoring are approximate (since the battery state is strongly dependent on the external temperature), but still allow you to evaluate the possible time of its operation without recharging.

Charging the battery:

- Connect the charger to the EXT POW connector on the front panel of the device;
- the screen displays the progress of charging the battery (you can turn on the device with any button except the ON-OFF button);
- the battery charges both during operation of the device and when it is turned off by pressing the ON-OFF button.

Attention! *Charge the battery only from the charger provided with the TDR-TA1M. The charge time of a fully discharged battery is no more than 5 hours.*
It is strictly forbidden to charge the battery at an ambient temperature below 0 ° C.

Note: The RESET button is used to forced unit turn off when the unit is frozen. (You can press the button with a long thin object, for example, a folded paper clip).

9 CERTIFICATE OF ACCEPTANCE

Cable fault locator TDR-TA1M, serial number _____ complies with technical specificationsand is ready for operation.

Release date «____»_____ 20___ year.

L.S.

Company representative _____ _____
(Signature) (Full name)

Based on the results of the initial verification, the Cable fault locator TDR-TA1M is considered usable.

Verification date «____»_____ 20___ year.

Verificator signature: _____ _____
(Full name)

L.S.

10 INFORMATION ON CONSERVATION AND PACKAGING

10.1 Certificate of conservation

Cable fault locator TDR-TA1M technical specifications, serial number _____ is conserved in accordance with the requirements of the instruction on packaging and conservation.

Conservation data: «____»_____20___year.

Term of conservation:

Conservation carried out by: (Signature)

Conservated device accepted by: (Signature)

L.S.

10.2 **Packaging certificate**

Cable fault locator TDR-TA1M technical specifications, serial number _____ is packed at the manufacturer according to the requirements of the packaging and conservation instruction.

Packaging date: «____»_____20___year.

Packaging carried out by: (Signature)

Packaged device accepted by: (Signature)

L.S.

11 WARRANTY

11.1 **The manufacturer guarantees the compliance of TDR-TA1M with the requirements of technical specifications in condition that consumer keeps to the operating, transportation and storage conditions established in this User Manual.**

11.2 **The warranty period is 12 months from the date of commissioning of TDR-TA1M but no more than 18 months from the manufacture date.**

11.3 **The warranty storage period is 6 months from the date of manufacture of TDR-TA1M.**

11.4 **The manufacturer undertakes to eliminate the identified defects free of charge or replace the failed parts of the TDR-TA1M or the entire TDR-TA1M within the warranty period if it can not be corrected at the customer enterprise.**

11.5 **Warranty does not apply to the battery pack supplied with the device.**

11.6 **After the expiration of the warranty period, the repair of the TDR-TA1M should be carried out in accordance with the section "Possible malfunctions and ways of their elimination" of this User Manual.**

11.7 **For warranty and post-warranty service, contact the manufacturer at:**

Office 6, 10A (bl.2),1-Vladimirovskaya Str, Moscow, 111123, Russia
Phone: +7 (495) 212-11-74
e-mail: info@technoac.com