

ST 301 "SPIDER"

WIRELINE ANALYZER



USER MANUAL

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1. GENERAL INFORMATION

The user manual describes the principle of operation of the ST 301 "SPIDER" wireline analyzer (hereinafter "Analyzer" or "ST 301"). The document contains hyperlinks that allow you to go to the text fragments of interest.

1.1. PURPOSE AND CAPABILITIES

The Analyzer is designed to detect and localize eavesdropping devices that are galvanically connected to power mains and low-current cables.

In the ST 301, passive and active modes of operation are used to detect enabled, switched off, or faulty eavesdropping devices.

Functionally the Analyzer consists of four components (DEVICES):

1. LOW FREQUENCY AMPLIFIER (LFA)
2. WIRE RECEIVER (WR)
3. NON-LINEAR JUNCTION DETECTOR (NLJD)
4. REFLECTOMETER (REF)

FUNCTIONALITY:

- detection and the analysis of signals cable (dynamic and electret) microphones in low-current cables;
- activation of electret cable microphones by giving to the cable of bias voltage for their detection;
- detection of signals of the eavesdropping devices transferring information on power mains and low-current cables in frequency range of 100 kHz - 180 MHz;
- detection of unauthorized galvanic connections to the cables using a NLJD and the REF;
- measurement of AC and DC voltage in the low-current cables.

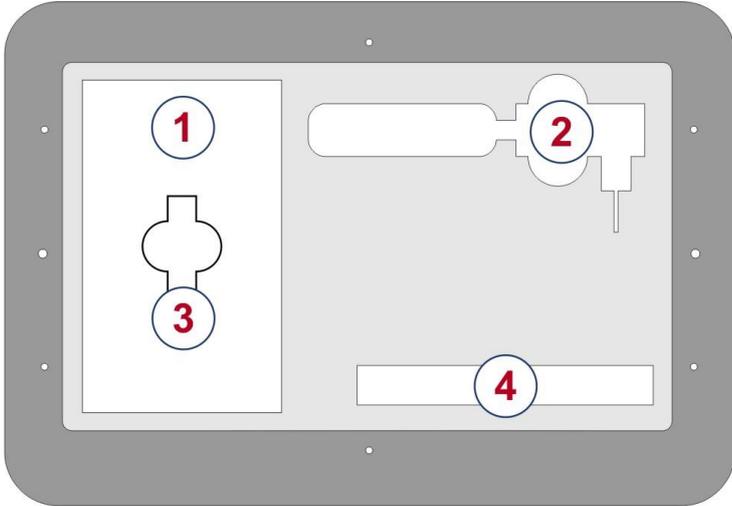
1.2. THE KIT

1.	Main unit.....	1
2.	Charger of the main unit.....	1
3.	Flash card	1
4.	Mini-USB patch cord.....	1
5.	Television splitter.....	1
6.	Headphones.....	1
7.	Adapter for testing of the power mains.....	1
8.	TV(m)/F(m) adapter.....	3
9.	TV(f)/F(m) adapter.....	1
10.	TV(f)/TV(f) adapter.....	1
11.	RJ11 (1/2) splitter	1
12.	RJ45 (1/2) splitter	1
13.	RJ11 socket	1
14.	RJ45 socket.....	1
15.	RJ45 short-circuit socket.....	1
16.	Adapter and screwdriver for connecting to the multi-wire cable.....	1
17.	Cable storage bag.....	1
18.	Television cable TV(f)/TV(m)	1
19.	Patch cord RJ45/TV(m) for connecting to the TV socket TV(f).....	1
20.	Patch cord for connecting to the RJ45 PC socket.....	1
21.	Patch cord for connecting to the RJ11 telephone socket.....	1
22.	Patch cord with a needle for connection to the cable shield.....	1
23.	Case.....	1

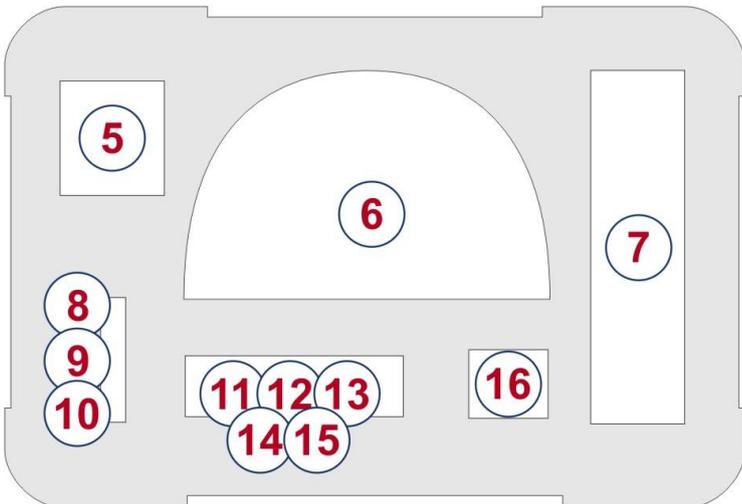


Fig.1

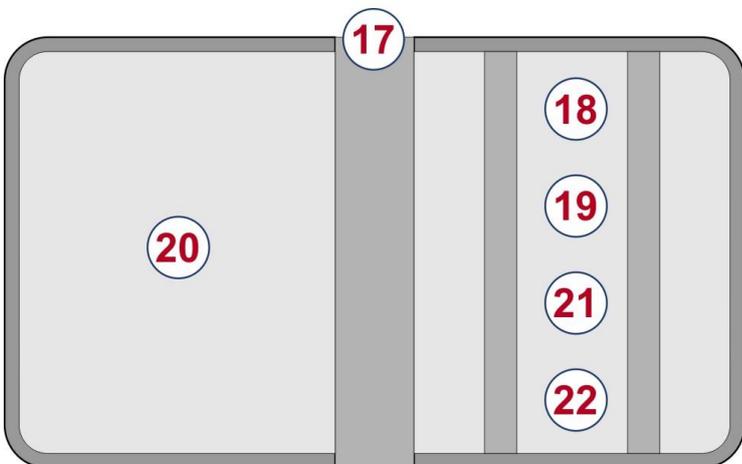
For transportation and storage of the ST 301 the shockproof, waterproof plastic case NANUK 915 is used. All items packed in a lodgment consisting of two parts and a bag located in a case.



Middle part of a lodgment



Lower part of a lodgment



Cable storage bag

Numbers indicate the elements of the kit, laid in a certain place of the lodgment and bag. The designations correspond to the numbering presented in item 1.2.1.

1.3. DESCRIPTION OF COMPONENTS

1.3.1. THE MAIN UNIT WITH THE ELECTRONIC SWITCH

Purpose of the main unit:

- forming and generating probing signals to the cables;
- switching control of the tested multi-wire cables;
- analysis of incoming signals and responses of probing signals;
- Analyzer modes control.

The appearance of the main unit is shown in Fig.2

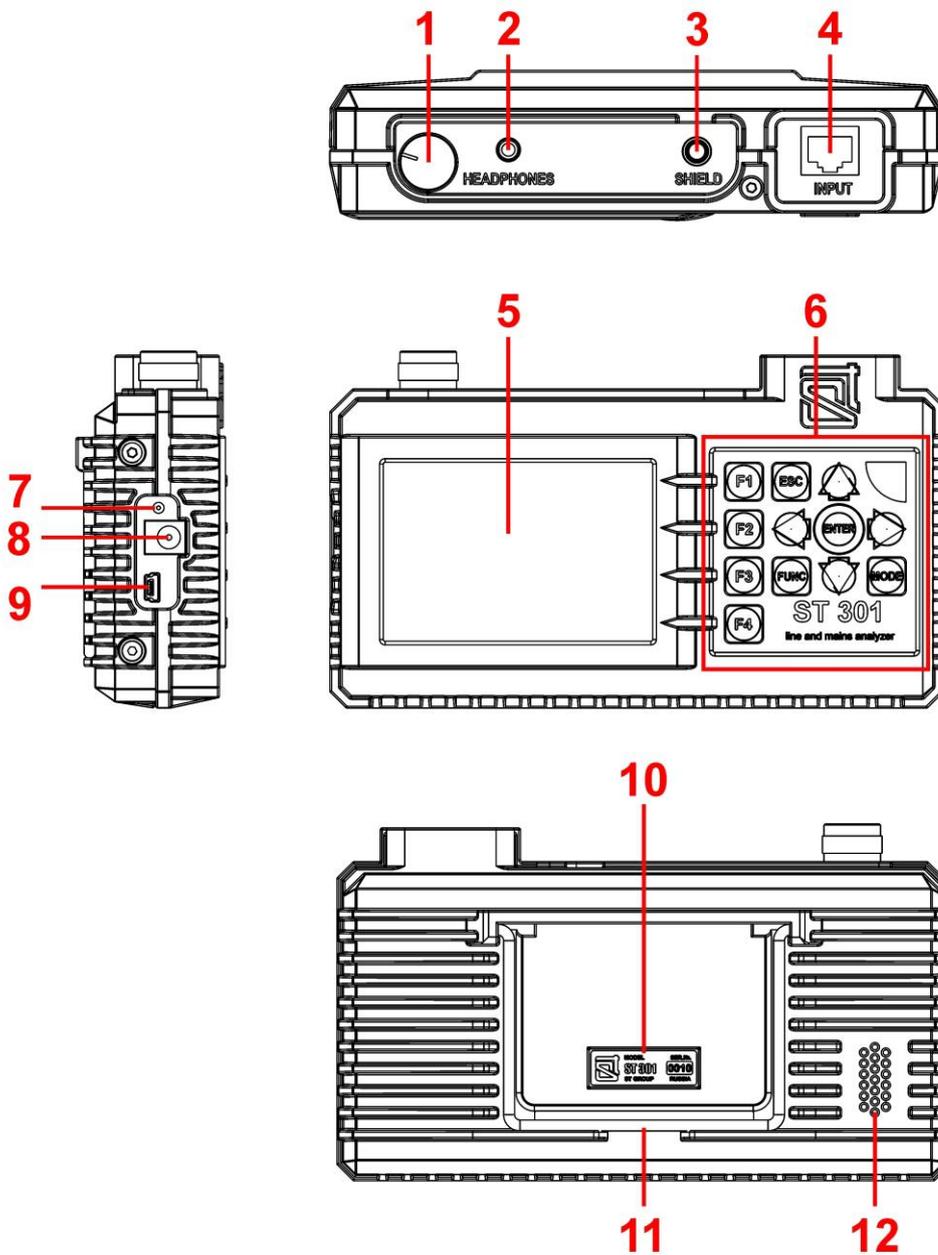


Fig.2

Designation in Fig.2	Designation on main unit	Use
1		Power tumbler / volume control
2	PHONES	Slot for connection of headphones
3	SHIELD	Slot for connection of the shield of the tested cable
4	INPUT	Input connector of the Electronic Switch
5		Analyzer monitor
6		Keyboard
	F1-F4	"Hot" buttons which purpose depends on the set operation mode
	ESC	Action canceling button (return on "one step")
	FUNC	Button for turn on of various modes
	ENTER	Button for confirm action
	MODE	Button to call the mode selection menu
7		Accumulator charge indicator
8		Slot for connection of the charger
9		Mini-USB connector for connection to the PC
10		Information plate with the serial number
11		Support
12		Integrated speaker phone

ELECTRONIC SWITCH

The Analyzer has an integrated Electronic Switch (hereinafter "Switch") designed to increase the efficiency of testing multi-wire cables.

Automated and manual control modes of the Switch allow to connect all combinations of wire pairs of a multi-wire cable to the RJ45 socket "INPUT" (Fig.2, item 4).

The control of the Switch is impossible when testing power mains.

1.3.2. ADAPTER FOR TESTING OF THE POWER MAINS

The adapter ([Fig.1, item 7](#)) is used for connect the main unit to the tested power mains. LED indicator in the plug, indicates the presence of voltage in the tested cable.

The adapter has the RJ45 plug. The contacts #1 and #2 are connected. Other contacts are not involved.

1.3.3. PATCH CORD FOR CONNECTING TO THE PC SOCKET (RJ45)

Standard patch cord ([Fig.1, item 20](#)), is used for connect the main unit to RJ45 PC socket.

1.3.4. PATCH CORD FOR CONNECTING TO THE TELEPHONE SOCKET (RJ11)

The patch cord ([Fig.1, item 21](#)) is used when testing the telephone cable that are equipped with RJ11 sockets.

The patch cord is equipped with RJ45 and RJ11 connectors. On the RJ45 connector six contacts are involved (#2 - #7). Two extreme contacts (#1 and #8) are not connected.

1.3.5. PATCH CORD RJ45/TV(M) FOR CONNECTING TO THE TV SOCKET TV(F)

The patch cord ([Fig.1, item 19](#)) is used when testing television receivers, cable and terrestrial television cables.

The cable is equipped with RJ45 and TV(f) connectors. On the RJ45 connector, only two extreme contacts (#1 and #2) are involved. Other contacts are not connected.

1.3.6. PATCH CORD WITH A NEEDLE FOR CONNECTING TO THE CABLE SHIELD

The patch cord with a needle ([Fig.1, item 22](#)) is used when testing multi-wire shielded cables, the screen of which is not connected to the connector. It connects to the "SHIELD" connector of the main unit. On the wire there is a pin plug and a needle probe. The needle pierces the outer insulation of the cable under test and provides contact with the screen.

1.3.7. ADAPTER FOR CONNECTING TO THE MULTI-WIRE CABLE

The adapter ([Fig.1, item 16](#)) is used to connect low-current cables with no connectors. When connecting such cables (twisted pair type), it is recommended to take into account [the color scheme of wires of a cable \(item 10.3\)](#).

1.3.8. PLAYER OF THE TEST SOUND (PTS). The player is not included in the package.

A player is required to search for eavesdropping devices. Any portable device equipped with a speaker (smartphone, tablet, voice recorder) can be used.

Purpose of the PTS:

- creation of an acoustic signal (the correlation of this signal and the information obtained using the ST 500 means that there is an active eavesdropping device with an unencrypted transmission channel in the room);
- forced inclusion of eavesdropping devices equipped with a VOX activation system;
- localization of detected listening devices;
- creation of the "masking noise" during the search operations.

Files with sounds are recorded on a USB drive ([fig.1, 7](#)). The user can use their own sound files that are optimally suited to the situation in which the search event is held (noise in the office, people talking, music, etc.).

1.3.9. RJ45 SHORT-CIRCUIT SOCKET

This socket ([Fig.1, item 15](#)) is used for short circuit of all wires of the cable equipped with the RJ45 connector at its test by NLJD.

1.3.10. MINI-USB PATCH CORD

Mini-USB patch cord ([Fig.1, item 4](#)) is used to connect the main unit to the USB port of a PC.

1.3.11. SPLITTERS AND ADAPTERS

The Analyzer kit contains a set of splitters and adapters used to test various types of cables. Options for their use are described in [item #2 \("Connecting to the cables"\)](#).

1.4. POWER SUPPLY

The operation of the Analyzer is allowed only from the built-in accumulator.

A fully charged accumulator provides the Analyzer operation for 3 hours.

The accumulator charge level is shown [in the Information line \(Fig.22, item 3\)](#) on the screen. The accumulator is charged using the charger ([Fig.1, item 2](#)).

To do this, insert the charger plug into the connector ([Fig.2, item 8](#)) on a side panel of the Analyzer and connect the charger to the 220 V / 50 Hz power mains.

Charging is followed by a red luminescence of the indicator of connection of the charger ([Fig.2, item 7](#)) on a side bar of the Analyzer.

Full charge time is not more than 5 hours. When charging is complete, the indicator changes from red to green.

It is forbidden to charge the accumulator during operation of the Analyzer!

1.5. SPECIFICATIONS

LOW FREQUENCY AMPLIFIER (LFA)	
Frequency range, Hz	20 - 25000
Input resistance, kOhm	200
Adjustment range of gain, dB	0 - 60
The maximum signal amplitude on an input, V	10
Spectral density of noise voltage, nV/Hz	6
Bias voltage values, V	0, ±5, ±10, ±15, ±20, ±26
Form of representation of a signal	Oscillogram Spectrogram
Measurement range on a direct current, V	±80
WIRE RECEIVER (WR)	
Frequency range, MHz	0.1 - 180
Time of scanning of all range, sec	0.3 - 1
Minimum level of detected signal in AUTOMATED mode, dBm	-60
Dynamic range, dB	50
Input resistance, Ohm	50
Demodulation	AM, FM
Bandwidth of the filter, kHz	180
The maximum allowed voltage in the cable, V	250 (AC), 80 (DC)
Data representation form	Spectrogram Oscillogram Table
NON-LINEAR JUNCTION DETECTOR (NLJD)	
Level (amplitude) of the probing signal, V	±14
Frequency of the probing signal, Hz	60
Separate indication of even and odd harmonics	yes
Minimum detectable level of non-linear distortion, %	0.1
REFLECTOMETER (REF)	
Range of distances, m	3 - 150
Error of measurements, m	±0,6
The ability to work on cables under voltage	no
Power supply	
The built-in lithium-polymer accumulator, V	3.7
Power consumption, W	<1
Operating time at the maximum power consumption, hour	>3
Charging interval of completely discharged accumulator, hour	5
Weight and dimensions	
Dimensions of the main unit (length, width, height), mm	165 x 98 x 40
Mass of the main unit, kg	0.47
Packaging dimensions (length, width, height), mm	390 x 310 x 170
Mass of the kit in packaging, kg	4.4

2. CONNECTING TO THE CABLES

2.1. CONNECTING TO THE POWER MAINS

The Analyzer connected to the power mains using an adapter ([Fig.1, item 7](#)).

The scheme of connection is shown in Fig.3.

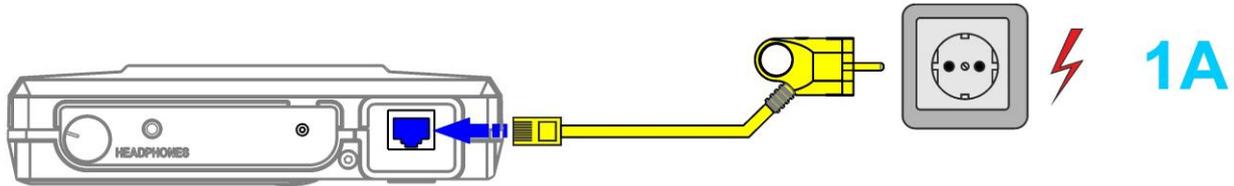


Fig.3

The adapter (in the plug) is connected to the socket of the tested cable, other end of the cable is connected to the slot of "INPUT" of the main unit.

The LED indicator on the adapter shows existence or lack of voltage in the tested cable.

2.2. CONNECTING TO THE LAN CABLE

The LAN cables can be equipped with RJ45 plugs or RJ45 sockets.

2.2.1. CONNECTING TO THE LAN CABLE EQUIPPED WITH RJ45 PLUGS

When testing LAN cable, without the need for parallel connection of terminal devices, the LAN cable equipped with a plug of RJ45 is connected directly to the slot of "INPUT" of the main unit.

The scheme of connection is shown in **Fig.4, 2A option**.

If test assumes parallel connection of terminal devices (PC, network printer, etc.), are used:

- patch cord ([Fig.1, item 20](#));
- RJ45 splitter ([Fig.1, item 12](#));
- RJ45 socket ([Fig.1, item 14](#)).

The scheme of connection is shown in **Fig.4, 2B option**.

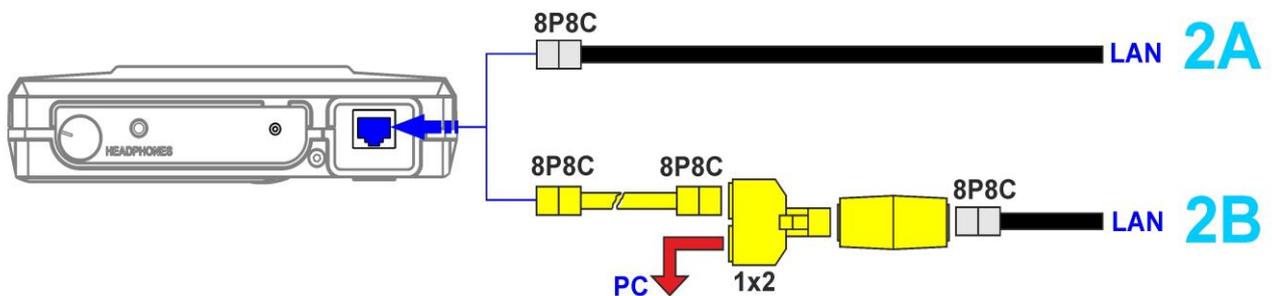


Fig.4

2.2.2. CONNECTING TO LAN CABLES EQUIPPED WITH RJ45 SOCKETS

When testing LAN cables, without the need for parallel connection of terminal devices, connection of the main unit to the PC socket is made by means of a patch cord ([Fig.1, item 20](#)).

The scheme of connection is shown in Fig.5, 2C option.

If test assumes parallel connection of terminal devices, for connection it is necessary to use:

- patch cord ([Fig.1, item 20](#))
- RJ45 splitter ([Fig.1, item 12](#))

The scheme of connection is shown in **Fig.5, 2D option.**

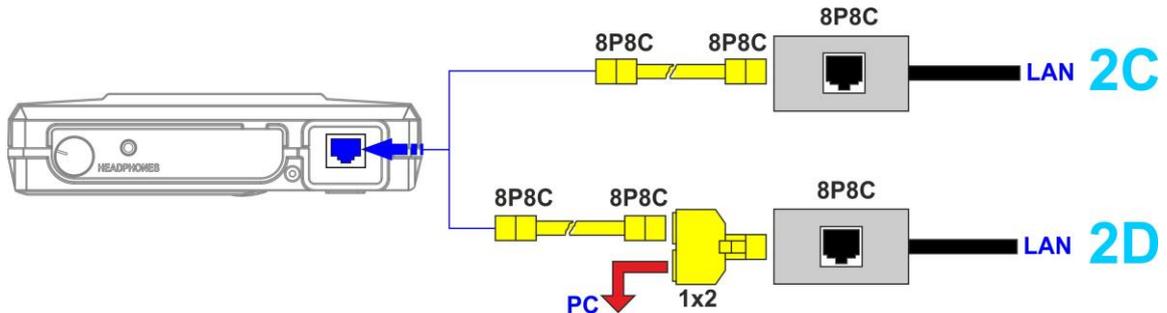


Fig.5

2.3. CONNECTING TO THE TELEPHONE CABLE

Telephone cables can be equipped with RJ11 plugs or RJ11 sockets.

2.3.1. CONNECTING TO THE TELEPHONE CABLE EQUIPPED WITH RJ11 PLUG

In the case when there is no need for parallel connection of terminal devices (telephone set or fax), the main unit is connected to the telephone cable with a patch cord equipped with RJ11 plug ([Fig.1, item 21](#)) through the RJ11 socket ([Fig.1, item 13](#)).

The scheme of connection is shown in **Fig.6, 3A option.**

If test assumes parallel connection of terminal units (telephone or fax), are used:

- patch cord ([Fig.1, item 21](#));
- RJ11 splitter ([Fig.1, item 11](#));
- RJ11 socket ([Fig.1, item 13](#)).

The scheme of connection is shown in **Fig.6, 3B option.**

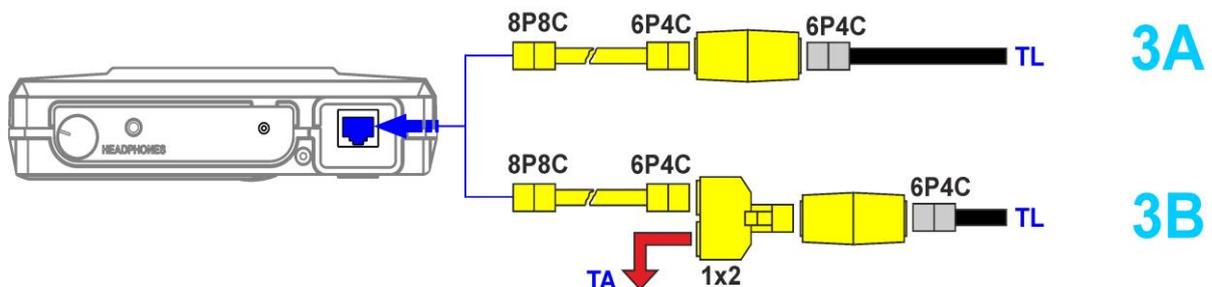


Fig.6

2.3.2. CONNECTING TO THE TELEPHONE CABLE EQUIPPED WITH THE RJ11 SOCKET

When testing a telephone cable (without the need for parallel connection of terminal equipment), the main unit is connected to the RJ11 socket using a patch cord ([Fig.1, item 21](#)).

The scheme of connection is shown in **Fig.7, 3C option**.

Options 3D and 3E show methods of parallel connection to telephone cables when using terminal devices (telephone or fax).

Option 3D is applied when the telephone cable is equipped **with the RJ11 socket**. In this case, for connection of the main unit it is necessary to use the RJ11 splitter ([Fig.1, item 11](#)) and a patch cord ([Fig.1, item 21](#)).

Option 3E is applied when the telephone cable is equipped **with the RJ11 double socket**. In this case, the main unit is connected to one of two slots of the socket by means of a patch cord ([Fig.1, item 21](#)), and the telephone or fax by means of a regular cable is connected to other slot.

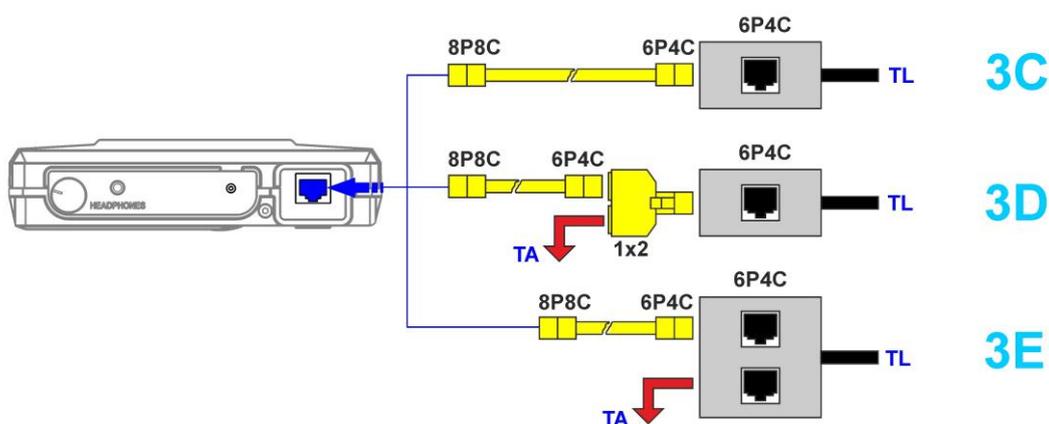


Fig.7

2.4. CONNECTING TO THE LOW-CURRENT MULTI-WIRE CABLE, WHICH IS NOT EQUIPPED WITH CONNECTOR

For test of the low-current multi-wire cables which are not equipped with a plugs or sockets, use the adapter ([Fig.1, item 16](#)). The scheme of connection is shown in Fig.8.

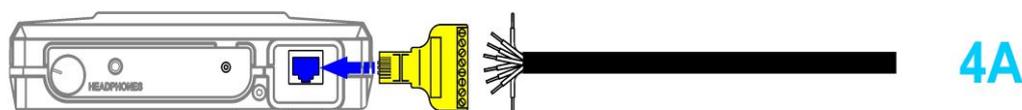


Fig.8

When connecting a LAN cable to the adapter, use the scheme ([item 10.3](#)).

This connection option is used when testing low-current cables using any device.

2.5. CONNECTING TO THE SHIELD OF LOW-CURRENT CABLE

When testing LAN cables, it is necessary (including) to test pairs consisting of wire of the multi-wire cable and the cable shield. If the cable shield is connected to the grounding contact of a socket or plug, use a "grounded" patch cord ([Fig.1, item 20](#)). Sometimes the shield of the cable does not connect to the grounding pin of a socket or plug.

In addition, the shielded cable under test may not be equipped with a socket or plug. In this case, connecting the main unit with a shielded patch cord will not provide the cable shield contact with the grounding contact ST 301.

For connection of the shield it is necessary to use a patch cord with a probe needle ([Fig.1, item 22](#)) equipped with a probe needle. This needle punctures the isolation of the tested cable and provided contact with the shield.

The other end of this patch cord is equipped with a jack that connects to the "SHIELD" slot of the main unit.

The scheme of connection to shielded cable (which no equipped with socket and plug) using the adapter ([Fig.1, item 16](#)) and a patch cord with a probe needle is shown in Fig.9.

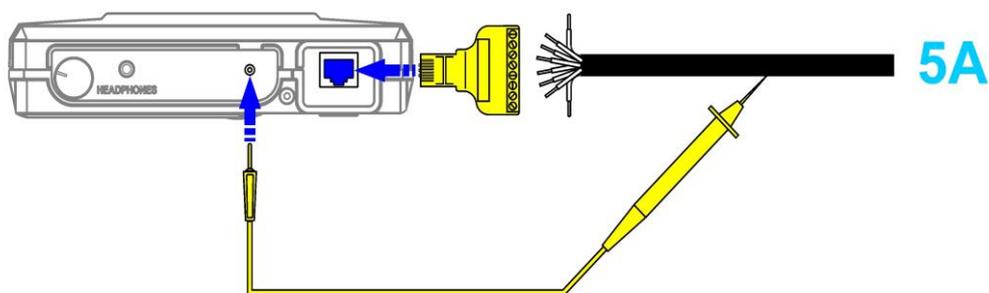


Fig.9

The scheme of connection of the shielded cable equipped with a plug is shown in Fig.10.

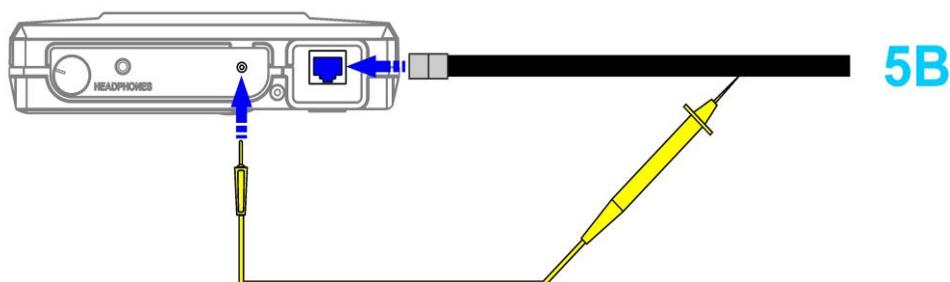


Fig.10

The cable is connected directly to the "INPUT" slot of the main unit. The contact with the cable shield is provided by means of the patch cord with the probe needle ([Fig.1, item 22](#)).

The scheme of connection of the shielded cable equipped with the socket is shown in Fig.11.

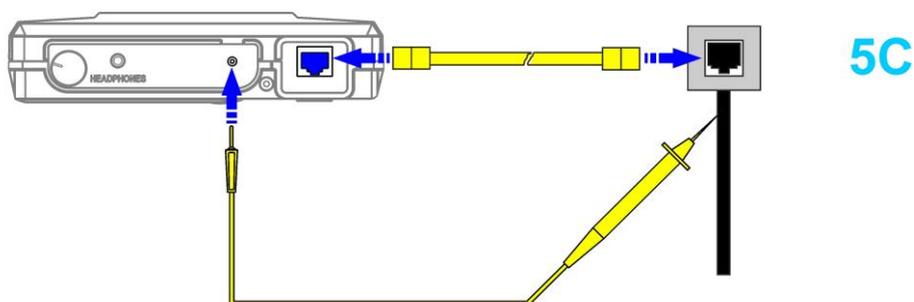


Fig.11

The main unit is connected to the socket by means of the patch cord ([Fig.1, item 20](#)).

The contact with the shield is provided by means of the patch cord with the probe needle ([Fig.1, item 22](#)).

2.6. CONNECTING TO THE TV SET AND TO THE TELEVISION CABLE

Television systems use coaxial cables equipped with plug-in connections of two main types (F-type and TV-type). Each of them can be a pin (designated by "male" or "m") or a socket (designated by "female" or "f").

For connection of the main unit to the TV, the splitter or to a television cable different cables and adapters from the ST 301 kit are used.

The appearance and names of the components are shown in Fig. 12.



Fig.12

When testing television cables WR is used. Regardless of what option of connection is used, switching to an input of the main unit is made by means of the RJ45/TV(m) patch cord (Fig.1, item 19).

In the Switch it is necessary to set pair of wires #1 and #2 as this pair is involved in the connector of a cable.

2.6.1. CONNECTING TO THE TV SET AND TO THE TV SOCKETS

The main unit is connected to an antenna input of the TV set using a patch cord (Fig.1, item 19). The scheme of connection is shown in Fig.13.

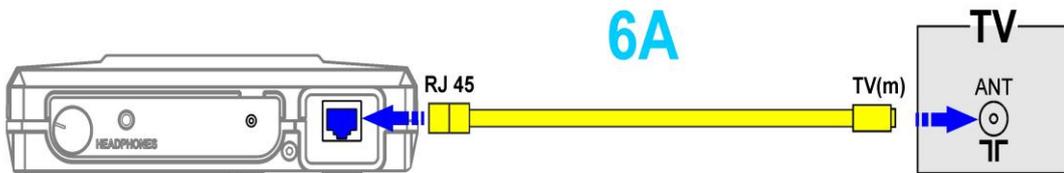


Fig.13

The main unit is connected to the television socket using a patch cord (Fig.1, item 19) and the TV(f)/TV(f) adapter (Fig.1, item 10). The scheme of connection is shown in Fig.14.

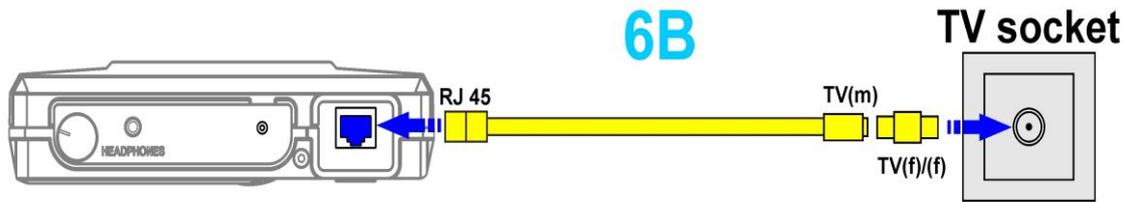


Fig.14

When ST 301 is connected in parallel to the TV cable, are used:

- RJ45/TV(m) patch cord ([Fig.1, item 19](#))
- TV splitter ([Fig.1, item 5](#))
- TV(m)/TV(f) television cable ([Fig.1, item 18](#))
- F(m)/TV(m) adapter ([Fig.1, item 8](#))
- F(m)/TV(f) adapter ([Fig.1, item 9](#))
- TV(f)/TV(f) adapter ([Fig.1, item 10](#))

The scheme of connection is shown in Fig.15.

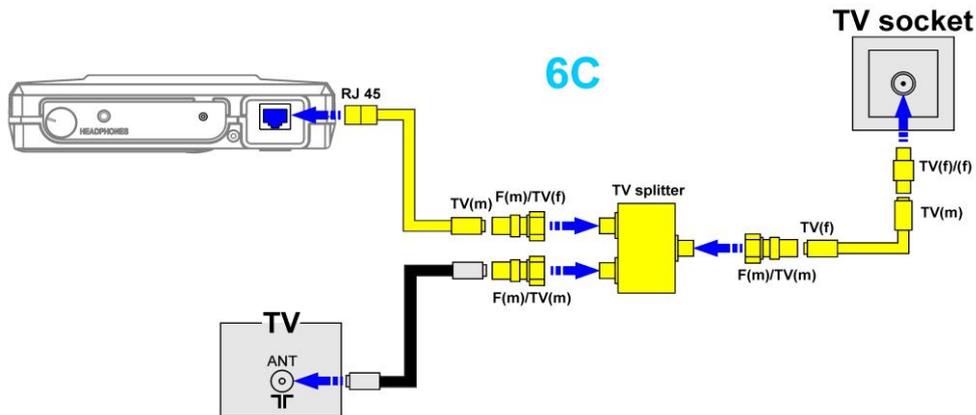


Fig.15

2.6.2. CONNECTION TO THE ANTENNA CABLE

The main unit is connected to the antenna cable using the patch cord ([Fig.1, item 19](#)) and the adapter ([Fig.1, item 10](#)).

The scheme of connection is shown in Fig.16.

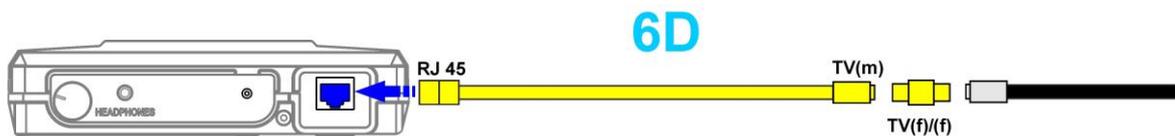


Fig.16

When ST 301 is connected in parallel to the TV cable and the TV set, are used:

- RJ45/TV(m) patch cord ([Fig.1, item 19](#))
- TV splitter ([Fig.1, item 5](#))
- TV(f)/(f) adapter ([Fig.1, item 10](#))
- TV(m)/TV(f) television cable ([Fig.1, item 18](#))
- F(m)/TV(m) adapter ([Fig.1, item 8](#))
- F(m)/TV(f) adapter ([Fig.1, item 9](#))

The scheme of connection is shown in Fig.17.

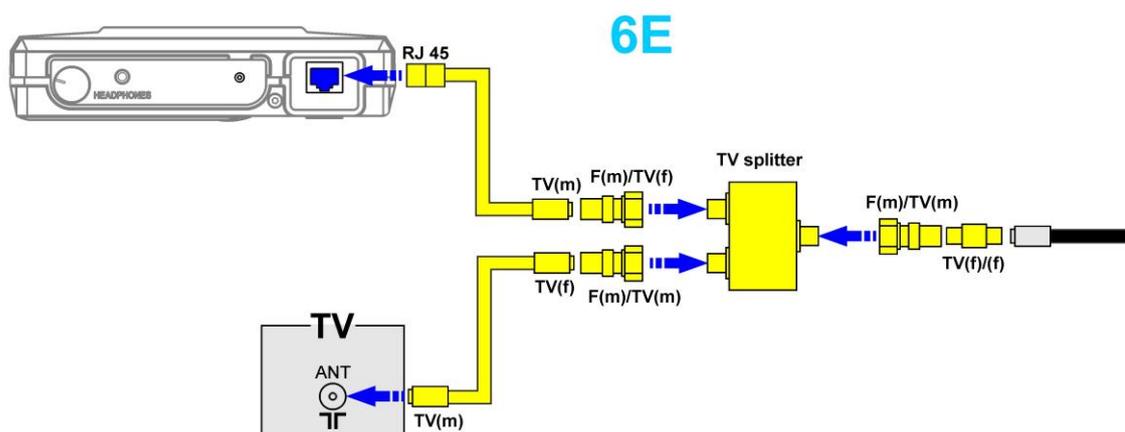


Fig.17

If the TV set or other terminal unit has the antenna input equipped with the F-type connector, then for parallel connection are used:

- RJ45/TV(m) patch cord ([Fig.1, item 19](#))
- TV splitter ([Fig.1, item 5](#))
- TV(m)/TV(f) television cable ([Fig.1, item 18](#))
- F(m)/TV(m) adapter ([Fig.1, item 8](#))
- F(m)/TV(f) adapter ([Fig.1, item 9](#))
- TV(f/f) connector ([Fig.1, item 10](#))

The scheme of connection is shown in Fig.18.

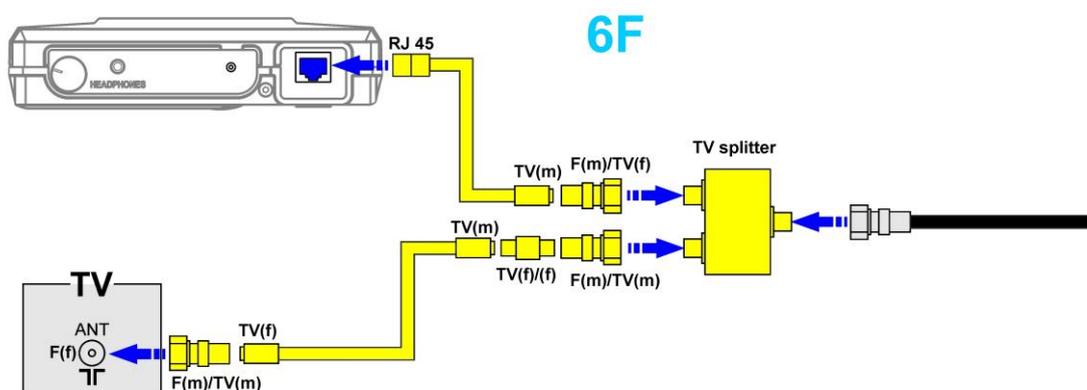


Fig.18.

2.6.3. CONNECTION TO THE EXTERNAL TV-SPLITTER

For connection to the external TV-splitter are used:

- RJ45/TV(m) patch cord ([Fig.1, item 19](#))
- TV splitter ([Fig.1, item 5](#))
- TV(m)/TV(f) television cable ([Fig.1, item 18](#))
- F(m)/TV(m) adapter ([Fig.1, item 8](#))
- F(m)/TV(f) adapter ([Fig.1, item 9](#))
- TV(f/f) adapter ([Fig.1, item 10](#))

The scheme of connection is shown in Fig.19.

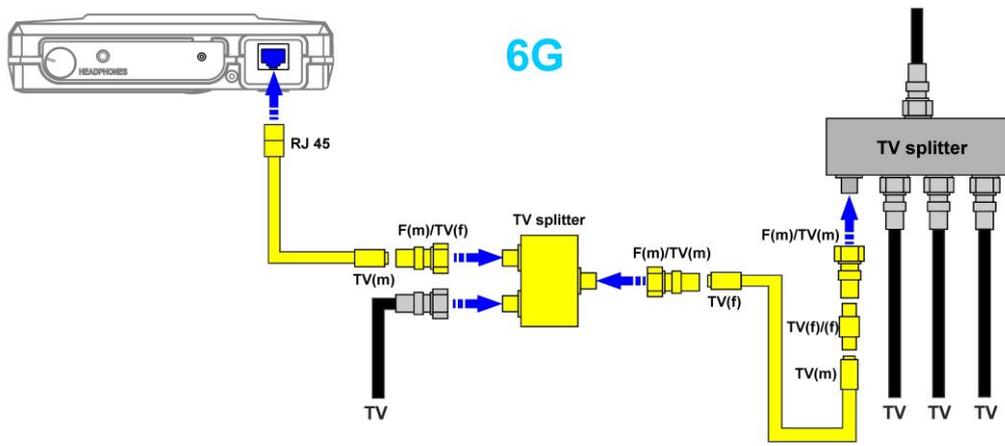


Fig.19

3. INTERFACE SETTINGS

3.1. TURNING ON/OFF

The Analyzer is turned on/off using the tumbler ([Fig.2, item 1](#)).
Screen view is shown in Fig.20.



Fig.20

On the screen: company logo, device name (ST 301) and firmware version. It is necessary to press any button on the keyboard for continue.

3.2. THE ANALYZER MAIN MENU

The Analyzer main menu is shown in Fig.21.

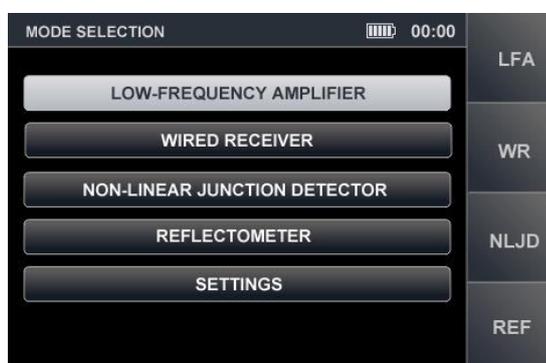


Fig.21

For inclusion of LFA, WR, NLJD, REF by means of  or  buttons set the tabular cursor on the corresponding item and press "ENTER" or to use "hot buttons" ("F1", "F2", "F3", "F4" respectively).

3.3. INFORMATION LINE

In the upper part of the screen, there is an information line (Fig.22).



Fig.22

In Fig.22:

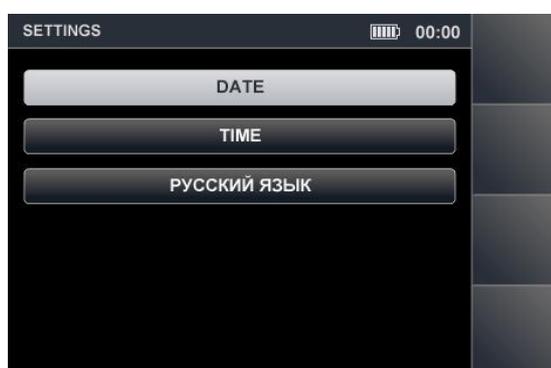
- 1 - device (such as WR) is on
- 2 - power mains test mode indicator
- 3 - connected wire pair indicator
- 4 - accumulator charge level indicator
- 5 - current time in a format "HH:MM"

3.4. SETTINGS (SERVICE MODE)

This mode is design to set the date, time and interface language (Russian or English). To activate the mode, use the  or  buttons or in the main menu to set the tabular cursor to the item "SETTINGS" and press "ENTER".

For exit to the main menu, press "ESC". Confirmed parameter changes when exiting the "SETTINGS" mode are saved, including when the power is turned off.

The screen of the "SETTINGS" mode is shown in Fig.23.

**Fig.23****3.4.1. DATE SETTING**

Using the  or  buttons, set the cursor to the "DATE" item and press "ENTER". The date setting menu (Fig.24) in the "DD-MM-YYY" format will appear on the screen.

**Fig.24**

Use the  or  buttons to set the cursor to the "DAY" menu item and use the  or  buttons to set the desired value. The values "MONTH" and "YEAR" are set in the same method.

To confirm the set values, press "ENTER". Exit from the "SETTINGS" mode without save the changes - "ESC".

3.4.2. TIME SETTING

Use the  or  buttons to set the cursor to the "TIME" menu item and press "ENTER". The time setting menu (Fig.25) in the "HH:MM" format will appear on the screen.



Fig.25

The time setting is carried out by analogy with the date setting (item 3.4.1).

3.4.3. INTERFACE LANGUAGE SETTING

To set the interface language, use the  or  buttons set the cursor on the "ENGLISH" menu item and press "ENTER". The interface language will change from Russian to English.

To set the Russian language set the cursor on the menu item "РУССКИЙ ЯЗЫК" and press "ENTER".

4. ELECTRONIC SWITCH SETTINGS

Before testing a multi-wire cable, it is necessary to determine its type.

Press "FUNC" for cable type selecting:

- "twisted pair" type cable (one, two, three or four pairs of wires);
- multi-wire cable (the maximum quantity of wires in the cable - eight).

The set parameters of a cable remain invariable for all modes (regardless of in what mode they were set) before the following correction or turning off the Analyzer.

The cable settings menu of the "twisted pair" type is shown in Fig.26

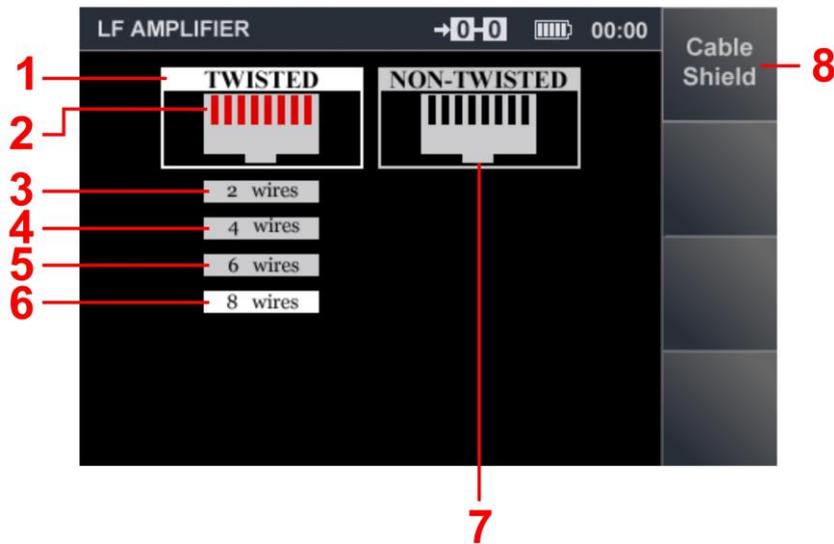


Fig.26

In Fig.26:

- 1 - "twisted pair" type cable setting indicator
- 2 - indicator of the input contacts in the Switch socket (RJ45) - the used contacts are displayed in red, the unused contacts in black
- 3-6 - indicators of the number of twisted pairs in the connected cable (the indicator with a white background shows the connected number of twisted pairs)
- 7 - "non-twisted pair" type cable indicator
- 8 - indicator of connection of the cable shield

Controls:

Button	Action
◀ ▶	Switching for setting "non-twisted pair" type cable
⏴ ⏵	Setting the number of wire pairs
F1	Connect / disconnect cable shield
ESC, FUNC	Go to the Analyzer main menu
F2, F3, F4, MODE, ENTER	Are not used

The cable settings menu of the "non-twisted pair" type is shown in Fig.27

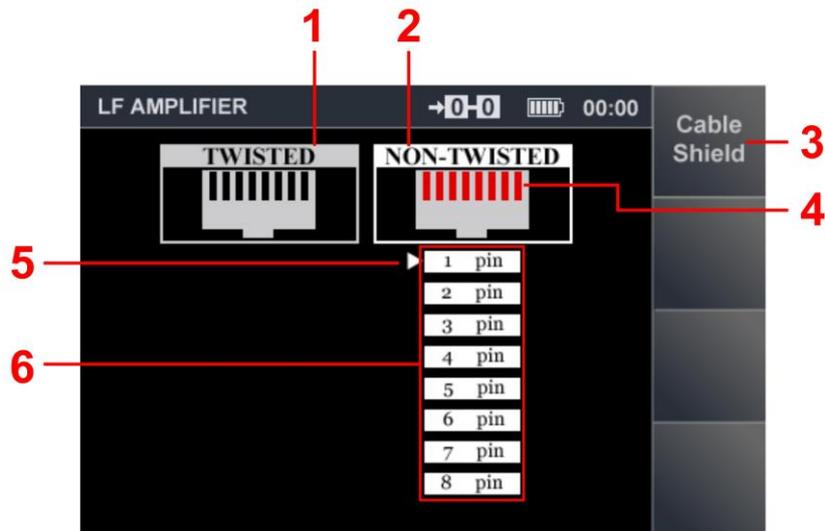


Fig.27

In Fig.27:

- 1 - "twisted pair" type cable setting indicator
- 2 - "non-twisted pair" type (any type) cable setting indicator
- 3 - indicator of connection of the cable shield
- 4 - indicator of the input contacts in the Switch socket (RJ45) - the used contacts are displayed in red, the unused contacts in black
- 5 - the cursor showing what position it is available to adjustment
- 6 - contacts indicator in the socket (used contacts are displayed in white, unused contacts are displayed in gray), the wire numbering corresponds to the pin numbering of the RJ45 socket

Controls:

Button	Action
↔	Switching for setting "twisted pair" type cable
↕	Cursor move
ENTER	Connect / disconnect of the selected contacts
F1	Connect / disconnect cable shield
ESC, FUNC	Go to the Analyzer main menu
F2, F3, F4, MODE	Are not used

4.1. STANDARD SETTINGS

Settings for the unshielded 4-pair "twisted pair" type cable (with or without a connector).

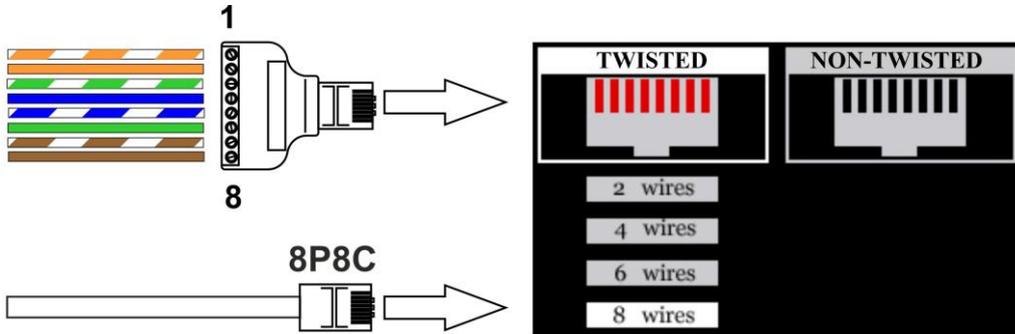


Fig.28

Settings for the shielded 4-pair "twisted pair" type cable (shield is connected to the connector).

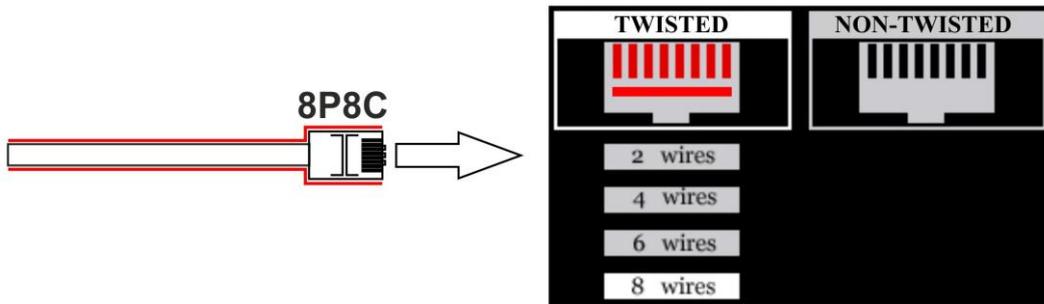


Fig.29

Settings for the unshielded 2-pair "twisted pair" type cable which not equipped with the connector.

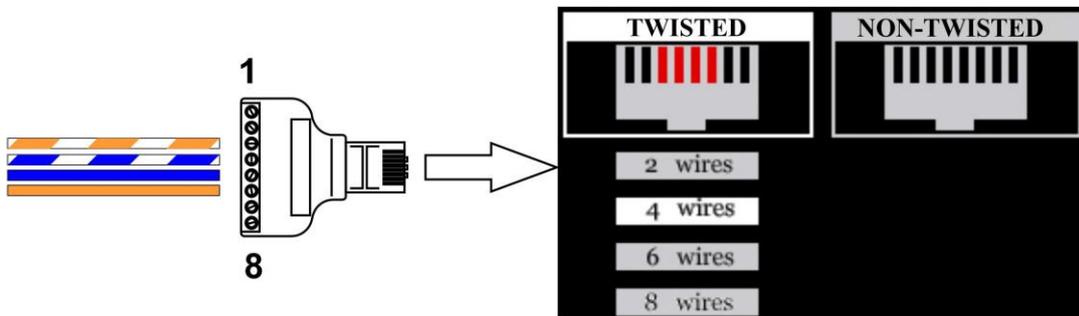


Fig.30

Settings for the unshielded 1-pair "twisted pair" type cable which not equipped with the connector.

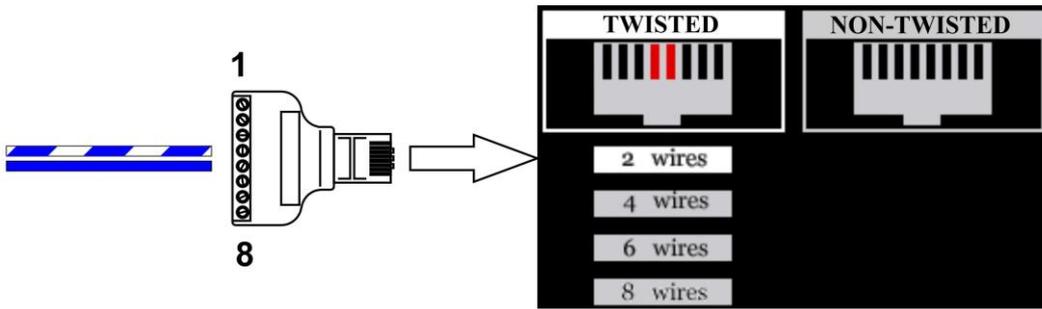


Fig.31

Settings for the unshielded 6 wires "non-twisted" type cable, equipped with the RJ11 (6P6C) connector.

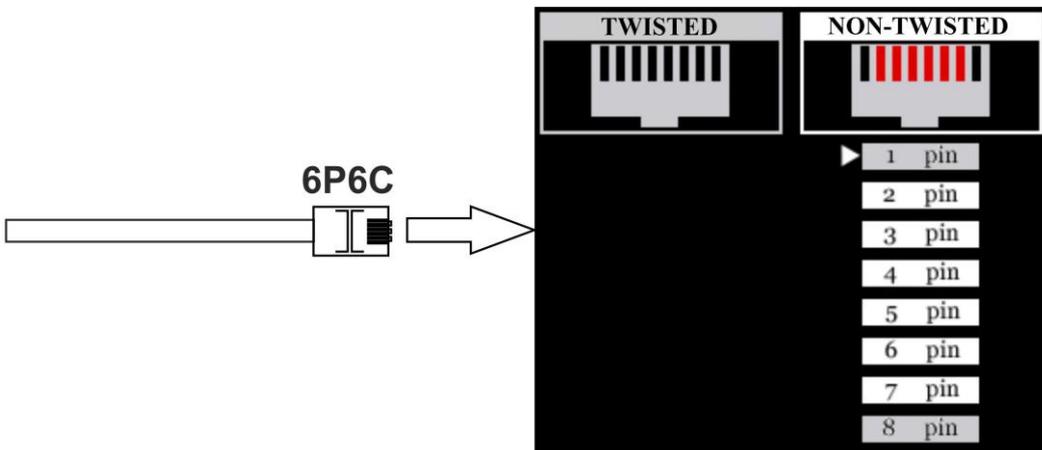


Fig.32

Settings for the unshielded 4 wires "non-twisted" type cable, equipped with the RJ11 (6P4C) connector.

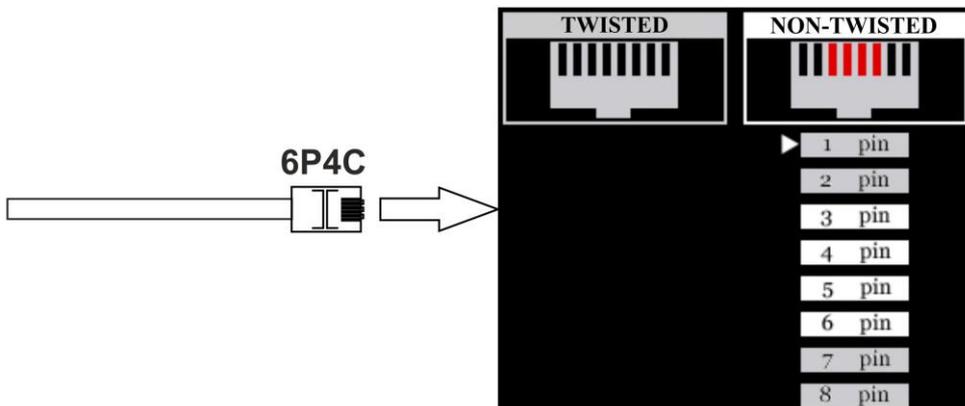


Fig.33

Settings for the unshielded 2 wires "non-twisted" type cable, equipped with the RJ11 (6P2C) connector.

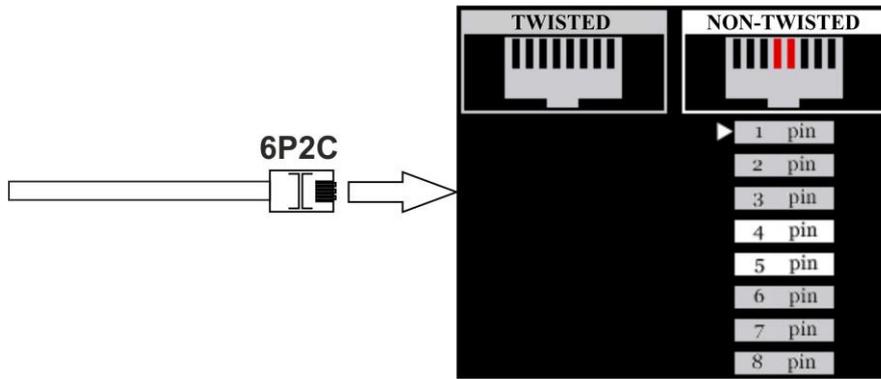


Fig.34

Settings for the unshielded 4 wires "non-twisted" type cable, which not equipped with the connector (connection to the first four contacts).

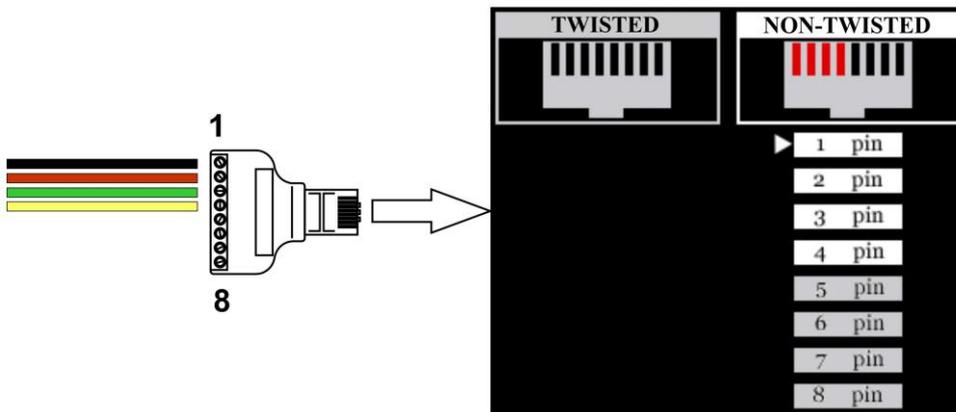


Fig.35

Settings for a special television cable from the ST 301 kit ([item 21, Fig.1](#)). In the cable connector (RJ45) only two wires (contacts #1 and #2) are connected.

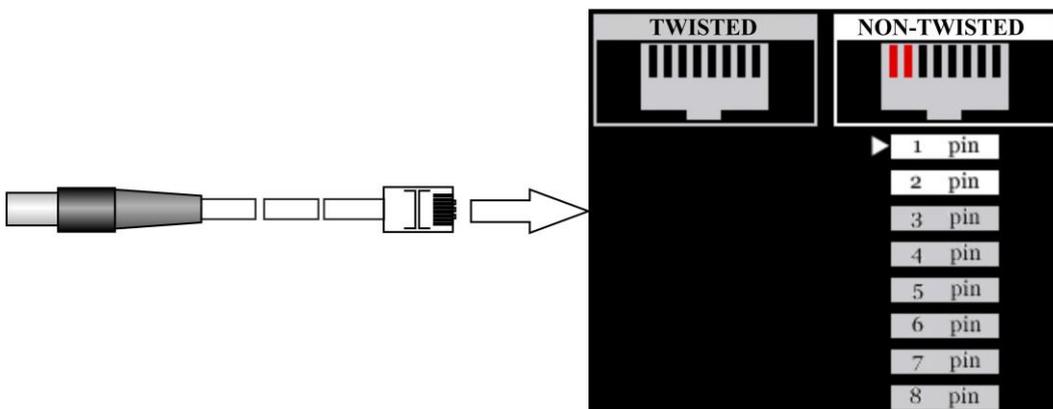


Fig.36

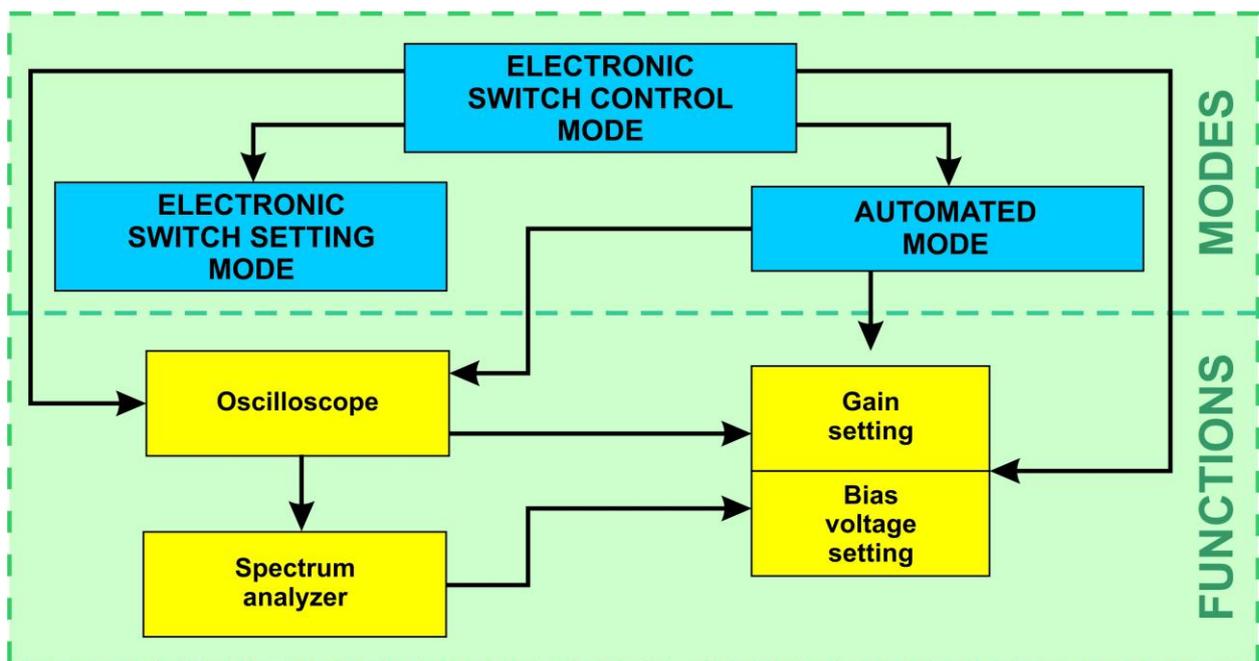
5. DEVICES

5.1. LOW-FREQUENCY AMPLIFIER (LFA)

LFA is design to detect low-frequency signals of eavesdropping devices in low-current cables. Signal analysis is performing using graphical information (oscillogram or spectrogram) and acoustic information (via headphones or the built-in speaker).

LFA is turn on in the Analyzer main menu [\(item 3.2\)](#).

LFA FUNCTIONAL DIAGRAM



5.1.1. LFA MAIN MENU

Available actions:

- Switch setting;
- connection a pair of wires in the MANUAL mode;
- gain setting;
- apply bias voltage to cable;
- acoustic signal analysis on the connected pair of wires;
- measurement of values of AC and DC voltage on the connected pair of wires;
- signal analysis on the connected pair according to the oscillogram and the spectrogram;
- automatic testing all combinations of wires of the connected cable with a possibility of acoustic signal analysis of each combination.

LFA main menu is shown in Fig.37.

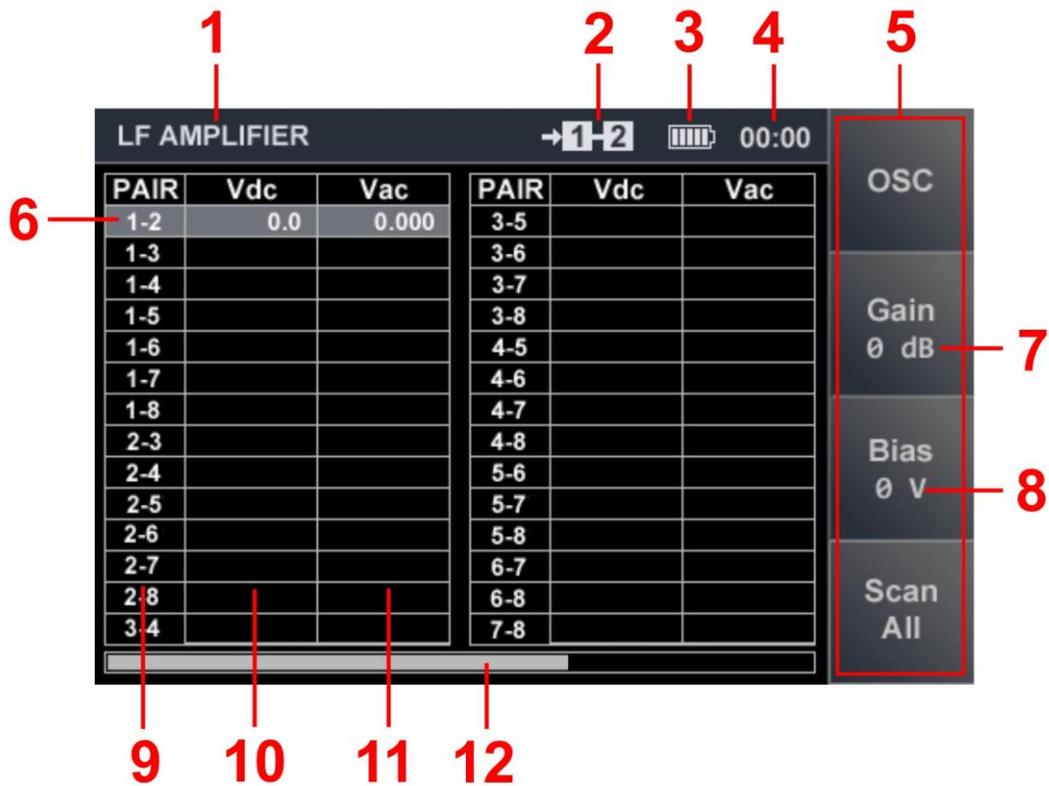


Fig.37

In Fig.37:

- 1 - LFA is on
- 2 - the connected pair of wires
- 3 - accumulator charge indicator
- 4 - clock
- 5 - "hot" buttons
- 6 - tabular cursor
- 7 - gain value
- 8 - bias voltage value
- 9 - pair of wires
- 10 - measured DC voltage
- 11 - measured AC voltage
- 12 - scroll bar

Controls:

Button	Action
	Tabular cursor move (the connected pair of wires)
F1, ENTER	Turning on OSCILLOSCOPE
F2	Turning on/off GAIN SETTING
F3	Turning on/off BIAS VOLTAGE SETTING
F4	Turning on AUTOMATED mode
ESC, MODE	Go to the Analyzer main menu
FUNC	Turning on SWITCH SETTING mode

5.1.2. GAIN SETTING

1. Press "F2". The field "Gain" will become lighter.
2. By means of the     buttons to set gain value in dB (0, 5, 10, 20, 30, 40, 50, 60) which will be displayed on the indicator (Fig.37, item 7).
3. Finish the adjustment ("F2"). The field "Gain" will become darker.

The set gain value remains unchanged until its next correction or power off.

5.1.3. BIAS VOLTAGE SETTING

1. Press "F3". The field "Bias" will become lighter.
2. By means of the  or  buttons set bias voltage value (from -26 V to +26 V with a step of 2 V) which will be displayed on the indicator (Fig.37, item 8).
3. If necessary to change the bias voltage polarity, press  or  buttons
4. Press "ENTER" for set value of bias voltage equal "0".
5. Finish adjustment ("F3"). The field "Bias" will become darker.

When setting gain or bias voltage, all buttons that are not involved in these procedures are blocked.

When bias voltage is supplied to the cable, the gain will be automatically reduced to 25 dB (if a higher value was previously set). If the connected pair voltage is more than ± 3 V (DC), the bias voltage supply is automatically blocked.

The field of the "F3" button takes a form:



In this case, for supplying of bias voltage it is necessary to disconnect the cable from the power source (to isolate a cable).

The set value of bias voltage remains unchanged until its next correction or power off

5.1.4. AUTOMATED MODE

For automated search in all possible combinations of wires of a multi-wire cable press "F4" ("Scan All"). The built-in Electronic Switch in turn the connects pairs of wires. The tabular cursor is set to the row corresponding to the connected pair of wires. Scanning stops for a few seconds to analyze the received signal by ear.

After the end of the scan cycle, the tabular cursor is set to an initial row (on which it was set prior to scanning).

If during scanning on any pairs suspicious signals were detected, after the end of the cycle, it is necessary to set the cursor on the corresponding line in the table and analyze this signals using an OSCILLOSCOPE and a SPECTRUM ANALYZER.

5.1.5. OSCILLOSCOPE

For turn on an OSCILLOSCOPE it is necessary to press "F1" in the LFA main menu. OSCILLOSCOPE screen is shown in Fig.38.

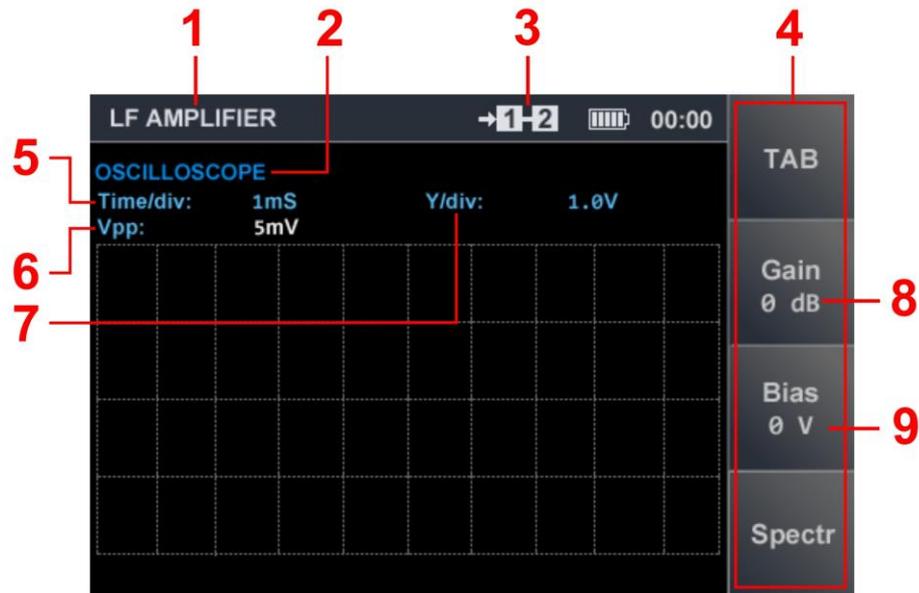


Fig.38

In Fig.38:

- 1 - LFA is on
- 2 - OSCILLOSCOPE mode
- 3 - the connected pair of wires
- 4 - "hot" buttons
- 5 - value of dividing the time axis (microsecond or millisecond)
- 6 - measured value of signal amplitude
- 7 - vertical scaling of the oscillogram
- 8 - gain value
- 9 - bias voltage value

After turning on the OSCILLOSCOPE, the previously set gain and bias voltage are used. Correction is possible without shutting down the OSCILLOSCOPE.

The order of setting described in [item 5.1.2](#) and [item 5.1.3](#).

OSCILLOSCOPE CONTROLS:

Button	Action
	Scaling of the oscillogram on a vertical
	Scaling of the oscillogram on a horizontal
F1, ESC	Go to LFA main menu
F2	Turning on/off GAIN SETTING
F3	Turning on/off BIAS VOLTAGE SETTING
F4	Turning on SPECTRUM ANALYZER
MODE	Go to the Analyzer main menu
FUNC, ENTER	Are not used

5.1.6. SPECTRUM ANALYZER

For turning on the SPECTRUM ANALYZER press "F4", when the OSCILLOSCOPE is on (Fig.38). SPECTRUM ANALYZER screen is shown in Fig.39.

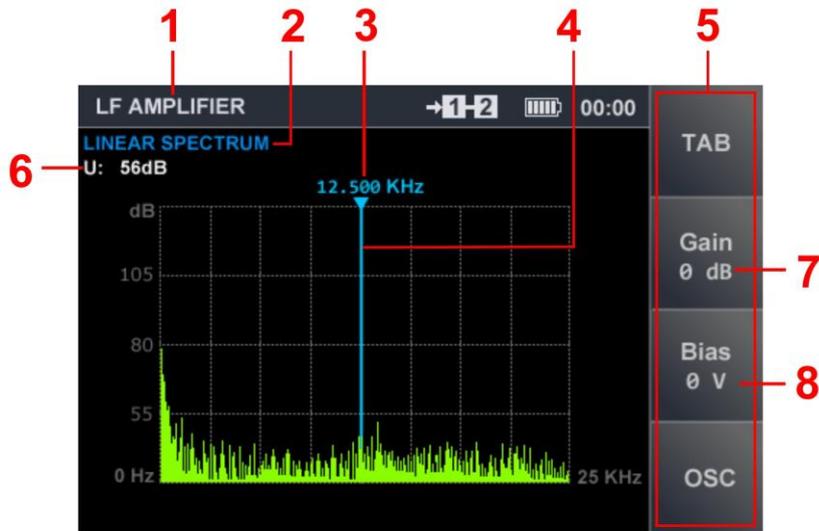


Fig.39

In Fig.39:

- 1 - LFA is on
- 2 - representation form (LINEAR SPECTRUM)
- 3 - marker frequency value
- 4 - marker
- 5 - "hot" buttons
- 6 - signal amplitude at a marker frequency
- 7 - gain value
- 8 - bias voltage value

The spectrogram is not scaled and is presented in all range (0 - 25 kHz).

SPECTRUM ANALYZER CONTROLS:

Button	Action
◀ ▶	Marker move
F1, ESC	Go to LFA main menu
F2	Turning on/off GAIN SETTING
F3	Turning on/off BIAS VOLTAGE SETTING
F4	Turning on OSCILLOSCOPE
MODE	Go to the Analyzer main menu
⏏ ⏠ ENTER, FUNC	Are not used

Values of the gain and bias voltage, which are earlier set when using an OSCILLOSCOPE remain. Adjustment of these parameters is possible without turning off the SPECTRUM ANALYZER. The order of change is described in [item 5.1.2](#) and [item 5.1.3](#).

5.2. WIRED RECEIVER (WR)

WR is design to detect of signals of the eavesdropping devices transferring information on power and low-current cables in the frequency range of 0.1-180 MHz.

Signal analysis is performing using graphical information (oscillogram or spectrogram) and acoustic information (via headphones or the built-in speaker).

To connect to the power mains an adapter is used ([Fig.1, item 7](#)).

To connect to low-current lines patch cords are used ([Fig.1, item 19-21](#)).

WR is turn on in the Analyzer main menu ([item 3.2](#)).

After that, it is necessary:

1. Select the type of the tested cable: the power mains or low-current (Low Voltage) cable.
2. Select test frequency range (0.1 - 60 MHz or 0.1 - 180 MHz).

5.2.1. CABLE TYPE SELECTION

After turning on WR, the menu for selecting the cable type is display on the screen (Fig. 40).

If the "Mains" menu item selected, a pair of wires 1-2 is connected. Switch control is blocking, since only two wires are tested.

The adapter cable uses two wires connected to contacts #1 and #2 of RJ45 plug.

When testing low-current lines, in most cases, multi-wire cables are analyzed. Connecting combinations of wires (in all modes) provides an integrated Electronic Switch.

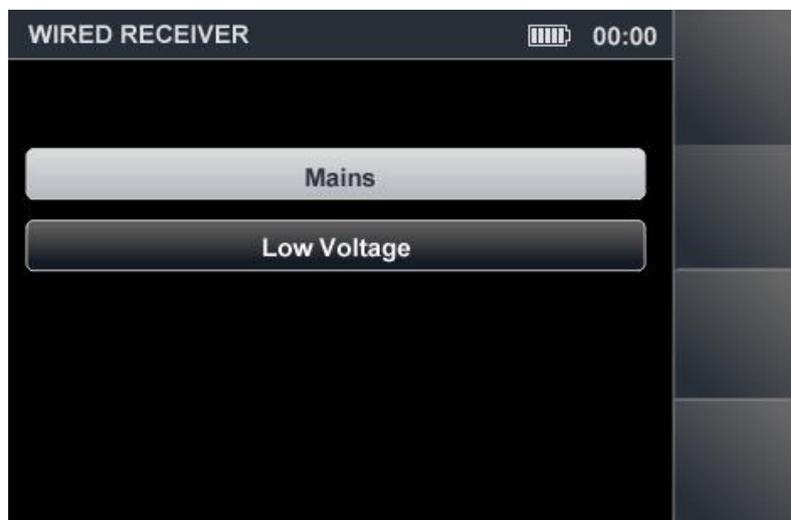


Fig.40

By means of the  or  buttons, select cable type and press "ENTER". The menu for selecting the frequency range will appear on the screen (Fig. 41).

5.2.2. FREQUENCY RANGE SELECTION

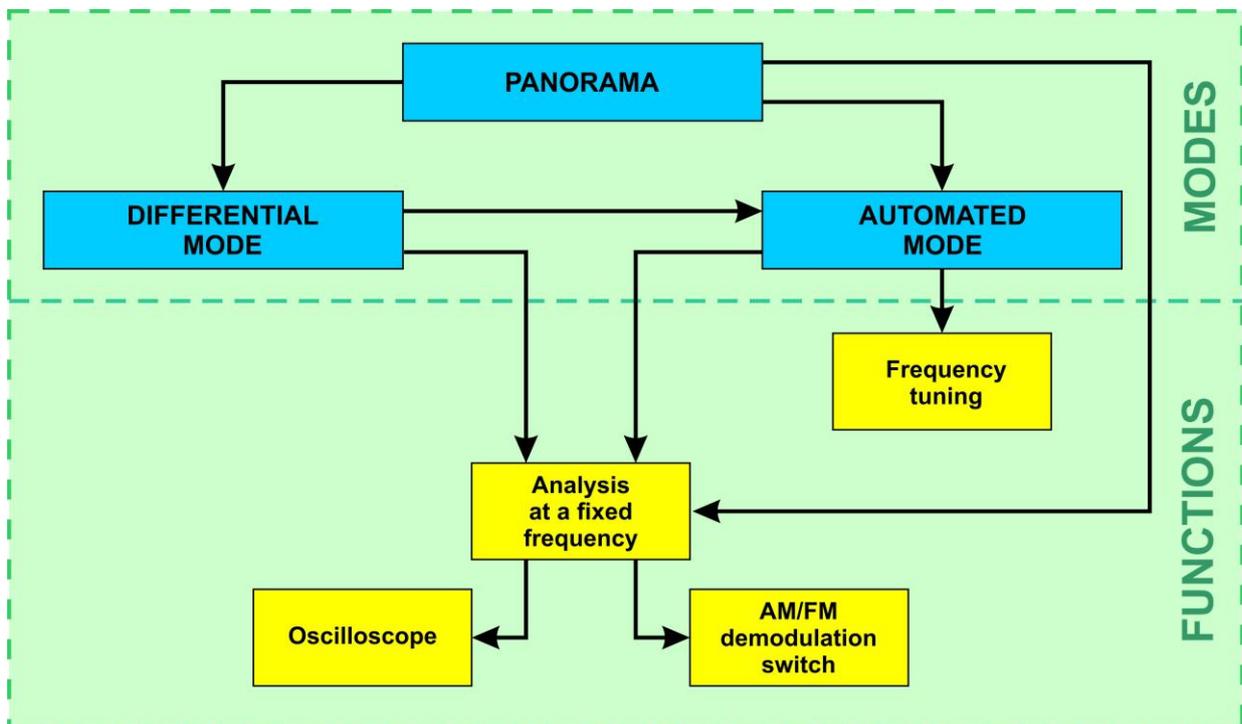
Signals are search in two ranges: 0.1 - 60 MHz or 0.1 - 180 MHz.

By means of the  or  buttons, select the one of menu item and press "ENTER".



Fig.41

WR FUNCTIONAL DIAGRAM (POWER MAINS TESTING)



5.2.3. POWER MAINS TESTING (PANORAMA MODE)

After selecting the type of cable and the frequency range, the spectrogram is display on the screen (Fig.42).

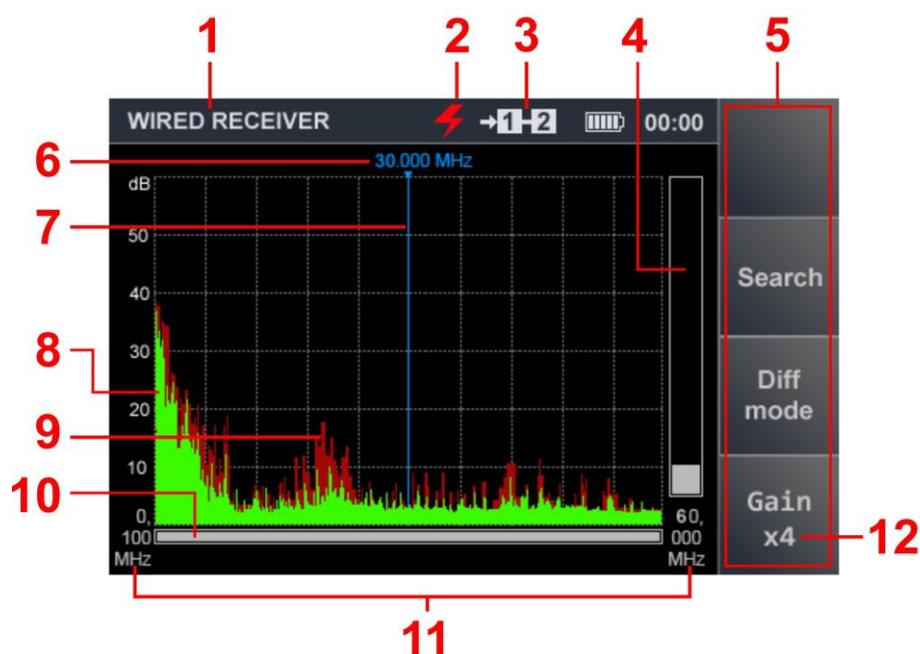


Fig.42

In Fig.42:

- 1 - WR is on
- 2 - power mains test indicator
- 3 - the connected pair of wires (when testing the power mains: "1-2")
- 4 - the signal level on a marker frequency
- 5 - "hot buttons"
- 6 - frequency value on a marker position
- 7 - marker
- 8 - spectrum obtained during the last measurement cycle (green color)
- 9 - maximum signal level at this frequency for all cycles (claret color)
- 10 - indicator showing the position of the set viewing band relative to the maximum possible
- 11 - initial and final frequency value of the set viewing band
- 12 - gain value (in times)

Available actions:

- signal analysis at a fixed frequency;
- obtaining a difference spectrogram in the DIFFERENTIAL mode;
- search of signals in the AUTOMATED mode;
- gain setting (x1, x2, x4);
- possibility of using an attenuator (20 dB).

Periodically updated graphical information displays the received signals in a given viewing range. Signals received in the last cycle are marked in green color.

The maximum signal levels (received during the range viewing session) are marked in claret color. The viewing range is display in digital form (Fig.42, item 11) and in graphical form (Fig.42, item 10).

Horizontal scaling is possible. This enables a detailed view of the part of the range of interest. To do this, use the ◀ or ▶ buttons to set the marker on the signal and use the ⏏ button to change the viewing band.

It is necessary to consider that at change of view pane earlier accumulated information about the maximum values of signals (a "claret" spectrum) is not saved. For the return scaling (increase in a scroll bar) the  button is used. Reduction or increase the viewing band is carried out concerning the frequency of the screen marker.

Controls:

Button	Action
	Spectrogram scaling
	Marker move
F2	Turning on AUTOMATED mode
F3	Turning on DIFFERENTIAL mode
F4	Turning on/off an attenuator. GAIN SETTING (x1, x2, x4)
ENTER	Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
ESC, MODE	Go to the Analyzer main menu
FUNC, F1	Are not used

5.2.4. DIFFERENTIAL MODE

In the DIFFERENTIAL mode, the signal levels obtained as a result of previous scanning cycles are taken to be "zero" and only signals that exceed them (difference spectrum) are displayed on the screen.

The DIFFERENTIAL mode purpose:

- reduce the influence of external noise and interference;
- monitor changes in the spectrogram when connecting equipment to the cable under test.

The DIFFERENTIAL mode is turn on in the PANORAMA mode (Fig.42) by pressing F3 ("Diff mode"). The field of this button will become lighter (Fig.43).

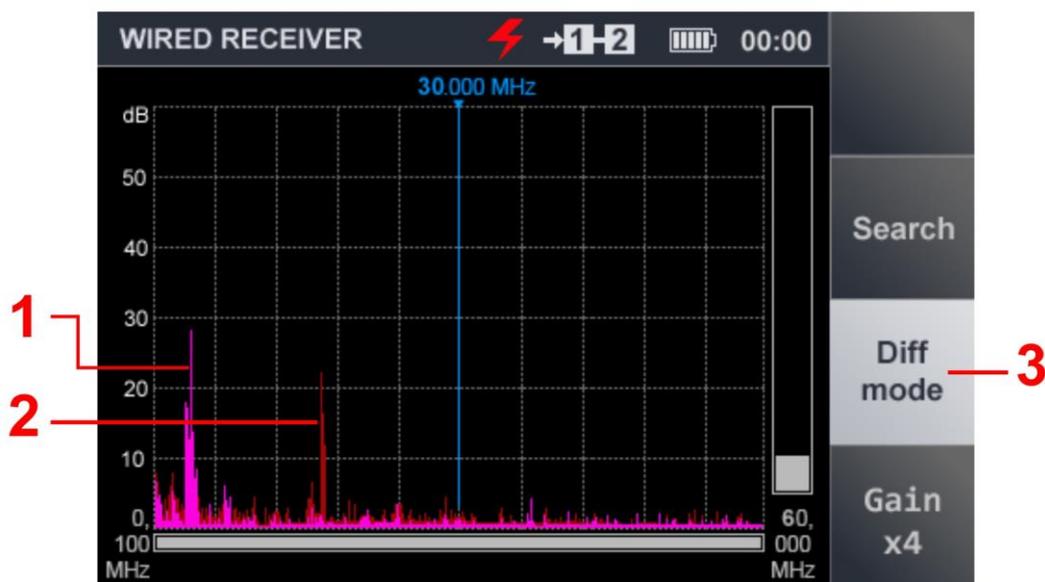


Fig.43

In Fig.43:

- 1 - difference spectrum obtained during the last measurement cycle (lilac color)
- 2 - difference spectrum obtained in previous measurement cycles (claret color)
- 3 - indicator of DIFFERENTIAL mode turning on (light field of the "F3")

Available actions:

- signal analysis at a fixed frequency;
- search for signals in the AUTOMATED mode;
- gain setting (x1, x2, x4);
- possibility of using an attenuator (20 dB).

Controls:

Button	Action
	Spectrogram scaling
	Marker move
F2	Turning on AUTOMATED mode
F3	Turning on DIFFERENTIAL mode
F4	Turning on/off an attenuator. GAIN SETTING (x1, x2, x4)
ENTER	Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
ESC, MODE	Go to the Analyzer main menu
FUNC, F1	Are not used

For the mode turning off (return to the PANORAMA mode) press "F3". The field of the "F3" will become more dark.

Changes to the span and attenuator settings made in the DIFFERENTIAL mode are saved when exit to the PANORAMA mode.

5.2.5. SIGNAL ANALYSIS AT A FIXED FREQUENCY

The function is designed to study signals in the PANORAMA mode or in the DIFFERENTIAL mode and allows to tune to the frequency of the detected signal, listen to the demodulated signal and examine it using an oscilloscope.

Turning on is carried out from the PANORAMA mode or from the DIFFERENTIAL mode.

Using the  or  buttons, set the marker on the signal and press "ENTER".

The screen is shown in Fig.44.

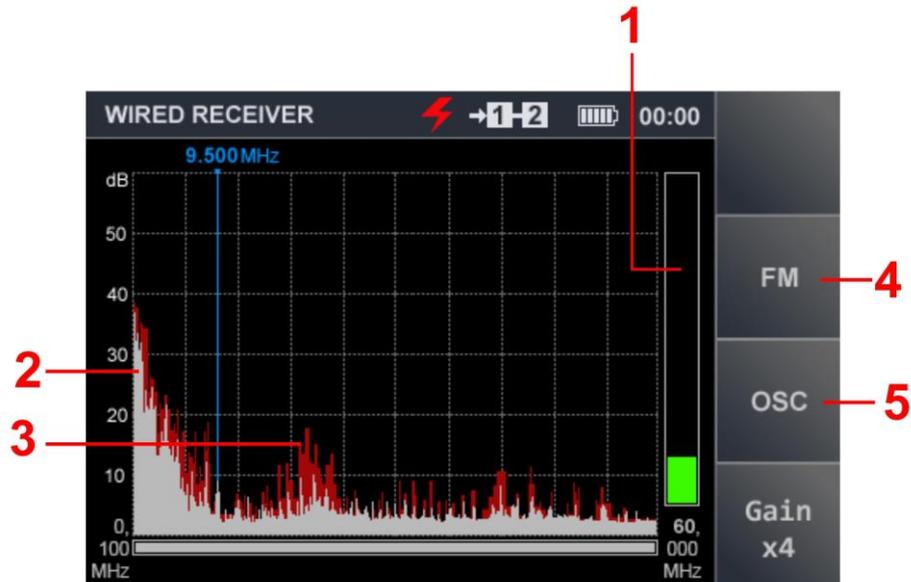


Fig.44

In Fig.44:

- 1 - the signal level at marker frequency
- 2 - spectrum obtained during the last measurement cycle (gray color)
- 3 - maximum signal level at that frequency for all cycles (claret color)
- 4 - "F2" button field (AM/FM demodulators switching)
- 5 - "F3" button field (OSCILLOSCOPE turning on)

Available actions:

- possibility of using AM/FM demodulators;
- possibility of using an OSCILLOSCOPE;
- frequency setting;
- gain setting (x1, x2, x4);
- possibility of using an attenuator (20 dB).

Controls:

Button	Action
	Marker move (frequency setting)
F2	Switching AM/FM demodulators
F3	Turning on OSCILLOSCOPE
F4	Turning on/off an attenuator. GAIN SETTING (x1, x2, x4)
ENTER, ESC	Turning off SIGNAL ANALYSIS AT A FIXED FREQUENCY
MODE	Go to the Analyzer main menu
FUNC F1 	Are not used

5.2.6. OSCILLOSCOPE

The detected signal (at a fixed frequency) can be analyzed using the OSCILLOSCOPE (press "F3"). Field of "F3" button ("OSC") will become lighter (Fig.45).



Fig.45

In Fig.45:

- 1 - WR is on
- 2 - the value of dividing of the time axis
- 3 - OSCILLOSCOPE is on

Available actions:

- determination of the timing parameters of the demodulated signal;
- listening of a signal on AM and FM;
- gain setting (x1, x2, x4);
- possibility of using an attenuator (20 dB).

Controls:

Button	Action
	Changing of scale division interval of horizontal sweep 100µS/200µS/500µS/1mS/2mS/5mS/10mS
F2	Switching AM/FM demodulators
F3	Turning off OSCILLOSCOPE
F4	Turning on/off an attenuator. GAIN SETTING (x1, x2, x4)
ENTER	Turning off SIGNAL ANALYSIS AT A FIXED FREQUENCY
ESC, MODE	Go to the Analyzer main menu
F1, FUNC 	Are not used

5.2.7. AUTOMATED MODE

In AUTOMATED mode, all signals are fixing whose amplitude exceeds the adaptive detection threshold. AUTOMATED mode is activated from the WR main menu (5.2.3) or the DIFFERENTIAL mode menu (5.2.4). Signals are searched within the viewing range and taking into account the results of the DIFFERENTIAL mode (if the AUTOMATED mode was switched from the DIFFERENTIAL mode). To turning on the AUTOMATED mode, press the "F2". The view of the screen after turning on the mode is shown in Fig.46.



Fig.46

In Fig.46:

- 1 - WR is on
- 2 - quantity of the detected signals
- 3 - "hot" buttons
- 4 - the tabular cursor
- 5 - numbers of the detected signals
- 6 - frequency of the detected signals
- 7 - the level of the detected signals
- 8 - position of the cursor relative to the number of rows in the table
- 9 - the signal level (on which the cursor is set)

Available actions:

- sorting of detected signals (by frequency or level);
- fast tuning to the detected signal by selecting it in the table;
- possibility of using an attenuator (20 dB);
- gain setting (x1, x2, x4);
- signal analysis at a fixed frequency;
- switching AM/FM demodulators;
- use an OSCILLOSCOPE.

Controls:

Button	Action
⬅️ ➡️ ⬇️ ⬆️	Tabular cursor move
FUNC	Sorting of signals
F1	Are not used
F2	Switching AM/FM demodulators
F3	Turning on OSCILLOSCOPE
F4	Turning on/off an attenuator. GAIN SETTING (x1, x2, x4)
ENTER	Turning off SIGNAL ANALYSIS AT A FIXED FREQUENCY
ESC	Exit from the AUTOMATED mode (step backwards)
MODE	Go to the Analyzer main menu

5.2.8. SIGNAL ANALYSIS AT A FIXED FREQUENCY (IN AUTOMATED MODE)

To enable the Analysis, it is necessary to set the tabular cursor on the row of the corresponding signal and press the "ENTER". The font color in the row will change from white to green. The color of the signal level indicator changes from gray to green.

The screen view is shown in Fig. 47.

WIRED RECEIVER					
Total : 77 signals					
1	0.500	9 dB	12	30.100	15 dB
2	0.700	8 dB	13	35.250	17 dB
3	1.000	9 dB	14	35.600	21 dB
4	1.350	12 dB	15	39.000	20 dB
5	3.050	11 dB	16	41.550	16 dB
6	7.250	25 dB	17	41.650	23 dB
7	11.100	17 dB	18	42.150	21 dB
8	18.300	10 dB	19	42.350	19 dB
9	18.350	15 dB	20	50.500	14 dB
10	21.500	16 dB	21	56.500	15 dB
11	21.750	25 dB	22	61.150	8 dB

Fig.47

Available actions:

- sorting of the detected signals (on frequency or on level);
- quick setup for the detected signal by selecting it in the table;
- frequency control;
- signal analysis at a fixed frequency;
- possibility of using AM/FM demodulators;
- possibility of using an OSCILLOSCOPE;
- possibility of using an attenuator (20 dB);
- gain setting (x1, x2, x4).

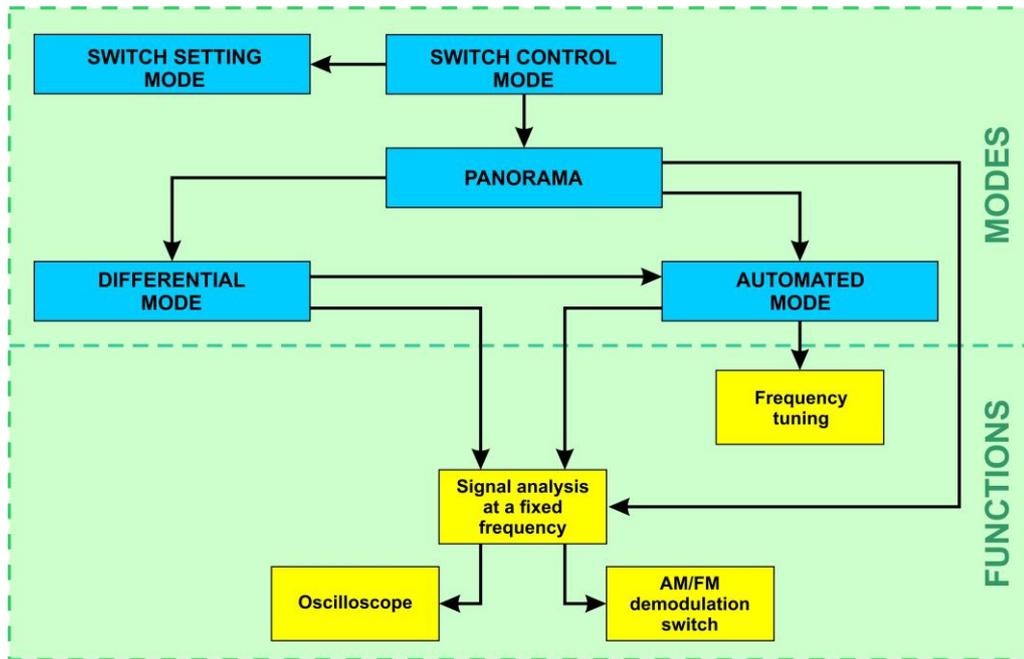
Controls:

Button	Action
	Tabular cursor move
	Frequency control
FUNC	Sorting of signals
F1	Are not used
F2	Switching AM/FM demodulators
F3	Turning on OSCILLOSCOPE
F4	Turning on/off an attenuator. GAIN SETTING (x1, x2, x4)
ENTER	Turning off SIGNAL ANALYSIS AT A FIXED FREQUENCY
ESC	Go to WR main menu
MODE	Go to the Analyzer main menu

The operation of the OSCILLOSCOPE is described in [item 5.2.6.](#)

5.2.9. LOW-CURRENT CABLES TESTING

WR FUNCTIONAL DIAGRAM (LOW-CURRENT CABLES TESTING)



After selecting the cable type ("Low voltage") and the frequency range, a table will be displayed on the screen (Fig. 48), in which all combinations of pairs of cable wires are displayed.

The maximum quantity of the tested wires is 9 (8 wires and the screen shield).

The screenshot shows the WR interface with a table of wire pairs and voltage levels. The table is divided into two columns. The left column lists pairs 1-2 through 3-4, and the right column lists pairs 3-5 through 7-8. The first row in the left column shows a pair of 1-2 with a Vdc of +10.0 and a Vac of 0. A red cursor is positioned over the first row of the left column. A red checkmark is visible in the right column next to the first row of the right column. The interface also shows a battery level indicator and a time display of 00:00.

PAIR	Vdc	Vac	PAIR	Vdc	Vac
1-2	+10.0	0	3-5		
1-3			3-6		
1-4			3-7		
1-5			3-8		
1-6			4-5		
1-7			4-6		
1-8			4-7		
2-3			4-8		
2-4			5-6		
2-5			5-7		
2-6			5-8		
2-7			6-7		
2-8			6-8		
3-4			7-8		

Fig.48

In Fig.48:

- 1 - WR is on
- 2 - the connected pair of wires
- 3 - turning on the PANORAMA mode for the analysis of signals in the connected pair
- 4 - the tabular cursor
- 5 - numbers of pairs of wires

- 6 - measured voltage values (DC)
- 7 - measured voltage values (AC)
- 8 - scroll bar (when all wires are tested relative to the cable shield)

Available actions:

- using the PANORAMA mode for the analysis of signals in the connected pair of wires;
- the Electronic Switch setup.

Controls:

Button	Action
	Tabular cursor move (choice of pair of wires)
F1, ENTER	Turning on PANORAMA mode
ESC, MODE	Go to the Analyzer main menu
FUNC	Turning on SWITCH SETTING mode
F2, F3, F4	Are not used

To select a pair of wires, you need to set the tabular cursor on the corresponding row in the table and press the "F1" or "ENTER". The screen displays the spectrogram in the selected pair of wires. The Electronic Switch is configured in accordance with [item 1.4](#).

5.2.10. LOW-CURRENT CABLE TESTING FEATURES

Testing of low-current cables is carried out by analogy to item 5.2.3–5.2.8. Additionally, it is possible to use the Electronic Switch. Spectrogram when testing a pair ("3-6") is shown in Fig. 49.

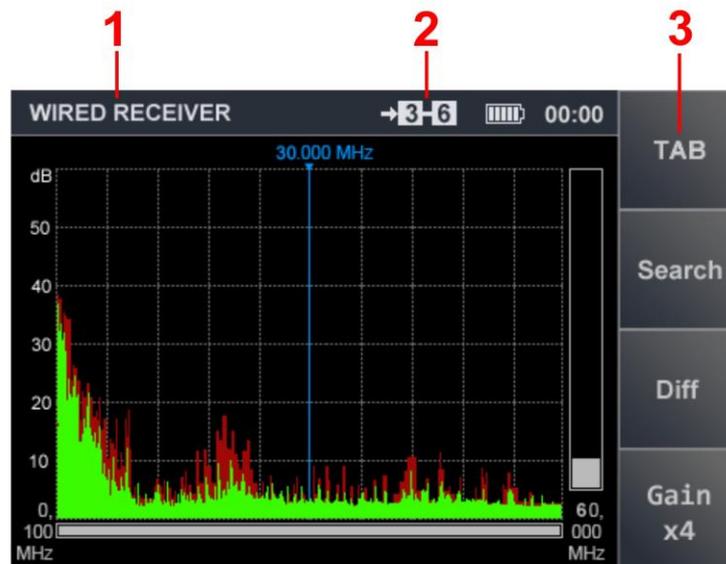


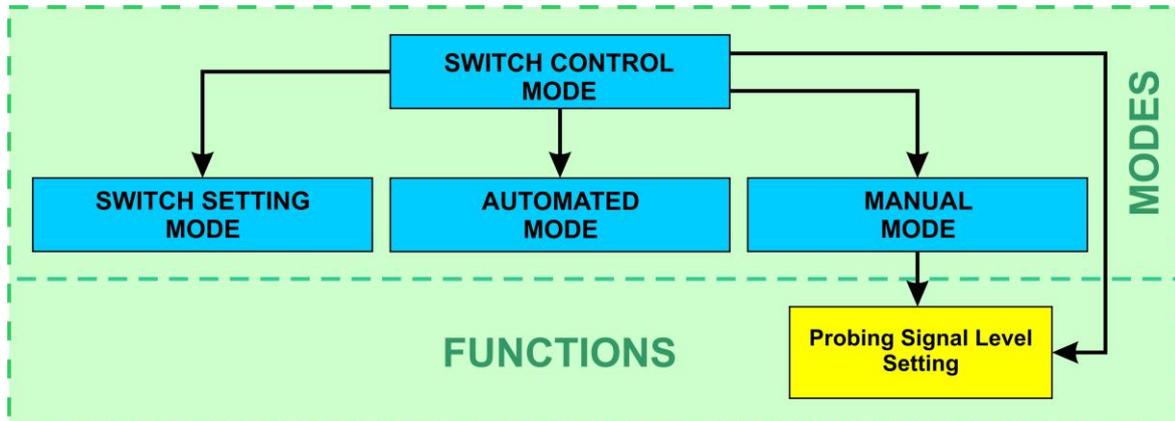
Fig.49

In Fig.49:

- 1 - WR is on
- 2 - the connected pair of wires
- 3 - exit to the main menu [item 5.2.9](#)

5.3. NON-LINEAR JUNCTION DETECTOR (NLJD)

NJLD FUNCTIONAL DIAGRAM



5.3.1. GENERAL INFORMATION

The NLJD is intended for detection of the eavesdropping devices (including turned off and/or faulty) connected to a cable.

The operation principle of the NLJD of the Analyzer is similar with an operation principle of a usual NLJD. The built-in transmitter emitted the probing signal to the tested cable, and the receiver fixes reflected signals at frequencies of second and third harmonics.

Existence of signals at these frequencies demonstrates presence in the cable of nonlinearity or metal-oxide-metal (MOM) structure. If the level of the second harmonic exceeds the level of the third harmonic, then with a high probability an electronic device is connected to the cable.

If the level of the third harmonic exceeds the level of the second harmonic, it is likely that a MOM structure is present in the cable.

In practice, cases when a signal is received only at the frequency of the second or only at the frequency of the third harmonic is quite rare.

Therefore, when signals are detected simultaneously at the frequencies of the second and third harmonics (regardless of the ratio of their level), it is necessary to test these cable.

For the NLJD to operate correctly, the tested cable must be disconnected from all electronic equipment.

Eavesdropping devices can be connected to the cable in parallel or in series (to break one wire). Each pair of wires must be tested by two methods:

- To search for parallel connections, the pair of tested wires must be broken at the far end (idle mode).
- To search for serial connections, the pair of tested wires must be closed at the far end (short circuit mode).

When testing the multi-wire cable equipped with RJ45 connectors in the short circuit mode it is necessary to use a special short-circuit socket ([Fig.1, item 15](#)).

If at pair of wires there is voltage more than ± 3 V, its test by means of a NLJD is impossible.

On the pair indicator (Fig. 50, item 2) the inscription "OVER" will appear. Such a cable must be de-energized.

Turning on the NLJD is made from the Analyzer main menu ([item 3.2](#)).

The NJLD main menu is shown in Fig.37.

5.3.2. NLJD MAIN MENU

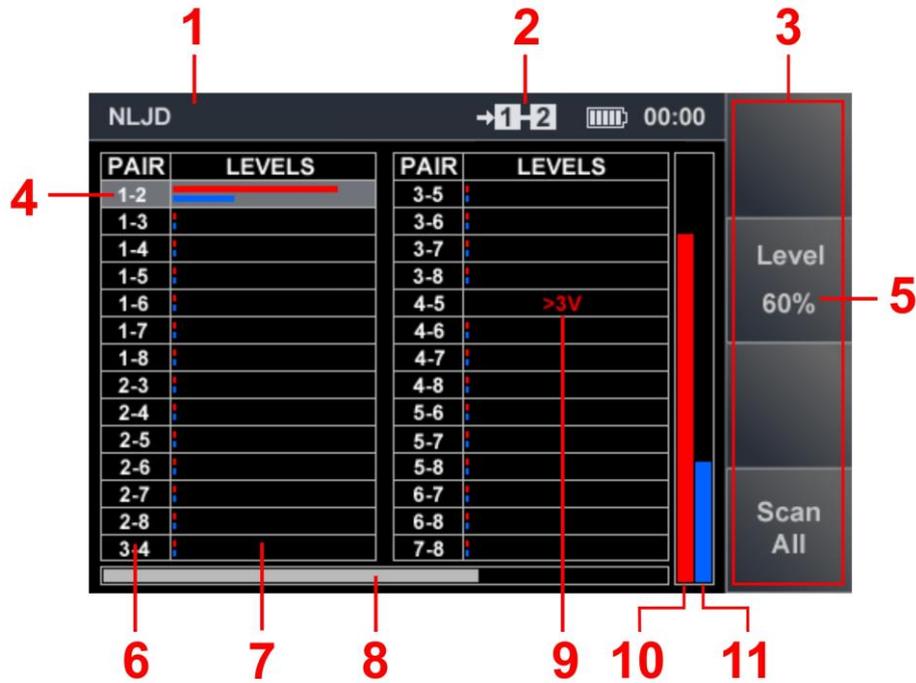


Fig.50

In Fig.50:

- 1 - NLJD is on
- 2 - the connected pair of wires
- 3 - responses levels in the connected pair of wires
- 4 - the tabular cursor
- 5 - the value of the probing signal level (% of maximum)
- 6 - pair of wires
- 7 - responses levels
- 8 - scroll bar (when all wires are tested relative to the cable shield)
- 9 - indication of voltage on pair (more than ± 3 V)
- 10 - graphical representation of the second harmonic response level (red color)
- 11 - graphical representation of the third harmonic response level (blue color)

Available actions:

- non-linearity assessment in all combinations of wires of a multi-wire cable;
- setting the probing signal level;
- the Switch setting.

Controls:

Button	Action
⏴ ⏵ ⏶ ⏷	Tabular cursor move
F2	Turning on/off PROBING SIGNAL LEVEL SETTING
F4	Scanning of all combinations of pairs of multi-wire cable
ESC, MODE	Go to the Analyzer main menu
FUNC	Turning on SWITCH SETTING mode
F1, F3, ENTER	Are not used

5.3.3. PROBING SIGNAL LEVEL SETTING

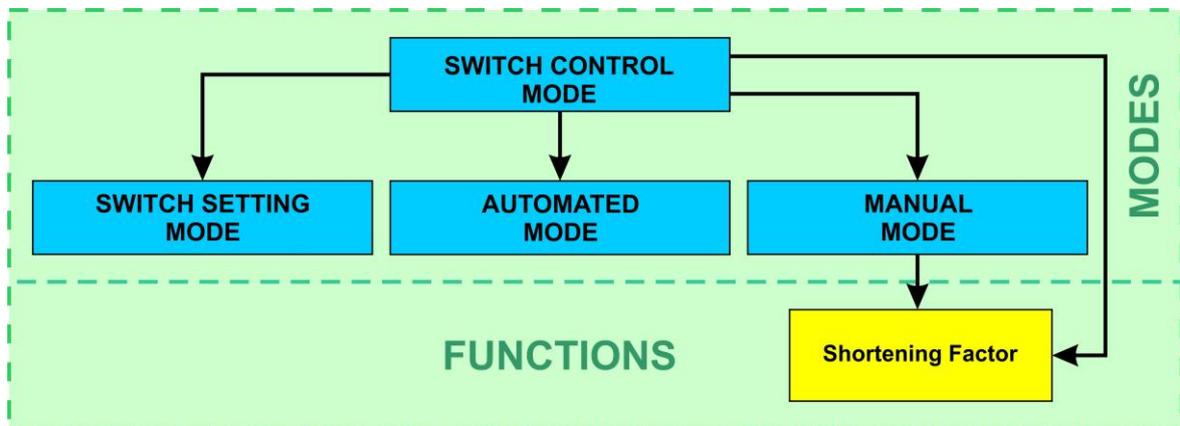
It is necessary:

- Press "F2". The indicator's field (Fig.50, item 5) will become lighter;
- By means of the  or  buttons to set value of gain in % (20, 40, 60, 80, 100) which is displayed on the indicator (Fig.50, item 5);
- Press "F2" (finish setting). The indicator's field (Fig.50, item 5) will become darker.

The value of the probing signal level does not change until the next setting or turn off the Analyzer.

5.4. REFLECTOMETER (REF)

REF FUNCTIONAL DIAGRAM



The REF is intended for testing cables in order to detect abnormal connections (heterogeneities).

A sinusoidal signal is emitted into the cable, which is reflected from the heterogeneity and returns with delay.

The phase of the reflected signal is different from the phase of the emitted signal. Similar procedures are performed for multiple frequencies.

As a result, a spectrum is formed with alternating maxima. Analysis of this spectrum allows us to determine the distance to the defect (heterogeneity) in the cable under test.

The REF determines the distance to the heterogeneity with an accuracy of ± 0.6 m., which depends on the correctly set Shortening Factor.

The procedure for setting the Shortening Factor is described in [item 5.4.2](#).

For the correct operation of the REF it is necessary:

1. Disconnect the cable from all electronic devices (only the cable is tested).
2. Have access to both ends of the cable.

Wires of cable should not be shorted at the far end. If the cable has branches, it must be segmented and each segment tested. REF can be used in AUTOMATED and MANUAL modes.

5.4.1. REF MAIN MENU

Turning on is made from the Analyzer main menu ([item 3.2](#)). Select the REF and press "ENTER". REF main menu shown at Fig.51:

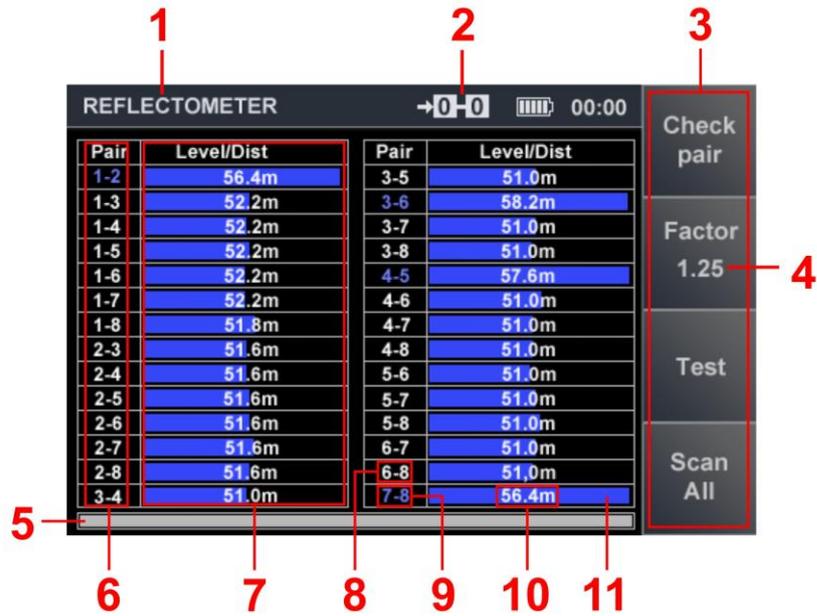


Fig.51

In Fig.51:

- 1 - REF is on
- 2 - the connected pair of wires
- 3 - "hot" buttons
- 4 - value of the Shortening Factor
- 5 - indicator showing continuation of the table if all wires and cable screen are tested ([item 4](#))
- 6 - numbers of pairs of wires
- 7 - results of measurements (distances and levels of a response)
- 8 - two wires from the different twisted pairs ("non-linked pairs"), marked by white color
- 9 - two wires from the same twisted pair ("linked pairs"), marked by blue color
- 10 - the measured distance to heterogeneity with the maximum level of a response
- 11 - response level from heterogeneity

Available actions:

- Shortening Factor setting;
- cable type setting;
- test of the connected pair of wires in the manual mode;
- test of all combinations of pairs of cable in the AUTOMATED mode.

Controls:

Button	Action
	Tabular cursor move
F1, ENTER	Turning on the MANUAL mode of test of single pair of wires
F2	Turning on/off Shortening Factor
F3	Turning on the single test on the connected pair of wires
F4	Turning on AUTOMATED mode
ESC, MODE	Exit to the Analyzer main menu
FUNC	Turning on SWITCH SETTING mode

5.4.2. SHORTENING FACTOR SETTING

For the correct operation of the REF, it is necessary to set a Shortening Factor (a characteristic showing how many times the phase or group wave velocity in the cable is less than the speed of light in vacuum).

The Shortening Factor depends on the type of wire, the size of its cross section and the electromagnetic parameters of the material from which the wire is made (capacity, inductance).

Sometimes technical documentation uses Velocity Factor (VF) also called Wave Propagation Speed or Velocity of Propagation (VoP) instead of a Shortening Factor. The values of these factors are indicated in reference books, cable specifications or on the Internet.

If only the Velocity Factor (Velocity of Propagation) is known, it is necessary to calculate the Shortening Factor according to the following algorithm:

1. The Velocity Factor value specified in % is transformed to decimal shares.
2. The inverse of the obtained value is calculated.

For example: Velocity Factor=60% (0.6). Shortening Factor = 1.67 (inverse value from 0.6).

The Shortening Factor equal 1.5 is by default set (corresponds to Shortening Factor of a two-wire SQR-2 cable). For setting of Shortening Factor it is necessary to press "F2". The dialog window (Fig.52) will appear.

The value of Shortening Factor is present in the "X.XX" format. Movement of a marker is made by means \leftarrow or \rightarrow buttons. Setting of value is made by means ∇ or \triangle buttons.

After setting of Shortening Factor for exit to the REF main menu it is necessary to press "F2", "ESC" or "ENTER".



Fig.52

The new Shortening Factor value will be display in the "F2" field (Fig.51, item 4). This value remains unchanged until the next setting or power off.

5.4.3. AUTOMATED MODE

AUTOMATED mode is used when testing a multi-wire cable. Measurements are made sequentially for each combination of wires.

To turn on the mode, in the REF main menu, press "F4" ("Scan All"). The tabular cursor is set to one of the rows of the table (Fig.51). Measurement begins. In the "Level/Dist" cell, "running points" appear.

After finishing the measurements, the response level (Fig.51, item 11) and the distance to the heterogeneity, the response from which has the highest level (Fig.51, item 10) are displayed in the cell.

After that, the tabular cursor moves to the next row and the measurements are repeated for another pair of wires. After the measurement on all combinations of wires, the scan ends.

The table will be filled with measurement results.

According to the results of the measurement cycle on all pairs, the maximum measured value of the response level is taken as 100%. The remaining values are scaled in percent relative to the maximum.

In case of need carrying out repeated measurement on specific pair need to be set the tabular cursor on the corresponding line and press "F3" ("Test").

If there is a voltage of more than ± 3 V on the connected pair of wires, this pair cannot be tested using the REF. This blocking voltage is indicated by the "OVER" icon on the indicator of the connected pair of wires (Fig.51, item 2).

To test such a cable, it is necessary to de-energize it.

It is possible that the external interference to the cable under test (including de-energized) will be very large. In this case, the work of the REF will be blocked and "Noise" will be displayed in the table.

To continue testing, it is necessary to find out the cause of the cues, try to eliminate them and then continue the measurement.

5.4.4. MANUAL MODE

When testing a cable in the AUTOMATED mode the operator obtains information sufficient for preliminary estimate of existence or lack of rough implementations in the tested cable and determination of "suspicious" pair of wires.

For obtaining more detailed information on all responses received when testing such pair of wires it is necessary to use the MANUAL mode.

For turning on the MANUAL mode from the REF main menu:

- set the tabular cursor on the row corresponding to "suspicious" pair of wires;
- press "F1" or "ENTER".

The MANUAL menu has two tables. The operator can make two cycles of measurements, and then compare their results. The gray color of the table fields is a sign that the table is active (available for measurements).

Use of two tables is advisable:

- when comparing results of testing of two pairs one multi-wire cables,
- when comparing results of testing of two different two-wires cables,
- when testing one pair from different ends of the cable.

MANUAL mode menu is shown in Fig.53.

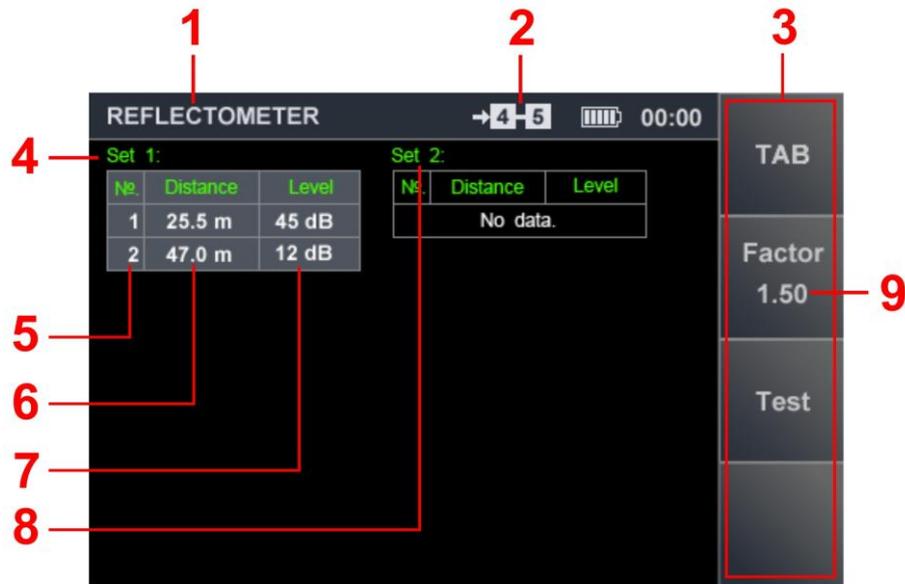


Fig.53

In Fig.53:

- 1 - REF is on
- 2 - the connected pair of wires
- 3 - "hot" buttons
- 4 - SET 1 table (in the drawing - the table is active)
- 5 - numbers of responses
- 6 - distances to heterogeneity
- 7 - response levels from heterogeneity
- 8 - SET 2 table (in the drawing - the table is passive)
- 9 - the set value of Shortening Factor

Available actions:

- assessment of the response level and the distance to the heterogeneity in the connected pair;
- comparison of results of two measurements;
- Shortening Factor setting.

Controls:

Button	Action
◀▶	Setting of the active table
F1, ESC	Turning off MANUAL mode (go to the REF main menu)
F2	Setting on/off Shortening Factor
F3	Turning on/off the single test (in the active table)
MODE	Go to the Analyzer main menu
FUNC	Turning on SWITCH SETTING mode
⏴ ⏵ F4, ENTER	Are not used

RECOMMENDATIONS FOR USE

6. TYPES OF THE WIRE EAVESDROPPING DEVICES

6.1. WIRE DYNAMIC AND ELECTRET MICROPHONES

Purpose: interception of the voice information in the room with the subsequent transfer via cables.

Dynamic (electrodynamic) microphones are the most common type of microphones. They do not require power to operate. The design of microphones lacks a preliminary power amplifier.

Information is transmitted via two wires (or one pair of multi-wire cable). The transmission range can be several hundred meters.

Electret microphones (one of the varieties of condenser microphones) are often used in eavesdropping equipment due to their low price and suitability for use in "cramped conditions".

The microphone design includes a preamplifier, for the operation of which a constant voltage of a certain polarity is required. This is achieved by applying "phantom" power to the microphone (simultaneous transmission of power and information signals over one wire). Some electret microphone models have an autonomous power supply.

Method of connection to the cable – parallel.

Power supply – 3 - 20 V

6.2. HIGH-FREQUENCY WIRE TRANSMITTERS

Purpose – interception and transfer of the voice information on power mains or low-current cables in the high-frequency range (0.1 - 30 MHz).

The transmission range of information on power mains, as a rule, does not exceed 500 meters within one or several buildings powered by one low-voltage bus of a transformer substation.

When using telephone cables or LAN cables (at frequencies of 5 - 30 MHz), the transmission range of information exceeds 500 meters.

Sometimes, high-frequency transmitters use coaxial cables of terrestrial or cable television as a channel for transmitting information (audio and video).

Method of connection to the cable – parallel.

Power supply – from the cable or an autonomous source.

6.3. TELEPHONE TRANSMITTERS

Purpose - interception of voice information transmitted over a telephone cable and its broadcast per a radio channel.

Telephone transmitters (low-power radio transmitters) modulate the reference frequency with electrical pulses that occur in the cable when talking on the phone. Most telephone transmitters turn on automatically when the handset picks up. Information (telephone calls) is broadcast outside the room via a radio channel.

Installation site – a telephone cable.

Method of connection to the cable - in parallel or to the break of the one of wires.

Power supply – from the cable or an autonomous source.

6.4. AUDIO RECORDER ADAPTERS

Purpose - interception of the voice information transferred on telephone cable with the subsequent record to the audio recorder.

Installation site – a telephone cable.

Method of connection to the cable – in parallel or to the break of the one of wires.

Power supply – from a telephone cable or an autonomous source.

OBJECTS TO TEST AND TYPES OF WIRE EAVESDROPPING DEVICES

Objects of test	Types of wire eavesdropping devices
Telephone cables of city automatic telephone exchange	<ul style="list-style-type: none"> • telephone transmitters • audio recorder adapters • high-frequency wire transmitters • wire dynamic and electret microphones
Telephone cables of PBX	<ul style="list-style-type: none"> • telephone transmitters • audio recorder adapters • high-frequency wire transmitters • wire dynamic and electret microphones
Power mains	<ul style="list-style-type: none"> • high-frequency wire transmitters
LAN cables	<ul style="list-style-type: none"> • high-frequency wire transmitters • wire dynamic microphones • wire electret microphones
Not operated (disconnected from terminal units) and/or illegally laid low-current cables	<ul style="list-style-type: none"> • high-frequency wire transmitters • wire dynamic and electret microphones
Cables of radio or cable television	<ul style="list-style-type: none"> • high-frequency wire transmitters of an audio information and video information

7. BASIC OPERATIONS

The basic operation is the actions of the Analyzer operator to implement certain search functions designed to detect different types of eavesdropping devices.

In each basic operation, one or more of the operating modes of ST 301, accessories from the kit, and other search devices are used. Based on these operations, methods for testing various cables are created.

BASIC OPERATIONS:

1. Detection of low-frequency signals in low-current cable.
2. Detection of high-frequency signals in power mains and low-current cable.
3. Detection of nonlinearity in the tested cable.
4. Detection of heterogeneity in the tested cable.
5. Localization of the detected eavesdropping devices.

7.1. BASIC OPERATION #1

DETECTION OF LOW-FREQUENCY SIGNALS IN LOW-CURRENT CABLES

The purpose of the basic operation is the detection of signals from dynamic and electret wire microphones.

Objects to test:

- telephone cables;
- LAN cables;
- other low-current cables including which are not operated, disconnected from terminal units and/or illegally laid.

The used device - LFA

For detection of low-frequency signals in low-current cables are used:

- The AUTOMATED mode is used when testing multi-wire cables.
- The MANUAL mode is used in the analysis of specific pair of multi-wire cable or when testing two-wire cables.

Additional equipment - PTS

7.1.1. IMPLEMENTATION OF BASIC OPERATION #1 ANALOG TELEPHONE LINE TESTING

Initial status

The tested telephone cable consists of 4 wires. The cable is equipped with a plug of RJ11 (6P4C). Terminal unit is analog telephone. For operation of the device two central contacts of the RJ11 connector are used. The operating voltage of the station is 12 V DC. The telephone line functions in the normal mode, the telephone set is connected to the line.

Operations procedure

1. Connect the Analyzer to a telephone cable [according to scheme in Fig.6 3B option.](#)
2. Turn on PTS in the room.
3. Turn on LFA.
4. Set type of the tested cable ("non twisted", ## 3,4,5,6 wires)
5. Connect headphones to the main unit. Set the volume level.
6. Set the maximum gain (60 dB).
7. Turn on the AUTOMATED mode (press "F4").

The Analyzer will start searching all possible combinations of wires, stopping at each combination for a few seconds. In this case, the operator has the opportunity to analyze the received signal according to the information in the headphones. The tabular cursor indicates the current wire combination to be tested. At the end of the cycle, scanning will stop.

Possible options of results of test and their interpretation

Option #1

Pair 3-6	Voltage is absent The PTS signal is not heard	The dynamic microphone is not detected. It is possible that an electret microphone is installed on the cable that is not powered at the time of testing. Testing is required with bias voltage applied in accordance with 7.1.1.1.
Pair 4-5	Voltage - 12V DC The PTS signal is not heard	

Option #2

Pair 3-6	Voltage is absent The PTS signal is heard	A dynamic microphone or electret microphone is installed on the cable. The electret microphone can be powered from its own source (possibly from a telephone line). It is necessary to localize the microphone using the PTS.
Pair 4-5	Voltage - 12V DC The PTS signal is not heard	

Option #3

Pair 3-6	Voltage is DC 3-20 V The PTS signal is heard	On the cable the electret microphone with a "phantom" power supply on wires ##3 and 6 is installed. It is necessary to localize the microphone using of PTS.
Pair 4-5	Voltage is DC 12 V The PTS signal is not heard	

The algorithm of localization of microphones is described in [item 7.5 \(Basic operation #5\)](#)

7.1.1.1. ACTIVATION OF ELECTRET MICROPHONES

If earlier, during testing, a dynamic microphone was not detected (option No. 1 of the previous paragraph), it is possible that an electret microphone was installed on the cable that was not powered at the time of testing. Test with giving of bias voltage is required.

Initial status

The scheme of connection of the device - without change.

Type of the connected cable and number of contacts - without changes.

Operations procedure

1. Set gain of 0 dB in the LFA main menu.
2. Set bias voltage of +12 V.
3. Set the tabular cursor to the row corresponding pair 3-6.

Possible results

1. If PTS signal is heard in the headphones, an electret microphone is detected. It must be localized using PTS.
2. If the PTS signal is not heard when the bias voltage is applied to the cable, the polarity of the applied voltage should be changed.
3. If the PTS signal is heard after changing the polarity of the voltage, an electret microphone has been detected. It must be localized using PTS.
4. If the PTS signal is not heard when applying bias voltage (with positive and negative polarity), there is no working electret microphone on the cable. There may be a faulty electret microphone (or a powered-off electret microphone with autonomous power supply) on the cable. These microphones are detected using NLJD and REF.

Recommendations

- If during testing the PTS signal is heard, it is possible that the microphone is installed directly in the telephone. In order to verify this, disconnect the device from the cable. If the TCP signal in the headphones is gone, then the eavesdropping device is installed in the telephone.
- If a non-PTS signal is heard, it is recommended to analyze it in the OSCILLOSCOPE or SPECTRUM ANALYZER mode.

7.2. BASIC OPERATION #2

DETECTION OF HF SIGNALS IN POWER MAINS AND LOW-CURRENT CABLES

The purpose of the basic operation is the detection of signals of the high-frequency transmitters using power and low-current cables for information transfer.

Objects to test:

- power mains;
- telephone cables;
- LAN cables;
- coaxial TV cables;
- other low-current cables including which are not operated, disconnected from terminal units and/or illegally laid.

The used device - WR

Additional equipment:

- adapter for testing of the power mains (when testing power mains) ([Fig.1, item 7](#));
- player of the test sound (PTS).

Detection of HF signals in power mains and low-current cables is implemented in two modes:

In the MANUAL mode information on loading of range is presented in the spectrogram form. For setup of the receiver for the detected signal it is necessary to set on it a marker by means of the  or  buttons. Information can be also presented in the form of a differential spectrogram in DIFFERENTIAL mode.

In the AUTOMATED mode information on loading of range is presented in the form of the table in which parameters of the detected signals are entered. For setting of the receiver for frequency of the detected signal the operator should install the tabular cursor on the corresponding row of the table. At a large number of the detected signals the AUTOMATED mode is much more convenient manual.

For the analysis of the detected signal in MANUAL and AUTOMATED the mode the SIGNAL ANALYSIS AT A FIXED FREQUENCY and OSCILLOSCOPE are used.

The greatest efficiency of search of HF of transmitters is reached at the combined use of the MANUAL and AUTOMATED operation modes of the WR.

7.2.1. IMPLEMENTATION OF BASIC OPERATION #2 POWER MAINS (229 V / 50 Hz) TESTING

Initial status

The power mains under test is powered and it is possible to de-energize it. In the room, devices consuming electricity (office equipment, lamps, etc.) are connects to the power mains according to the standard scheme. The power mains supplies only this room.

It is assumed that in the room on the power mains or in devices connected to it, high-frequency transmitters can be installed that transmit information outside the premises through the same power mains.

Test algorithm

1. De-energize the power mains (turn off the power switch in the switchboard).
2. Make sure there is no voltage in the power mains.
3. Disconnect all equipment from the power mains (unplug the power plugs from sockets).
4. Connect the adapter ([Fig.1, item 7](#)) to the main unit and to the socket of the tested cable.
5. Turn on Analyzer. Turn on WR.
6. Set cable type - POWER MAINS (item "Mains" in menu).
7. Set the frequency range. De-energized cable spectrogram will be displayed on the screen.
8. Set optimum level of the detected signals ("F4").

When testing the power mains, the Switch automatically connects the "1-2" pair of wires, which corresponds to the configuration of the contacts in the adapter plug. Switch control at the same time is blocked. In information line, the icon  (test of the power mains) is displayed.

A spectrogram of the de-energized cable is displayed on the screen. When the power is off, eavesdroppers that are powered by the mains will not work. All detected signals can be considered "safe" (interference, signals from broadcasting radio stations, etc.). To exclude such signals during further testing, it is necessary to use the DIFFERENTIAL mode.

9. Turn on the DIFFERENTIAL mode ("F3").

A difference spectrogram is displayed on the screen. The levels of all previously received signals will be taken as "0". Only newly appearing signals will be displayed on the screen.

10. Turn on the power switch in the switchboard.

If a high-frequency transmitter is installed on the power mains, then it will turn on when power is applied. The signals of the eavesdropping device will be detected.

When new signals appear in the difference spectrogram, it is necessary to turn on the AUTOMATED mode ("F2" - "Search").

A table of detected signals will be generated on the screen. The cursor will be set to the first line (signal with the lowest frequency).

11. Turn on PTS and set the volume.

12. Connect headphones ("PHONE") and set the volume.

13. Analyze the demodulated signal by turning on the demodulators "AM" and "FM" ("F2").

14. If necessary, adjust the frequency of the signal, activate the "SIGNAL ANALYSIS AT FIXED FREQUENCY" function ("ENTER"). Use the ◀ or ▶ buttons to set the frequency at which the signal legibility will be maximum. To deactivate the "SIGNAL ANALYSIS AT FIXED FREQUENCY" function, press "ENTER" again.

15. Analyze the demodulated signal on an OSCILLOSCOPE ("F3"). Return to the table of the AUTOMATED mode ("F3").

16. Set the tabular cursor to the next line.

17. Repeat signal analysis, changing types of modulation of AM/FM ("F2").

18. Similarly test all detected signals.

The absence of new signals in the difference spectrogram when the power supply is turned on (when turning on the power switch in the switchboard) means that there are no active eavesdropping devices on the power mains.

Please note that defective and / or disconnected eavesdropping devices with a remote control that are in standby mode can be connected to the cable. Search for such devices using NLJD.

Options for possible changes in the difference spectrogram when the power switch is turned on and the reasons for their occurrence:

*2. New signals detected. During their analysis, it was possible to hear the control sound.
The reason: an analog HF transmitter installed in the room transmits information via cable*

*2. New signals detected. During their analysis, it was not possible to hear the control sound.
The reason: a digital (or coded) HF transmitter is operating in the line. Additional analysis of such signals and search for their source is required.*

*3. Increase of the background level in the frequency range of 10-100 MHz.
The reason: the PLC modem is operating in the line.*

After analyzing all the detected signals, it is necessary to check the changes in the difference spectrogram when connecting electricity consumers.

To do this, first you need to get the difference spectrogram of the energized powered mains, and then connect all the devices in turn.

Thus, it is possible to determine which of the consumers is the source of the "dangerous" signal.

19. Exit AUTOMATED mode ("ESC"). The difference spectrogram of the energized power mains to which the equipment is not connected will be displayed on the screen.

20. Exit the DIFFERENTIAL mode ("F3"). The current spectrogram of the energized mains to which the equipment is not connected will be displayed on the screen.

21. Turn on the DIFFERENTIAL mode again ("F3") The difference spectrogram of the energized mains is displayed on the screen. The levels of all previously detected signals will be taken as "0".

22. Connect one of the devices consuming electricity to the power mains under test. The difference spectrogram (taking into account the connection of this device) will be displayed on the screen. If new signals are detected in the PANORAMA mode, turn on the AUTOMATED mode ("F2") and analyze each of them in the table of detected signals (as described earlier).

After all signals have been analyzed, exit AUTOMATED mode ("ESC") and turn off DIFFERENTIAL mode ("F3"). Turn on the DIFFERENTIAL mode ("F3") again and get a new difference spectrogram.

After that, connect the next device and analyze new signals according to the described algorithm.

Testing is completed, after testing the power mains with all connected devices consuming electricity.

Devices whose connection led to the appearance of "dangerous" signals on the differential spectrogram must be disassembled and checked for the presence of extraneous components in them.

7.2.2. IMPLEMENTATION OF BASIC OPERATION #2 ANALOG TELEPHONE LINE TESTING

Unlike power mains (two-wire cables), low-current cables, as a rule, are multi-wire cables. For test such cables, the operator sequentially connects all possible combinations of wires to the Analyzer.

Initial status

The cable under test connected to PBX. The telephone set connected to the line via the socket. The handset is "hung up". The telephone line powered from PBX and operates normally.

The high-frequency transmitter can be connected to the telephone line laid indoors or is installed in the telephone set.

Algorithm of test of an analog telephone line

1. Connect ST 301 to the tested cable. [Option 3B \(Fig.6\)](#), [option 3D, 3E \(Fig.7\)](#).
2. Turn on PTS and set the volume of a control sound.
3. Connect headphones to the main unit ("PHONE").
4. Turn on the Analyzer and turn on WR.

5. Select the cable type - "LOW-CURRENT LINE" ("Low Voltage" item in menu)
6. Select the frequency range (100 kHz - 60 MHz or 100 kHz - 180 MHz).
7. The Switch table will be displayed on the screen, in which all combinations of wire pairs are displayed (Fig.48).
8. Press "FUNC" and set cable type ("non twisted" type, wires #3,4,5,6).

When connecting a four-wire telephone cable, contacts ##3, 4, 5, 6 of the Switch slot are used. Based on this, it is necessary to test the combinations of wires:

*3-4; 3-5; 3-6;
4-5; 4-6;
5-6.*

It is necessary to consider that the transmitter can be powered normally (from the activated "4-5" pair), and transmit information over another pair.

9. In the Switch table, set the cursor on the row corresponding to the pair "3-4". The cell displays the voltage value in the connected pair (during normal operation of the telephone line there is no voltage on this pair).
10. Press "ENTER". The spectrogram of the "3-4" pair will be displayed on the screen.
11. Set optimum gain ("F4").
12. Turn on the AUTOMATED mode ("F2").
13. Listen to all detected signals consistently switching AM and FM demodulators ("F2").
14. Exit the AUTOMATED mode ("ESC") to the PANORAMA mode.
15. Press "F1" for switching to the Switch table (SWITCH CONTROL mode).
16. Set the tabular cursor on the next pair of wires, press "ENTER".
17. Test the remaining combinations of wires in accordance with item #11-14.

Listening of PTS sound means existence in the room of the active analog wire high-frequency transmitter.

In this case (remaining on that combination on which "the dangerous signal" was detected) it is necessary to disconnect the telephone set from the cable under test.

If at the same time the "dangerous" signal is gone, so the source of this signal is installed in the telephone set.

If at shutdown of the telephone set the signal is not gone, so its source is connected to the cable (indoors since there is a correlation with a control sound).

Also it is necessary to pay attention to digital signals which are not correlated with a control sound.

Perhaps these signals are transmitted by an encoded (digital) transmitter. It is recommended to analyze such signals in the OSCILLOSCOPE.

The algorithm of localization of microphones is described in [item 7.5 \(Basic operation #5\)](#)

7.2.3. FEATURES OF TESTING OF THE HF TELEVISION CABLES

On the television cables high frequency transmitters of audio signals and/or digital or analog transmitters of video signals can be installed.

In this case, the cables are used as a channel for transmitting audio and video information.

The technical capabilities of ST 301 do not allow demodulating the video signal.

The main features of the camcorder's transmission channel can be detected:

- signals in the frequency range of the "reverse channel" (5 - 40 MHz);
- the frequency of the detected signal does not match any of the broadcast television channels;
- signal change (on an oscilloscope) with a sharp change in the illumination in the room.

7.3. BASIC OPERATION #3 DETECTION OF NONLINEARITY IN THE CABLE

Purpose of basic operation - detection of the devices, which are connected to the cable.

Objects to test:

- telephone cables;
- LAN cables;
- coaxial TV cables;
- other low-current cables.

The used device - NLJD

Additional equipment - RJ45 short-circuit socket ([Fig.1, item 15](#)).

7.3.1. IMPLEMENTATION OF BASIC OPERATION #3 ANALOG TELEPHONE LINE TESTING

Most eavesdropping devices are connecting to the telephone cable line in parallel (telephone transmitters, voice recorders, high frequency wire transmitters, cable microphones). Sometimes, telephone transmitters are connecting to a "break" in one of the wires of the telephone cable.

Based on this, testing must be carried out in two modes:

- the other end of the cable is open (for detecting parallel connections);
- the other end of the cable is short-circuited (for detecting serial connections).

For short circuit of the cable equipped with RJ plug special RJ45 socket is used ([Fig.1, item 15](#)).

Initial status

The object of testing is a four-wire PBX analog telephone cable. The cable has two central wires. Telephone set is connected to the cable through a telephone jack. The handset is off-hook. The cable is powered by the PBX and operates normally. The cable is equipped with a 6P4C plug (all four wires are connected).

Analog type telephone line testing algorithm:

1. Disconnect the telephone cable from the PBX (the cable is not short-circuited)
2. Disconnect the telephone set from the cable.
3. Connect ST 301 to the cable (options [3A in Fig.6](#) or [3C in Fig.7](#)).
4. Turn on ST 301, NLJD.

5. Press "FUNC", set cable type. In this case - an unshielded, "non twisted" type cable. Contacts ##3, 4, 5, 6 are involved (the 4-wire cable with connector 6P4C, [Fig.33](#)).
6. Press again "FUNC" and enter to NLJD main menu. The screen shown in Fig.54.

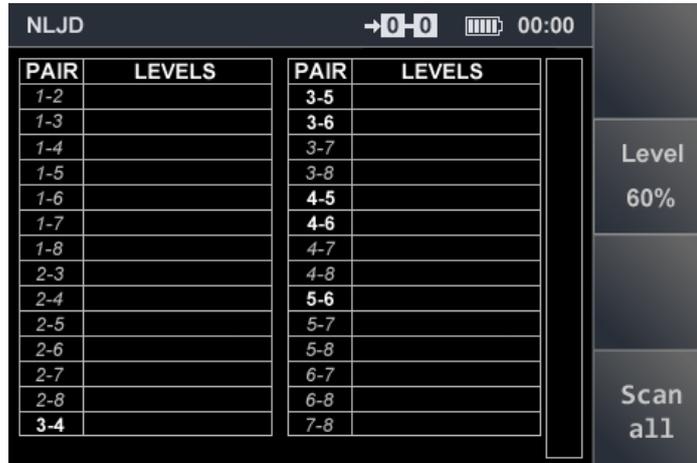


Fig.54

The pairs of wires to be tested are highlighted in white. Gray (in italics) are pairs of unconnected wires that will not be tested.

7. Set the probing signal level. For the short cables testing, it is recommended to set the level of 20-40%.
8. Press "F4". The Analyzer will alternately connect and test all pairs of telephone cable wires. Upon completion of testing, the levels of the received signals at the second (red color) and third (blue color) harmonics will be display in the corresponding columns of the table. If there are no connected electronic devices on the cable, the measurement results will be display on the screen shown in Fig. 55. The levels of reflected signals are negligible and the same.

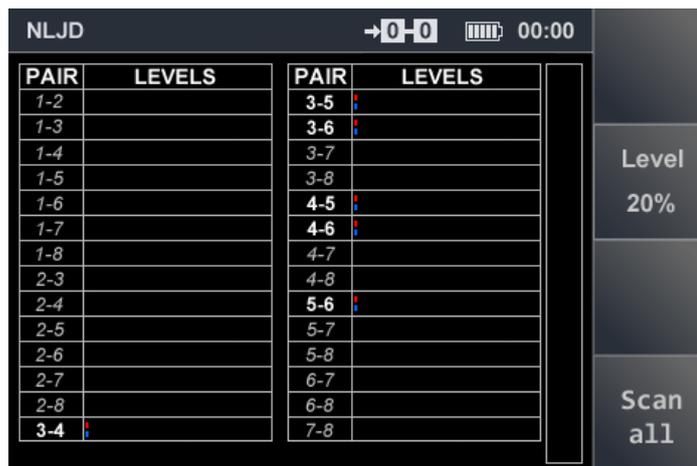


Fig.55

9. Test with short-circuited far end of cable. To do this, use a cable special RJ45 socket ([item 17, Fig.1](#)). After the far end is shorted, press "F4" (start the test cycle).
If electronic devices are not connected to the cable, the results of measurements displayed on the Analyzer screen will correspond to Fig.56.

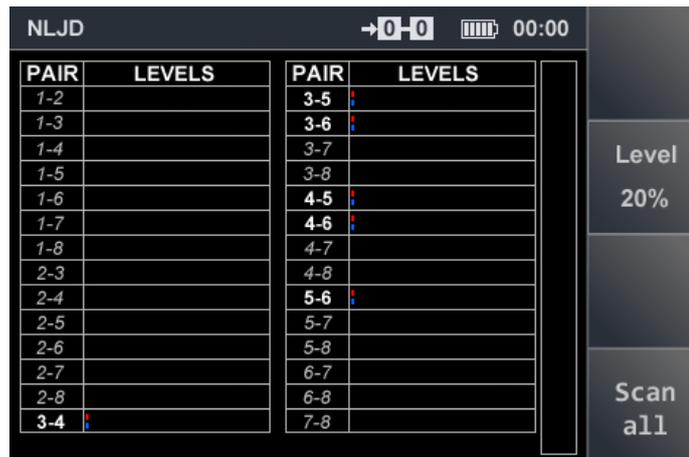


Fig.56

Existence of indication on a "blue" scale means that in the tested pair it is detected by MOM-structure.

Sometimes the response at the frequency of the third harmonic can be given by eavesdropping devices. In any case, if there are signals displayed on the "red" and "blue" scales (regardless of the ratio of their levels), further testing of the pair of wires on which the nonlinearity was detected is necessary.

Test results for various types of connections of eavesdropping devices to the tested cable

In Fig.57 the result of testing of a telephone cable is presented, at **parallel connection to wires #4 and #5** (the central pair of a cable).

The telephone radio transmitter, the high-frequency wire transmitter, the dictation adapter can be such devices. Level of the second harmonic exceeds the level of the third that speaks about connection of the electronic device.

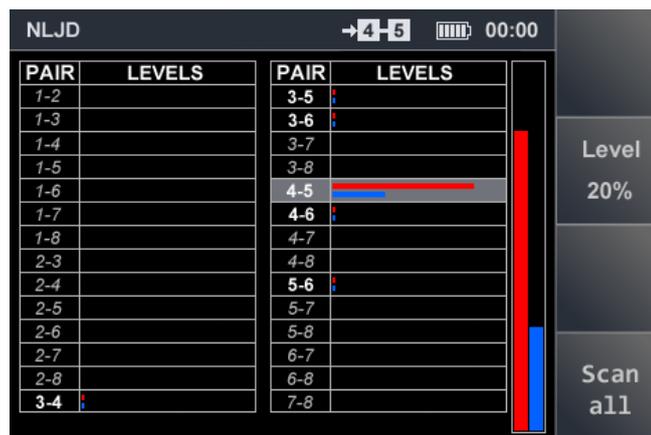


Fig.57

In Fig.58 the result of testing of a telephone line is presented, **at parallel connection of the electronic device to wires #3 and #6** (the electret cable microphone using non-used two wires or the high-frequency wire transmitter for information transfer). Level of the second harmonic exceeds the level of the third (the electronic device connected to the cable).

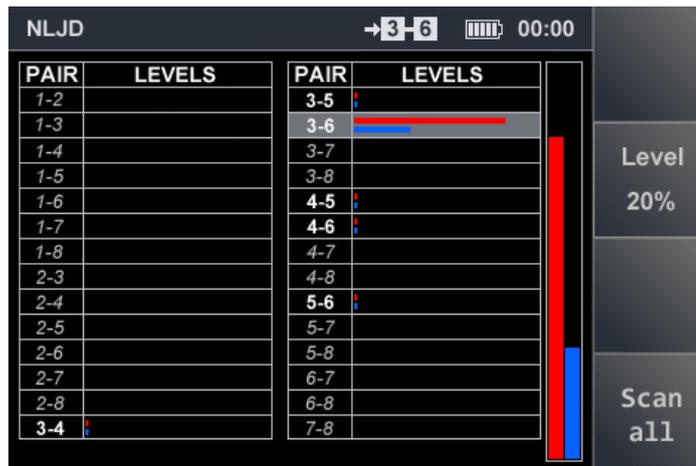


Fig.58

In Fig.59 the result of testing of a telephone line at **consecutive connection to one wire of the central pair** is presented. Responses are detected on all pairs with wire #4. Level of the second harmonic exceeds the level of the third that speaks about connection of electronic device. Consistently connected telephone radio transmitter can be such device.

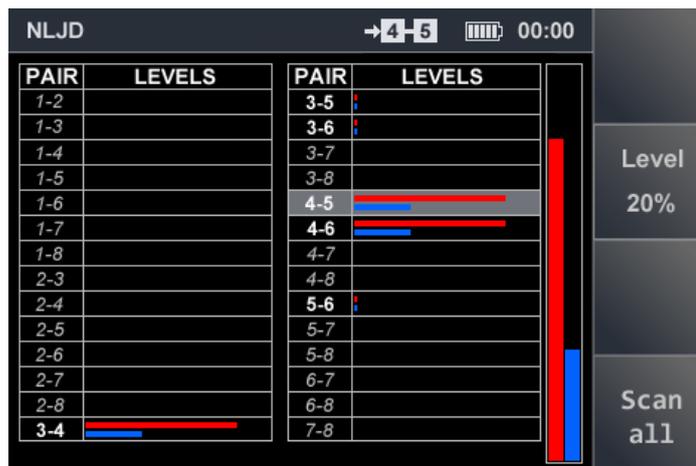


Fig.59

7.4. BASIC OPERATION #4 DETECTION OF HETEROGENEITY IN THE CABLE

Purpose of basic operation - detection of the devices which are connected to cables which are identified by the REF as heterogeneity.

Objects to test:

- telephone cables;
- LAN cables;
- coaxial TV cables;
- other low-current cables.

The used device - REF

7.4.1. THEORETICAL ASPECTS OF THE REFLECTOMETRY

Main physical characteristics of the cable

One of the characteristics of the cable is wave impedance (Z_b), the resistance that an electromagnetic wave encounters when propagating along any homogeneous (that is, without reflection) guide system, including cable.

If the cable has no defects, its wave impedance does not change throughout. The only source of reflected signal may be the end of the cable.

When testing all combinations of pairs of wires of such a cable, responses should be obtained at the same distance corresponding to the length of the cable.

If there is a heterogeneity (break, short circuit or the devices connected to a cable) the probing signal is reflected from it completely, or partially.

The wave impedance of the cable at high frequencies, which are usually used in pulse reflectometers, is calculated by the formula:

$$Z_b = \sqrt{\frac{L}{C}}$$

Z_b - wave impedance

L - inductance

C - capacity

An increase in inductance leads to an increase in wave impedance, and an increase in capacitance leads to its decrease.

The capacity of a two-wire line depends, inter alia, on the distance between the wires, which, in this case, can be considered as plates of a capacitor.

The mutual arrangement of wires in a multi-wire cable will determine the wave impedance of various combinations of wires. Increasing the distance between the two wires leads to a decrease in capacitance and an increase in the value of wave impedance.

The wave impedance, which determines the attenuation of the signal, in different combinations of wires of the same cable may be different.

Given that the level of the probing signal is the same for all tested wire combinations, it can be assumed that the response levels in different combinations of such cables will not be the same.

In this case, certain patterns will appear that allow the correct interpretation of the test results.

Relative positioning of wires in multi-wire low-current cables

The most common types of cables:

- multi-wire round cable;
- multi-wire flat cable;
- multi-wire cable, consisting of several twisted pair.

Each type of a cable has features of a relative positioning of wires.

In multi-wire round cable, the wires are approximately the same distance from each other. The lengths of all wires are the same and match the length of the cable. The electrical parameters (resistance, inductance, capacity) of all combinations of wires will be approximately the same.

The wave impedance of all combinations of wires should also be the same. The wave impedance of most round cables is 300 - 700 Ohm. These cables are often used to transmit low-frequency signals (telephone lines, burglar and fire alarms, etc.).

In multi-wire flat cable, the wires of the same length (matching the cable length) are arranged in a row. Capacitive coupling pairs formed by adjacent wires will be greater than other pairs of wires. The smallest capacitive coupling will be at the wires located at the edges.

This arrangement determines the different wave impedance in different combinations of wires.

Multi-wire cable, consisting of several twisted pair.

Each pair of wires is twisted with a different pitch. This avoids spurious emissions, compensates for interference, and reduces signal transmission loss. Due to the different pitch of the twist, the lengths of wires of different pairs are different. These lengths are always greater than the cable length.

The wave impedance of twisted pairs is ≈ 100 Ohm. The wave impedance of the combinations formed by wires from different twisted pairs will be significantly more than 100 Ohm. The "twisted pair" type cables are designed to transmit RF signals over a large (up to 100 meters) distance.

Since the REF output has a wave impedance of ≈ 50 Ohm, an input cable inconsistency leads to losses of the probing and reflected signal. The most consistent with the REF output are twisted pairs.

Influence of Shortening Factor on measurement of distance to heterogeneity.

An important characteristic of the cable is the Shortening Factor, the value of which is determined for each type. Factor shows how much the propagation speed of the electromagnetic signal in this type of cable is less than in vacuum.

The Shortening Factor affects the correctness of determining the distance to heterogeneity. The Shortening Factor is specified in the cable specification or on manufacturers' websites.

For round and flat multi-wire cables, (regardless of the set Shortening Factor), the measured lengths of pairs without defects will be the same. If an incorrect value of the Shortening Factor is set, the measured length will differ from the real one.

Shortening Factor of the cable consisting of twisted pairs.

The speed of the electromagnetic signal in the cable, consisting of "non-twisted" pairs, will be the same. The speed of the electromagnetic signal in different pairs of cable, consisting of "twisted" pairs, will be different.

In "linked" pairs, the signal propagation speed will be less than in "non-linked" pairs. Thus, with the same Shortening Factor set, different distances to heterogeneity (or the end of the cable) will be measured:

- distances to heterogeneities in "non-linked" pairs are the same;
- distances to heterogeneities in "linked" pairs are different.

Results of testing

The results of testing a multi-wire cable are presented in tabular form. Knowing the features of cable structures without defects it is possible to detect and identify the anomalies existing in them.

REFERENCE STRUCTURES OF DIFFERENT TYPES OF CABLES

4-wire round cable

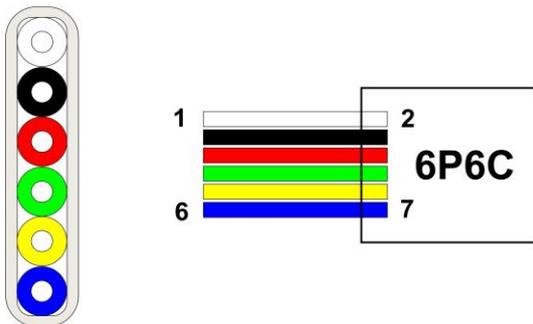


Pair	Level/Dist	Pair	Level/Dist
1-2		3-5	31.6m
1-3		3-6	31.6m
1-4		3-7	
1-5		3-8	
1-6		4-5	31.6m
1-7		4-6	31.6m
1-8		4-7	
2-3		4-8	
2-4		5-6	31.6m
2-5		5-7	
2-6		5-8	
2-7		6-7	
2-8		6-8	
3-4	31.6m	7-8	

Features of structure

1. Distances to heterogeneities with maximum response levels are the same. In a cable that has no defects, when the correct value of the Shortening Factor is set, they correspond to the length of the cable.
2. Response levels are the same across all tested wire combinations.

6-wire flat cable

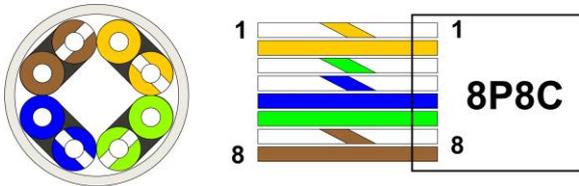


Pair	Level/Dist	Pair	Level/Dist
1-2		3-5	36.0m
1-3		3-6	36.0m
1-4		3-7	36.0m
1-5		3-8	
1-6		4-5	36.0m
1-7		4-6	36.0m
1-8		4-7	36.0m
2-3	36.0m	4-8	
2-4	36.0m	5-6	36.0m
2-5	36.0m	5-7	36.0m
2-6	36.0m	5-8	
2-7	36.0m	6-7	36.0m
2-8		6-8	
3-4	36.0m	7-8	

Features of structure

1. Distances to heterogeneities with high response levels are the same. In the cable without defects, when the correct value of the Shortening Factor is set, they correspond to the length of the cable.
2. Response levels are different. Maximum levels - on the pairs of wires located nearby: 2-3; 3-4; 4-5; 5-6 (capacitive coupling in these pairs is maximum). Levels decrease in combinations as the distance between the wires increases (capacitive coupling in these pairs weakens). The minimum level is on the pair of wires 2-7.

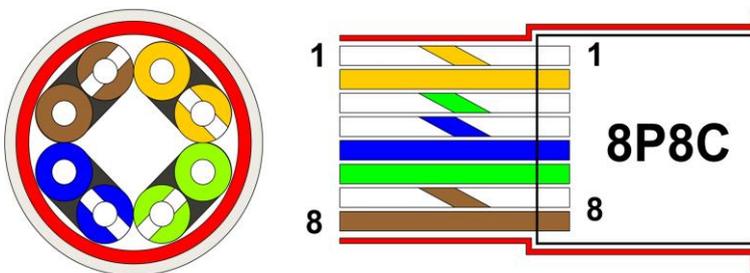
The cable consisting of four twisted pair



Pair	Level/Dist	Pair	Level/Dist
1-2	56.4m	3-5	51.0m
1-3	52.2m	3-6	58.2m
1-4	52.2m	3-7	51.0m
1-5	52.2m	3-8	51.0m
1-6	52.2m	4-5	57.6m
1-7	52.2m	4-6	51.0m
1-8	51.8m	4-7	51.0m
2-3	51.6m	4-8	51.0m
2-4	51.6m	5-6	51.0m
2-5	51.6m	5-7	51.0m
2-6	51.6m	5-8	51.0m
2-7	51.6m	6-7	51.0m
2-8	51.6m	6-8	51.0m
3-4	51.0m	7-8	56.4m

Features of structure

1. Distances to heterogeneities with maximum response levels are different. This is due, firstly, to the different speed of signal propagation in "linked" and "non-linked" pairs, and secondly, with different lengths of wires (different twist pitch). In "linked" pairs, the propagation speed is lower (there is a longer delay in the arrival of the response), therefore, the measured distance is greater. The difference in the measured distances of the "linked" pairs is determined by the different twist pitch. In the "non-linked" pairs, the propagation speed is higher. The measured distance is less.
2. The response levels for "linked" and "non-linked" pairs are different. The maximum levels are fixed on the connected pairs of wires 1-2; 3-6; 4-5; 7-8 (capacitive coupling in these pairs is maximum). In "non-linked" pairs, capacitive coupling is weaker, which leads to lower response levels (usually half the levels in "linked" pairs). Moreover, the response levels in "non-linked" pairs are approximately equal to each other.
3. If pairs formed by the shield and one of the wires were involved in testing, in the absence of defects the response levels in these pairs should be equal to each other. The distances to heterogeneity (or to the end of the cable) exceed the distances measured on the "linked" pairs and are also equal to each other.



Pair	Level/Dist
1-SH	58.6m
2-SH	58.6m
3-SH	58.0m
4-SH	58.6m
5-SH	58.6m
6-SH	58.0m
7-SH	58.0m
8-SH	58.0m

CHANGE OF STRUCTURES AS A RESULT OF EMERGENCE OF DIFFERENT DEFECTS

Break of one of wires of the "twisted pair" type cable

Pair	Level/Dist	Pair	Level/Dist
1-2	76.8m	3-5	72.6m
1-3	72.0m	3-6	77.4m
1-4	72.6m	3-7	72.6m
1-5	72.6m	3-8	72.6m
1-6	72.6m	4-5	79.2m
1-7	72.6m	4-6	72.6m
1-8	72.6m	4-7	72.6m
2-3	73.2m	4-8	72.6m
2-4	73.2m	5-6	72.6m
2-5	73.2m	5-7	72.6m
2-6	73.2m	5-8	72.6m
2-7	72.8m	6-7	72.6m
2-8	72.0m	6-8	72.6m
3-4	72.6m	7-8	76.8m

Cable without defects

Pair	Level/Dist	Pair	Level/Dist
1-2	21.6m	3-5	72.6m
1-3	21.0m	3-6	77.4m
1-4	21.0m	3-7	73.2m
1-5	20.4m	3-8	73.2m
1-6	21.0m	4-5	79.2m
1-7	19.8m	4-6	72.6m
1-8	20.4m	4-7	72.6m
2-3	73.8m	4-8	72.6m
2-4	73.8m	5-6	72.6m
2-5	73.8m	5-7	72.6m
2-6	73.2m	5-8	72.6m
2-7	73.2m	6-7	73.2m
2-8	73.2m	6-8	73.2m
3-4	72.6m	7-8	76.8m

Cable with defects

1. The response levels in the "linked" pairs are not the same (in a pair of 1-2 this level is higher than in the other three "linked" pairs).
2. Distances to heterogeneities with maximum response levels in "non-linked" pairs are not the same. In all combinations with wire #1, the distance to the heterogeneity is from 19.8 to 21.6 meters.
3. The response levels in the wires of different pairs are different. So in combination with wire #1, the levels are higher.

CONCLUSION: the reference structure is broken. The probable cause of the structural violation is a wire break #1 at a distance of 20 meters from the beginning of the cable.

Parallel connection to the "twisted pair" type cable

Pair	Level/Dist	Pair	Level/Dist
1-2	76.8m	3-5	72.6m
1-3	72.0m	3-6	77.4m
1-4	72.6m	3-7	72.6m
1-5	72.6m	3-8	72.6m
1-6	72.6m	4-5	79.2m
1-7	72.6m	4-6	72.6m
1-8	72.6m	4-7	72.6m
2-3	73.2m	4-8	72.6m
2-4	73.2m	5-6	72.6m
2-5	73.2m	5-7	72.6m
2-6	73.2m	5-8	72.6m
2-7	72.8m	6-7	72.6m
2-8	72.0m	6-8	72.6m
3-4	72.6m	7-8	76.8m

Cable without defects

Pair	Level/Dist	Pair	Level/Dist
1-2	22.2m	3-5	72.6m
1-3	21.6m	3-6	77.4m
1-4	21.0m	3-7	73.2m
1-5	21.6m	3-8	73.2m
1-6	21.6m	4-5	79.2m
1-7	21.0m	4-6	72.6m
1-8	21.0m	4-7	73.2m
2-3	21.0m	4-8	73.2m
2-4	21.0m	5-6	72.6m
2-5	21.0m	5-7	72.6m
2-6	21.6m	5-8	73.2m
2-7	21.6m	6-7	72.6m
2-8	21.6m	6-8	73.2m
3-4	72.6m	7-8	76.8m

Cable with defect

1. The response levels in "twisted" pairs are not the same (in a pair of 1-2 this level is higher than in the other three twisted pairs).
2. In the pair 1-2, heterogeneity was detected at a distance much smaller than in the other "linked" pairs
3. Distances to heterogeneities with maximum response levels in "non-linked" pairs are not the same. In all combinations with wires #1 and #2, the distance to the heterogeneity is less than the distance to the end of the cable in the remaining "non-linked" pairs.
4. The response levels in "non-linked" pairs are different. In combination with wires #1 and #2, these levels are lower.

CONCLUSION: the reference structure is broken. The probable cause of the structure violation is a defect in pair 1-2 (parallel connection or breakage of both wires of the pair at a distance of ≈ 20 meters from the beginning of the cable).

Parallel connection to "non-linked" pair in a cable from twisted pair cables

Pair	Level/Dist	Pair	Level/Dist
1-2	76.8m	3-5	72.6m
1-3	72.0m	3-6	77.4m
1-4	72.6m	3-7	72.6m
1-5	72.6m	3-8	72.6m
1-6	72.6m	4-5	79.2m
1-7	72.6m	4-6	72.6m
1-8	72.6m	4-7	72.6m
2-3	73.2m	4-8	72.6m
2-4	73.2m	5-6	72.6m
2-5	73.2m	5-7	72.6m
2-6	73.2m	5-8	72.6m
2-7	72.8m	6-7	72.6m
2-8	72.0m	6-8	72.6m
3-4	72.6m	7-8	76.8m

Cable without defects

Pair	Level/Dist	Pair	Level/Dist
1-2	76.8m	3-5	72.6m
1-3	76.8m	3-6	77.4m
1-4	72.6m	3-7	77.4m
1-5	72.6m	3-8	21.0m
1-6	76.8m	4-5	79.2m
1-7	76.2m	4-6	72.6m
1-8	21.0m	4-7	72.6m
2-3	21.0m	4-8	21.0m
2-4	21.0m	5-6	72.6m
2-5	21.0m	5-7	73.2m
2-6	21.0m	5-8	21.0m
2-7	21.0m	6-7	77.4m
2-8	21.0m	6-8	21.0m
3-4	72.6m	7-8	76.8m

Cable with defect

1. The response levels in "twisted" pairs are not the same (in pairs 1-2 this level is slightly higher than in the other three "linked" pairs).
2. Distances to heterogeneities with maximum response levels in "non-linked" pairs are not the same. In all "non-linked" pairs with wires #2 and #8, the distance to the heterogeneity is less than the distance to the end of the cable in the remaining "non-linked" pairs.
3. The response levels in wires of the different "non-linked" pairs are different. So in a pair of 2-8, the response level is maximum (exceeds the response levels in "linked" pairs). The response levels in all "non-linked" pairs with wires #2 and #8 are higher than in other "non-linked" pairs.

CONCLUSION: the reference structure is broken. The probable cause of the structure violation is a defect in a pair of 2-8 (parallel connection at a distance of ≈ 21 meters from the beginning of the cable).

Connection to pair "wire-shield" in a cable from twisted pair

Pair	Level/Dist	Pair	Level/Dist
1-2	76.8m	3-5	72.6m
1-3	72.0m	3-6	77.4m
1-4	72.6m	3-7	72.6m
1-5	72.6m	3-8	72.6m
1-6	72.6m	4-5	79.2m
1-7	72.6m	4-6	72.6m
1-8	72.6m	4-7	72.6m
2-3	73.2m	4-8	72.6m
2-4	73.2m	5-6	72.6m
2-5	73.2m	5-7	72.6m
2-6	73.2m	5-8	72.6m
2-7	72.8m	6-7	72.6m
2-8	72.0m	6-8	72.6m
3-4	72.6m	7-8	76.8m

Cable without defects

Pair	Level/Dist	Pair	Level/Dist
1-2	76.8m	3-5	72.6m
1-3	72.0m	3-6	77.4m
1-4	72.6m	3-7	20.4m
1-5	72.6m	3-8	72.6m
1-6	72.6m	4-5	79.2m
1-7	20.4m	4-6	72.6m
1-8	72.6m	4-7	21.2m
2-3	73.2m	4-8	72.6m
2-4	73.2m	5-6	72.6m
2-5	73.2m	5-7	21.2m
2-6	73.2m	5-8	72.6m
2-7	20.4m	6-7	21.2m
2-8	72.0m	6-8	72.6m
3-4	72.6m	7-8	76.8m

Cable with defect

Pair	Level/Dist
1-SH	82.2m
2-SH	82.2m
3-SH	82.2m
4-SH	82.8m
5-SH	82.8m
6-SH	82.2m
7-SH	82.2m
8-SH	82.2m

Pair	Level/Dist
1-SH	82.2m
2-SH	82.2m
3-SH	82.2m
4-SH	82.8m
5-SH	82.8m
6-SH	82.2m
7-SH	24.8m
8-SH	82.2m

1. Response levels in twisted pairs are not the same (in pair 7-8 this level is lower than in the other three "linked" pairs).
2. Distances to heterogeneities with maximum response levels in "non-linked" pairs are not the same. In all "non-linked" pairs, where wires #7 are involved, the distance to the heterogeneity is less than the distance to the end of the cable in the remaining "non-linked" pairs.
3. Response levels in "non-linked" pairs are different. The response levels in all "non-linked" pairs with wire #7 are slightly higher than in other "non-linked" pairs.
4. The response levels in the "wire and shield" pairs are not the same. In the 7-SH pair, the level is higher than in the other pairs with the shield.
5. The distances to the heterogeneity in the "wire and shield" pairs are the same, with the exception of the 7-SH pair, where the distance to the heterogeneity is fixed at a distance much smaller than in the other pairs.

CONCLUSION: the reference structure is broken. The probable cause of structure violation is a defect in pair 7-SH (parallel connection at distance ≈ 21 meters from the beginning of a cable).

Serial connection to a wire in a flat cable

Pair	Level/Dist	Pair	Level/Dist
1-2		3-5	36.0m
1-3		3-6	36.0m
1-4		3-7	36.0m
1-5		3-8	
1-6		4-5	36.0m
1-7		4-6	36.0m
1-8		4-7	36.0m
2-3	36.0m	4-8	
2-4	36.0m	5-6	36.0m
2-5	36.0m	5-7	36.0m
2-6	36.0m	5-8	
2-7	36.0m	6-7	36.0m
2-8		6-8	
3-4	36.0m	7-8	

Pair	Level/Dist	Pair	Level/Dist
1-2		3-5	36.0m
1-3		3-6	36.0m
1-4		3-7	36.0m
1-5		3-8	
1-6		4-5	10.2m
1-7		4-6	10.2m
1-8		4-7	10.2m
2-3	36.0m	4-8	
2-4	10.2m	5-6	36.0m
2-5	36.0m	5-7	36.0m
2-6	36.0m	5-8	
2-7	36.0m	6-7	36.0m
2-8		6-8	
3-4	10.2m	7-8	

Cable without defects

Cable with defect

1. In all combinations with wire #4 the level of a response is higher.
2. In all combinations with wire #4, heterogeneity is detected at a distance shorter than the cable length

CONCLUSION: the reference structure is broken. The probable cause of structure violation is a defect of wire #4 (serial connection to the wire or a break at a distance of ≈ 10 meters from the beginning of the cable).

Parallel connection to pair in a flat cable

Pair	Level/Dist	Pair	Level/Dist
1-2		3-5	36.0m
1-3		3-6	36.0m
1-4		3-7	36.0m
1-5		3-8	
1-6		4-5	36.0m
1-7		4-6	36.0m
1-8		4-7	36.0m
2-3	36.0m	4-8	
2-4	36.0m	5-6	36.0m
2-5	36.0m	5-7	36.0m
2-6	36.0m	5-8	
2-7	36.0m	6-7	36.0m
2-8		6-8	
3-4	36.0m	7-8	

Pair	Level/Dist	Pair	Level/Dist
1-2		3-5	36.0m
1-3		3-6	36.0m
1-4		3-7	36.0m
1-5		3-8	
1-6		4-5	10.2m
1-7		4-6	36.0m
1-8		4-7	36.0m
2-3	36.0m	4-8	
2-4	36.0m	5-6	36.0m
2-5	36.0m	5-7	36.0m
2-6	36.0m	5-8	
2-7	36.0m	6-7	36.0m
2-8		6-8	
3-4	36.0m	7-8	

Cable without defects

Cable with defect

1. Response level in pair 4-5 is significantly higher, than on other pairs.
2. In pair 4-5, the distance to the heterogeneity is less than the cable length.

CONCLUSION: the reference structure is broken. The probable cause of structural disruption is a defect in pair 4-5 (parallel connection at a distance of ≈ 10 m from the beginning of the cable).

Preparation of cable for testing

All electronic devices must be disconnected from the cable. If the cable has branches, it is necessary to test each cable segment separately, having previously disconnected it from the main cable.

When using REF it is assumed that the cable segment under test or the cable as a whole does not have heterogeneities. It is recommended to use idle mode (a pair of wires is open at the opposite end).

Testing in AUTOMATED mode

Testing of a multi-wire cable begins with test in the AUTOMATED mode. The test consists in comparing the obtained structure with the reference structure of the cable of the corresponding type.

The purpose of the test is to identify abnormal structural changes and identify the type of defect detected.

Testing in MANUAL mode

Testing in MANUAL mode is performed when testing a two-wire cable or after testing in AUTOMATED mode of a multi-wire cable.

The purpose of testing is to localize the heterogeneity in the tested pair. MANUAL mode testing is to compare the test results of one pair of wires from different ends of the cable.

7.4.2. TESTING OF THE MULTI-WIRE CABLE

1. Test cable in AUTOMATED mode. Determine the structure (response levels in different pairs and distances to heterogeneity with maximum response levels).
2. Compare the resulting structure with the reference structure of this type of cable.
3. If there are no differences in structures, test is end.
4. If there are anomalies in the resulting structure, find a pair or wire with a defect. Try to identify a defect.
5. In MANUAL mode, test a defective pair (or pairs with a defective wire) by connecting alternately from both sides of the cable.
6. Analyze the results received in the MANUAL mode and specify distance to heterogeneity.
7. By means of a cable locator, a usual NLJD and the other equipment for search to localize the place of connection to the cable of the eavesdropping device.

7.4.3. TESTING OF THE TWO-WIRE CABLE (PAIR OF THE MULTI-WIRE CABLE) IN MANUAL MODE

1. Connect the Analyzer to one of the ends of the tested cable.
2. In the MANUAL mode to take measurements in the SET 1 table.

3. Without leaving the MANUAL mode, to connect the Analyzer to other end of a cable and to take measurements in the table SET 2.
4. Analyze results of two measurements. If the received values are identical, test is finished.
5. If the measurement results are different, determine the exact distance to the detected heterogeneity, detected closer than the response from the end of the cable.

An example of analysis of test results in MANUAL mode is shown in Fig. 60.

In both tables, the measured distance to the far heterogeneity is 74.6 m. The response level from this heterogeneity is approximately the same in both measurement cycles (13 dB and 12 dB). This heterogeneity is the end of the cable. So the cable length is 74-75 m.

During the first measurement cycle, heterogeneity was detected at a distance of 53.4 m. The response level from this heterogeneity exceeds the response level from the end of the cable. In the second measurement cycle, heterogeneity was detected at a distance of 21.2 m. The response level from the heterogeneity is very large (104 dB).

This is due to the fact that heterogeneity was detected at a small distance from the connection point of ST 301. Also, heterogeneity was detected at a distance of 42.8 m with a low response level (16 dB). Probably, this response is the harmonic of the signal received at a distance of 21.2 m.

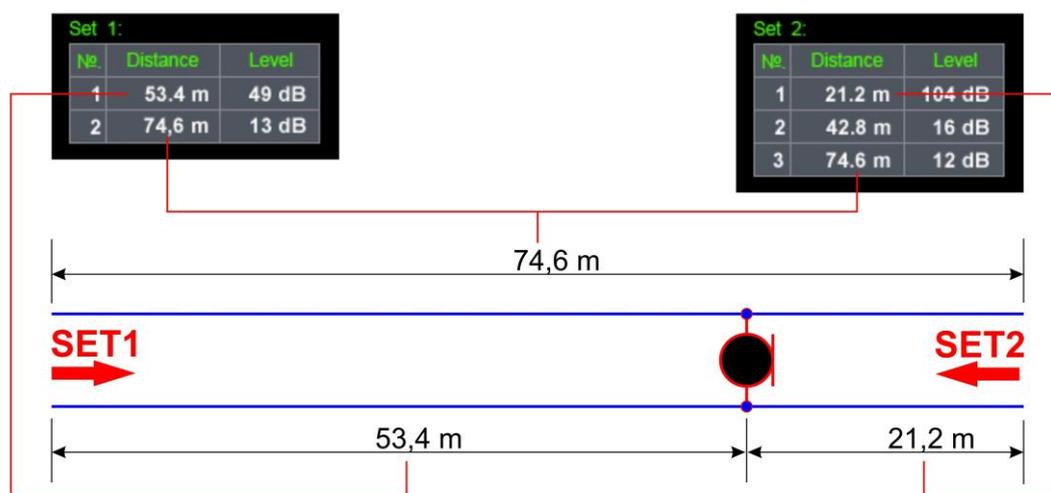


Fig.60

Considering the measured line length, the response obtained in the first measurement cycle at a distance of 53.4 m and in the second measurement cycle at a distance of 21.2 m are responses from the same heterogeneity.

This conclusion is confirmed by the addition of the measured distances to the heterogeneity in the first and second cycles: $21.2 \text{ m} + 53.4 \text{ m} = 74.6 \text{ m}$. (a value equal to the length of the cable is obtained).

7.4.4. PROCEDURE FOR TESTING OF THE TWO-WIRED CABLE (PAIR OF THE MULTI-WIRE CABLE)

1. Disconnect the tested cable from the equipment on distant end.
2. Connect a cable to the Analyzer depending on type of the tested cable:

2A (Fig.4), 2C (Fig.5), 3A (Fig.6), 3C (Fig.7), 4A (Fig.8), 5A (Fig.9),
5B (Fig.10), 5C (Fig.11), 6A (Fig.13), 6D (Fig.16)

3. Turn on REF.
4. Set cable type and the involved Switch contacts ("FUNC").
5. Set the Shortening Factor ("F2").
6. Set the tabular cursor to the row corresponding to the interesting pair of wire.
7. Turn on the MANUAL mode ("F1").
8. By means of the ◀ or ▶ buttons set active the table SET 1.
9. Begin measurements ("F3") and wait for the end of the test (filling of cells of the table).
10. By means of the ◀ or ▶ buttons set active the table SET 2.
11. Disconnect a cable from the Analyzer.
12. Without turning off the Analyzer, connect the other end of the cable.
13. Begin measurements ("F3") and wait for test results (filling of cells of the table).
14. Compare and analyze results of two measurements.

Information messages in the MANUAL mode:

No data	no measurements were made
Noise	unacceptably high level of "noise" in the cable
Measuring	there is a process of measurements
> 3v!!!	there is a voltage exceeding permissible value in the cable
No defects	the response is not received (wires too long, too big signal attenuation, only one wire is connected to an input of the Switch)

7.4.5. PROCEDURE FOR TESTING OF THE MULTI-WIRE CABLE

1. Disconnect the tested cable from the equipment on distant end.
2. Connect a cable to the Analyzer depending on type of the tested cable:

2A (Fig.4), 2C (Fig.5), 3A (Fig.6), 3C (Fig.7), 4A (Fig.8), 5A (Fig.9), 5B (Fig.10), 5C (Fig.11)

3. Turn on REF.
4. Set cable type and the involved Switch contacts ("FUNC").
5. Set the Shortening Factor ("F2").
6. Turn on the AUTOMATED mode ("F4").
7. Compare the resulting structure with the reference structure corresponding to this type of cable. If differences are found in the resulting structure, identify the pair of wires or a wire that is the source of the anomalies.
8. Set the tabular cursor to the row corresponding to the interesting pair of wire.
9. Turn on the MANUAL mode ("F1")

Then proceed in accordance with [item 7.4.3.](#)

Information messages in the AUTOMATED mode:

Noise	unacceptably high level of "noise" in the cable
> 3v	there is a voltage exceeding permissible value in the cable
0.0m	the response is not received (too long wires, too big signal attenuation, only one wire is connected to an input of the Switch)
.....	there is a process of measurements

7.5. BASIC OPERATION #5 LOCALIZATION OF THE DETECTED EAVESDROPPING DEVICES

If during testing a transmission channel of the eavesdropping device is detected, it becomes necessary to localize it.

In case of detection of uncoded transmission channel of the eavesdropping device it is possible to define the place of its installation by means of PTS. This method of localization is called "Acoustic method" (item 7.5.1.).

Localization of the eavesdropping device (with an encoded transmission channel) or a non-operating eavesdropping device (containing semiconductor elements and connected to the cable) is performed using the [ST 400 "CAYMAN" NLJD](#) or similar devices (item 7.5.2.).

7.5.1. ACOUSTIC METHOD OF LOCALIZATION

The use of the acoustic method is possible only if an uncoded transmission channel of a eavesdropping device is detected.

To implement the method, two operators are required. One operator moves the PTS around the room, the other operator controls the level of the received signal using ST 301.

Action with PTS:

1. Turn on PTS and reduce the volume level.
2. Slowly move PTS within the room.

Analyzer operator actions:

1. Turn on LFA or WR (depending on which device the eavesdropping device was detected).
2. Connect headphones. Listen to an acoustic background of the room.
3. Control level volume of PTS.

The installation place of the eavesdropping device will coincide with the place where the audibility of the test sound of PTS was best.

7.5.2. LOCALIZATION BY MEANS OF ST 301 AND NLJD

By this method it is possible to localize the eavesdropping device having electronic components.

Two operators are necessary. One irradiates the tested cable with a NLJD, another - controls the NLJD signal level in the cable by means of the Analyzer.

At radiation by a NLJD of the electronic devices close to the tested cable, but not connected to it the operator of a NLJD receives responses second and third harmonics, and the operator of ST 301 does not fix any signals.

If the NLJD irradiates the electronic device connected to the cable, NLJD operator fixing nonlinearity.

The operator of ST 301 hears a characteristic signal of a NLJD in headphones.

The place where both operators detect the responses, is an installation site of the eavesdropping device.

This method is most effective when using NLJD ST 400 "CAYMAN" in the SEARCH mode.

ST 301 operator actions:

1. Disconnect all regular devices from the cable.
2. Connect the tested cable to the Analyzer.
3. Turn on the Analyzer.
4. Turn on LFA.
5. Connect pair on which the signal of the eavesdropping device was detected (LFA or PR) or connection to the cable is revealed (NL or REF).
6. Connect headphones. Control existence of a characteristic signal of a NLJD "CAYMAN" and in case of its listening to report about it to the second operator.

NLJD operator actions:

1. Turn on a NLJD "CAYMAN" and set the search SEARCH mode.
2. Move the antenna of a NLJD along the tested cable.

8. SOFTWARE

8.1. GENERAL INFORMATION

8.1.1. PURPOSE

1. Configuring the Electronic Switch.
2. Devices control.
3. Analysis of the results of testing in real time.
4. Saving in graphical and text format test results.
5. When using NLJD or REF, the saved results can be used for comparative analysis in subsequent test of the same cable.
6. Firmware update.

8.1.2. PC REQUIREMENTS

1. Operating system: Windows 7, 8, 10 (64 bits).
2. Free hard disk space: at least 1 Gb.
3. Availability of USB port.
4. MS Office software is installed on the PC.
5. A program for viewing graphic files is installed on the PC.

8.1.3. INSTALLING THE SOFTWARE

Distribution kit is located in the "Prog_ST301" folder on the flash card ([Fig.1, item 3](#)).

INSTALLATION:

1. Copy the folder "Prog_ST301" to PC HDD.
2. Install the ST 301 driver (run the CDM21228_Setup.exe).
3. Run the ST301.exe file. The PC screen is shown in Fig.61. The message on the indicator (Fig.61, item 1) will display: "ST301: no connection! " in red color.
4. Using the mini-USB patch cord ([Fig.1, item 4](#)) connect the main unit to the PC. The alternating messages will appear on the connection indicator: "ST301: request to connect ... " in blue color and "ST301: no response! " in red color.
5. Turn on the main unit. The message "ST301: connected" should appear on the indicator (Fig.61, item 1) and on the ST 301 screen.

After that, the software is considered to be successfully installed on the PC.

8.1.4. ACCUMULATOR CHARGE CONTROL

After the start of the software, the splash screen is displayed on the main unit screen ([Fig.20](#)). It does not have an indicator of accumulator charge level. For this purpose, the indicator on the PC screen is used (Fig.61, item 7).

8.1.5. GRAPHIC INTERFACE

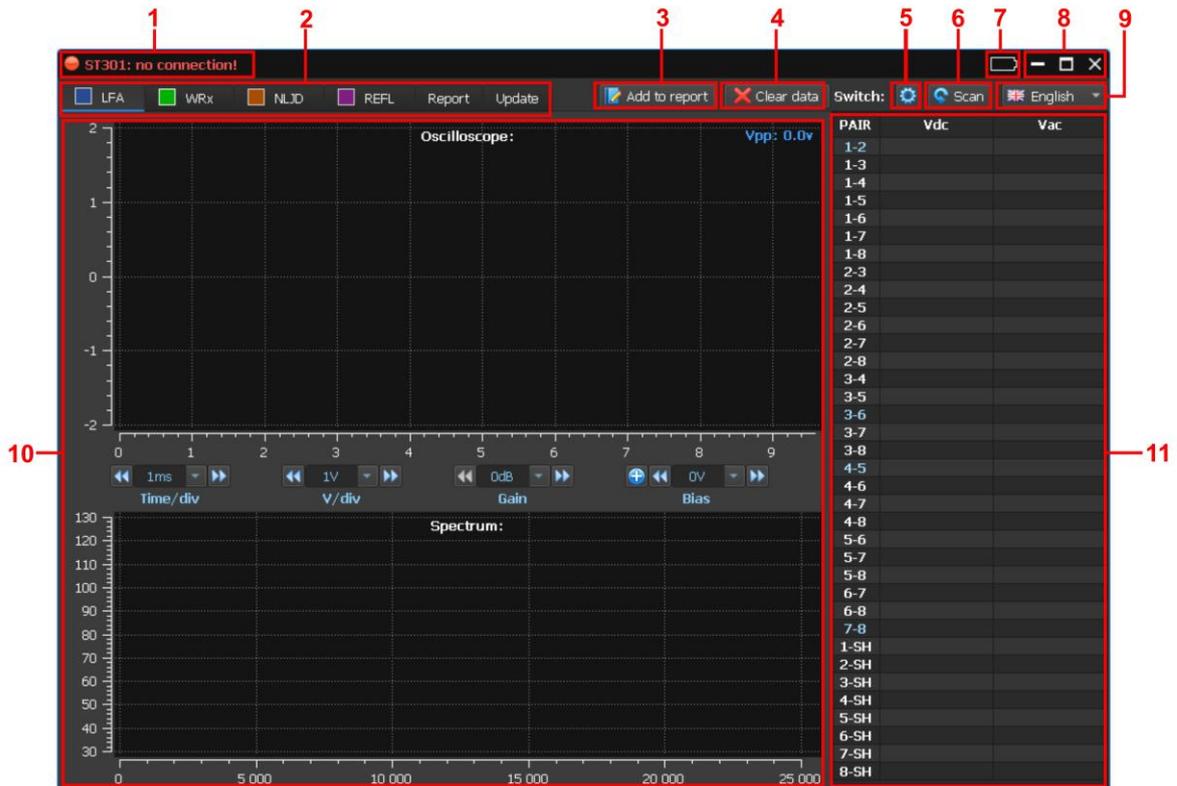


Fig.61

In Fig.61:

- 1 - PC connection indicator
- 2 - buttons to turn on the devices or report mode or firmware updating mode
- 3 - button to add current information to the report
- 4 - button to delete current test results (creation a new report)
- 5 - button to turn on/off the Switch configuration mode
- 6 - button to turn on the AUTOMATED mode of the Switch
- 7 - accumulator charge level indicator
- 8 - control of window
- 9 - switching interface language
- 10 - controls and analysis results in the selected device and mode of operation
- 11 - information window, where, depending on the device turned on, it is displayed:
 - measured value of DC/AC voltage (LFA)
 - number of detected signals (WR)
 - response level (NLJD)
 - distance to the heterogeneity with the maximum response level and the response level (REF)

8.1.6. ELECTRONIC SWITCH

The Switch used by all devices, except the power mains testing mode (WR). The software allows you to configure the Switch and manage it with automated or manual cable testing.

To the Switch setup, click  (Fig.61, item 5). The setup window will appear on the screen.

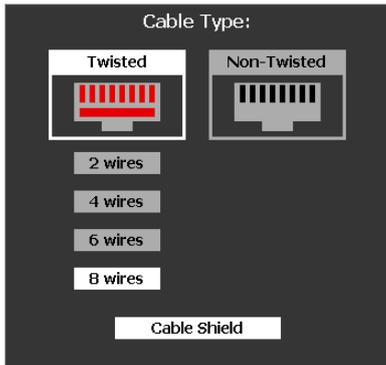


Fig.62A

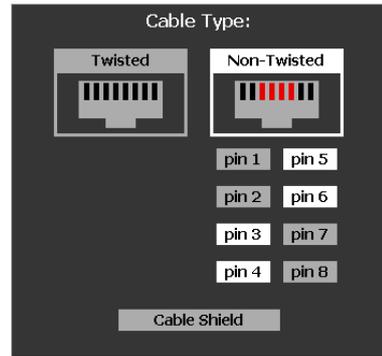


Fig.62B

On the left part of the window there is a menu for configuring the Switch when testing a "Twisted pair" type cable (Fig.62A), on the right part - "Non-twisted pair" type cable (Fig.62B).

At the bottom of the window is a button for connecting (disconnecting) the cable shield to the switch. The switch setup procedure is similar to that presented in item 4.

To select the cable type and pin number, click the corresponding button.

The set parameters do not change when switching devices and remain until the next correction or turning off the Analyzer.

When the Switch setup is finished click  (Fig.61, item 5).

In the window (Fig. 61, item 11) displays the contacts configuration.

Not connected pairs are marked by gray color, connected pair are marked by white color, and the connected "linked pairs" (two wires from the same twisted pair) are marked by blue color.

8.2. LFA

To enable LFA click  PC screen shown in Fig.63.



Fig.63

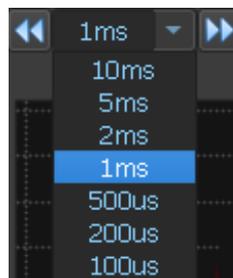
In Fig.63:

- 1 - LFA is on
- 2 - OSCILLOSCOPE
- 3 - buttons for scaling the amplitude axis of the oscilloscope
- 4 - buttons for scaling the time axis of the oscilloscope
- 5 - buttons for gain setting
- 6 - buttons for bias voltage setting
- 7 - SPECTRUM ANALYZER
- 8 - Switch information
- 9 - tabular cursor (the connected pair of wires)

8.2.1. SCALING THE TIME AXIS OF THE OSCILLOSCOPE

Scaling is done in two methods:

1. Click on  (Fig.63, item 4). A list of values is displayed on the screen:



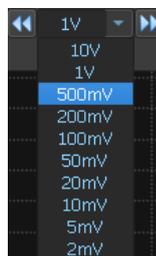
To select a value, click on the corresponding field. The indicator displays the selected value

2. Use the  (decrease value) and  (increase value) buttons.

8.2.2. SCALING THE AMPLITUDE AXIS OF THE OSCILLOSCOPE

Scaling is done in two methods:

1. Click on  (Fig.63, item 3). A list of values is displayed on the screen:



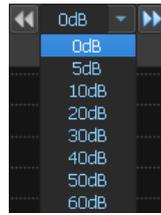
To select a value, click on the corresponding field. The indicator displays the selected value

2. Use the  (decrease value) and  (increase value) buttons.

8.2.3. GAIN SETTING

The gain is set in two methods:

1. Click on  (Fig.63, item 5). A list of values is displayed on the screen:



To select a value, click on the corresponding field. The indicator displays the selected value

2. Use the  (decrease value) and  (increase value) buttons.

8.2.4. BIAS VOLTAGE SETTING

The bias voltage is set in two methods:

1. Click on  (Fig.63, item 6). A list of values is displayed on the screen:



To select a value, click on the corresponding field. The indicator displays the selected value

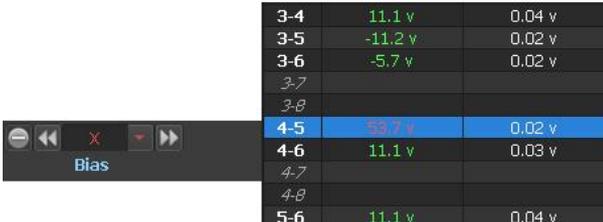
2. Use the  (decrease value) and  (increase value) buttons.

To change the polarity of the bias voltage, click the  button or  button, located to the left of the  button. If a positive bias voltage is set, the  button is active.

If a negative bias voltage is set, the  button is active.

The value and polarity of the bias voltage is displayed in green on the Switch window ([Fig.63, item 8](#)). Red color displays voltage values in the supplied pairs exceeding 3 V (DC). Voltage values not exceeding 3 V (DC) are displayed in white.

Attention! If the connected pair of wires is powered and the voltage on it exceeds 3 V (DC), then bias voltage supply is not possible. The screen view is shown in Fig. 64.



3-4	11.1 v	0.04 v
3-5	-11.2 v	0.02 v
3-6	-5.7 v	0.02 v
3-7		
3-8		
4-5	53.7 v	0.02 v
4-6	11.1 v	0.03 v
4-7		
4-8		
5-6	11.1 v	0.04 v

Fig.64

8.2.5. AUTOMATED MODE

To turning on the AUTOMATED mode, click  (Fig. 61, item 6). When scanning, the measured values of direct and alternating voltage are displayed in the Switch window, (Fig. 61, item 10). On each pair, the Analyzer pauses for a few seconds so that the operator can evaluate the received signal. Signal analysis is performed using an oscillogram, a spectrogram (on a PC screen) and acoustic information (via a built-in speaker or headphones).

To stop scanning, click again 

8.2.6. MANUAL MODE

Manual mode is used to analyze signals in a specific combination of wires. To connect it, click on the corresponding row of the Switch table (Fig. 61, item 10), which will be highlighted in blue.

Capability when testing in manual mode:

- gain settings;
- bias voltage turning on;
- scaling of the oscillogram (along the time or amplitude axis);
- measurement of signal parameters on an oscillogram (spectrogram) using a marker.

To measure the signal parameters using a marker, you need to set it to OSCILLOSCOPE window ([Fig.63, item 2](#)) or to SPECTRUM ANALYZER window ([Fig.63, item 7](#)).

The PC screen will display:

- in OSCILLOSCOPE window – voltage and duration values;
- in SPECTRUM ANALYZER window– frequency and level values.

8.2.7. REPORT MODE (GENERAL INFORMATION)

The mode is intended for storing graphic and tabular information about testing on the PC HDD. Graphic information (screenshots of oscillogram, spectrogram and Switch table) is saved in PNG format files.

Tabular data is saved in MS Excel format files.

The saved information can be used as attachments to documents that are executed after testing.

8.2.7.1. CREATING FILES

To create report files, click  Add to report. The menu will be displayed on the screen (Fig. 65) with a list of information that can be saved. Depending on the device used, this list varies.



Fig.65

After selecting screenshots (Screens) and tables (Tabs) of interest and clicking the "Add to Report", the program creates files with specific names and extensions.

Sample the file names:**LFA. Oscillogram screenshot (PNG file):****lfa_osc_4-5_120901.png**

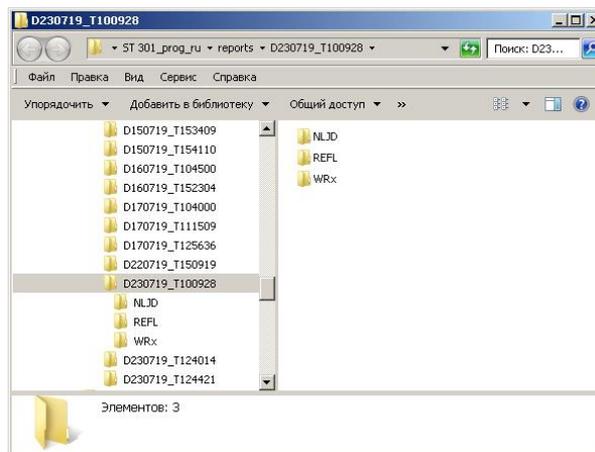
lfa – LFA device;
 osc – oscillogram;
 4-5 – the connected pair of wires;
 120901 – file creation time (hour_min_sec).

REF. Switch table data (MS Excel file):**ref_sw_120901.xlsx**

ref – REF device;
 sw – Switch;
 120901 – file creation time (hour_min_sec).

8.2.7.2. SAVING FILES

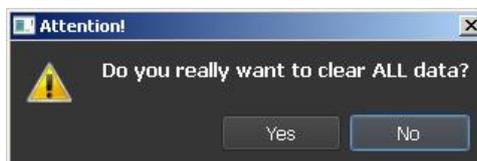
Files are saved in the multi-level folder "reports" in the root directory "ST 301_prog" (Fig.66).

**Fig.66**

Files created during the operation of LFA, WR, REF and NLJD are saved, respectively, in the folders "LFA", "WRx", "REF", "NLJD".

They are located in a higher level folder. The name of this folder, by default, has the format "Dddmmy_Thhmmss" ("ddmmy" - the date the folder was created, "hhmmss" - the time the folder was created). In this folder saves all files created from the moment the software was launched until it exited (within one session).

When the  Clear data is pressed, the session ends forcefully. In this case, previously saved information can be deleted (clear all data) after confirming the request:



It is recommended to begin a new session when testing the next cable (each cable under test has one session).

8.2.7.3. FILE OPERATIONS

To view the saved files, click **Report** (Fig.67, item 1).

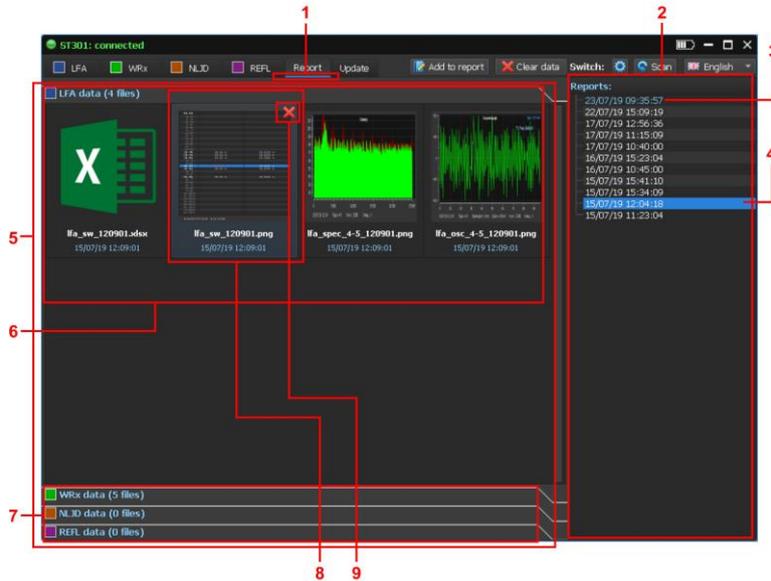


Fig.67

In Fig.67:

- 1 - REPORT mode
- 2 - list of saved sessions
- 3 - current session
- 4 - analyzed session (previously saved) session
- 5 - analyzed session information
- 6 - screenshots and tables from the open folder of one of the devices
- 7 - other folders with data of the other three devices
- 8 - active file
- 9 - active file delete button

On the right side of the screen is a list of saved sessions. The name of the session corresponds to the date and time of creation. The first in the list is the folder for the current session (highlighted in blue). Other folders are arranged in decreasing order of their creation date. To view the information of a saved session, click on the corresponding folder.

On the left side of the screen (Fig.67, item 5) will be displayed:

- screenshots and tables of a saved session of the device (Fig.67, item 6). In Fig. 67 - LFA
- three bookmarks for displaying information on other devices (Fig.67, item 7)

To view the information in these folders, click on the appropriate folder.

To view the file, double-click on the file.

To delete a file, click on it, then click «X» and confirm the deletion.



It is possible to work with files in Windows Explorer. To do this, double-click on one of the sessions (Fig. 67, item 2) and go to the desired folder (Fig. 68).

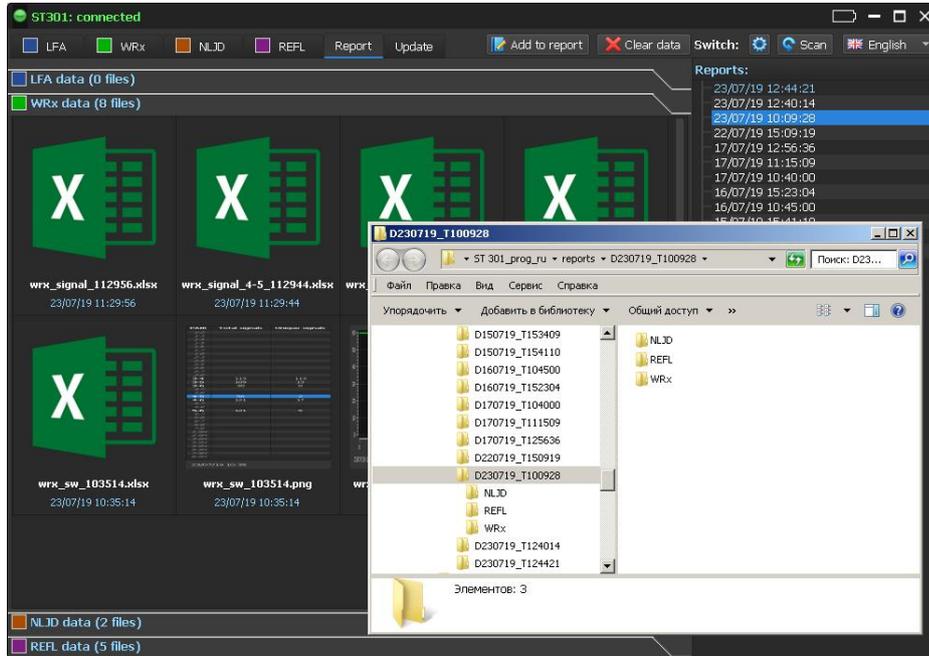


Fig.68

8.2.8. REPORT MODE (LFA)

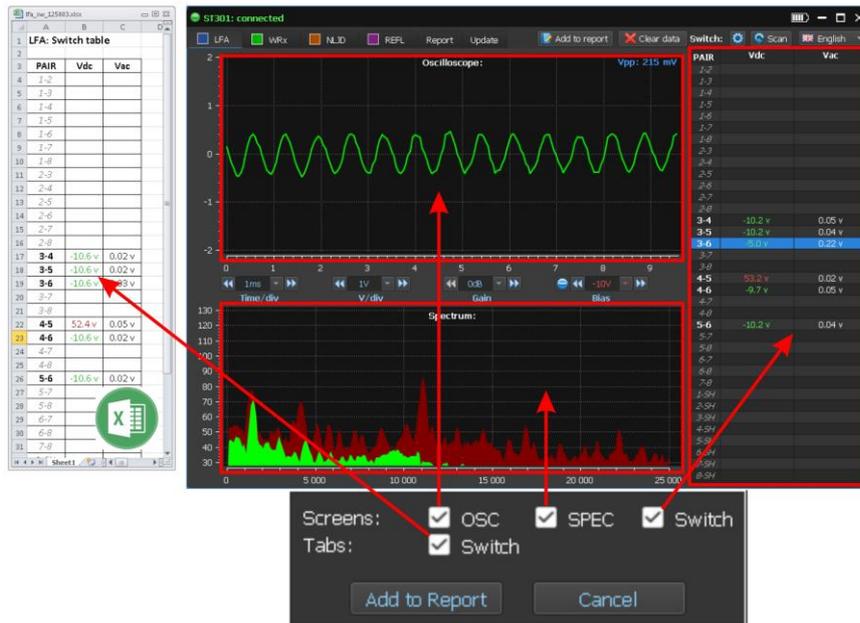


Fig.69

When using LFA, it is possible to save (Fig.69):

1. Graphic information in the form of PNG ("Screen") files:

- oscillogram screenshot (check box "OSC")
- spectrogram screenshot (check box "SPEC")
- Switch table screenshot (check box "Switch")

2. Switch table data as a MS Excel file (check box "Switch").

Sample the file names:**1. Oscillogram screenshot (PNG file):****lfa_osc_4-5_120901.png**

lfa – LFA device;

osc – oscillogram;

4-5 – the connected pair of wires;

120901 – file creation time (hour_min_sec).

2. Spectrogram screenshot (PNG file):**lfa_spec_4-5_120901.png**

lfa – LFA device;

spec – spectrogram;

4-5 – the connected pair of wires;

120901 – file creation time (hour_min_sec).

3. Switch table screenshot (PNG file):**lfa_sw_120901.png**

lfa – LFA device;

sw – Switch;

120901 – file creation time (hour_min_sec).

4. Switch table data (MS Excel file):**lfa_sw_120901.xlsx**

lfa – LFA device;

sw – Switch;

120901 – file creation time (hour_min_sec).

After clicking "Add to Report" the files will be saved on the PC HDD.

8.3. WR

To turning on WR click  PC screen shown in Fig.70.



Fig.70

In Fig.70:

- 1 - WR is on
- 2 - SPECTRUM ANALYZER
- 3 - marker
- 4 - marker frequency value
- 5 - signal level indicator
- 6 - connected pair of wires
- 7 - buttons for frequency range setting
- 8 - buttons for cable type setting
- 9 - buttons for gain setting
- 10 - buttons for scanning step setting
- 11 - buttons for fixed frequency and marker control
- 12 - turning on/off the AUTOMATED mode
- 13 - turning on/off the DIFFERENTIAL mode
- 14 - buttons for scaling of the OSCILLOSCOPE time axis
- 15 - modulation mode (AM/FM)
- 16 - OSCILLOSCOPE

MODES:

- SPECTRUM ANALYZER);
- OSCILLOSCOPE;
- DIFFERENTIAL mode;
- AUTOMATED mode;
- SWITCH CONTROL;
- CREATION OF REPORTS

8.3.1. CABLE TYPE SETTING

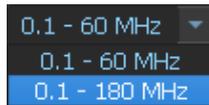
WR is designed to test power mains and low current cables. After turning on, the type of cable to be checked is set by default: "Power mains" (Fig.70, item 8). A pair of contacts "1-2" is connected. All functions of the Switch are blocked.

To change the cable type, click  (Fig.70, item 8).

The button will take the form:  All functions of the Switch will become available.

8.3.2. FREQUENCY RANGE SETTING

Click  (Fig.70, item 7). A list of frequency range is displayed on the screen:



To select a value, click on the corresponding field.

8.3.3. GAIN SETTING

The gain is set by two methods:

1. Click on  (Fig.70, item 9). A list of values is displayed on the screen:



To select a value, click on the corresponding field. The indicator displays the selected value

2. Use the  (decrease value) and  (increase value) buttons.

8.3.4. SPECTRUM ANALYZER

When turn on the WR, the SPECTRUM ANALYZER mode is automatically set (for analyzing signals in the selected frequency range). Signals detected during the last scan cycle are displayed in green. Claret color displays the maximum signal levels detected over the entire duration of the SPECTRUM ANALYZER.

SCANNING STEP SETTING

The scanning step is set by two methods:

1. Click on  (Fig.70, item 10). A list of values is displayed on the screen:



To select a value, click on the corresponding field. The indicator displays the selected value

2. Use the  (decrease value) and  (increase value) buttons.

The scanning step determines the viewing range of the SPECTRUM ANALYZER:

- scanning step 200 kHz - viewing range 60 MHz (maximum band);
- scanning step 100 kHz - viewing range 30 MHz;
- scanning step 50 kHz - viewing range of 15 MHz (minimum band).

When changing the scanning step, the SPECTRUM ANALYZER is scaled (in frequency) relative to the position of the marker (Fig.70, item 3), which is always the center of the new range.

MARKER CONTROL

There are two methods of marker control (Fig.70, item 3):

1. Use the  (decrease value) and  (increase value) buttons. (Fig.70, item 11). The position of the marker then changes to the set scanning step.
2. By clicking on the corresponding area of the SPECTRUM ANALYZER screen (Fig.70, item 2).

The frequency value on the marker is displayed on the indicators (Fig.70, item 4 and item 11).

8.3.5. THE DIFFERENTIAL MODE

In the DIFFERENTIAL mode, the levels of all signals detected earlier are taken as "0".

On the SPECTRUM ANALYZER screen, only signals with a level exceeding previously recorded (difference spectrum) are displayed.

It is possible to adjust the parameters and control of the SPECTRUM ANALYZER.

To turn on the mode, click  (Fig. 70, item 13).

The button will take the form 

Signals detected in the last scan cycle are indicated in purple. Olive color displays the maximum signal levels received for the entire time of operation (from the moment the DIFFERENTIAL mode is turned on).

To turn off the mode, click 

8.3.6. OSCILLOSCOPE

In OSCILLOSCOPE mode, the signal is analyzed at a fixed frequency, the value of which is displayed on the indicators (Fig.70, item 4 and item 11).

The analysis is performed by the oscillogram and by listening to the demodulated signal.

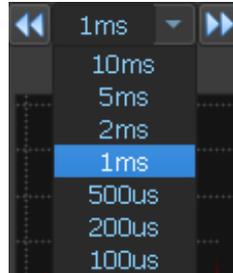
It is possible to scale the time axis of the OSCILLOSCOPE and change the type of modulation (AM / FM).

To turning on the OSCILLOSCOPE or the SPECTRUM ANALYZER, click on the corresponding area of the screen (Fig.70, item 16 and item 2).

SCALING THE TIME AXIS OF THE OSCILLOSCOPE

There are two methods of scaling:

1. Click on  (Fig.70, item 14). A list of values is displayed on the screen:



To select a value, click on the corresponding field. The indicator displays the selected value

2. Use the  (decrease value) and  (increase value) buttons.

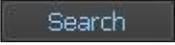
MODULATION TYPE SETTING

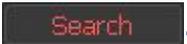
Click  (Fig.70, item 15). A list will appear on the screen:



To select the type of modulation, click on the appropriate field.

8.3.7. AUTOMATED MODE

In AUTOMATED mode, a list of signals is generated whose levels exceed the adaptive detection threshold. To turn on the mode, click  (Fig. 70, item 12).

The button will take the form: . To turn off the mode, click this button again.

Testing in AUTOMATED mode is performed:

1. within the set viewing range;
2. taking into account the results obtained in the DIFFERENTIAL mode (if the inclusion was made from the DIFFERENTIAL mode);
3. only in the connected pair of wires.

The screen is shown in Fig.71.

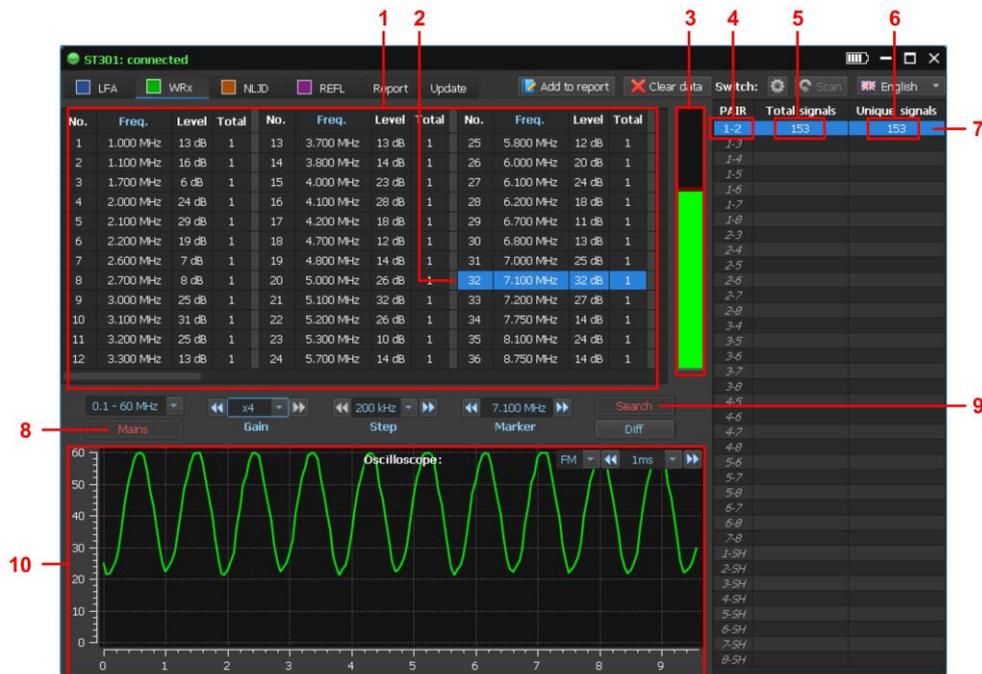


Fig.71

In Fig.71:

- 1 - detected signal table
- 2 - tabular cursor
- 3 - signal level indicator (on which the tabular cursor is set)
- 4 - connected pair of wires
- 5 - total number of signals detected in this pair of wires
- 6 - number of signals detected only in this pair of wires
- 7 - Switch table row (connected pair of wires)
- 8 - type of cable
- 9 - AUTOMATED mode indicator
- 10 - OSCILLOSCOPE

Attention! If there are no signals in the frequency range after turning on the AUTOMATED MODE, the message **"Nothing found"** is displayed on the screen.

SWITCH TABLE (IN AUTOMATED MODE)

When using AUTOMATED mode, the Switch table displays:

1. Connected pair of wires (Fig. 71, item 4).
2. The total number of signals detected in this pair of wires (Fig. 71, item 5).
3. The number of signals that were detected only in this pair (Fig. 71, item 6).

When testing the power mains, only one pair is tested, so the total number of detected signals and the number of signals detected in this pair are the same. When testing multi-wire (low-current) cables, these indicators are different.

TABLE OF DETECTED SIGNALS

The table of detected signals (Fig. 71, item 1) displays:

1. number of detected signal,
2. the frequency of the detected signal,
3. detected signal level,
4. number of pairs of wires in which a signal is detected at this frequency. When testing power mains, this parameter is "1", since only one pair is tested.

To tune to the frequency of the detected signal, click on the corresponding row of the table. The oscillogram of the demodulated signal (Fig. 71, item 10) will be displayed on the screen.

By changing the scanning step and controlling the marker, you can adjust the frequency of the signal under analysis. To turn off the mode, click **Search** (Fig.71, item 9).

If AUTOMATED mode is later turned on (provided that the signals were previously detected), the screen will display a request:



When confirming ("Yes"), the information in the table about previously detected signals will be updated. In other case ("No"), a table with previously received data will be displayed on the screen.

8.3.8. FEATURES OF TESTING LOW-VOLTAGE LINES

Low-voltage cables, as a rule, are multi-wire cables. All combinations of wires must be tested.

Algorithm for testing a low-current line:

1. Select the type of cable to be tested ([item 8.3.1](#)) "low-current" cable. After that, the Switch control features will become available.
2. Configure the Switch ([item 8.1.6](#)).
3. Select frequency range ([item 8.3.2](#)).
4. Set the gain ([item 8.3.3](#)).
5. Click **Scan**. The Analyzer will test all pairs of connected wires one by one. The Switch table displays information about the number of detected signals in each pair (total number of signals and the number of "unique" signals).
6. Set the cursor on the first connected pair. Analyze signals with a SPECTRUM ANALYZER and OSCILLOSCOPE.
7. If necessary, turn on AUTOMATED mode ([item 8.3.7](#)) and analyze the table of detected signals.

In accordance with this algorithm, it is necessary to examine all connected pairs.

Attention! When testing low-voltage cables in the AUTOMATED mode table, it is possible to mark signals in red or green.

Usually, hazardous and suspicious signals are marked in red, and non-hazardous signals in green. Signals at the same frequencies detected in other pairs are automatically marked with the same color.

This procedure reduces the scan time, since there is no need to check the already marked signals. To mark the signal, double-click the row of the table. The color of the inscription will change sequentially from white to green and then to red. Color marking is taken into account when creating the report in the table of detected signals (item 8.3.9).

8.3.9. REPORT MODE

To create report files click  The menu will be displayed on the screen (Fig. 72) with a list of information that can be saved.



Fig.72

After selecting screenshots (Screens) and tables (Tabs) and clicking , the program creates files with specific names and extensions.

When using WR, it is possible to save (Fig.73):

1. Graphic information in the form of PNG ("Screen") files:

- oscillogram screenshot ("OSC" check box)
- spectrogram screenshot ("SPEC" check box)
- Switch table screenshot ("Switch" check box)

2. Tabular data as MS Excel file ("Tabs"):

- Switch table data ("Switch" check box)
- list of signals detected on one pair ("Signal table" check box)
- list of signals detected on all pair ("All pairs" check box)

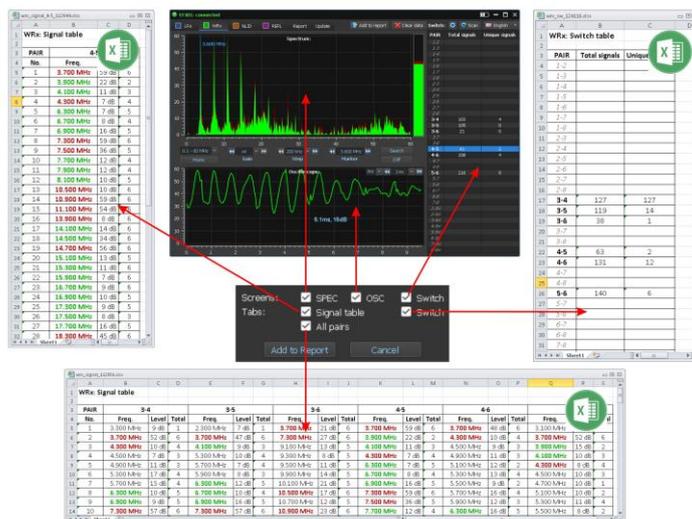


Fig.73

Sample the file names:**1. Oscillogram screenshot (PNG file):****wrx_osc_4-5_120901.png**

wrx – WR device;
osc – oscillogram;
4-5 – the connected pair of wires;
120901 – file creation time (hour_min_sec).

2. Spectrogram screenshot (PNG file):**wrx_spec_4-5_120901.png**

wrx – WR device;
spec – spectrogram;
4-5 – the connected pair of wires;
120901 – file creation time (hour_min_sec).

3. Switch table screenshot (PNG file):**wrx_sw_120901.png**

wrx – WR device;
sw – Switch;
120901 – file creation time (hour_min_sec).

4. Switch table data (MS Excel file):**wrx_sw_120901.xlsx**

wrx – WR device;
sw – Switch;
120901 – file creation time (hour_min_sec).

5. List of signals detected in one pair (MS Excel file):**wrx_signal_3-6_121317.xlsx**

wrx – WR device;
signal – signals list;
3-6 – the connected pair of wires;
121317 – file creation time (hour_min_sec).

6. List of signals detected in all pairs (MS Excel file):**wrx_signal_121317.xlsx**

wrx – WR device;
sw – Switch;
120901 – file creation time (hour_min_sec).

Saved files are located in the "WRx" folder of the corresponding session. To view it, click on the "WRx data" tab ([Fig.68](#)). Operating with files is described in [item 8.2.7.3](#).

8.4. NLJD

To enable NLJD click  PC screen shown in Fig.74.

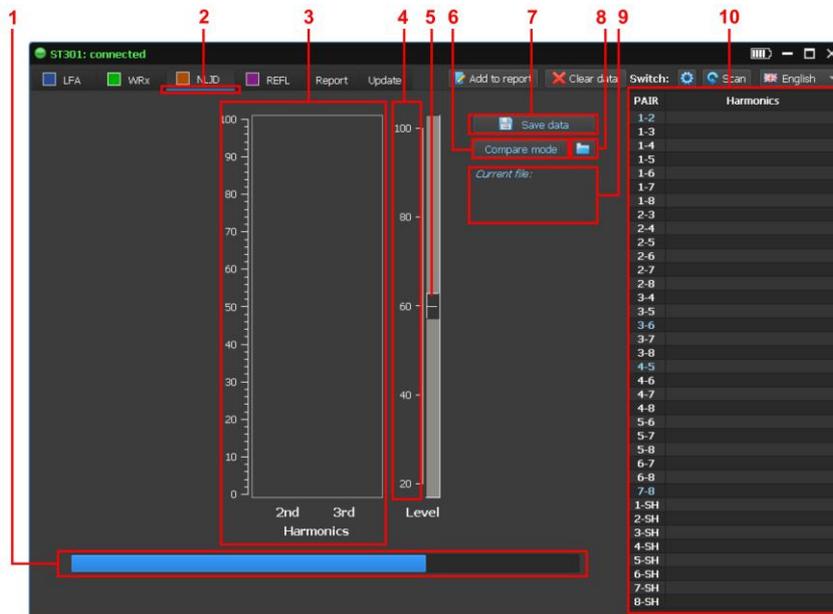


Fig.74

In Fig.74:

- 1 - calibration progress indicator
- 2 - NLJD is on
- 3 - second and third harmonic level indicator
- 4 - probing signal amplitude scale (in % of maximum level)
- 5 - scroll bar and slider for setting the probing signal level
- 6 - button for turning on COMPARISON mode
- 7 - button for saving parameters and test results
- 8 - button for loading saved parameters and test results
- 9 - information about the downloaded file, which is used for comparison
- 10 - Switch table

After turning on the device, calibration takes place within a few seconds. This process is shown on the indicator (Fig. 74, item 1). After that, NLJD is ready to operate.

8.4.1. OPERATING PROCEDURE

1. Configure the Switch according to the type of cable being tested ([item 8.1.6](#)).
2. Set the probe signal level, move the slider (Fig. 74, item 5) to the desired position. If the length of the tested cable is less than 100 m, it is not recommended to set the level to more than 60%
3. Click  The Switch, in turn, connects all the combinations of wires, supplies them with a probing signal and fixes the response levels at the frequencies of the second and third harmonics. Graphical information about the response levels is displayed in the Switch

table (Fig. 75, item 1) opposite the corresponding pair. Red indicates the level of the second harmonic, blue indicates the level of the third harmonic. After testing all wire combinations, the scan will end.

- To view an enlarged image of the responses (Fig. 75, item 3 and item 4), set the tabular cursor (Fig. 75, item 2) on the row with the desired combination of wire pairs.

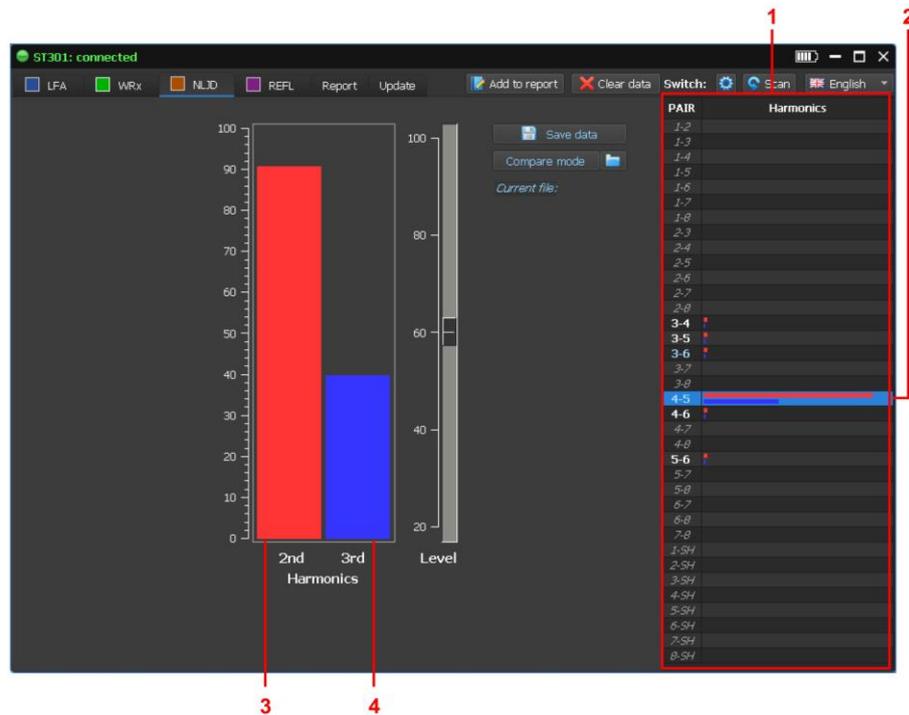


Fig.75

Attention! If a voltage exceeding 3 V is present in any pair of wires, the supply of the probing signal to this pair is blocked. A message appears in the corresponding row: **>3V**

8.4.2. TEST RESULT SAVING

Test results and current parameters of the NLJD can be saved on a PC as a file with the extension **.nljd**

SAVED DATA:

- Switch settings,
- probing signal level,
- response levels at frequencies of 2 and 3 harmonics on each combination of wires.

When retesting this cable, this information will be used to compare with the results of the current test.

To save the data, click  (Fig. 74, item 7). A window for entering comments appears on the screen. It is recommended to indicate the identification data of the cable under test and the level of the probing signal.

Comment:

The date and time of testing will be indicated in the properties of the created file. After entering the comment, click "Save". The file is saved according to the standard WIDOWS procedure with the location and file name.

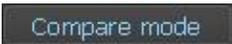
8.4.3. COMPARISON MODE

The mode is used during periodic testing of the same object to compare the results of the current test with the saved results.

Procedure:

1. Download the saved file by clicking  (Fig.74, item 8). After loading, the indicator (Fig.67, item 9) will display the file name and the entered comment.

Current file: 4565432.nljd
TL: 456-54-32

2. Set the level of the probing signal, from the comment
3. Configure the Switch according to the type of cable being tested. ([item 8.1.6](#)).
4. Begin scanning ([item 8.4.1](#)).
5. After scanning, click  ([Fig.67, item 6](#)).

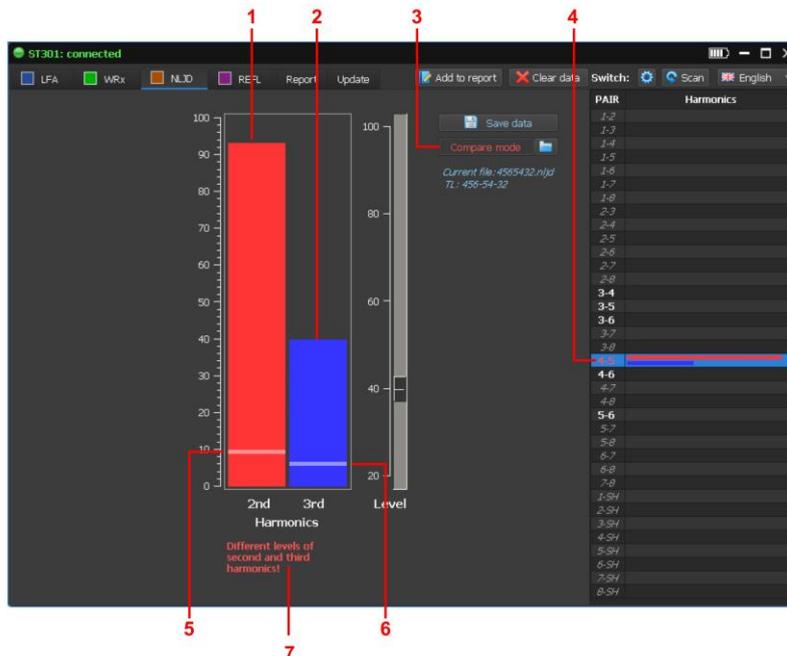


Fig.76

The color of the label on the button (Fig. 76, item 3) will change from blue to red. In the Switch table, the numbers of wire pairs in which the response levels have changed (relative to the saved) are highlighted in red (Fig.76, item 4).

When setting the tabular cursor on this row, the indicator will display:

- saved second and third harmonics levels (Fig.76, item 5 and item 6 respectively);

- current levels of second and third harmonics (Fig.76, item 1 and item 2 respectively). The mismatch message is displayed below the indicator. (Fig.76, item 7).

Fig. 76 shows the situation when the current levels of the second and third harmonics on the "4-5" pair significantly exceed the previously measured ones.

This may be due to the appearance of nonlinearity when connecting an electronic device to the cable.

It is possible that the current response levels are less than previously measured (Fig.77).

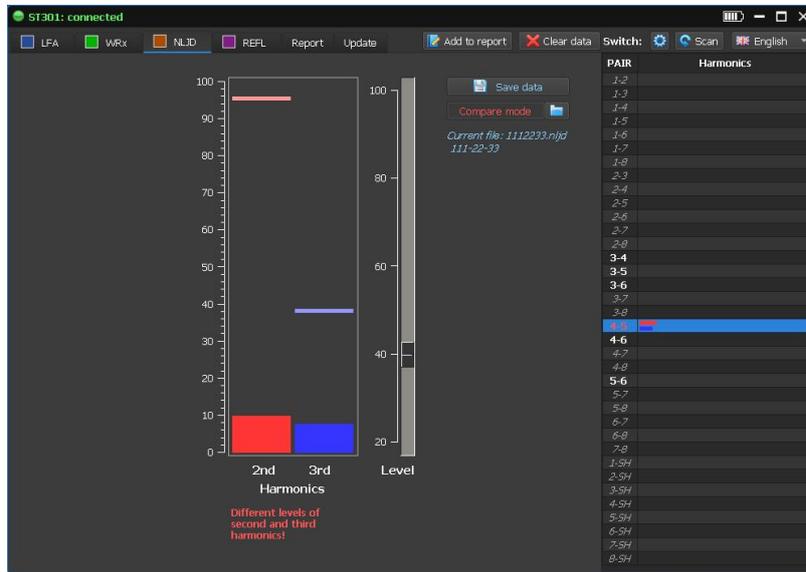


Fig.77

Attention! If the level of the probe signal does not correspond to the level in the saved file, when the comparison mode is activated, the message appears on the screen:

Different levels of the probing signal (in the file - <XX%>)

In this case, set the level of the probing signal corresponding to the saved level and re-scan.

8.4.4. REPORT MODE

To create report files click . The menu will be displayed on the screen (Fig. 78) with a list of information that can be saved.



Fig.78

After selecting screenshots and tables and clicking , the program generates files with specific names and extensions.

When using NLJD, it is possible to save graphic information (Fig.79) as PNG files:

- screenshot of the level 2 and 3 harmonics indicator ("Harmonics" check box);

- Switch table screenshot ("Switch" check box).

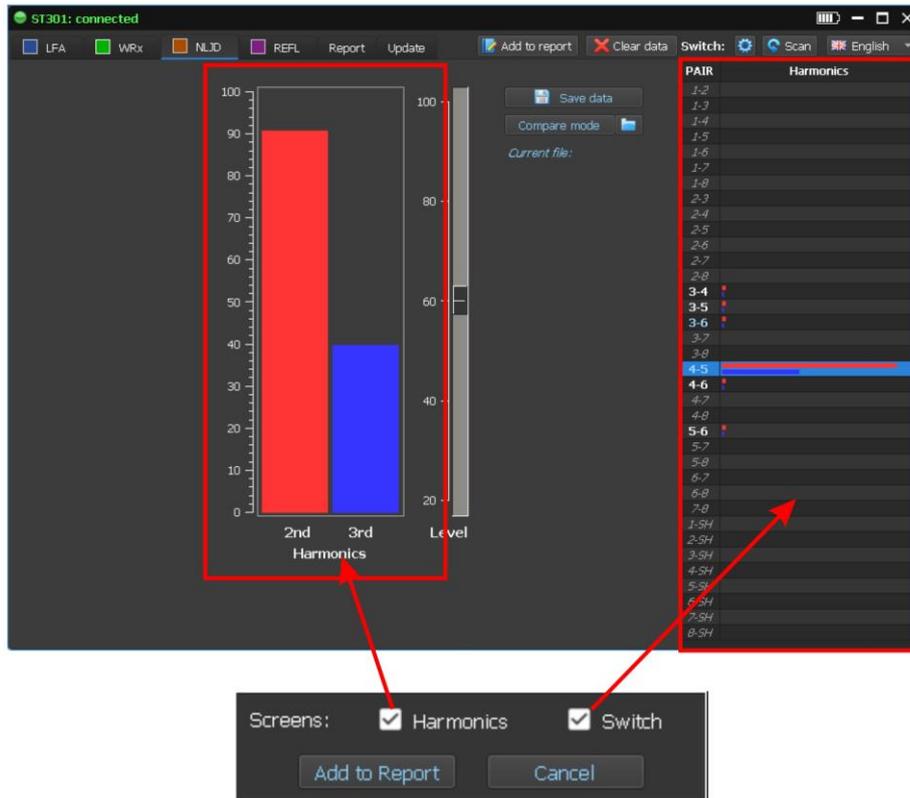


Fig.79

Sample the file names:

1. Screenshot of the level 2 and 3 harmonics indicator (PNG file):

nljd_1-6_120901.png

nljd – NLJD device;
 1-6 – the connected pair of wires;
 120901 – file creation time (hour_min_sec).

2. Switch table screenshot (PNG file):

nljd_sw_120901.png

nljd – NLJD device;
 sw – Switch;
 120901 – file creation time (hour_min_sec).

Saved files are located in the "NLJD" folder of the corresponding session. To view it, click on the "NLJD data" tab ([Fig.68](#)). Operating with files is described in [item 8.2.7.3](#).

8.5. REF

To turn on REF click  PC screen is shown in Fig.80.

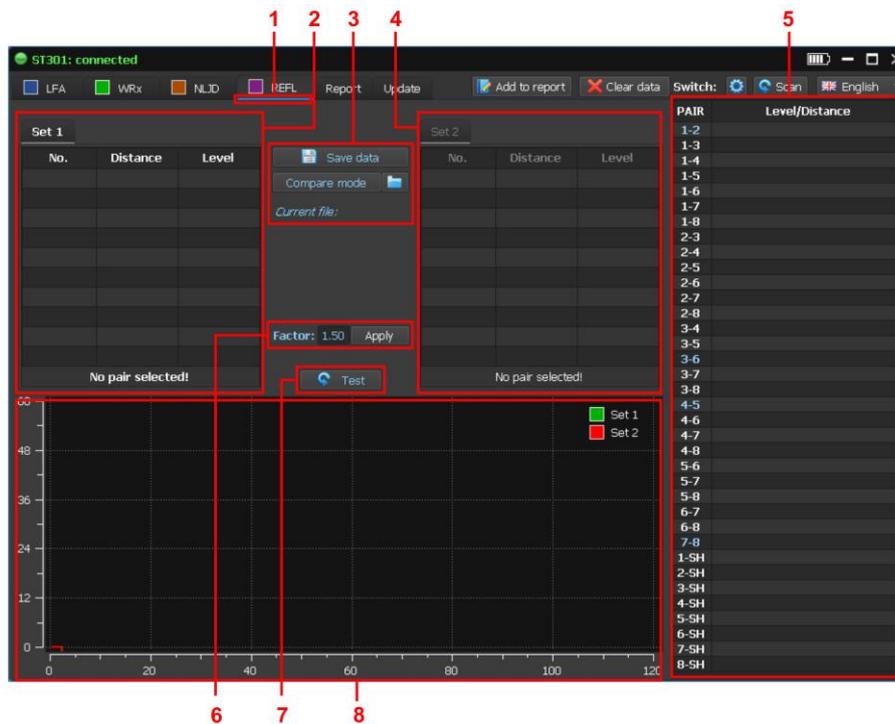


Fig.80

In Fig.80:

- 1 - REF is on
- 2 - result table "Set 1"
- 3 - control of saving and loading measurement results
- 4 - result table "Set 2"
- 5 - Switch table
- 6 - Shortening Factor setting
- 7 - single test on the connected pair
- 8 - reflectogram

8.5.1. THE SWITCH CONFIGURATION PROCEDURE

The Switch configuration procedure is described in [item 8.1.6](#). Particular attention should be paid to configuring the Switch when testing cables consisting of twisted pairs of wires.

This is due to the nature of the [response structure in such cables](#).

8.5.2. SHORTENING FACTOR SETTING

The default setting of Shortening Factor = 1,50.

To change it, input the new value (Fig. 81, item 1) and click the "Apply".



Fig.81

The screen will display a request:



If confirmed ("Yes"), all previous results will be deleted. The indicator (Fig. 81, item 1) will display the new value of the Shortening Factor. Otherwise ("No") Shortening Factor and earlier measurement results will not change

REF MODES:

- AUTOMATED mode;
- MANUAL mode;
- COMPARISON mode;
- REPORT mode.

8.5.3. AUTOMATED MODE

In this mode, each combination of wires is tested. To turning on (off) the mode, click  Test results are displayed in the Switch table (Fig.80, item 5 or Fig.82).

For each pair (Fig. 82, pos. 1), the distance to the heterogeneity with the maximum response level (Fig. 82, pos. 2) and the response level (Fig. 82, pos. 3) are displayed.

PAIR	Level/Distance
1-2	54.6 m
1-3	50.4 m
1-4	50.4 m
1-5	50.4 m
1-6	50.4 m
1-7	51.0 m
1-8	51.0 m
2-3	50.4 m
2-4	50.4 m
2-5	50.4 m
2-6	50.4 m
2-7	51.0 m
2-8	51.0 m
3-4	50.4 m
3-5	50.4 m
3-6	55.8 m
3-7	50.4 m
3-8	50.4 m
4-5	55.2 m
4-6	50.4 m
4-7	50.4 m
4-8	50.4 m
5-6	50.4 m
5-7	50.4 m
5-8	50.4 m
6-7	50.4 m
6-8	50.4 m
7-8	54.0 m
1-SH	
2-SH	
3-SH	
4-SH	
5-SH	
6-SH	
7-SH	
8-SH	

Fig.82

Attention!

- If a voltage of more than 3V is present in it when testing a pair of wires, the signal supply to this pair is blocked. In the row of the table will indicate: **>3V**.
- In the presence of large external interference on the cable (including de-energized), the operation of the reflectometer will be blocked. In the row of the table will indicate: **"Noise"**
- If due to the long cable length or significant attenuation it is not possible to get a response (even from the end of the cable) in the row of the table will indicate: **"No defects!"**

8.5.4. MANUAL MODE

MANUAL mode is used to test two-wire cables or a pair of multi-wire cable to obtain more detailed information about the heterogeneity in the cable than in AUTOMATED mode.

In AUTOMATED mode, the screen displays only the distance to one heterogeneity, with a maximum response level.

In MANUAL mode, the screen displays:

- result tables of "Set 1" and "Set 2" with information about all detected heterogeneities in a pair of wires (Fig. 83, item 1 and item 3);
- reflectogram (Fig. 83, item 1).

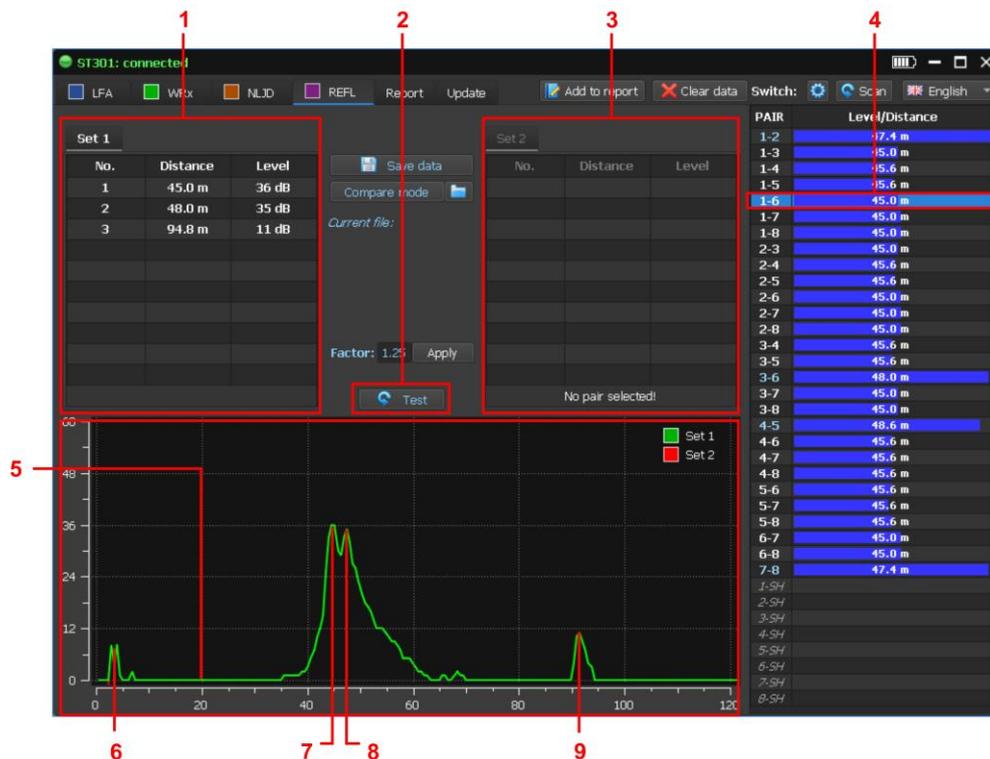


Fig.83

RESULT TABLES ("Set 1" and "Set 2")

Result tables displayed all detected responses in the connected pair of wires (Fig. 83, item 4). Data can be obtained after a single test of this pair or after a test cycle in AUTOMATED mode.

Each row corresponds to one detected heterogeneity. The row displays the number of heterogeneity ("No."), the distance to the heterogeneity ("Distance") and the level of response

from the heterogeneity ("Level").

Two tables ("Set 1" and "Set 2") are displayed. It is possible to operate with only one (active) table. In the active table, data is displayed in white (Fig. 83, item 1). In an inactive table, data is displayed in gray (Fig. 83, item 3). To activate a table, click on it.

8.5.5. REFLECTOGRAM

Reflectogram is a graphical form for displaying cable test results using REF. The distance is displayed on the horizontal axis, and the response level in the connected pair is displayed on the vertical axis.

The reflectogram of the active table of measurement results is displayed. The reflectogram of the "Set 1" table is displayed in green (the "Set 2" table in red).

When comparing the results of two tests, both reflectograms are displayed. The reflectogram associated with the active table is superimposed on the reflectogram associated with the inactive table.

When combining the mouse cursor with a reflectogram, the distance to the heterogeneity and the corresponding response level are displayed (near the cursor icon).

Fig. 83 shows a reflectogram obtained by testing the pair "1-6", which is associated with the active table "Set 1".

REFLECTOGRAM INTERPRETATION (in Fig.83):

- 6 - response from the computer socket at a distance of 3 m. In the tables "Set 1" and "Set 2", responses received at a distance of less than 5 meters are not displayed.
- 7 - response from the end of the cable (45 m.)
- 8 - harmonic of the response from the computer socket and the end of the cable (48 m.)
- 9 - harmonic of the response from the end of the cable (94.5 m.)

8.5.6. TEST RESULT SAVING

REF parameters and test results can be saved on the PC HDD to a file with the extension **.refl**. When retesting this cable, this information will be used to compare with the results of the current test.

SAVED DATA:

- Switch settings
- Shortening Factor value
- capacitive coupling levels of all tested pair of wires
- distances to all detected heterogeneities and response levels from them (for each pair)

To save the data, click  (Fig. 80, item 3). A window for entering comments appears on the screen.

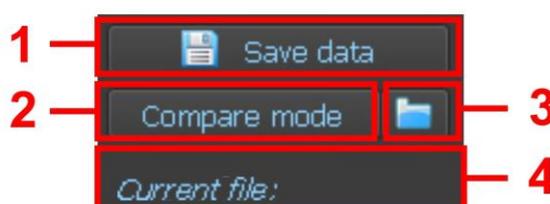
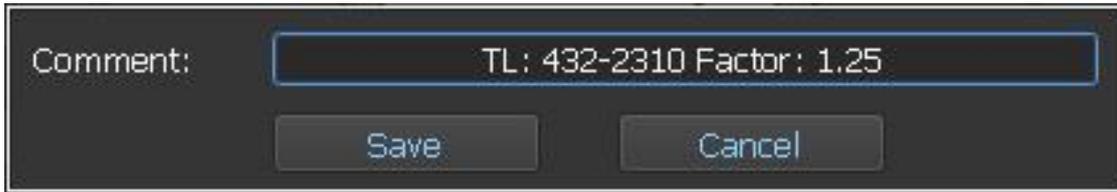


Fig.84

A screen for entering comments will appear on the screen (cable identification data and the value of the Shortening Factor used with the test).



The date and time of testing will be indicated in the properties of the created file. After entering the comment, click "Save". The file is saved according to the standard WIDOWS procedure with the location and file name.

8.5.7. COMPARISON MODE

The comparison mode allows to get information about the change in the heterogeneity in the pairs of wires of the cable being tested after the previous test (if this data was saved). This mode is convenient for periodic testing of the same cable.

Procedure:

1. Download the saved file by clicking  (Fig.84, item 3). After loading, the indicator (Fig.84, item 4) will display the file name and the entered comment.

The Switch will be configured according to the saved settings.

2. Set the Shortening Factor specified in the file comments.
3. Click  (begin a measurement cycle in all combinations of connected wires). After the scan is completed, the Switch table (for each pair of wires) displays information about the connection structure and the distance to the heterogeneity with the maximum level of response.
4. Click  The label on the button will turn red (Fig. 85, item 1). In the Switch table, the numbers of pairs in which changes are detected will be highlighted in red (Fig. 85, item 2). When setting the tabular cursor on such a row, the test results will be displayed in the "Set 1" and "Set 2" tables. Differing parameters will be highlighted in red (Fig. 85, item 4 and item 5). The information field (Fig. 85, item 3) displays the changes.

Two reflectograms will be displayed on the screen (Fig.85, item 6):

- reflectogram in green color - current test results,
- reflectogram in red color - based on saved data.

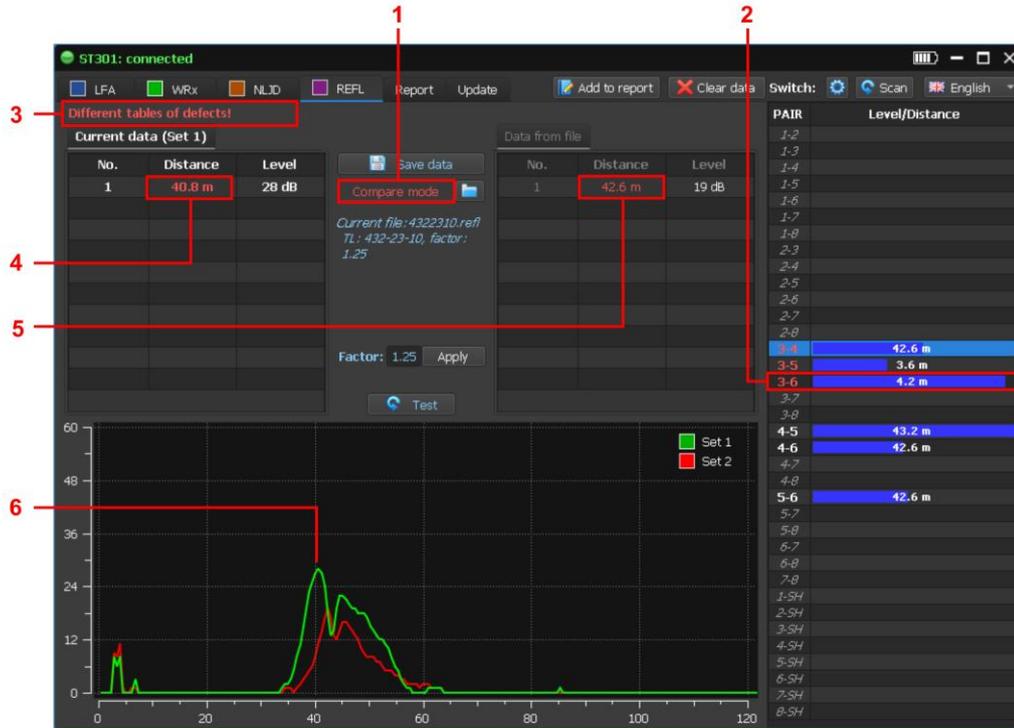


Fig.85

Fig. 85 (as an example) compares the test results of a telephone cable. The tabular cursor (Fig.85, item 2) is set to the pair "3-6" (the pair number is highlighted in red), where the changes were detected.

Analyzing the tables and reflectogram, it can be concluded that a new heterogeneity appears at a distance of 40 meters (about 3 meters from the end of the cable).

This heterogeneity is visible on the reflectogram (Fig.85, item 6).

Messages in the information line when comparing test results

Message	Explanations
No data in the file for this pair!	There are no saved measurement results on this pair. The results of current measurements have nothing to compare.
No new measurements for this pair!	The saved file contains the measurement results. There were no measurements in the current measurement cycle.
In the file - the noise. In the current data - no.	In the saved file, an unacceptable level of "noise" was recorded on this pair. This level was not detected in the current measurement cycle.
In the file - more than 3v. In the current data - no.	In the saved file, a voltage of more than 3V was recorded in this pair. There are no measurements in the current cycle
In the current data - the noise. In the file - no.	In the current measurement cycle, an unacceptable level of "noise" was detected in this pair. There was no "noise" in the saved file in this pair.
In the current data - more than 3v. In the file - no.	In the current measurement cycle, a voltage of more than 3V is detected. In the saved file, this pair was de-energized.
In the file - the noise. In the current data - more than 3v.	In the saved file, an unacceptable level of "noise" was detected on this pair. In the current measurement cycle on this pair, the voltage is more than 3V.

Message	Explanations
In the file - more than 3v. In the current data - the noise.	In the saved file, a voltage greater than 3V was recorded on this pair. An unacceptable "noise" level was detected on this pair in the current measurement cycle.
In the file - the noise. In the current data - no defects.	In the saved file, an unacceptable level of "noise" was detected on this pair. In the current measurement cycle, this pair did not have a single response.
In the file - more than 3v. In the current data - no defects.	In the saved file, a voltage greater than 3V was recorded on this pair. In the current measurement cycle, this pair did not have a single response.
In the file - there are defects. In the current data - no defects.	In the saved file, at least one response from heterogeneity was received on this pair. In the current measurement cycle, this pair did not have a single response.
Different tables of defects!	Parameters of heterogeneities in the saved file and in the results of current measurements are different

8.5.8. REPORT mode

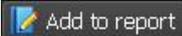
To create report files click . The menu will be displayed on the screen (Fig. 86) with a list of information that can be saved.



Fig.86

When using REF, it is possible to save (Fig.86):

1. Graphic information as PNG format files ("Screens"):

- Reflectogram screenshot ("Graph" check box)
- Switch table screenshot ("Switch" check box)

2. Tabular data as MS Excel files ("Tabs").

- results of the last measurement on one pair ("Defects table" check box)
- measurement results for all cable pairs ("All pairs" check box)
- comparison of the results of two measurements on one pair ("Compare data" check box). Saving is available only when the "Compare mode" is on (item 8.5.7).

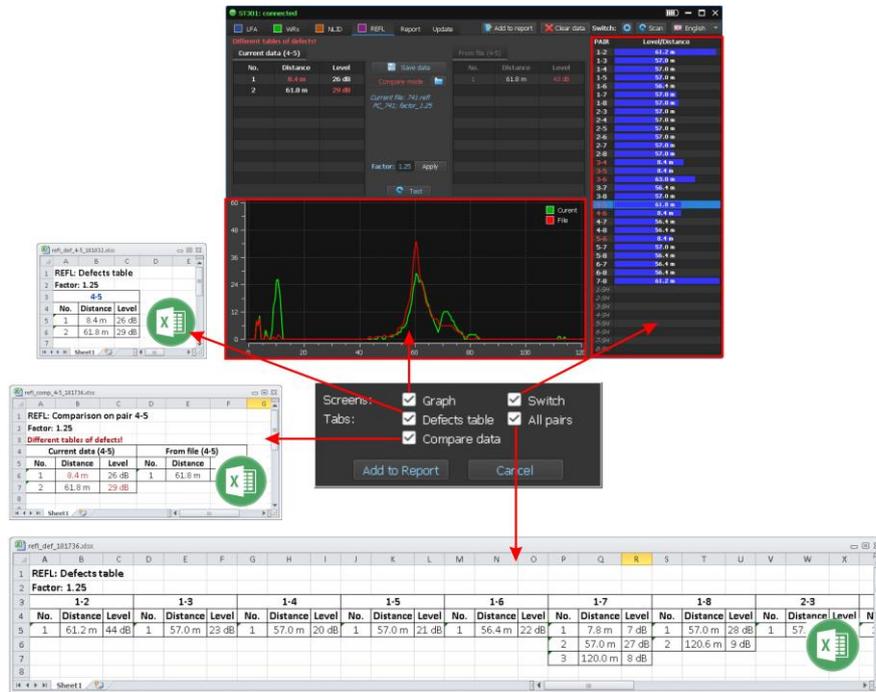


Fig.87

Sample the file names:

1. Results of the last measurement on one pair (MS Excel file):

refl_def_1-7_105826.xlsx

refl – REF device;
 def – heterogeneity response table;
 1-7 – the connected pair of wires;
 105826 – file creation time (hour_min_sec).

2. Comparison of the results of two measurements on one pair (MS Excel file):

refl_comp_1-3_105047.xlsx

refl – REF device;
 comp – measurement comparison table;
 1-3 – the connected pair of wires;
 105047 – file creation time (hour_min_sec).

3. Measurement results for all cable pairs (MS Excel file):

refl_def_105826.xlsx

refl – REF device;
 def – heterogeneity response table;
 105826 – file creation time (hour_min_sec).

4. Reflectogram screenshot (PNG file):

refl_def_105826.png

refl – REF device;
 def – heterogeneity response table;
 105826 – file creation time (hour_min_sec).

5. Switch table data (MS Excel file):

refl_sw_105047.png

refl – REF device;
 sw – Switch;
 121317 – file creation time (hour_min_sec).

Saved files are located in the "REF" folder of the corresponding session. To view it, click on the "Refl data" tab ([Fig.68](#)). Operating with files is described in [item 8.2.7.3](#).

8.5.9. REF MODES

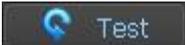
1. Testing in AUTOMATED mode

1. Connect test cable to the Analyzer.
2. Configure the Switch according to the type of cable being tested.
3. Set the Factor.
4. Click  and wait for the end of the measurement cycle.
5. Analyze the test results, taking into account the [typical connection structure of the cable](#) under test.

2. Analysis of the responses received in AUTOMATED mode in the selected pair

After testing in AUTOMATED mode, set the cursor (in the Switch table) to the pair of wires of interest. In the active measurement table, the response parameters on the connected pair will be displayed, on the screen - the reflectogram associated with this table.

3. Repeated one-time test on the selected pair

1. In the Switch table, set the cursor on the pair of wires of interest.
2. Click 

In the active measurement table, the response parameters on the connected pair will be displayed, on the screen - the reflectogram associated with this table.

4. Comparison of test results of two different pairs of the same cable

1. After testing in AUTOMATED mode, place the cursor in the Switch table on one of the pairs of wires. In the active measurement table, the response parameters on the connected pair will be displayed, on the screen - the reflectogram associated with this table.

2. Click on an inactive table (to activate it).
3. Set the cursor in the Switch table to another pair of wires. The activated measurement table displays the parameters of the detected responses on the second pair. Two reflectograms corresponding to the results of measurements on one and on the other pairs will be displayed on the screen.
4. To analyze the results (two tables of measurements and the reflectograms).

5. Comparison of the results of two measurements taken from different ends of the cable.

1. Activate the table "Set 1".
2. Test cable in AUTOMATED mode.
3. Save the test results (item 8.5.6.).
4. Go to the other end of the cable.
5. Connect the cable to the main unit.
6. Turn on the Analyzer and the PC.
7. Run the program (REF).
8. Perform testing in AUTOMATED mode.
9. Download the file with the test results of this cable from the opposite end
10. Turn on the COMPARISON MODE (item 8.5.7).
11. Analyze the result.

If the cable does not have heterogeneities, the results in both tables should be the same or very close (in the Switch table, no pair should be highlighted in red). Reflectograms must also be the same.

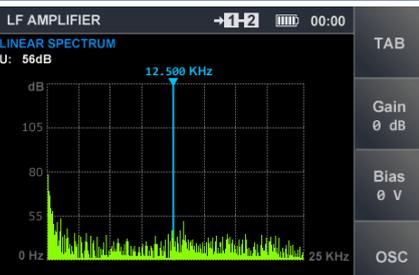
REFERENCE INFORMATION

9. CONTROLS

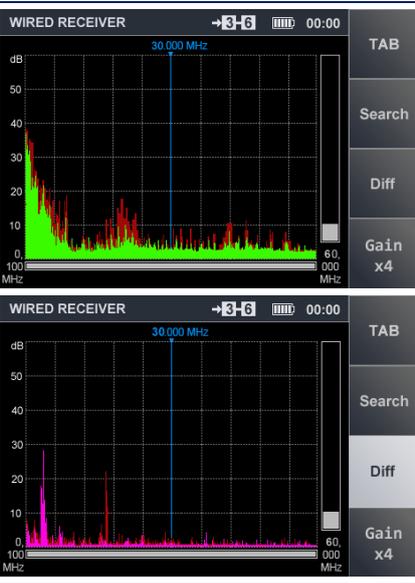
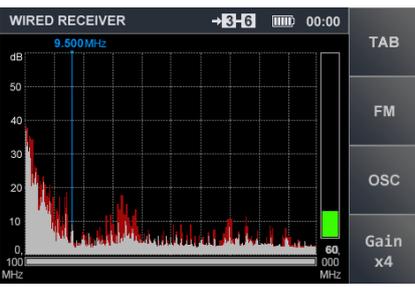
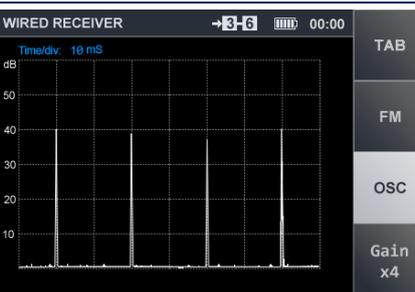
9.1. INITIAL SETTINGS

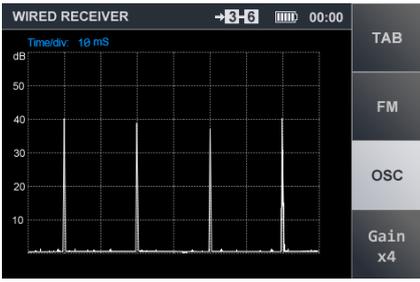
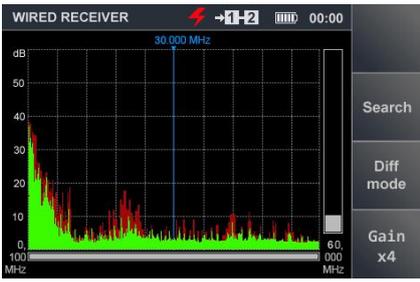
	Button	Action
ANALYZER MAIN MENU		
	F1	Turning on LFA
	F2	Turning on WR
	F3	Turning on NLJD
	F4	Turning on REF
	↑ ↓	Tabular cursor move
	ENTER	Action confirmation
SETTINGS		
	↑ ↓	Tabular cursor move
	ENTER	Action confirmation
	ESC	Go to Analyzer main menu
SETTING THE DATE		
	↑ ↓	Choice of a position
	↑ ↓	Correction of value
	ENTER	Save and exit
	ESC	Exit without saving
SETTING THE TIME		
	↑ ↓	Choice of a position
	↑ ↓	Correction of value
	ENTER	Save and exit
	ESC	Exit without saving
ELECTRONIC SWITCH SETTING		
	ESC FUNC	Switching in the previous screen
	F1	Exception/connection of contact "Cable shield"
	↑ ↓	Cable type selection ("Twisted"/"Non- twisted" pair)
	↑ ↓	Number of contact setting
	ENTER	Exception/connection of contacts

9.2. LFA

	Button	Action
SWITCH TABLE		
	ESC MODE	Go to Analyzer main menu
	FUNC	Turning on SWITCH SETTING mode
	ENTER F1	Turning on OSCILLOSCOPE
	F2	Turning on GAIN SETTING
	F3	Turning on BIAS VOLTAGE SETTING
	F4	Turning on AUTOMATED mode
		Tabular cursor move
GAIN SETTING		
		Increase
		Reduce
	F2	Turning off GAIN SETTING
BIAS VOLTAGE SETTING		
		Increase
		Reduce
		Bias voltage polarity reversal
	ENTER	Setting of bias voltage = "0"
	F3	Turning off BIAS VOLTAGE SETTING
OSCILLOSCOPE		
	ESC, F1 MODE	Switching in the CONTROL of the SWITCH mode
	MODE	Go to Analyzer main menu
	F2	Turning on GAIN SETTING
	F3	Turning on BIAS VOLTAGE SETTING
	F4	Turning on SPECTRUM ANALYZER
		Scaling on Y axis
	Scaling on Time axis	
SPECTRUM ANALYZER		
	ESC, F1	Turning on SWITCH CONTROL mode
	MODE	Go to Analyzer main menu
	F2	Turning on GAIN SETTING
	F3	Turning on BIAS VOLTAGE SETTING
	F4	Turning on SPECTRUM ANALYZER
		Marker move

9.3. WR

	Button	Action
LOW-CURRENT CABLES TEST		
SWITCH TABLE		
	ESC MODE	Go to Analyzer main menu
	FUNC	Turning on SWITCH SETTING mode
	F1 ENTER	Turning on the PANORAMA mode
		Tabular cursor move
PANORAMA mode / DIFFERENTIAL mode		
	MODE	Go to Analyzer main menu
	FUNC	Turning on SWITCH SETTING mode
	ESC, F1	Turning on SWITCH CONTROL mode
	F2	Turning on AUTOMATED mode
	F3	Turning on/off DIFFERENTIAL mode
	F4	Gain setting, turn on/off an attenuator
	ENTER	Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
		Zoom + ¹
	Zoom - ¹	
	Marker move (frequency setting)	
¹ - Scaling happens concerning the set frequency (on a marker)		
PANORAMA mode, Signal Analysis at a Fixed Frequency		
	MODE	Go to Analyzer main menu
	F1	Turning on SWITCH CONTROL mode
	ESC ENTER	Switching to PANORAMA mode
	F2	Switching of AM/FM demodulators
	F3	Turning on OSCILLOSCOPE
	F4	Gain setting, turn on/off an attenuator
	Marker move (frequency setting)	
OSCILLOSCOPE, turned on from the PANORAMA mode (Signal Analysis at a Fixed Frequency)		
	MODE	Go to Analyzer main menu
	F1	Turning on SWITCH CONTROL mode
	F2	Switching of AM/FM demodulators
	F3 ESC	Turning off SIGNAL ANALYSIS AT A FIXED FREQUENCY
	F4	Gain setting, turn on/off an attenuator
	Scaling on Time/div axis	

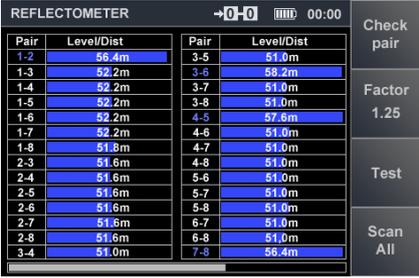
	Button	Action
The AUTOMATED mode (the main table)		
	MODE	Go to Analyzer main menu
	ESC	Switching to PANORAMA mode
	F1	Turning on SWITCH CONTROL mode
	F2	Switching of AM/FM demodulators
	F3	Turning on OSCILLOSCOPE
	F4	Gain setting, turn on/off an attenuator
	ENTER	Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
	Tabular cursor move	
The AUTOMATED mode, Signal Analysis at a Fixed Frequency		
	MODE	Go to Analyzer main menu
	ESC	Switching to AUTOMATED mode
	ENTER	Switching to AUTOMATED mode
	F1	Turning on SWITCH CONTROL mode
	F2	Switching of AM/FM demodulators
	F3	Turning on OSCILLOSCOPE
	F4	Gain setting, turning on/off an attenuator
	Tabular cursor move	
	Frequency setting	
OSCILLOSCOPE. Turned on from the AUTOMATED mode, Signal Analysis at a Fixed Frequency		
	MODE	Go to Analyzer main menu
	F1	Exit to the Table (SWITCH CONTROL mode)
	F2	Switching of AM/FM demodulators
	F3, ESC	Exit to the table (SIGNAL ANALYSIS AT A FIXED FREQUENCY)
	F4	Gain setting, turning on/off an attenuator
	Scaling on Time/div axis	
POWER MAINS TEST		
PANORAMA mode / DIFFERENTIAL mode		
	MODE	Go to Analyzer main menu
	ESC	Go to Analyzer main menu
	F2	Turning on AUTOMATED mode
	F3	Turning on/off DIFFERENTIAL mode
	F4	Gain setting, turning on/off an attenuator
	ENTER	Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
		Zoom + ²
	Zoom - ²	
	Marker move (frequency setting)	
² - Scaling happens concerning the set frequency (on a marker)		

	Button	Action
PANORAMA mode, Signal Analysis at a Fixed Frequency		
	MODE	Go to Analyzer main menu
	ESC ENTER	Exit to the PANORAMA mode
	F2	Switching of AM/FM demodulators
	F3	Turning on OSCILLOSCOPE
	F4	Gain setting, turning on/off an attenuator
		Marker move (frequency setting))
OSCILLOSCOPE. Turned on from the PANORAMA mode, Signal Analysis at a Fixed Frequency		
	MODE	Go to Analyzer main menu
	F2	Switching of AM/FM demodulators
	F3, ESC	Turning off OSCILLOSCOPE. Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
	F4	Gain setting, turning on/off an attenuator
		Scaling on Time/div axis
The AUTOMATED mode		
	MODE	Go to Analyzer main menu
	ESC	Exit to the PANORAMA mode
	F2	Switching of AM/FM demodulators
	F3	Turning on OSCILLOSCOPE
	F4	Gain setting, turning on/off an attenuator
	ENTER	Turning on SIGNAL ANALYSIS AT A FIXED FREQUENCY
	Tabular cursor move	
The AUTOMATED mode, Signal Analysis at a Fixed Frequency		
	MODE	Go to Analyzer main menu
	ESC ENTER	Go to the table of the AUTOMATED mode
	F2	Switching of AM/FM demodulators
	F3	Turning on OSCILLOSCOPE
	F4	Gain setting, turning on/off an attenuator
		Tabular cursor move
		Frequency setting
	OSCILLOSCOPE. Turned on from the AUTOMATED mode, Signal Analysis at a Fixed Frequency	
	MODE	Switching to Analyzer main menu
	F2	Switching of AM/FM demodulators
	F3 ESC	Turning off OSCILLOSCOPE. Go to the table (Signal Analysis at a Fixed Frequency function)
	F4	Gain setting
		Scaling on Time/div axis

9.4. NLJD

	Button	Action
NLJD main menu		
	MODE ESC	Go to Analyzer main menu
	FUNC	Turning on SWITCH SETTING mode
	F2	Turning on PROBING SIGNAL LEVEL ADJUSTMENT
	F4	Turning on AUTOMATED mode
		Tabular cursor move
PROBING SIGNAL LEVEL SETTING		
		PROBING SIGNAL LEVEL SETTING (%)
	F2	Turning off PROBING SIGNAL LEVEL SETTING

9.5. REF

	Button	Action
REF main menu		
	MODE ESC	Go to Analyzer main menu
	FUNC	Turning on SWITCH SETTING mode
	F1	Turning on the MANUAL mode
	F2	Turning on SHORTENING FACTOR setting
	F3	Turning on the single test on the connected pair
	F4	Turning on the AUTOMATED mode
	Tabular cursor move	
SHORTENING FACTOR SETTING		
		Selecting cursor position
		Setting Shortening Factor
	F2 ENTER	Save and exit
ESC	Exit without saving	
MANUAL mode		
	MODE	Go to Analyzer main menu
	FUNC	Turning on SWITCH SETTING mode
	ESC F1	Turning off the MANUAL mode, go to REF main menu
	F2	Turning on/off Factor setting
	F3	Turn on the single test (in the active table)
	Switching of the active table (SET1/SET2)	

10. INFORMATION ON CABLES

10.1. "TWISTED PAIR" TYPE CABLE

"Twisted pair" type cable is one or several pairs of insulated wires twisted together (with a small number of turns per unit length), covered with plastic.

Twisting is carried out in order to reduce electromagnetic interference from external sources and mutual interference during signal transmission.

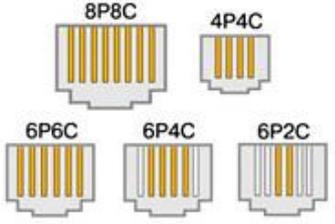
"Twisted pair" type cable is one of the components of structured cabling systems, is used in telecommunications and computer networks.

The most common cables are four, two and one twisted pairs of wires.

10.2. RJ CONNECTORS

RJ (Registered Jack) - a standardized interface that describes the design of both parts of the connector ("plug" and "socket") and their switching options.

There are standards RJ11, RJ14, RJ25, RJ45 and others.

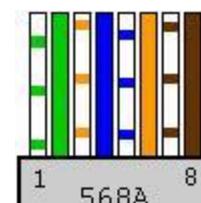
Standard	Scheme	Purpose
RJ9	4P4C	Connecting the handsets to the telephone
RJ11	6P2C	Connecting 2-wire telephones
RJ12	6P6C	Connecting 6-wire telephones
RJ11	6P4C	Connecting 4-wire telephones
RJ21	50-pin	Connection of PBX or other telecommunication equipment
RJ25	6P6C	Connecting 6-wire telephones
RJ45S	8P4C with key	Modem connecting
RJ45	8P8C	LAN connecting
RJ50	10P10C	UPS (American Power Conversion and Eaton Corporation)
		<p>xPyC designation:</p> <p>"xP"- number of positions in the plug or in the socket "yC"- number of contacts in the plug or in the socket</p>

10.3. WIRING OF A CABLE CONSISTING OF FOUR TWISTED PAIRS OF WIRES

For Ethernet 10Base-T and 100Base-T, orange and green pairs are used. The remaining pairs are reserved for the Gigabit Ethernet standard (1000Base-T). There are two options for wiring 568A or 568B. The most commonly used option is 568B.

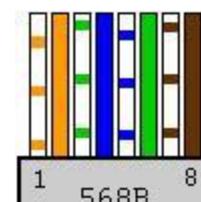
EIA/TIA-568A WIRING SCHEME

1 st connector #	Color of wire	2 nd connector #
1	white and green (TX+)	1
2	green (TX-)	2
3	white and orange (RX+)	3
4	blue	4
5	white and blue	5
6	orange (RX-)	6
7	white and brown	7
8	brown	8



EIA/TIA-568B WIRING SCHEME

1 st connector #	Color of wire	2 nd connector #
1	white and orange (TX+)	1
2	orange (TX-)	2
3	white and green (RX+)	3
4	blue	4
5	white and blue	5
6	green (RX-)	6
7	white and brown	7
8	brown	8



10.4. CROSSOVER CABLE WIRING SCHEME

A crossover cable is used to connect directly the network cards of two PCs. A crossover cable is a cable, one end of which is crimped according to option 568A, and the other end according to option 568B. The same wiring is used to connect the hubs.

1 st connector #	Color of wire	2 nd connector #
1	white and green (TX+)	3
2	green (TX-)	6
3	white and orange (RX+)	1
4	blue	4
5	white and blue	5
6	orange (RX-)	2
7	white and brown	7
8	brown	8

Other options for connecting two PCs using a crossover cable are presented in the table:

1st CONNECTOR #	COLOR OF WIRE	2nd CONNECTOR #
OPTION #1		
1	white and green (TX+)	3
2	green (TX-)	6
3	white and orange (RX+)	1
4	blue	7
5	white and blue	8
6	orange (RX-)	2
7	white and brown	4
8	brown	5
OPTIONS #2		
1	white and orange (TX+)	3
2	orange (TX-)	6
3	white and green (RX+)	1
4	blue	7
5	white and blue	8
6	green (RX-)	2
7	white and brown	4
8	brown	5

10.5. WIRING OF A CABLE CONSISTING OF THREE, TWO, AND ONE PAIR OF WIRES

RJ connector pin #	RJ25	RJ14	RJ11	Contemporary coloring	Obsolete coloring
1	X			white and green	orange
2	X	X		white and orange	black
3	X	X	X	blue	red
4	X	X	X	white and blue	green
5	X	X		orange	yellow
6	X			green	blue

10.6. TELEPHONE CABLES

By the type of switching, analog, hybrid and digital PBX are distinguished. Hybrid PBXs differ from digital in the way they switch signals. In digital PBXs, the voice frequency signal is converted to a coded digital electrical signal, which is then switched.

The term "hybrid lines" means that both system and analog phones can be connected to such lines. In hybrid PBX, "non-digitized" (analogue electrical tone signal without conversion) is switched.

Cable type	Purpose	User device
two-wire, analogue	municipal telephone cable, analogue office PBX	analogue telephone
two-wire, digital	PBX digital cable	digital telephone
four-wire, digital	PBX digital cable	digital system telephone
four-wire, hybrid	PBX hybrid cable	analogue system telephone

CABLES USED IN TELEPHONE LINE

Cable type	RJ connector	RJ connector pin #	Wire coloring	
			Modern	Obsolete
2-wire analog	RJ-9	2-3 – analog signal	green orange	red green
	RJ-11/14/25	3-4 – analog signal	white and blue blue	red green
2-wire digital	RJ-11/14/25	3-4 – digital signal	white and blue blue	red green
4-wire digital	RJ-14/25	3-4 – digital signal	white and blue blue	red green
		2-5 – PBX commands	white and orange orange	black yellow
4-wire hybrid	RJ-14/25	3-4 – analog signal	white and blue blue	red green
		2-5 – PBX commands	white and orange orange	black yellow