Packet Network Tester and Analyzer MAKS-EM

User Manual Combined with Data Sheet

Contents

List of Abbreviations
1Purpose 5
2Technical Information and Specifications 6
3Scope of Supply 8
4Tester Structure and Operation 9
5Marking 16
6Packaging 17
7General Operation 18
8Safety Precautions 19
9Preparation for Work 20
10 Operation Procedure 21
10.1 Main Menu and Working with the Menu 21
10.2 Process Topology 22
10.3 “Measurement” Menu 23
10.4 Cable Diagnostics 24
10.5 TCP/IP Utilities 25
10.6 Connection Variants 28
10.7 BER Test 30
10.8 Traffic Test 31
10.9 RFC 2544 Method 34
10.10 Packet Jitter 39
10.12 Remote OAM Management 43
10.13 Loopback Testing 44
10.14 Through Mode 46
10.15 Statistics 47
10.16 Memory 49
10.17 Interface Settings 50
10.18 Remote Management 52
10.19 Tester Settings and Options 56
11Calibration Procedure 59
12 Maintenance 65
13 Transportation and Storage 66
14 Product Details 67
Manufacturer’s Warranty 68
Acceptance Certificate 69
Packing Certificate 70
Information on Primary Calibration and Periodic Recalibration 71
Reclamation 72
Appendix A. 74

The present MAKS–EM User Manual is meant to make the user familiar with the Tester characteristics and service instructions to operate it correctly and effectively.

In the present Manual, the following abbreviations and designations are used:

Table 1.1

ARP	Address Resolution Protocol
Back-to-back	Limit Load test
BER	Bit Error Rate
CRC	Cyclic Redundancy Checksum
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DSCP	Differentiated Services Code Point
DUT	Device Under Test
Frame Loss Rate	Frame Loss Rate test
VLAN ID	VLAN Identifier
IFG	Inter Frame Gap
IP	Internet Protocol
IP address	Unique identifier (address) of a device connected to the integrated network on TCP/IP basis
LAN	Local Area Network
Latency	Frame latency test
MAC	Media Access Control
MAC address	Unique identifier (address) used for network devices addressing at the physical level
OAM	Operations Administration Maintenance (Channel status monitoring protocol)
OSI	Open Systems Interconnection Reference Model
QoS	Quality of Service settings
PCP	Precedence Code Point (for VLAN as per IEEE 802.1p)
Ping	Utility used for connection test in TCP/IP-based networks
Precedence	Traffic Precedence
RJ-45	One of Registered Jack standard connectors used for connection of twisted pairs
SFD	Start of Frame Delimiter
SFP	Small Form-factor Pluggable (A transmitter/receiver used for data transmission in telecommunications)
SLA	Service Level Agreement (An agreement on the service level between an operator rendering communication services and a client)
Throughput	Throughput test
ToS	Type of Service

TPID	Tag Protocol Identifier
VID	VLAN Identifier
VLAN	Virtual Local Area Network
VLAN tag	The corresponding field of Ethernet frame
TP	Twisted Pair
SC	Short Circuit
PC	Personal Computer
SW	Software

Conventions

Conventions listed in the table below are used in the present User Manual.

Table 1.2

Description	Example
Text **in bold** shows user's action	press **"Sav**e**"** button
Names of menu items and input & display fields are represented **in bold**	on the **"Statistics"** menu
Text to be entered into menu fields or the PC is displayed in the following font	in the following way: http://192.168.0.111
Paragraphs marked with "**Caution**!" warn the user against a hazardous situation that may damage the equipment or cause bodily injuries.	**Caution!**

1 Purpose

Packet Network Tester and Analyzer MAKS-EM is destined for use while servicing, putting into operation and certifying Ethernet and Gigabit Ethernet networks.

MAKS-EM performs accurate measurements of TP Ethernet (10BASE-T, 100BASE-T, 1000BASE-T) and optical Ethernet (1000BASE-X).

MAKS-EM functional capabilities include:

- Traffic generation and testing at data link, networking and transport levels at two interfaces simultaneously
- RFC 2544-recommended test procedure
- Jitter measurement
- Loopback testing at physical, data link and networking levels
- Channel integrity and IP routes testing
- Received and transmitted traffic statistics collection and display
- Connection between measuring ports (Through mode)
- Copper cable diagnostics
- Remote control via USB port and Ethernet

1.1. Utmost Permissible Operation Conditions

MAKS-EM is a portable Tester designed for operation within the following conditions:

- environment temperature + 5 °C… + 40 °C
- relative air humidity up to 90% at the temperature of + 25 °C
- atmospheric pressure 450 Mmhg (60 kPa) min. and 795 Mmhg (106 kPa) max.

The Tester is powered from battery or AC mains 220 $^{+22V}/_{-33V}$ (if a power unit is used). MAKS-EM is meant for continuous operation during 24 hours.

2 Technical Information and Specifications

The Tester provides:

- support and testing of two fully independent Ethernet/Gigabit Ethernet interfaces
- traffic generation at physical, data link and networking levels
- received and transmitted traffic statistics collection and display (sorting according to frame types, sizes and erroneous frames)
- current test results generation and on-screen display
- RFC 2544-recommended measurements of throughput, latency, frame loss and back-to-back
- channel integrity and IP routes testing: ping, traceroute and DNS support
- loopback at physical, data link, networking and transport levels, with or without MAC and IP swapping
- pass-through connection from one measurement port to another with monitoring and statistics collection (Through mode)
- traffic filtering at data link and networking levels
- cable diagnostics: cable quality, distance to fault, crossover, etc.
- ARP & DHCP support
- remote device detection via Ethernet OAM
- traffic transmission test
- testing in Multistream mode
- packet jitter measurement
- remote control via USB port and separate Ethernet port by means of remote management software
- saved settings and test results storage in internal memory

Specifications

Table 2.1

Characteristics	Description
Interfaces	
Electrical Ethernet/IP	Two RJ45 interfaces 10 Mbps, 100 Mbps,1000 Mbps
Optical Ethernet/IP	Two SFP interfaces 1000 Mbps
Managing interface for connection to PC	USB client, Ethernet 10/100 BASE-T
Display	Graphical, multicolour, 320x240 dpi
Battery	AA NiMH, 6 ea
Weight and Size	
Depth	196 mm
Width	100 mm
Height	40 mm
Weight	0.6 kg
Power	
Stand-alone operation in test mode	up to 4 h
Battery charge time	12 h max.
Supply voltage	12 V
Utmost Permissible Operation Conditions	
Environment temperature	+ 5 °C… + 40 °C
Relative air humidity	up to 90% at the temperature of + 25°C
Atmospheric pressure	450 Mmhg (60 kPa) min. and 795 Mmhg (106 kPa) max.
Other Characteristics	
TST test output pulse amplitude	1.5 V ± 0.5 V

3 Scope of Supply

Table 3.1

Name	Quantity	Note
MAKS-EM Tester and Analyzer	1	
Power unit	1	*
USB cable	1	*
Duplex patch cord	3	*
Duplex optical patch cord	2	**
Test adapter TA1	1	**
Fiber optic SFP module	2	**
Carrier bag	1	*
Software CD	1	
Protective case	1	**
User Manual combined with Data Sheet	1	
* It is possible to use items of other types providing the same characteristics of the Tester		
** Supplied at customer's request		

4 Tester Structure and Operation

4.1. Front Panel

Figure 4.1 shows front panel of the Tester where LED indicators, display and keypad are located.

Figure 4.1 Front Panel

4.1.1. LED Indicators

LED indicators (LEDs) provide visual control of measuring conditions and data transmission/reception.

LEDs are placed directly above the display. Both A and B ports are provided with four LEDs each: Test, Rx, Tx, Link (left to right). Depending on Tester operation modes, LEDs show different types of status information. On the display under LEDs you can find captions describing mode of the Tester and LEDs.

LEDs Description

Test LEDs show port engagement in test fulfillment. At that, they can be of three different colours:

- **green** – either **"Loopback"** or **"Through"** mode is on, or the port is engaged in test fulfillment;
- **orange** – one of unfinished tests containing errors is being fulfilled at the moment;
- **red** – the last test on the port was unsuccessful;

On-screen captions of **Test** LEDs can be as follows:

A->A – traffic transmission topology from port A to port A selected;
A->B – traffic transmission topology from port A to port B selected;
B->A – traffic transmission topology from port B to port A selected;
B->B – traffic transmission topology from port B to port B selected;
BERT – port is busy with **"BER"** test traffic reception/transmission;
CAB – port is busy with cable test signals reception/transmission;
DNS – port is busy with **"DNS"** test packets reception/transmission;
JIT – port is busy with **"Packet Jitter"** test traffic reception/transmission;
LB – **"Loopback"** menu option has been selected;
LB1 – level 1 **"Loopback"** mode is on;
LB2 – level 2 **"Loopback"** mode is on;
LB3 – level 3 **"Loopback"** mode is on;
LB4 – level 4 **"Loopback"** mode is on;
MS – port is busy with **"Multistream"** test traffic transmission and reception
OAM – **OAM** mode is activated;
PING – port is busy with **"Ping"** test traffic reception/transmission;
RFC – port is busy with **"RFC 2544"** test traffic reception/transmission;
THRU – **"Through"** menu has been selected or **"Through"** mode is on;
TRR – port is busy with **"Traceroute"** test packets reception/transmission;
TRAF – port is busy with test traffic data reception/transmission.

Test LED caption is highlighted white in **"Loopback"** and **"Through"** modes. **Test** LED caption is highlighted yellow on **"Process Topology"** menu at traffic generation port and also during tests with traffic generation. **Test** LED caption is highlighted red if the last test performed at that port was not successful;

Rx LEDs report data reception status.
green – frames are being received at the corresponding port.
Green highlighting of **Rx** LED caption reports the port being RFC 2544 test traffic recipient, or **"Loopback"** or **"Through"** modes being on.

Tx LEDs report data transmission.
green – frames are being transmitted at the corresponding port.
Yellow highlighting of **Tx** LED caption reports port engagement in RFC 2544 test traffic reception.

Link LEDs report **connection** status.
Green – the corresponding port is connected
On-screen captions of the LEDs report transmission speed: **1000** for 1000BASE-T and 1000BASE-X, **100** for 100BASE-T, **10** for 10BASE-T, **NS** – no synchronization.

4.1.2. Display

Tester screen is represented by a coloured graphical LCD with 320×240 pixels resolution.

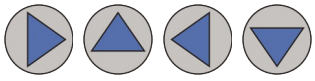
4.1.3. Keypad

The Tester is managed and alphanumeric information is entered by means of the keypad.

Keys

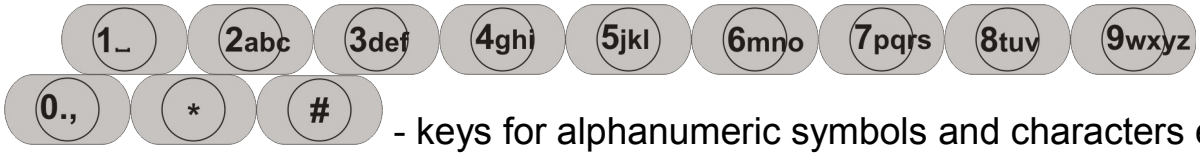
 - **"On/Off" key.** (see Paragraph 9.4).

- functional keys whose functions depend on Tester mode. If the key is available, its dedication will be displayed in the keys description in the lower part of the display.

 - arrow keys.

 - **"Enter"** key. It is used to enter the menu sections or subsections and to change menu options.

 - **"Menu"** key, press it to return to the previous menu or cancel current action.



- keys for alphanumeric symbols and characters entry.

4.1.4. External Connectors

Figure 4.1 shows location of external connectors on the upper, lower and lateral sides.

Назначение разъемов и подключаемые к ним устройства приведены в таблице 4.1.

All connectors are marked on Tester case in accordance with the denominations listed in Table 4.1.

Table 4.1. Purpose of MAKS-EM Connectors

Marking	Purpose
A, B	RJ-45 to connect to DUT or network under test
SFP A, SFP B	to connect to DUT or network via SFP modules
12 V	to connect power unit or battery charger
LAN	an RJ45 for remote management
USB	a USB port for remote management
TST	an RJ-12 for Tester calibration
⏚	grounding
RST	hidden hardware reset button *

* **Note**: To reset of the Tester, press the hidden reset button in RST aperture with a thin and blunt pin. At that, current settings are not saved, and next time the Tester is switched on its settings will go back to the data saved when the Tester was switched off normally last time (see Paragraph 9.4).

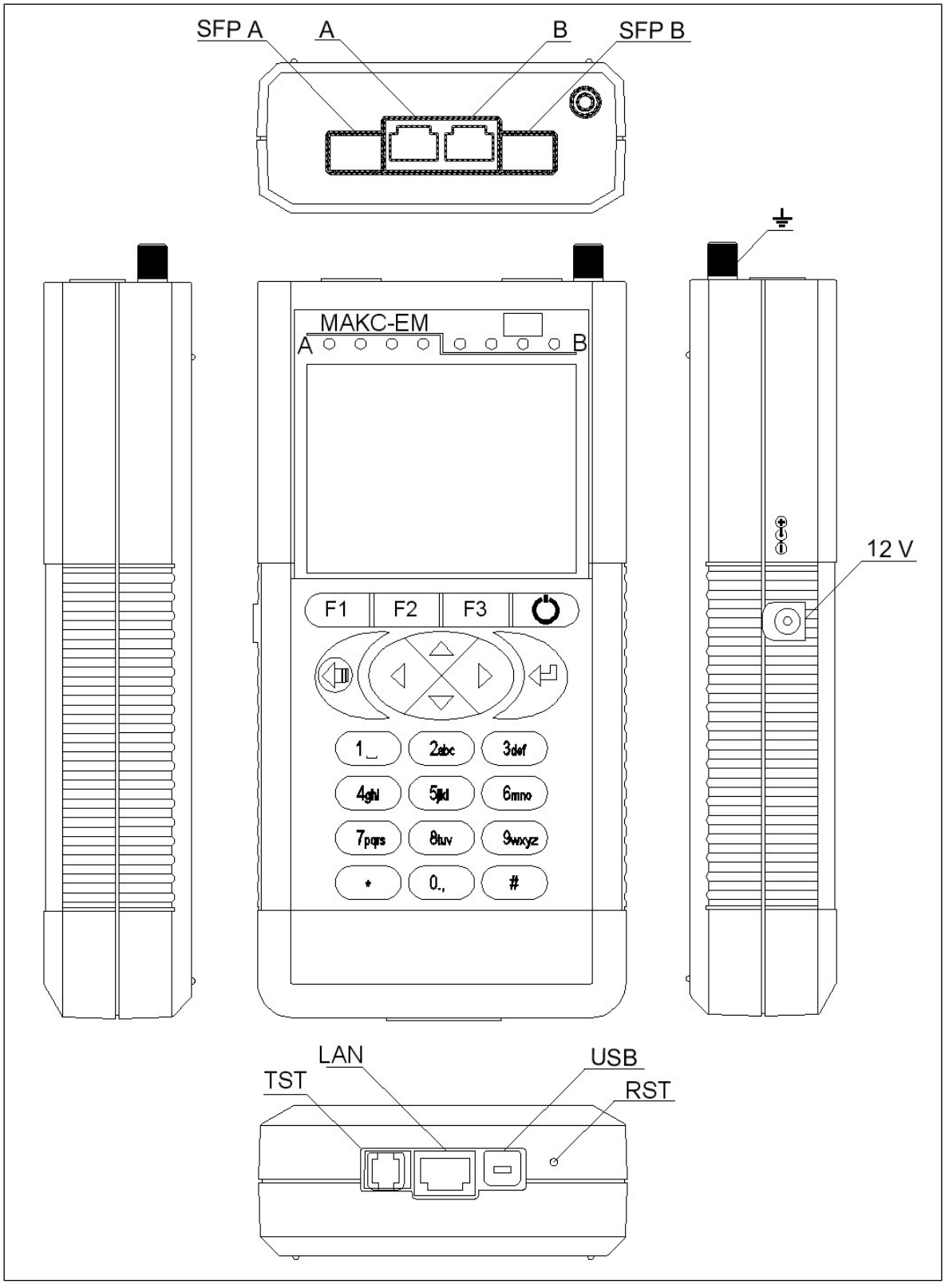


Figure 4.1 Connectors Location

Connection of SFP Receiver/transmitter

SFP A and SFP B connectors are used for connection of SFP optical modules or SFP copper modules with external RJ-45 to the Tester. SFP modules supplied with the Tester and other modules can be used.
Please make sure that the receiver/transmitter and the connector support the same physical interfaces before inserting the SFP module. Do not forget to lock the SFP module latch. When inserting the SFP module make sure that its label is facing the Tester front panel. When the module is installed it will be securely fixed in the connector using the module's locking latch. If the module has been installed properly, you will hear a click.

Caution! If it is not easy to install the SFP module for the first time, please do not exert extra force on it to avoid connector damage.

Before an SFP module (see Paragraph 10.19.3) is securely fixed, the corresponding LED may already indicate its availability. Please make sure that the module has been installed correctly.

Please use a rubber cap to protect a temporarily unused SFP module from contamination.

Before removing an SFP module from the connector, disconnect fiber optical plugs by pressing their latches and carefully take the cable out of the receiver/transmitter. After that, unlock the SFP module latch and pull it to remove the module from the connector.
Correct storage of SFP modules: you should use antistatic boxes or packages and protect fiber optical connectors with rubber caps.

4.2. Component Specifications

4.2.1. Power Unit

MAKS-EM power unit serves to supply the Tester from AC mains and integral battery cell. It represents a static power supply unit with built-in short circuit and overload protection.

Input: AC voltage 100 ÷ 240 V, 50 ÷ 60 Hz.

Output: DC voltage 12 V, current up to 1.5 A, constant.

Power unit soldered connections are arranged according to Figure 4.2.

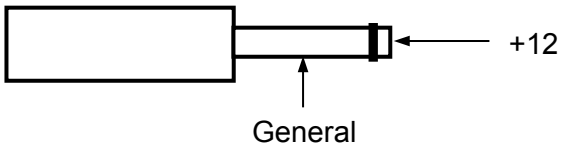


Figure 4.2 Soldered connections of power unit jack plug

5 Marking

5.1. MAKS-EM Tester has the following marks:
- name of the manufacturer;
- equipment conditional name;
- month and year of manufacture;
- equipment serial number (as per manufacturer's numbering system).

5.2. Marking of consumer packaging includes:
- trademark of manufacturing plant;
- name and plant denomination of the device;
- packing date;
- transportation and storage temperature information.

5.3. Shipping data must include:
- consigner and consignee names;
- cargo package gross and net weight;
- "Fragile freight!", "Keep dry" and "This side up!" handling instructions.

6 Packaging

6.1. MAKS-EM Tester, its accessories kit and in-line documentation are placed into a bag and then packed into a cardboard box according to the corresponding construction documentation. Packing the Tester into an additional box is specified in the delivery contract. Pack the equipment in a room with relative humidity of 80 % max. and at a temperature of 15°C… 35°C.

7 General Operation

7.1. Before starting MAKS-EM operation it is highly recommended to familiarize with the present User Manual, purpose of keys, external connectors and components of the Tester.

7.2. The Tester should be operated in the conditions not exceeding its operation conditions. The supply mains must be free from voltage spikes. There must not be strong electrical and/or magnetic field sources next to the working place.

7.3. Protect the Tester and its power unit from hits, moisture, dust and continuous exposure to direct sunlight.

7.4. If you put the Tester into operation after its stay in cold weather conditions, you will have to place it in standard environment for at least 2 hours, and only then start its operation.

7.5. If service interruptions last for more than two hours, it will be recommended to disconnect power unit from the mains.

7.6. The Tester can be powered from:

- mains 220 $^{+22\ V}/_{-33\ V}$ 50…60 Hz by means of a power unit;
- battery cells (6 × AA NiMH, 2300 mAh each).

"  " indicator in screen bottom-right corner shows battery characteristic. The fewer segments are displayed, the lower battery is. At that, as battery discharges, indicator colour starts changing into green, yellow and red. When battery is being recharged, the indicator alternately changes its colours. As soon as power supply is connected, battery indicator will acquire the following form: "  ".

Battery cell characteristic (refer to paragraph **10.16.1).** Full battery charge time in normal weather conditions does not exceed 14 hours.

Battery service life depends on the number of "charge-discharge" cycles. This battery type is meant for approximately 500 "charge-discharge" cycles.

When battery cells are fully charged, and depending on their condition, Tester operating period in off-line mode will be equal to at least four hours.

Note: It is acceptable to use (6 × AA) NiMH or NiCd battery cells of lower capacity. In this case, full charge time and off-line performance will be shorter.

8 Safety Precautions

Caution! External power unit carries fatal voltage. Do not operate damaged power unit.

9 Preparation for Work

9.1. Unpack the Tester and examine it visually. Check set completeness according to Table 2.1.

9.2. Keep the Tester in normal conditions for at least 2 hours.

9.3. Plug in the power unit (if Tester is going to be mains-powered).

If Tester is going to be battery-powered, you will have to charge the battery cells first. They will charge only in if the Tester is switched on (refer to paragraph 7.6).

9.4. To switch the Tester on, press **"On/Off"** key and hold it for 2 seconds. When the Tester is powered and it starts, you will see main menu on the screen.

To switch the Tester off, press **"On/Off"** key once and then confirm switching-off by means of the menu. The Tester saves current settings each time it is switched off correctly. The Tester will load all the saved settings and enable the set functions when it is switched on next time.

10 Operation Procedure

10.1 Main Menu and Working with the Menu

Main menu appears as soon as you switch Tester on.
Figure 10.1 shows main menu structure.

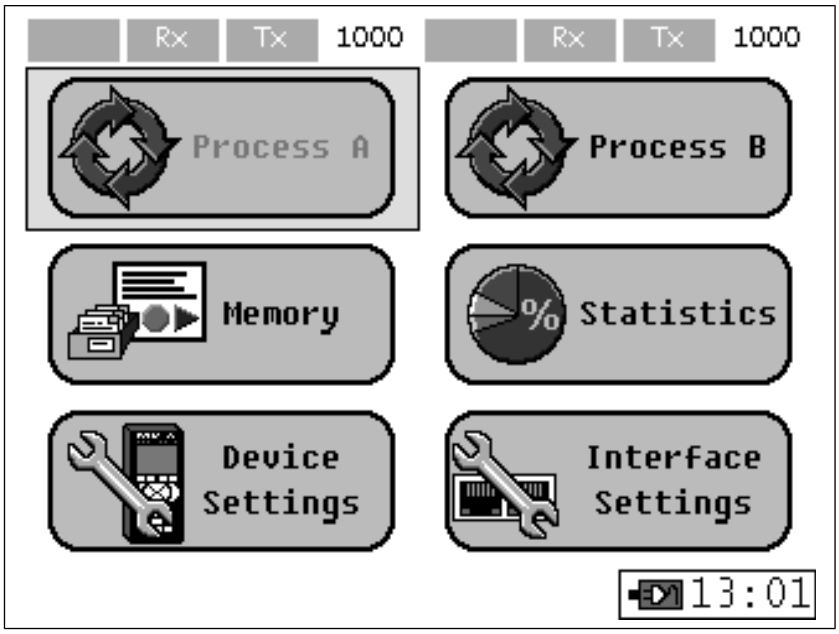


Figure 10.1 Main menu

“Process A” and **“Process B”** menus show port A and port B process topology.

“Memory” menu serves for test data reading (such as record name, time, date), saving test results and downloading previously saved results.

“Statistics” menu represents measurement statistics;

“Device Settings” menu serves to select the required operation settings;

“Interface Settings” menu displays settings of the following three Ethernet ports: measurement port A, measurement port B and remote management port.

Working with the Menu

Navigation through menu icons, tabs and lines is effected using arrow keys. At that, active icon or tab captions are highlighted blue whereas captions of inactive ones are highlighted black. **“Enter”** key serves to enter menu options. When you enter a tab, your current tab caption will change its colour from black to light grey. To leave your current tab, press **“Menu”** key. Entry fields with changeable parameters and check marks captions are blue whereas other information fields are black.

10.2 Process Topology

“Process A” and **“Process B”** main menu sections allow the user to select process topology for ports A and B. **“Process Topology”** menu is illustrated in Figure 10.2.

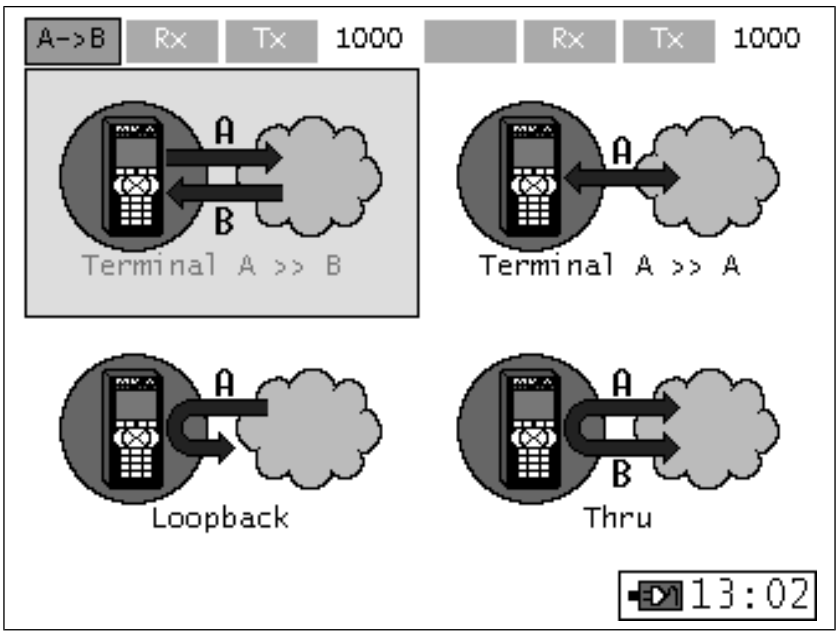


Figure 10.2 “Process Topology” Menu

“Terminal” mode defines traffic reception and traffic transmission ports. This mode sets topologies for tests with traffic generation: **“RFC 2544”**, **“Traffic Test”, “Packet Jitter”, “Multistream”** and **“BER”**. It is not essential to select reception port topologies for **“TCP/IP”** and **“Cable Diagnostics”** tests.

“Loopback” and **“Through”** modes do not allow performance of any tests at the selected port.

While tests are running or when **“Loopback”** and **“Through”** modes are activated, the selected port is busy and it will not be possible to enter some menu options (ones that can cause a collision, will be blocked). In this case, icons of the blocked menu options become grey. If tests engaging both ports are running or modes engaging both ports are enabled, some menu options of the opposite port will also be blocked.

10.3 “Measurement” Menu

“Process Topology” menu sections - **“Terminal A>>B”**, **“Terminal A>>A”**, **“Terminal B>>B”** and **“Terminal B>>A”** - provide access to **“Measurement”** menu designed to select tests for ports A and B.

“Measurement” menu is illustrated in Figure 10.3.

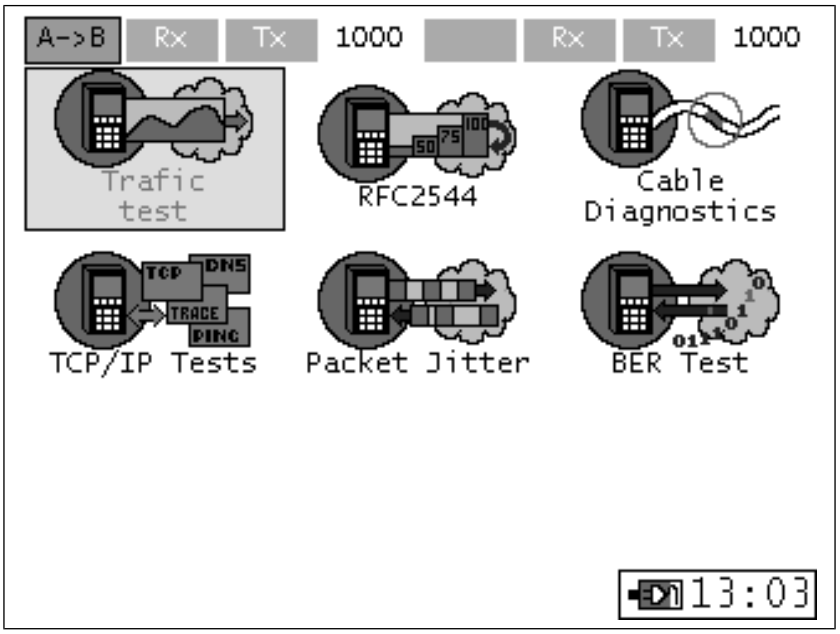


Figure 10.3 “Measurement” menu

The menu includes the following tests:

- **Traffic Test;**
- **RFC 2544;**
- **Cable Diagnostics;**
- **TCP/IP Tests;**
- **Packet Jitter;**
- **BER Test;**
- **OAM;**
- **Multistream.**

Coloured icons indicate launchable tests. Grey icons indicate unavailable (blocked) tests. Test blocking may be caused by conjoint measurements of the selected or another port, or unavailability of the corresponding Tester option.

10.4 Cable Diagnostics

Cable diagnostics is performed in two stages: quality test and determination of twisted pair parameters. Cable quality test is based on breakage diagnostics reflectometric technique that includes distance to fault measurement and cable/plugs fault type definition. Cable quality test is run without in-line synchronization and that is why **Link** LED extinguishes during this test. Each TP of RJ-45 connector (1-2, 3-6, 4-5, 7-8) is tested separately.

"Cable Diagnostics" menu is illustrated in Figure 10.4.

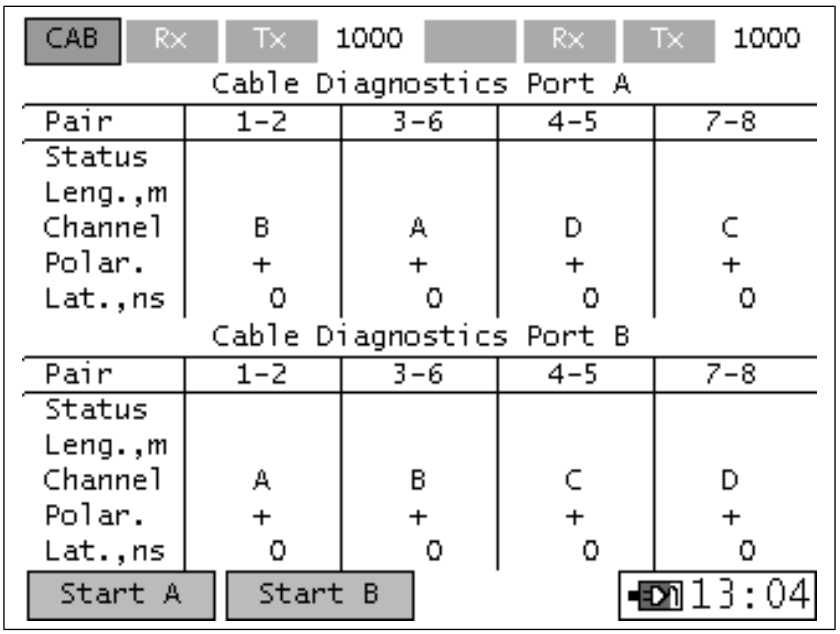


Figure 10.4 Copper cable diagnostics

Cable quality test results displayed in **"Status"** field may be as follows:

- **OK** – the cable is OK and is connected to the line;
- **error** – test not passed*;
- **breakage** – breakage of the TP;
- **SC** – TP short circuit;
- **satis.** – satisfactory**.

Dist. – distance to SC or breakage, or to impulse reflection point (when "Status" field displays **"satis."**). If SC or line breakdown happens, distance to failure will be determined by means of reflectometric technique with the accuracy of +/-1 m. In other cases, cable length is measured with the accuracy of up to 10 m.

Channel* ** – MDI or MDI-X channel (see Table A.7, Appendix A).

Polar. – TP polarity. It can take on the following values: positive "+" or negative "-".

Del. – selected TP skew delay due to length difference of separate pairs. It shows differential delay of the specified TP with reference to the shortest TP. Measuring inaccuracy is 8 ns.

* **Note:** if during remote point test burst mode of the line was enabled (100 Mbps with no self-matching) and it was not automatically desynchronized.

** **Note:** the TP is not short-circuited or broken but the reflected signal amplitude is low because of plugs/sockets contact fault (as an example).

*** **Note:** straight-through cable is self-matched according to MDI-MDIX pattern, crossover cable - according to MDI-MDI or MDIX-MDIX pattern.

TP parameters are determined when line is synchronized.

10.5 TCP/IP Utilities

10.5.1 Ping test

Ping test is used to check achievability of a certain network node. Frame receiving device, if able to, responds to the ping request sent according to ICMP so that the user could count round-trip delay. Frame loss percentage is also determined. **"Ping test"** menu is illustrated in Figure 10.5.1.

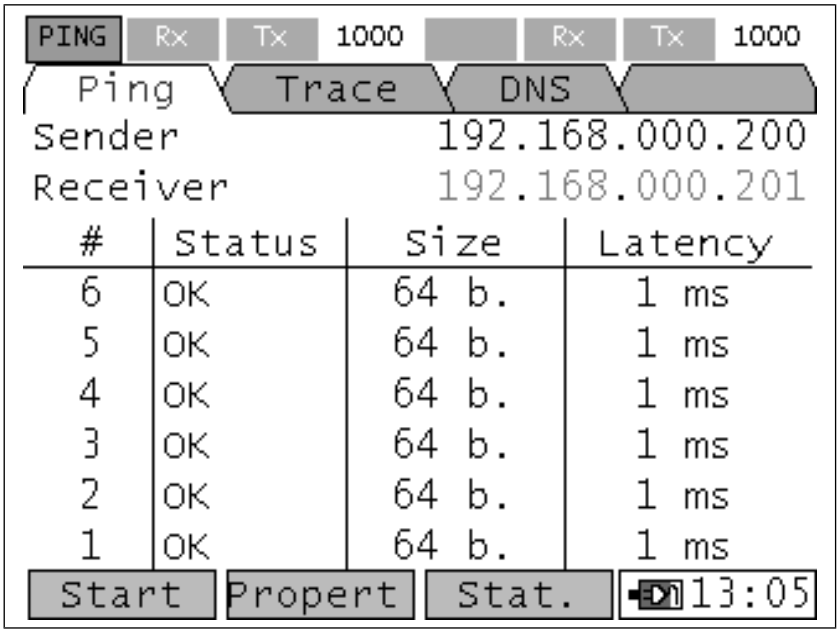


Figure 10.5.1 Ping test

Test result is presented in tabular form. The table shows data on the six latest ping requests as well as statistics on the latest test time slot. The first table column indicates ping request number. The second one shows ping request status that can take the following forms:

- **Request** – ping request was made, but the response message has not been received yet;
- **OK** – ping request was responded correctly;
- **Timeout** – wait time is over;
- **Interrupted** – wait time for the latest ping request was interrupted by the user.

The third column displays sent frame payload value in bytes. The fourth column shows round-trip propagation delay.

Ping Settings

IP address - destination address, address of the device ICMP-packets are sent to in order to check its achievability;

Payload – frame payload length in bytes; for networks not supporting jumbo frames maximum ICMP-packet payload length is equal to 1472 bytes;

Wait time – ping response wait time (in ms);

Pause – time between two sequential ping requests (in ms).

Ping Statistics

In accordance with ping test results, the following measured parameters are displayed:

- sent frames number
- received frames number
- lost frames number
- average latency
- minimum latency
- maximum latency.

10.5.2 Traceroute

"Traceroute" test determines frame route in TCP/IP networks. Information on all intermediate routers a frame passes through on its way to the end node is shown in the table formed during test run. "**Traceroute"** menu is illustrated in Figure 10.5.2.

Test result is presented in tabular form. The table shows intermediate node data. The first table column indicates intermediate node number. The second column indicates intermediate node IP address. If wait time is over, the line will display **"timeout"*** message. The third column indicates node response latency. The table is navigated page by page using **"Up"** and **"Down"** arrow keys.

* **Note:** Many network nodes block ability to respond to ICMP frames. In such cases, **"timeout"** message is displayed.

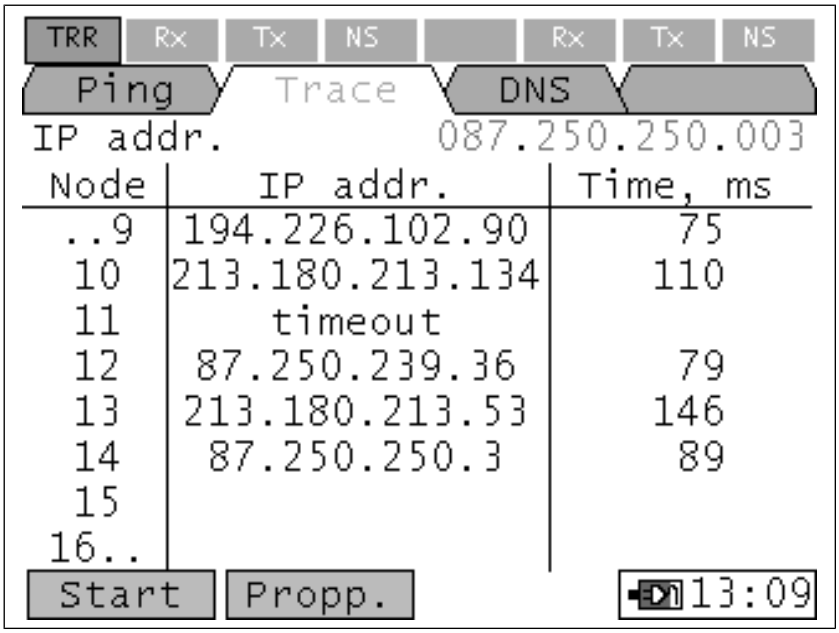


Figure 10.5.2 Traceroute test

Traceroute Test Settings
IP address – destination IP address, end node IP address.
Wait time – intermediate network node response time.

10.5.3 DNS

DNS (Domain Name System) stands for a distributed system providing information on domains. This function allows getting host IP address by its domain name.

"DNS" menu is illustrated in Figure 10.5.3.

DNS Test Settings
Domain name – domain name according to which DNS request will be made
Status – current test status
Domain IP – received domain IP address

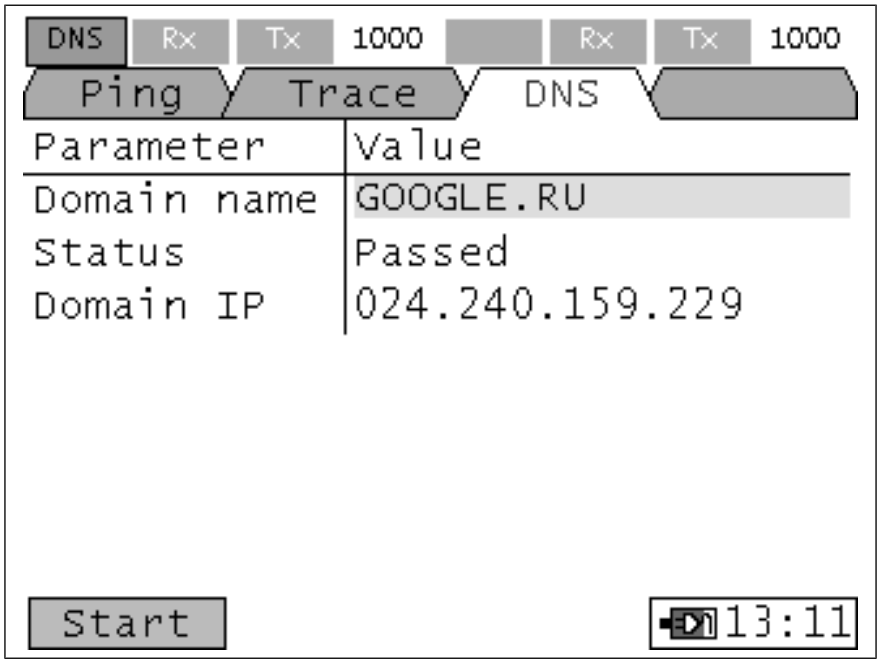


Figure 10.5.3 DNS

"Status" field during DNS test may be as follows:

- **passed** – test was OK and DNS request was responded
- **in progress** – DNS request was made, test is awaiting response
- **error** – error at test launching (wrong domain name, etc.)
- **" "** – test has not been launched.

10.6 Connection Variants

Tests with traffic generation are the following: **"Traffic Test"**, **"RFC 2544"**, **"Packet Jitter"**, **"BERT"**, **"Multistream"**. In order to run these tests, the Tester must be connected either to network section or DUT according to the two connection diagrams (A and B) illustrated in Figures 10.6.1 and 10.6.2.

Variant A: loopback function may be activated by means of the second MAKS-EM Tester or the second port of the same MAKS-EM Tester (if two interfaces are available at one point), or MAKS-EMB tool.

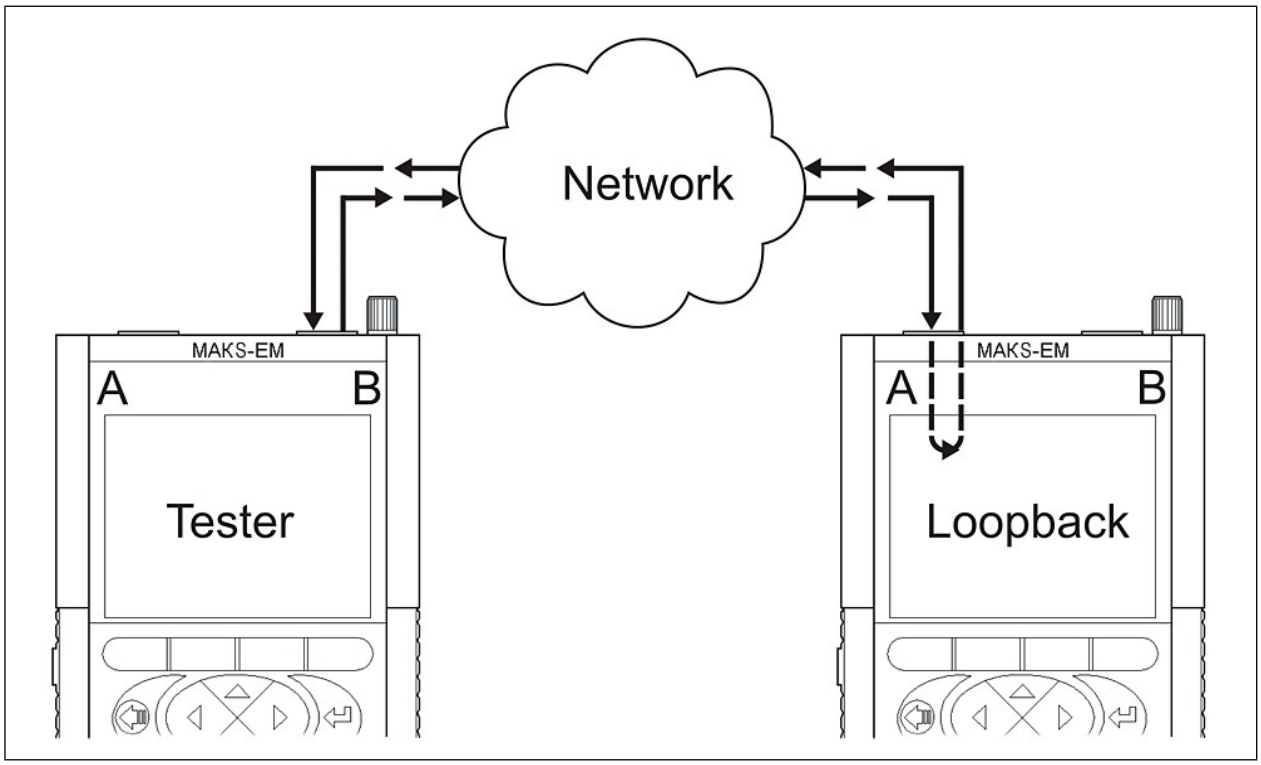


Figure 10.6.1 Tester Connection in Test Mode, Variant A

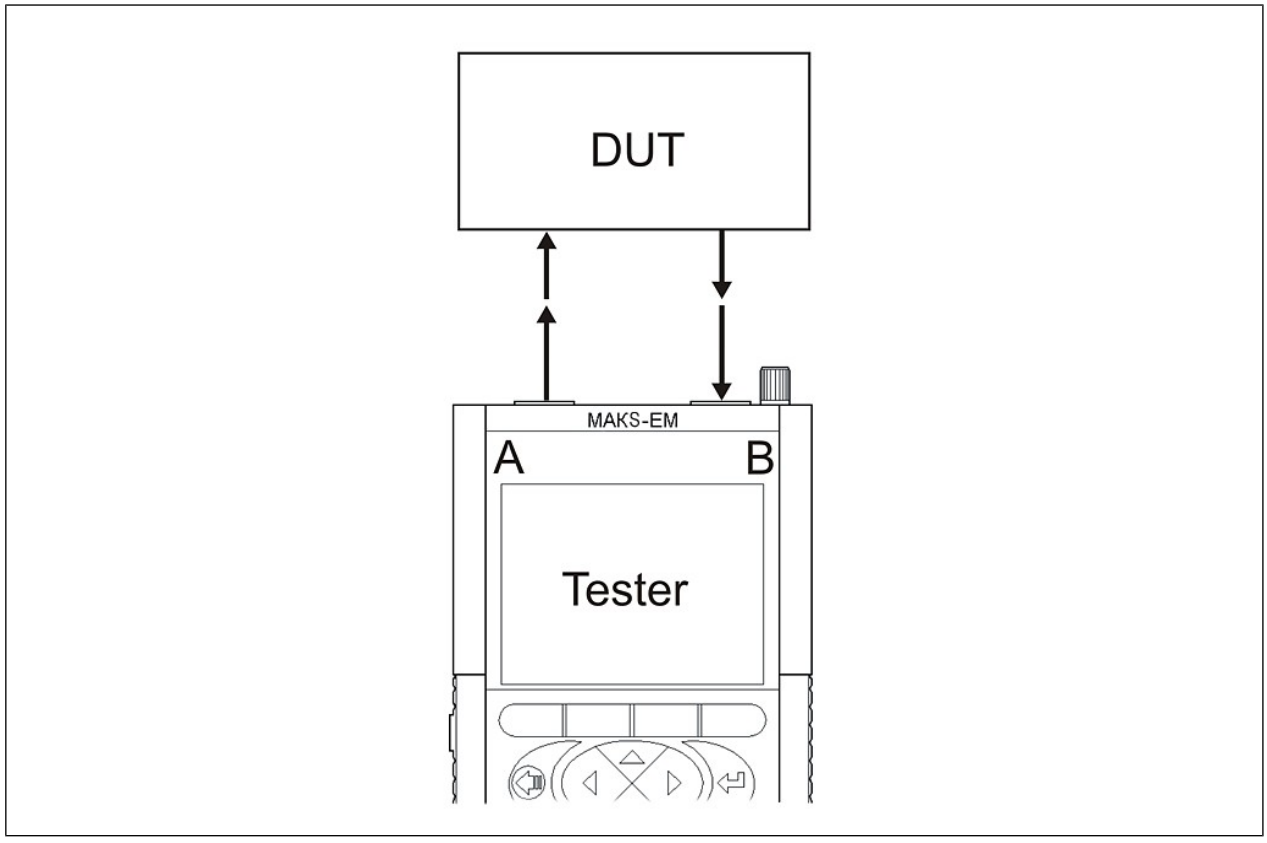


Figure 10.6.2 Tester Connection in Test Mode, Variant B

Network sections with distant loopback point are usually tested in accordance with diagram A. At that, loopback level (from 1 to 3) is selected depending on the network equipment used within this network section. For example, if a network section involves only network commutators (switches), you will have to activate Level 2 Loopback function, but if a section involves routers, you will have to switch on Level 3 Loopback function. For more on Loopback function, see paragraph 10.13.

Variant B is more frequently used for testing of network equipment. In this case test traffic is transmitted in unidirectional way from one port to another.

10.7 BER Test

10.7.1 BER Test Description

BER test represents Level 1 test allowing the user to check a channel for bit errors. Bit Error Rate (BER) is equal to a ratio of received erroneous bits to the total bits received.

BER test is not suitable for testing of network sections containing Level 2 and Level 3 network equipment because it may cause packet loss.

When a network section looped up according to Variant A (see Figure 10.6.1) is tested, it is necessary to activate Level 1 loopback at the remote point.

"BER test" menu is illustrated in Figure 10.7

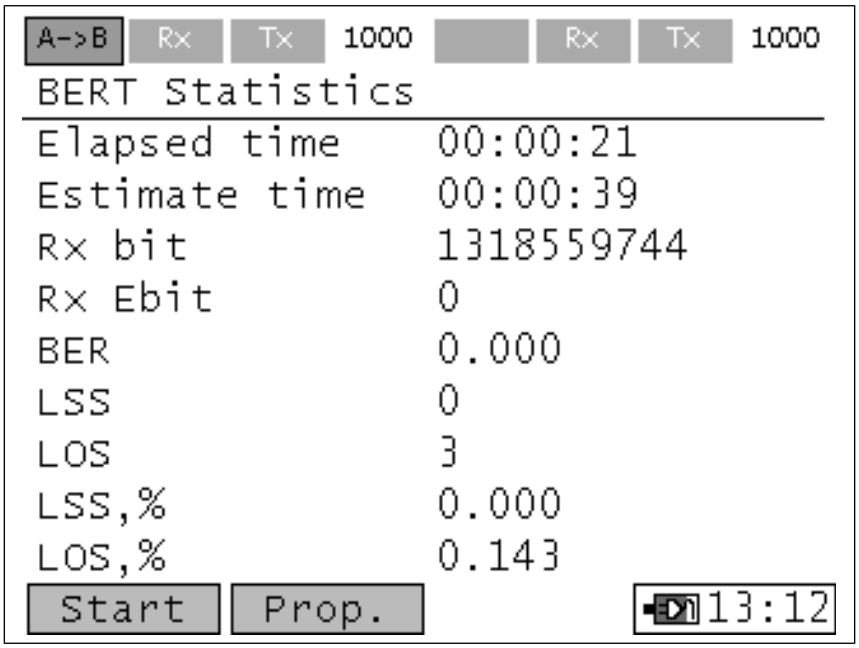


Figure 10.7 BER test

The following fields are displayed on test status menu:
Elapsed time – time from the beginning of BER test
Estimate time – time until the end of BER test

Rx bit – number of received bits
Rx Ebit – number of received erroneous bits
BER – ratio of received erroneous bits to total bits received
LSS – number of seconds without pattern synchronization
LOS – number of seconds without line synchronization
LSS,%% – ratio of time with no test pattern synchronization to elapsed time
LOS,%% – ratio of time with no line synchronization to elapsed time

10.7.2 BER Test Settings

The following fields are displayed on **Settings** menu:
Pattern type – pattern type selection: user pattern specified in **User Pattern** field, PRBS $2^{11}-1$, $2^{15}-1$, $2^{20}-1$, $2^{23}-1$, $2^{29}-1$, $2^{31}-1$, CRTP.
User Pattern – 32 bits of user pattern
Frame size – frame size in bytes
Units – units in which load value is set: % or bps
Load – load value in % or bps.
Duration – time duration of the test set in “hh:mm:ss” format. If its value equals zero, the test will run endlessly.

10.8 Traffic Test

10.8.1 Traffic Test Description

Traffic test is the simplest of all MAKS-EM tests. It is used to check transmitting capability of a channel. Tester is connected according to either of the two variants described in paragraph 10.6.
Traffic is generated and frame loss is analyzed within the set time according to the selected load and frame size.
“Traffic Test” menu is illustrated in Figure 10.8
Test menu contains the following functional buttons:
Start/Stop – test start and stop,
Prop. – access to test settings.
The following fields are displayed on test status menu:
Elapsed time – time from the beginning of traffic test
Estimate time – time until the end of traffic test
Load – load value of the generated stream
Tx frames– transmitted frames number
Rx frames – received frames number
Tx bytes – received bytes number

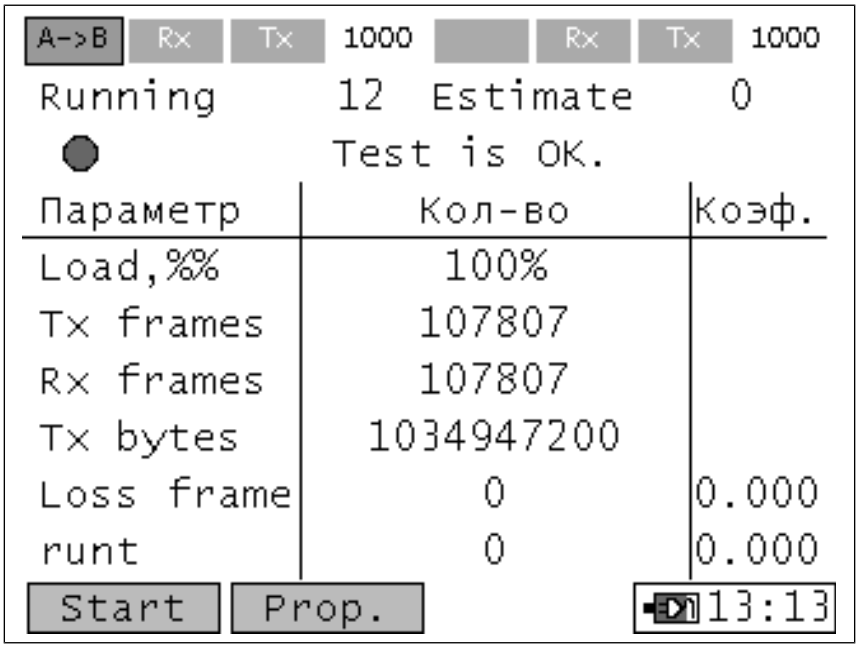


Figure 10.8 Traffic test

Vrt Mbps – current test traffic speed. This data is displayed only during test run.

PDV – average packet jitter

Loss frame* – number of lost bytes equal to the difference between transmitted frames number and received frames number. It is displayed in “Number” column. Frame loss ratio is displayed in “Ratio” column.

* **Note:** even if frame loss is not detected, loss rate may be equal to a non-zero value. It can be explained by channel latency and sender/receiver buffer latency.

Runt – number of received frames less than 64 bytes of size with correct checksum is displayed in “Number” column. Ratio of such erroneous frames is displayed in “Ratio” column.

CRC – number of received frames with erroneous checksum displayed in “Number” column. Erroneous frames ratio is displayed in “Ratio” column.

Jabber – number of received frames more than 1518 bytes of size with erroneous checksum is displayed in “Number” column. Erroneous frames ratio is displayed in “Ratio” column.

Err. frames – received erroneous frames total number (Runt, Jabber, CRC) it displayed in “Number” column. Error ratio is displayed in “Ratio” column.

Pause – pause frames total number

When the test is finished, one of the following messages will appear on the display:

- **Test passed** – test has passed successfully with no frame loss at this load
- **Test errors** – errors occurred during the test
- **Loss rate exceeded** – test passed, but some frames were lost at this load.

10.8.2 Traffic Test Settings

"Header" Tab

The tab contains settings fields similar for all tests with traffic generation. For its description refer to paragraph 10.8.3.

"Adjustment" Tab

Load Type – this parameter is not used since it is a constant load test

Rate, % – traffic generation rate in %

Packet length – length of generated frames in bytes

Duration – time duration of the test set in "hh:mm:ss" format. If its value equals zero, the test will run endlessly.

10.8.3 Settings of Tests with Traffic Generation, "Header" Tab

The tab contains setting fields similar for all tests with traffic generation: i.e. **Traffic Test**, **RFC 2544** and **Packet Jitter**. Individual settings for each test are stored in Tester memory.

Connection speed, source MAC address, source IP address, VLAN and MPLS measurement interface parameters are specified on **"Interface Settings"** menu. Refer to paragraph 10.15 for description.

Level 2

Automatic MAC Destination – automatic option of destination MAC address resolution by means of ARP request performed before running the test. When this option is check marked, "**Received MAC**" field disappears and its value is disregarded.

MAC Dest. – destination MAC address. If network section under test does not contain routers, destination MAC address will be the address of frame receiving/loopbacking device. Alternatively, destination MAC address will be defined by MAC address of the nearest router.

MAC Source – address of traffic generating interface is set as source MAC address. This field indicates the value specified on **"Interface Settings"** menu.

Level 3

Automatic IP Destination – if this field is check marked, destination IP address will be similar to opposite port IP address at A->B and B->A test topology.

IP Dest. – destination IP address

IP Source – address of traffic generating interface is set as source IP address. This field indicates the value specified on **"Interface Settings"** menu.

ToS/Precedence – activation/deactivation of QoS settings. Check marking blocks DSCP and its value is disregarded. For detailed description of fields refer to RFC 791. ToS field bit names are presented in Table A.1, Appendix A.

Precedence – frame precedence specifies P0-P2 bits in ToS field. It assumes values from 0 to 7. Correspondence of precedence values and names are presented in Table A.2, Appendix A.

ToS – T0-T3 bits in ToS field displayed in binary form. May assume the following values: 0000, 0001, 0010, 0100 and 1000.

DSCP – activation/deactivation of QoS settings. Check marking blocks **ToS/Precedence** and its value is disregarded. DSCP field bit names are presented in Table A.3, Appendix A. The field may assume values from 0 to 64 and it displays 6 uppermost DS0-DS5 bits from the corresponding frame header byte in binary form. Lettered abbreviation is also displayed (see RFC 2474 and RFC 2597 for more details). Correspondence of precedence values and names are presented in Tables A.4 and A.5, Appendix A.

Level 4

Check marking makes settings of transport level packet available.

UDP srs – source port number

UDP dst – destination port number

Source MAC address, source IP address and VLAN and MPLS fields are set by means of **"Interface Settings"** menu.

10.9 RFC 2544 Method

10.9.1 RFC 2544 Test Description

RFC 2544 method is a standard of diversified Ethernet testing. It describes the script of an automated Ethernet channel test procedure with deficient operating traffic. The script contains key parameters for throughput, latency, frame loss and back-to-back testing. Each test allows checking certain parameters described in SLA. Test methodology defines frame sizes, test duration and number of test repeats.

MAKS-EM Tester allows running four basic RFC 2544 tests:

- **Throughput**. Evaluation of maximum bit rate. At this rate, number of test frames transmitted through DUT or network section is equal to the number of frames sent from test equipment. This test is used for recording maximum switching speed of transport Ethernet elements. Minimum determinable throughput value expressed in % is calculated by the following formula: $\frac{L}{2^{26}}$, where *L* is packet length in bytes.

- **Latency**. Evaluation of time slot during which a frame is transmitted from source to destination and back in accordance with the diagram illustrated in Figure 10.6.1. This value is called round-trip delay. When data is transmitted from one port to another according to test pattern presented in Figure 10.6.2, only one-way delay is measured. Default setting suggests fulfillment of 30 tests regarding whose results average delay is calculated.

  Note: The lowest measurable latency value is equal to 8 ns.

- **Frame loss rate**. Testing a network section or a network device capability of supporting real-time applications (retransmission is not possible). This test allows calculating percentage of frames not transmitted by network element at constant load because of hardware resource deficiency. Please note that high percentage of frame loss is a cause of QoS degradation.

- **Back-to-back**. Time slot needed to manage maximum load is determined. Test pattern is illustrated in Figure 10.6.2. It is mostly used to test such network devices as multiplexers, commutator switches and routers.

MAKS-EM supports simultaneous RFC 2544 testing from two interfaces.

10.9.2 RFC 2544 Test Settings

"Header" Tab

This tab contains similar setting fields for all tests with traffic generation. Refer to paragraph 10.8.3 for description.

"Frames" Tab

RFC 2544 method recommends using the following seven preset frame sizes: 64, 128, 256, 512, 1024, 1280 and 1518 bytes at Ethernet testing. These values are set by default. It is possible to set other frame sizes and apply extended RFC 2544 pattern that allows using frames of random sizes

including Jumbo frames* from 1519 to 9600 bytes of length. You can also set an additional test frame from 64 to 9600 bytes of length. Frame sizes in bytes should be specified in lines. Field check marking allows the corresponding configuration of the frame.

***Note:** Some routers either do not support Jumbo frames or have to be preconfigured to support them. Please familiarize with the specific router documents to estimate the possibility of Jumbo frames support.

"Throughput" Tab

Enable – check marking allows running **"Throughput"** test.

Load min – load value expressed in percents. Achievement of this value stops **"Throughput"** test. If "zero" value is set, the test will continue until an irreducible load value stated in paragraph 10.9.1 is achieved.

Load max – percentage load value at the beginning of **"Throughput"** test for each frame size.

Interval – time period of continuous test fulfillment with specified frame sizes and parameter values.

"Latency" Tab

Enable – check marking allows running **"Latency"** test.

Number of Trials – number of trials of each specified frame size in "Latency" test.

Interval – time period of continuous test fulfillment with specified frame sizes and parameter values.

User Load – if the field is check marked, "Latency" test will run with the load specified in below settings. Otherwise the test will run with the load being the result of "Throughput" test.

Load – percentage load value at the beginning of "Latency" test. It is possible to set specific load value for each frame size.

"Frame Loss" Tab

Enable – check marking allows running **"Frame Loss Rate"** test.

Interval – time period of continuous test fulfillment with specified frame sizes and parameter values

Step loading – percentage load value by which the load of each successive test stage will decrease in case of frame loss.

First load - percentage load value at the beginning of "Frame Loss" test.

Last load – percentage load value to whose level "Frame Loss" load decreases. If frame loss is not detected at any stage, load will not decrease to the level of final load value.

"Back-to-back" Tab

Enable – check marking of this field allows running **"Back-to-back"** test.

Min time – minimum time duration during which the Tester managed maximum load. It is calculated for each frame size.

Max time – maximum time duration during which the Tester managed maximum load. It is calculated for each frame size.

Number – number of trials in **"Back-to-back"** test for each set frame size.

"Extra" Tab

Learning Int. – waiting time in microseconds after sending a Learning frame and before frames transmission starts;

Wait Interval – waiting time in microseconds during which Tester awaits sent frames return from the network.

10.9.3 RFC 2544 Test Statistics

"**RFC 2544" Menu** is illustrated in Figure 10.9

Test menu contains three functional buttons:

Start/Stop – test launch and stopping.

Prop. – access to test settings.

Graph/Table – presentation of the selected test results in tabular form or graphically.

Table fields are automatically filled in with current test results. The table contains the following common fields:

Status – the field displays current test status. It may take the following forms:

- **Passed** – test passed;
- **Wait** – test has not started yet;
- **In progress** – test is running at the moment;
- **Stop** – test was discontinued;
- **Disabl.** – test of this frame size is disabled;
- **Failed / Error** – "Throughput" test failed because of frame loss at minimum load; "Back-to-back" test failed because of the losses during the minimum time slot;

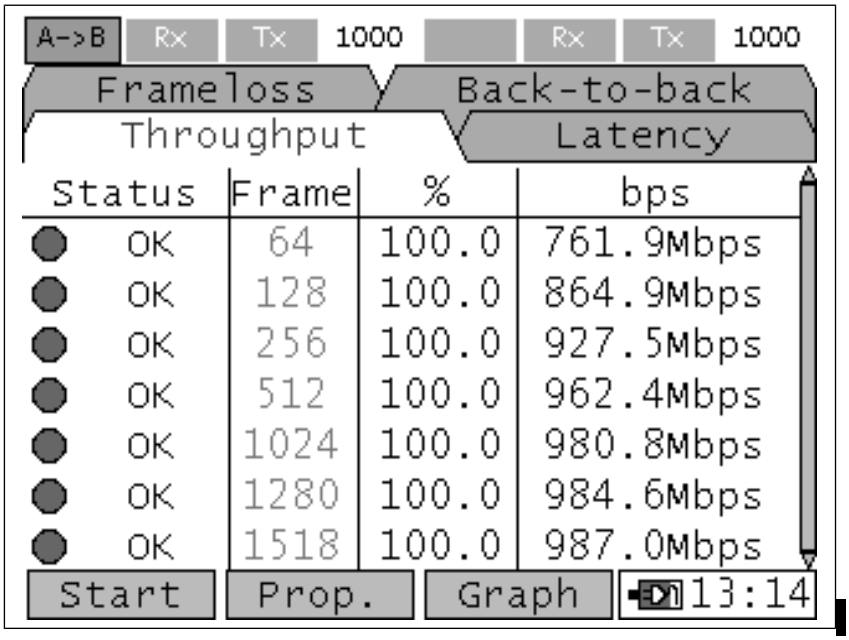


Figure 10.9 RFC 2544 Test

- **No Cx.** – no line synchronization during the test;
- **No Tx** – no test traffic transmission;
- **No Rx** – no test traffic reception;
- **RxTx** – number of received test frames exceeds the number of transmitted test frames.

If critical errors occur, the current test will be discontinued and the following test will be launched.

"Frame" – this field shows test packet size at each test.

"Throughput" Tab

"%" – the field shows measured throughput rate in percentage of maximum channel rate (if the test has been successful). During test run, the field shows current load.

"V L1/ V L2" – this field displays throughput value in Mbps, Kbps or bps for Levels 1 and 2. During the test, the field shows current load value.

To select a level, press "Down" arrow key and then use "Left" and "Right" arrow keys. Level 2 throughput value is equal to information speed **V L2**. Maximum throughput value is calculated by the following formula:

$$T_{L2} = V_f \times \frac{S}{(S + P + SFD + IFG)},$$ where

T_{L2} – level 2 throughput;

V_f – connection speed (1000 Mbps, 100 Mbps, 10 Mbps);

S – frame size;

P – preamble (7 bits);

SFD – start frame delimiter (1 bit);

IFG – interframe gap (12 bits).

Maximum Level 1 throughput of a lossless channel is equal to connection speed, i.e. $T_{L1} = V_f$. Maximum Level 2 throughput is calculated by the above-mentioned formula. T_{L2} values for different frame sizes are presented in Table A.6, Appendix A.

"Latency" Tab

"Load" – the field displays tested load value expressed as a percentage.

"Lat. Time" – the field shows measured average latency value (if the test was successful). During the test, current measured latency value is displayed in this field.

"Frame Loss" Tab

"Load" – this field displays tested load values in %. To view the required column, press **"Down"** arrow key and then select the needed column containing load data using **"Left"** and **"Right"** keys. Frame loss value for the selected load will be displayed in **"Loss"** column. Measurements are performed before the trial which will detect no frame loss. That is why only values of loads that participated in tests are displayed in the table.

"Loss" – the field displays frame loss value in % for the selected load.

"Back-to-back" Tab

"Min" – referring to "Back-to-back" test, this field shows minimum time interval during which Tester managed maximum load

"Max" – referring to "Back-to-back" test, this field shows maximum time interval during which Tester managed maximum load

10.10 Packet Jitter

RFC 3393 defines packet jitter as a delay difference between transmission of two packets. MAKS-EM Tester allows measuring packet jitter distribution within the range from zero to the upper user-set limit.

Note: Packet jitter measurement is Tester option **04-PDV.**

10.10.1 Packet Jitter Test Settings

"Header" Tab

The tab contains setting fields similar for all tests with traffic generation. For its description see paragraph 10.8.3.

"Adjustment" Tab

Load – shows the tested load value in %

Pack. len. – length of the generated frames expressed in bytes.

Duration – time duration of the test set in "hh:mm:ss" format.

Threshold – jitter value expressed in microseconds used as the upper limit for jitter distribution.

10.10.2 Packet Jitter Test Statistics

"Report" Menu of **"Packet Jitter"** test is illustrated in Figure 10.10.

"Report" Tab
The tab displays general test results:
Test Time – time since test launch.
Time to en. – time to the end of test.
Rx. Pack.:
All – received frames number.
In order – number of frames sent and received in the same order, expressed numerically and as a percentage of general frames number.
Not in ord. – number of frames received in an inversed order as against the order they were sent expressed numerically and as a percentage of general frames number.

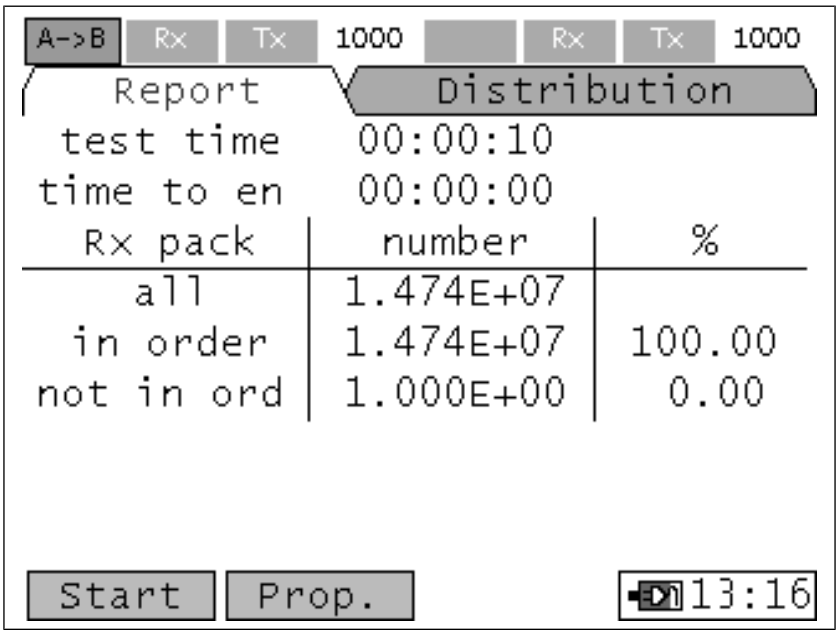


Figure 10.10 Packet Jitter Testing

"Distribution" Tab
"Jitter" – this column shows ranges of the ten intervals jitter values of the received packets fall within. These intervals are formed by division of the **"Threshold"** value into ten equal parts.
"%" – this column shows number of frames with jitter whose value has fallen within this range, expressed in a percentage of sent frames general number *.

*** Note:** Packets that arrived out of turn do not come into account. So if it happens, total distribution value may be less than 100%**.**

Graph/Table – test results display as a graph or a table.

10.11 Multistream

"Multistream" test is used for simultaneous generation of traffic containing frames with different characteristics.

Note: "Multistream" test is Tester option **04-MS**.

10.11.1 "Multistream" Test Settings

"Header" Tab

The tab contains settings fileds similar for all tests with traffic generation (refer to Paragraph **10.8.3.**).

To set frame header for a stream, select the required stream in **"Stream No. X"** field**.** To change stream number use **"Enter"** or **"Left"** and **"Right"** keys.

"Copy" – the key serves to copy stream 1 settings to use them for the current stream.

"Extra" Tab

Duration – test duration in "hh:mm:ss" format. If the value equals zero, the test will run endlessly.

Stream No. X – selection of a stream for its configuration.

Load type – this parameter is not used. The test generates constant load.

Unit – selection of units in which **"Load"** field value for the selected stream will be entered.

Load – load value for the selected stream.

Packet length – packet length in bytes generated for the selected stream during the test.

10.11.2 "Multistream" Test Statistics

"Multistream" test statistics menu is shown in Figure 10.11.

Test menu contains the following two functional keys:

Start/ Stop – test activation and deactivation.

Sett. – access to test settings.

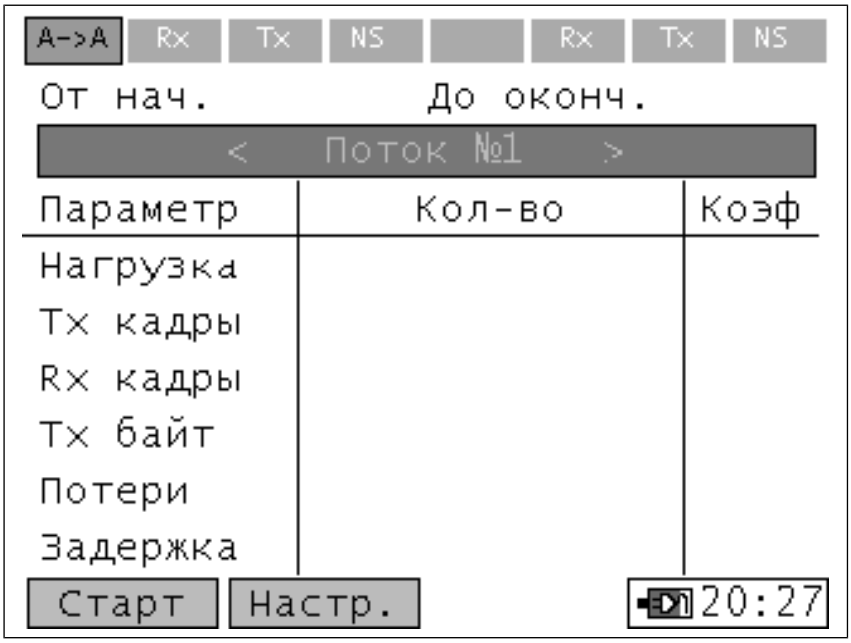


Figure 10.11 “Multistream” Test

The following fields are displayed in “Measurements” field:

Test time – time since **“Multistream”** test launch.

Time to en. – time to the end of **“Multistream”** test.

Load – value of generated stream load.

Tx frames – number of transmitted frames in the selected stream.

Rx frames – number of received frames in the selected stream.

Tx byte – number of transmitted bytes in the selected stream.

Loss* – number of lost bytes in the selected stream equal to the difference between transmitted bytes number and received bytes number. It is displayed in **“Number”** column. Frame loss ratio is displayed in **“Ratio”** column.

* **Note:** during the test, “Loss” field may display a nonzero value even if no frames have been lost. This can be explained by channel latency and sender/receiver buffer latency.

Latency – the measured average latency value of the selected stream (if test was successful). During test run the field displays current measured latency value.

When the test is finished, one of the following messages will appear on the screen:

- **Test passed successfully** – тест пройден и для данной нагрузки все кадры прошли без потерь;
- **Test errors** – errors occurred during the test
- **Loss rate exceeded** – test passed, but some frames were lost at this load.

10.12 Remote OAM Management

OAM protocol functions allow MAKS-EM Tester display information on remote point supported modes and also activate loopback mode at a remote point.

“OAM” menu is illustrated in Figure 10.11.It includes the following settings:

OAM mode – OAM mode selection for this port may be as follows:

Active – port can respond OAM commands of remote devices, it regularly sends OAM discovery commands and it can activate Level1 loopback mode at a remote device.

Passive – port can only respond remote devices’ OAM commands

Off – function is switched off

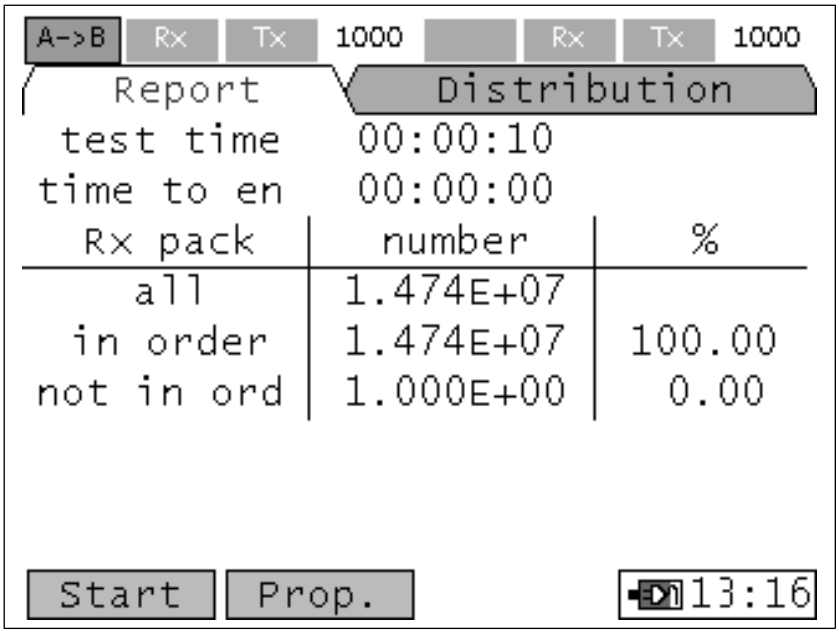


Figure 10.12 Remote OAM management

“Remote Managem.” Tab - displays remote point operation modes and settings. It contains the following fields:

MAC address – MAC address of the discovered remote device

Vendor – remote device unique identifier

Remote Loopback – activation of loopback mode by a remote device

OAM mode remote – remote device OAM mode. See description above.

Unidirectional – remote device unidirectional connection

Link Events – notifications of remote device connection errors.

If the remote device supports Loopback activation function, Loopback can be activated /deactivated using **“Start”** and **“Stop”** buttons.

Note: it is necessary to deactivate OAM function at the port generating test traffic or enable its passive mode before running tests with traffic generation.

10.13 Loopback Testing

Tester is connected to a network or a network device according to the diagram presented in Figure 10.13. MAKS-EM allows activation of two independent loopback modes at both USB ports or loopback activation at one port and any other available function at the second one.

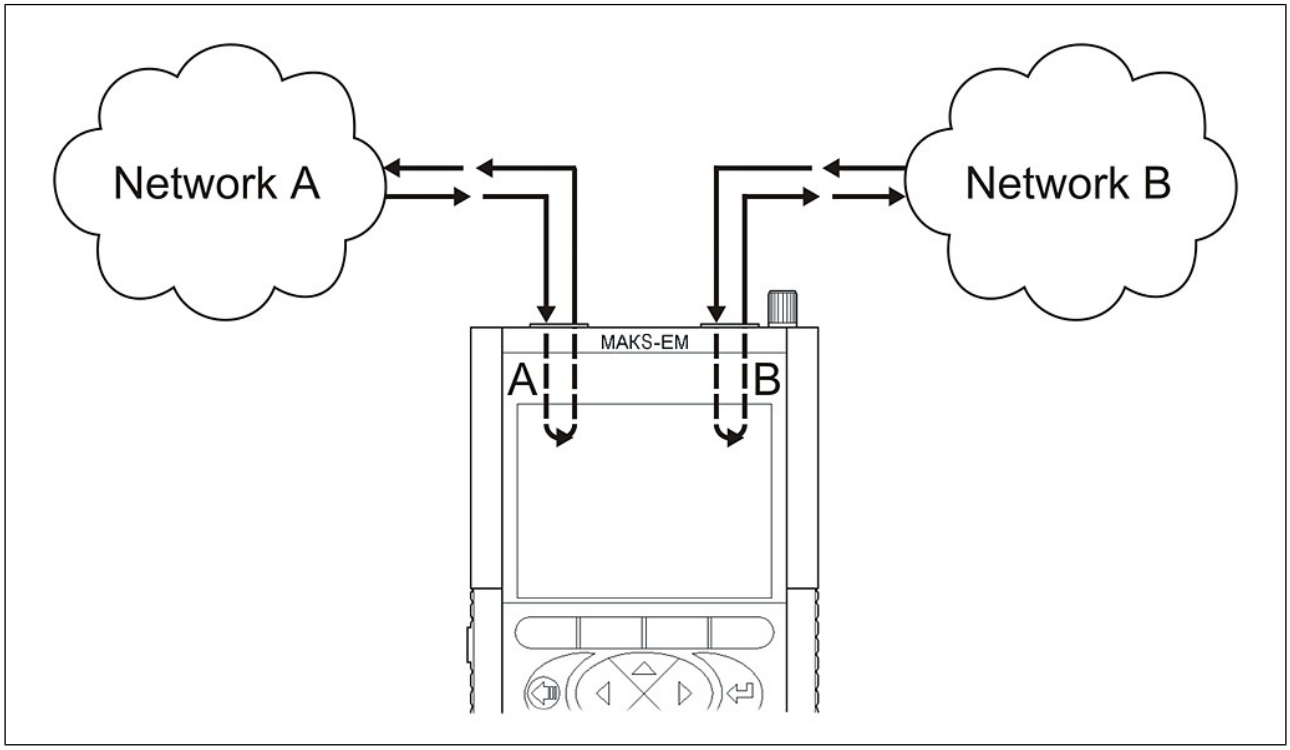


Figure 10.13 Loopback Mode Connection Diagram

10.13.1 Loopback Settings, “Common” Tab

“Loopback” function allows testing a network without changing its settings. Such a test can be run at different OSI levels:

- **at physical level:** all incoming frames are looped back inversely. At that, their structure does not undergo any changes.
- **at data link level:** incoming frames are looped back inversely. It is possible to activate algorithm of source and destination MAC address swapping and algorithm of MAC address shifting at loopback. Frames containing identical source and destination MAC field data, OAM frames, ARP requests and multicast frames are hard filtered at reception and are not looped back inversely.
- **at networking level:** incoming frames are looped back inversely. It is possible to activate algorithm of source and destination IP address swapping at loopback. When network level loopback is activated, settings of the above mentioned swapping and shifting algorithms at data link level will also be effective.

Status – selection and activation of the level to be looped back. You can change the mode by means of **Enter** key and **Left** and **Right** arrow keys. The field may look as follows:

Off – **"Loopback"** function deactivation.
Level 1 – physical loopback activation.
Level 2 – data link loopback activation.
Level 3 – networking loopback activation.
Level 4 – transport loopback activation.

Press **"Set"** button to change mode.

When loopback at any level is activated, level settings will be blocked and available in view-only mode.

10.13.2 Second Level Loopback Settings

If **"Replace MAC"** is not check marked, level 2 loopback activation will lead to automatic swapping of source and destination MAC address frame fields.

Replace MAC – check marking of **"Source**" and **"Destination"** fields results in swapping of source and destination MAC addresses of the received frames for source and destination MAC addresses specified in the corresponding fields.

Source – specifies new source MAC address.

Destination – specifies new destination MAC address.

Replace VLAN ID – check marking activates VLAN ID swapping. Received packet VLAN ID field is swapped for the value from the corresponding field.

Replace Priority – swapping of transmitted traffic priority (IEEE 802.1p standard). Received packet PCP field is swapped for the value from the corresponding field.

10.13.3 Third Level Loopback Setting

If **"Replace IP"** is not check marked, level 3 loopback activation will result in automatic swapping of source and destination fields of IP address frame.

Replace IP – check marking of **"Source**" and **"Destination"** fields results in swapping of source and destination IP addresses of the received frames for source and destination IP addresses specified in the corresponding fields.

Source – specifies new source IP address.

Destination – specifies new destination IP address.

Replace ToS/Precedence – check marking activates swapping of ToS field with QoS parameters. Check marking of this field blocks **DSCP** installation and its value is disregarded. Refer to RFC 791 for detailed field description. ToS field bit names are listed in Appendix A, Table A.1.

ToS – this field specifies new value of ToS byte T0-T3 bits. It is displayed in binary form and may assume the following values: 0000, 0001, 0010, 0100, 1000.

Precedence – specifies new value of ToS byte P0-P2 bits. It can assume values from 0 to 7. Correspondence of precedence names and their values are shown in Appendix A, Table A.2.

Replace DSCP – check marking activates swapping of DSCP field with QoS parameters. Check marking of this field blocks **ToS/Precedence** installation and its value is disregarded. DSCP field bit names are listed in Appendix A, Table A.3. The field may assume values from 0 to 64, it displays 6 uppermost DS0-DS5 bits of the corresponding frame header byte in binary form. Alphabetic abbreviation (refer to RFC 2474 and RFC 2597 for more detailed information) is also displayed. Correspondence of DSCP names with their values are shown in Appendix A, Tables A.4 and A.5.

10.14 Through Mode

"Through" mode allows optical/electrical Ethernet traffic monitoring and analysis. You should connect MAKS-EM to the gap between two network sections or two network devices as illustrated in Figure 10.13. When done, traffic received from port A will be forwarded to port B and the traffic received from port B will be forwarded to port A. **"Through"** mode can also be used to convert one Ethernet standard into another. Thus, you can convert optical 1000BASE-X Ethernet into electrical 1000BASE-T Ethernet and others.

Statistics on received and transmitted frames is displayed on **"Statistics"** menu. If connection speed values of two ports differ, frame loss during transmission from the port with higher connection speed to the one with lesser speed will be acceptable.

To activate **"Through"** function, check mark the corresponding menu option (see Figure 10.2).

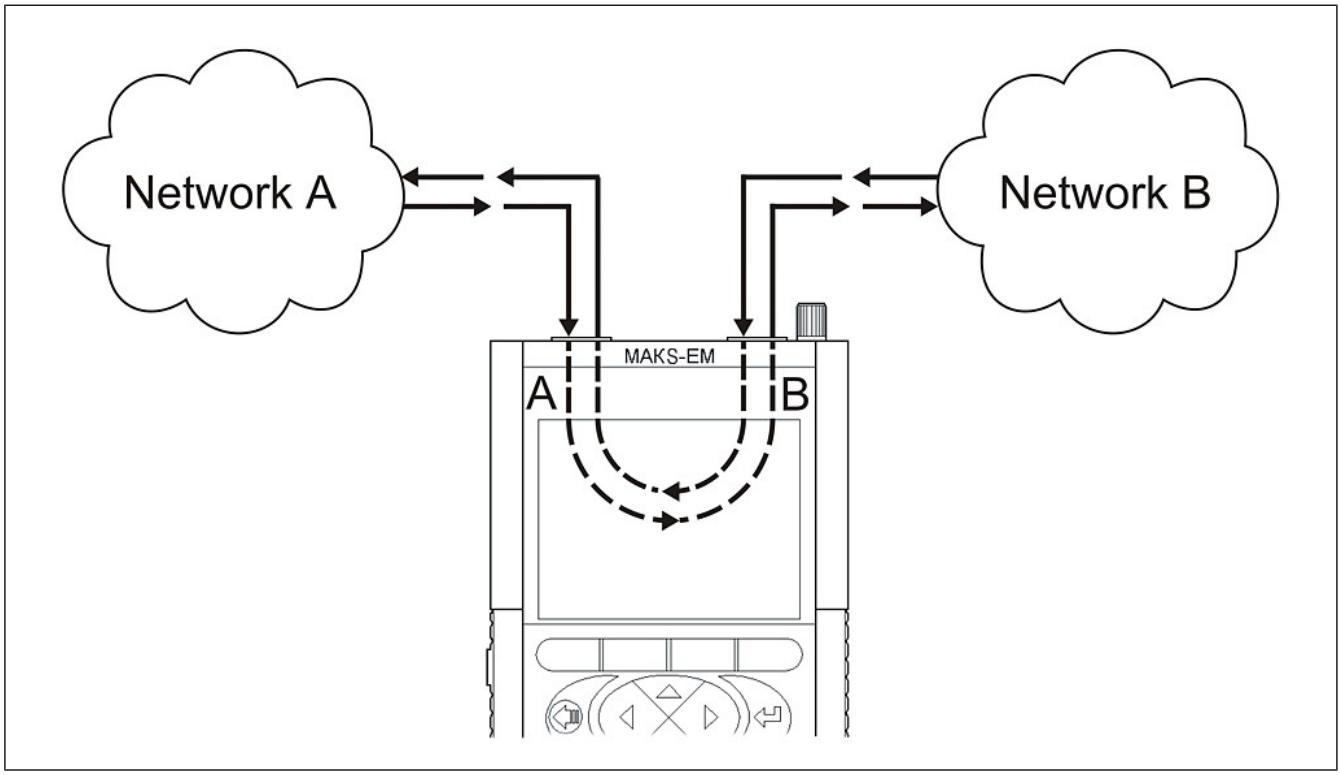


Figure 10.14 **“Through”** mode connection diagram

10.15 Statistics

Tester collects statistics on the received and transmitted frames. Statistics information is sorted as to levels, frame types, frame sizes and erroneous frames. **“Statistics”** menu appearance is illustrated in Figure 10.15.

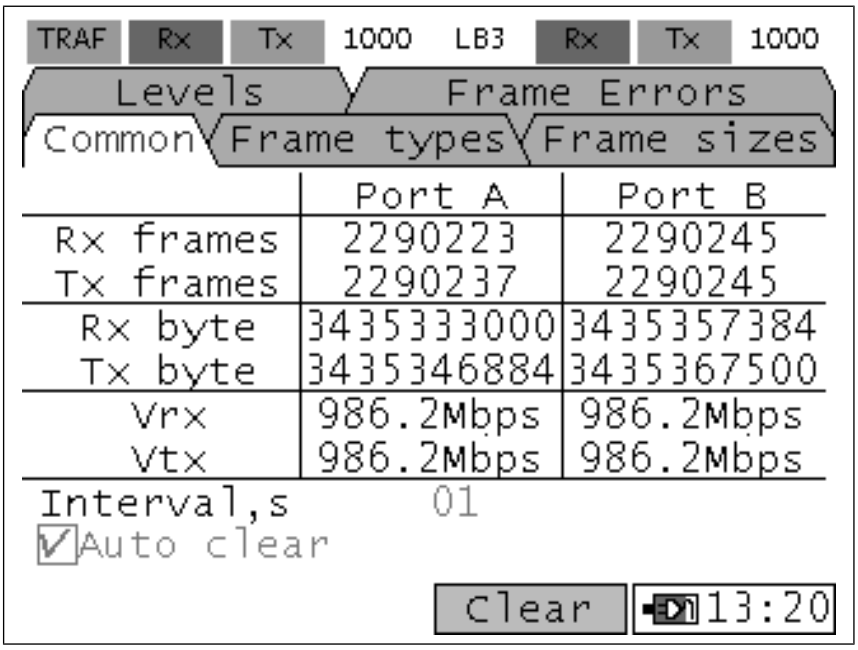


Figure 10.15 Statistics

10.15.1 “Statistics” Menu Options

“Common” Statistics

Fields display received and transmitted data for ports A and B expressed in bytes and frames.

Rx frames – received frames number
Tx frames – transmitted frames number
Rx bytes – received bytes number
Tx bytes – transmitted bytes number

Auto clear. – when check marked, all statistics information will be reset each time a new test with traffic generation is launched (**RFC 2544**, **Traffic test**, **Packet jitter**, **Multistream**, **BER**).

Speed Statistics

V L1 – Level 1 reception and transmission speed for both ports in bps;

V L2 – Level 2 reception and transmission speed for both ports in bps. Its values can be interpreted as instantaneous values of data reception and data transmission speeds without regard to preamble, interframe gap and start frame delimiter.

Maximum Level 2 speed at interfaces is calculated by the following formula:

$$V_i = V_f \times \frac{S}{(S + P + SFD + IFG)}$$, where

V_i – information rate;
V_f – connection speed (1000 Mbps, 100 Mbps, 10 Mbps);
S – frame size;
P – preamble (7 bits);
SFD – start frame delimiter (1 bit);
IFG – interframe gap (12 bits).

V L3 – Level 3 reception and transmission speed for both ports in bps.

Frame Types

Broadcast – broadcast frames
Multicast – multicast frames
Unicast – unicast frames
Pause – pause frames
Rx – received frames number
Tx – transmitted frames number

Frame Sizes

Size – frame size (in bytes)
Rx – received frames number

Tx – transmitted frames number

In order to see statistics on another port, enter the tab using Enter key and select the required port using **"Left"** and **"Right"** arrow keys.

Frame Errors

CRC – number of received frames with checksum error

Runt – number of received frames of less than 64 bytes in length with correct checksum

Jabber – number of received frames of more than 1518 bytes in length with checksum error.

10.16 Memory

MAKS-EM Tester is equipped with embedded non-volatile 20-records memory used for saving test results. **"Memory"** menu is illustrated in Figure 10.16.

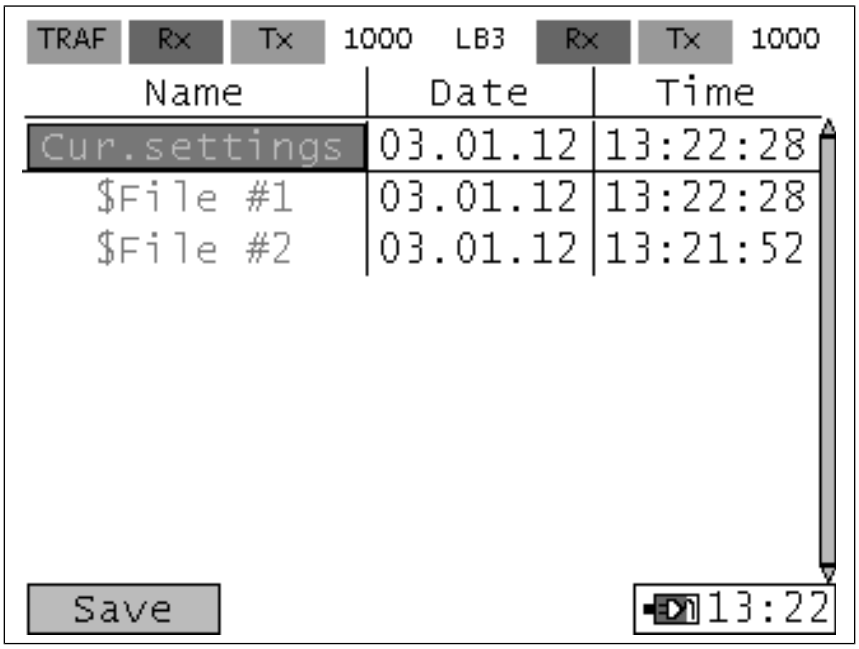


Figure 10.16 Memory

To save current settings and results of performed tests, place cursor in "**Cur. Settings"** line and press **"Save"**. Then, enter record name and press **"Save"**.

To upload or delete previously saved records, you should position cursor in the line containing the required record and press **"Load"** or **"Delete"** *.

***Note:** When tests are running it is impossible to upload settings and results from the memory. You have to discontinue all tests first.

Press **"By date"**/ **"By name"** to select the way the saved data will be sorted.

10.17 Interface Settings

“Interface Settings” menu displays settings of measurement ports A and B and LAN remote management port.

“Interface Settings” menu is illustrated in Figure 10.17.1.

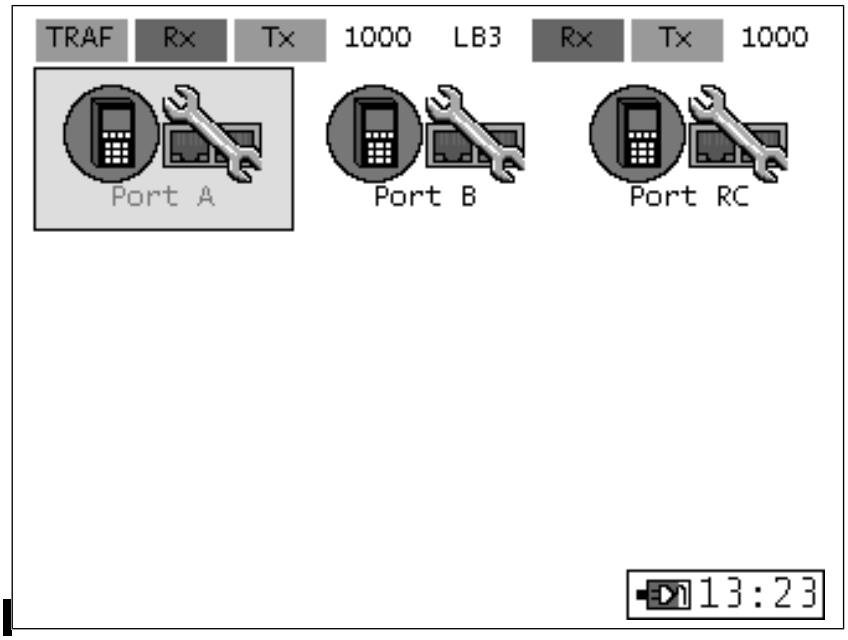


Figure 10.17.1 Interface Settings

“Interface Settings” menu opens access to the menu containing settings of each port.

Settings menu is illustrated in Figure 10.17.2.

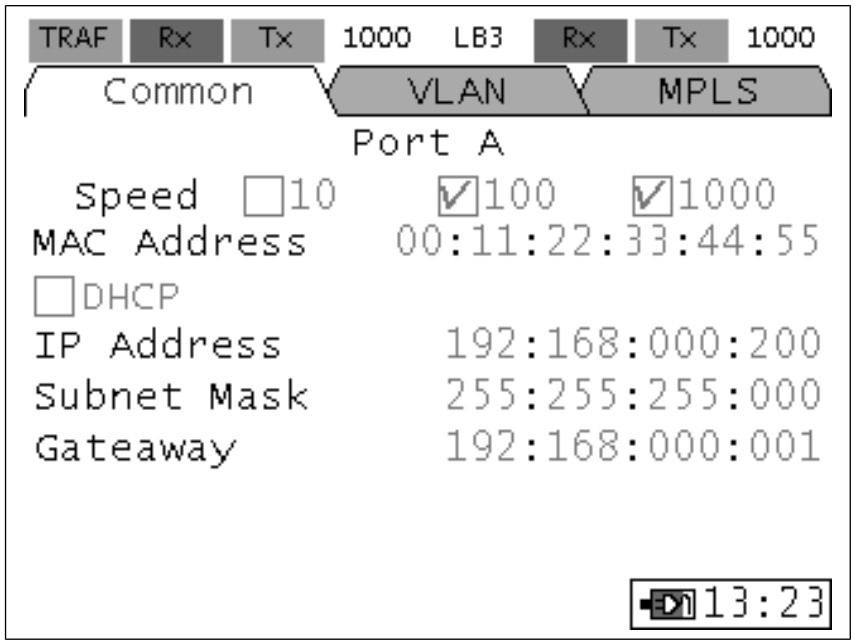


Figure 10.17.2 **“Interface Settings”** menu, **“Common”** tab

“Interface Settings” menu of each port contains three tabs: **“Common”**, **“VLAN”** and **“MPLS”**.

“Common” tab

Speed – data transmission speed selection. When **“10”**, **“100”** and **“1000”** options are check marked, connection will be configured automatically at the highest possible speed. If only one option is check marked, connection will be forcedly configured for the selected speed *.

Duplex – **half duplex** (**“HDX”**) or **full duplex** (**“FDX”**) mode selection. Check mark one or both fields.

MAC Address – MAC address of the configured port **: A, B or LAN;

DHCP*** – as soon as this function is activated, port IP address, subnet mask and other parameters will be received automatically from DHCP server.

IP Address – subnet IP address

Subnet mask – subnet mask

Gateway – subnet gateway

*** Note:** When Tester is connected optically via SFP modules, transmission speed is always selected automatically and is equal to 1,000 Mbps regardless of any check marked options.

**** Note:** New MAC address of the port will be valid only after Tester reloading.

****** Note:** If Loopback function is activated at the actual interface, DHCP will not run. In order to activate it, you will first have to deactivate Loopback and receive DHCP settings.

“VLAN” Tab

VLAN**** – VLAN parameters activation/deactivation (according to IEEE 802.1q and IEEE 802.1p standards). Assumes values equal to the number of VLAN tags to be inserted into frame. If the value is equal to zero, traffic will be generated without VLAN.

TPID – tag protocol identifier

PCP – transmitted traffic Precedence (for IEEE 802.1p standard)

VID – 4 bytes long VLAN identifier; values can be set within the range of 0……4095.

****** Note:** When VLAN is on, minimal lengths will make up 68 bytes for one VLAN tag, 72 bytes – for two VLAN tags and 76 bytes – for three VLAN tags because of frame tag fields lengthening. At lesser frame sizes an error report will be displayed. RFC 2544 test with default frame size values (i.e. 64 bytes and more) will not run.

"MPLS" Tab

MPLS – MPLS parameters activation/deactivation. Assumes values equal to the number of MPLS tags from 0 to 3. If the value is equal to zero, traffic will be generated without MPLS tags.
Value – tag value
QoS – class of packet service
TTL – packet lifetime

Note: MPLS seetings management is Tester option **04-MPLS**.

10.18 Remote Management

Remote MAKS-EM management allows configuring Tester parameters, setting and launching tests as well as viewing and saving test results. USB and LAN ports serve for remote management of the Tester.

10.18.1 Remote Management via USB

USB port (see Figure 4.2) is used for remote MAKS-EM management. To organize an interface between Tester and PC you should install driver package for virtual **CP210x_VCP_Win2K_XP_S2K3.exe.** COM port emulation. When the driver is installed, connect the Tester to PC via USB cable. New COM port will appear on Device Manager.

10.18.2 Remote management via Ethernet

Remote management via Ethernet is Tester option **04-RC**.
To manage the Tester, connect it to LAN connector by means of a patch-cord (see Figure 4.2). Configure the third Ethernet interface serving for remote management using **"Interface Settings"** menu, then **"Rem. Manag. Port"** (see Figure 10.17.1).
Note: When the Tester is managed remotely via Ethernet, **"Screen Shot"** function is disabled.

10.18.3 Remote Management Software Operation

Start EMRemote.exe program. Dialogue box of the program is illustrated in Figure 10.18. The program is common for MAKS-EM and MAKS-EMB but it can manage only one Tester/Tool at a time.

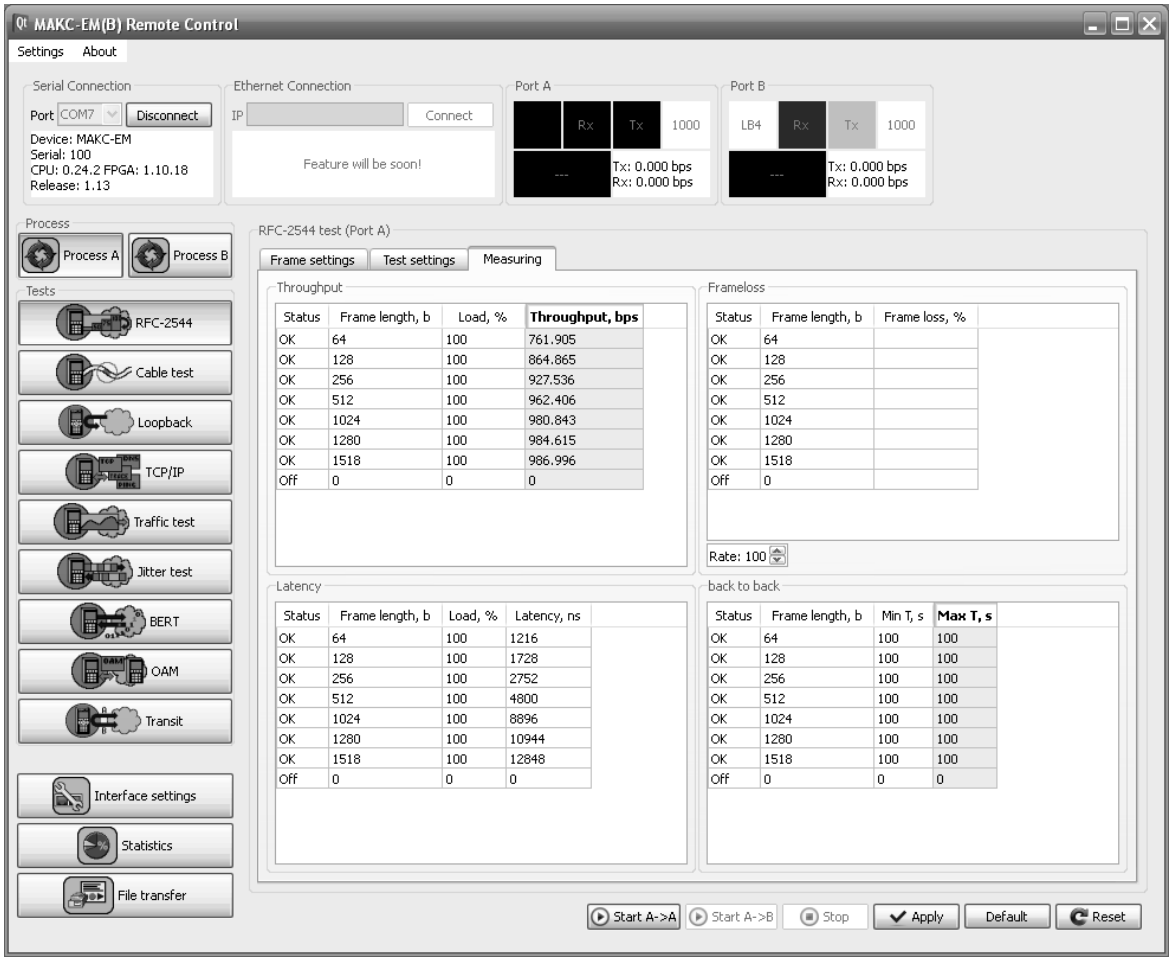


Figure 10.18 Remote Management via USB Software

To manage the Tester via USB, select number of the virtual COM port connected to Tester interface in **“Port”** drop-out list and press **“Connect”** button.

To manage the Tester remotely via Ethernet, enter IP address of the third Ethernet interface into **“IP”** input field of **“Connection via Ethernet”** section and press **“Connect”** button. Management of the Tester via Ethernet is analogous to its management via USB.

В случае успешного соединения в строке состояния должна появиться надпись о типе подключенного устройства, также появятся значения версий прошивок CPU, FPGA, номер релиза ПО и серийный номер прибора, а закладки измерительных функций должны стать активными. Если требуется разорвать связь, например, для обновления микрокодов прибора или подключения другого прибора, необходимо нажать на кнопку **«Разъединить»**.

If connection is successful, the connected device info indicating its type will appear in the status bar. Also CPU and FPGA firmware versions values and Tester serial number will be displayed. Measurement functions tab will become active. Press **"Disconnect"** button if disconnection is required (for example, to upgrade the Tester software or connect another device).

Remote Management functionality is analogous to functionality of the Tester.

Measuring ports status is displayed in **"Port A"** and **"Port B"** upper status group. Status group messages update automatically one time per second. The group comprises four LEDs: **Test**, **Rx**, **Tx** and **Link** (from left to right). LEDs show different status information depending on Tester operation modes. Meaning and highlighting of indicator captions correspond to LEDs meaning and their captions (refer to Paragraph 4.1.1).

Test LEDs show port engagement in test fulfillment. Test LED captions may be as follows:

BERT – port is busy with BER test traffic reception or transmission;
CAB – port is busy with cable test signals transmission and reception;
DNS – port is busy with **"DNS"** test packets transmission and reception;
JIT – port is busy with **Packet Jitter** test traffic transmission or reception;
LB1 – level 1 **"Loopback"** mode is on;
LB2 – level 2 **"Loopback"** mode is on;
LB3 – level 3 **"Loopback"** mode is on;
LB4 – level 4 **"Loopback"** mode is on;
MS – port is busy with **"Multistream"** test traffic transmission and reception;
OAM – OAM mode is activated;
PING – port is busy with **"Ping"** test traffic transmission and reception;
RFC – port is busy with **"RFC 2544"** test traffic transmission or reception;
THRU – **"Through"** menu has been selected or **"Through"** mode is on;
TRT – port is busy with **"Traceroute"** test packets transmission and reception;
TRAF – port is busy with traffic test data transmission or reception.

Rx LED indicates data reception status. Green **Rx** LED reports that the port is busy with traffic reception.

Tx LED indicates data transmission process. Yellow highlighting of **Tx** LED reports that the port is busy with traffic transmission.

Link LED indicates connection status. **Link** LED captions indicate data transmission speed: **1000** for 1000BASE-T and 1000BASE-X, **100** for

100BASE-T, **10** for 10BASE-T, **NS** – no synchronization. **"H"** symbol stands for half duplex mode and **"F"** symbol stands for full duplex mode.

Speeds of data transmission and reception on interfaces are indicated below LEDs in bps. Parameter values can be defined as instantaneous values of reception and transmission information rates without notice of preamble, interframe gap and start frame delimiter.

"Process A" and **"Process B"** buttons select a port whose menu is being displayed on screen.

The list of tests and MAKS-EM functions can be found on functional tabs on the left side panel. Functional tabs are as follows:

- **RFC 2544 Test**
- **Multistream Test**
- **Cable Test**
- **Loopback**
- **TCP/IP**
- **Traffic Test**
- **Packet Jitter**
- **BER Test**
- **OAM**
- **Thru**
- **Interface Settings**
- **Statistics**
- **File Transmission**

Settings of all tests and functions are analogous to the tests and functions presented by the on-screen menu (see the corresponding paragraphs 10.4 - 10.19).

To activate changed settings, press **"Apply"** button. If you need to return to the settings saved in Tester memory, press **"Reset"** button. To update current settings of the Tester press **"Update"**. Test results and statistics information are updated automatically once per second. Tests are launched by **"Start"**, **"Start A->A»**, **"Start A->B"**, **"Start B->A"** and **"Start B->B"** buttons (dependent on possible and required test topologies).

Report Files Transmission

In order to save reports on your PC, you should enter **"File Transfer"** tab on Remote Management Software, press **"Update"** button, select files previously saved in Tester memory or select current test results and download the files using **"Load"** button. The report will be saved in Remote Management Software directory as a *pdf-formatted file. To delete previously

saved files from Remote Management Software, you should select files and press **"Delete"** button.

10.18.4 Report File Transmission

To save test reports to a PC, enter "**File Transmission"** tab of Remote Management Software, press **"Update"**, select pre-saved files in Tester memory, check mark the needed test reports ("BERT", "RFC 2544, "Traceroute," "Packet jitter", "Ping", "Traffic Test" or/and "Multistream" and download the file(s) using **"Download"** button. The selected report with all its settings and fulfilled tests will be saved to Remote Management Software directory as a *pdf file. Pre-saved files kept in Tester can be deleted from Remote Management Software using **"Delete"** button.

Screenshot

To make a screenshot you should press **"Screenshot"** button in **"File Transfer"** tab. Save the file in *png format using the dialogue box that will pop out.

10.19 Tester Settings and Options

10.19.1 General Settings

"Common" tab of **"Device Settings"** menu is illustrated in Figure 10.19.

"Common" tab contains the following fields:

Language – interface language selection: Russian, English.

Battery – displays battery voltage (in standard operation mode, Tester battery voltage must not exceed 6 V).

Charging – battery will be charged if the corresponding field is check marked. If the Tester is powered from an external source, charging option field can be marked either manually or automatically when the lower battery charge threshold is reached. You can unmark the field manually or it will be unmarked automatically after 14 hours of battery charging.

Date – current date setting and display.

Time – current time setting and display.

Serial number –serial number of the Tester.

Software release – displays release number of the embedded software.

Serial number – displays serial number of the Tester.

Reset to default – return of all menus to factory settings. Hover the cursor over the field to discover "Reset" button. Press the button.

10.19.2 Display Settings

Highlighting – screen highlighting settings;
Brightness – image brightness settings;
Contrast – image contrast settings.

10.19.3 SFP

Data on the SFP modules inserted into ports A and B is displayed on the screen. To select the required port, place the cursor in **"SFP module A (B)"** line and use **"Right"** and **"Left"** arrow keys.

The following information is displayed on the menu :
Manufacturer – SFP module manufacturer. When the module is taken out, the field displays "Unavailable".
Module serial number – SFP module serial number according to the manufacturer's classification.
Revision – module revision версия модуля по номенклатуре производителя according to the manufacturer's classification.
Date – manufacturing date.
Batch number.
Temperature – current value of the temperature inside the module*.
Input power – measured value of optical signal input power *.

***Note:** Not all SFP modules provide reliable data on these fields. Please clarify the information with module manufacturer.

10.19.4 Options

Extra functions of MAKS-EM Tester will be available after purchase of the corresponding options. To activate one or several options, the user should get activation key which is unique for each existing MAKS-EM Tester.

Find **"Key"** field on the screen.
Key – enter the key into the required Tester field. If the key is shorter in characters than the field, set low bits of the digit. After entering the key, press **"Activ."** button. **"Key"** field will display zeros value after activation of the key.
Note: if activated options happened to reset as a result of misoperation or due to any other reasons, please contact the manufacturer's support engineers.

If the activation was successful, Remote Management Software buttons and menu items responsible for the corresponding functions will become

unblocked. Also, names of the activated options will be displayed under **"Key"** field. List of existent Tester options is presented in Table 10.19.

Table 10.19

Option Name	Description
04-RC	Remote Management via Ethernet
04-PDV	Packet Jitter Measurement
04-MPLS	Settings of MPLS packet fields
04-MS	Multistream

11 Calibration Procedure

The present test procedure determines methods and instruments of primary calibration and periodic recalibrations of MAKS-EM packet network Testers manufactured by JSC SPE “KOMETEH” registered in St. Petersburg, Russia. In-service Testers and Testers after being stored or/and repaired are subject to calibration.

Recalibration period makes up 2 years.

11.1 Calibration Stages

Tester maintenance reduces itself to periodic visual inspection of the power unit and the cords aimed at keeping them clean and in good order.

11.1.1 During calibration, stages listed in Table 11.1 should be performed.

Table 11.1

No.	Operation Name	Test procedure paragraph	Conducting an operation at	
			primary calibration	periodic recalibration
1	External examination	11.7.1	Yes	Yes
2	Assaying	11.7.2	Yes	Yes
3	Bit-timing frequency error calculation	11.7.3	Yes	Yes
4	Calculation of frequency error at payload transmission	11.7.4	Yes	Yes
5	Calculation of information content measurement error	11.7.5	Yes	Yes

11.2 Calibration Instruments

11.2.1 When calibrating the Tester, you should use calibration instruments listed in Table 11.2.

Table 11.2

Test procedure paragraph	Calibration instrument name, type and metrological characteristics
11.7.3, 11.7.4, 11.7.5	Electronic frequency analyzer Ч3-63/1: 0.1 Hz – 1500 MHz, (0,03–10) V, $\pm 5 \cdot 10^{-7} f \pm 1$ units; ≥1 MOhm

11.2.2 It is acceptable to use other calibration instruments with metrological characteristics analogous to those of the listed equipment.

11.2.3 Calibration instruments must be in good order, they must be verified and have verification certificates.

11.3 Skill Requirements

Calibration must be performed by certified personnel familiar with the present test procedure as well as user manuals of MAKS-EM Tester and calibration instruments.

11.4 Safety Requirements

You must implement safety measures specified in Tester and calibration instruments' user manuals during calibration process.

11.5 Calibration Conditions

11.5.1 When calibrating the Tester, you should observe the following conditions:

- environment temperature (20±5)°C;
- relative air humidity (65±15)%;
- atmospheric pressure (100±8) kPa;
- supply voltage (220±11) V;
- industrial network frequency (50±0.5) Hz.

11.6 Preparation for Calibration

11.6.1 Prior to calibrating the Tester, you should check operating instructions for availability and make sure that validity period of calibration instrument certificate has not expired.

11.6.2 Switch calibration instruments on and warm them up for as long as it is specified in their user manuals.

11.7 Calibration

11.7.1 External Examination

Method of visual inspection is used to check conformance of the products to their technical documentation (as to completeness, proper marking and package). Also, Tester is checked for visible damage as well as connecting cables, clamps and connectors are checked for integrity.

11.7.2 Assaying

You should assay the Tester after you have studied its user manual. Ability of the Tester to switch on, its service capability as well battery status and Tester ability to operate from AC mains using adapter/power supply unit are to be checked.

Battery operation of the Tester should also be checked. If necessary, charge the battery using AC adapter coming with the Tester. Check Interface Settings selection, general settings, test procedure setting, cables and service capability in basic modes in the specified sequence.

11.7.2.1 Connect port A of the assayed MAKS-EM Tester to its port B. Enter “Interface Settings” menu and configure measuring interfaces with the following manually preset parameters: port A IP address - 192.168.0.1, port B IP address - 192.168.0.2, port A MAC address – 00:11:22:33:44:55, port B MAC address – 00:11:22:33:44:54, VLAN – 0, interface bit rate for both measurement ports – 1000 Mbps. Select “Process B” menu – “Loopback” and set Level 1. Then select “Process A” menu – “Terminal A>>A” – “RFC 2544” and configure RFC 2544 throughput test with default settings. Specify port B IP address as the destination IP address and check mark “Automatic Destination MAC”. Disable other RFC 2544 tests and enable RFC 2544 test by pressing “Start” button. Test pass is observed at different packet lengths at physical level.

11.7.2.2 Connect port A of the assayed MAKS-EM Tester to its port B. Select “Process B” menu – “Loopback” and set Level 2. Then select “Process A” menu – “Terminal A>>A” – “RFC 2544” and enable throughput test from RFC 2544 test package according to paragraph 11.7.2.1. Observe test pass at different packet sizes at data link level. Similarly, observe test pass at networking level after setting Level 3 Loopback.

11.7.2.3 Connect port A of the assayed MAKS-EM Tester to its port B. Select “Process B” menu – “Loopback” and set Level 3 on the assayed Tester. Then select “Process A” menu – “Terminal A>>A” – “Traffic Test” with the following settings: load 100%, packet length - 64 bytes, нагрузка 100%, test

duration – 10 seconds. Start the test and observe it pass successfully. Transmission of the selected frames can be observed in “Statistics” menu. Test with 1518 bytes packet size is run in a similar manner.

11.7.2.4 It is necessary to control required parameters and statistics on Tester menu and their service capability in the corresponding modes.

11.7.3 Bit-timing frequency error calculation

Bit-timing frequency error is calculated by means of a frequency analyzer. Frequency analyzer is connected to the Tester in the manner illustrated in the diagram, see Figure 11.7.

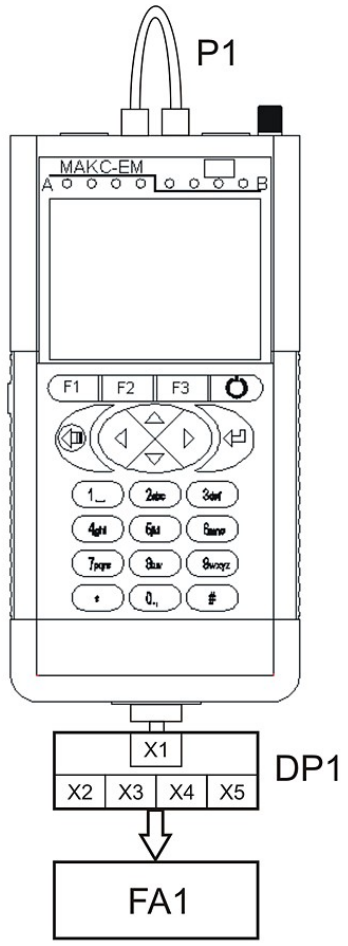


Figure 11.7Connection diagram

P1 – patch cord of 1 to 10 m in length;
DP1 – test adapter;
FA1 – Ч3-63/1 frequency analyzer or its equivalent

Frequency analyzer is connected to X2 connector of the test adapter. Measured value must be equal to 125.00 MHz with a relative accuracy of $2 * 10^{-5}$.

11.7.4 Calculation of Frequency Error at Payload Transmission

100% channel load error is calculated by means of a frequency analyzer connected to the Tester via diagnostic outlet.

Connection diagram is illustrated in Figure 7.1 Connect frequency analyzer to X4 connector of the test adapter.

Frequency of information bytes transmission during package generation with irreducible time slot for several packet lengths is measured. Absolute measurement error is ±15 kHz.

Absolute error is measured as follows:

$$\Delta = F_{TF} - F_T, \quad \text{where}$$

F_{BTF} – bit-timing frequency measured by frequency analyzer;
F_T – theoretical value calculated for each data link speed.

Maximum channel load is calculated according to the following formula:

$$F_T = 125 \times M \times (L+8)/(L+20) \text{ Mbps}, \quad \text{where}$$

L – packet length, bytes
M = 1 for 1000BASE-T
M = 0.1 for 100BASE-T
M = 0.01 for 10BASE-T

Depending on transmission speed and packet length, bit-timing frequency (F_{BT}) values in MHz are listed in Table 11.3. Limits of tolerable bit-timing relative error (with account of temperature instability and aging treatment) make up ±15 kHz.

Table 11.3

Packet Length, bytes	10BASE-T	100BASE-T	1000BASE-T
64	1.071	10.714	107.143
128	1.149	11.486	114.865
256	1.196	11.957	119.565
512	1.222	12.218	122.180
1024	1.236	12.356	123.563
1280	1.239	12.385	123.846
1518	1.240	12.402	124.025

Deactivate all tests on port B of MAKS-EM Tester by means of “Process B” menu. Make sure there are no captions under port B “Test” LED. Set connection speed of 10 Mbps for both measurement ports on “Interface Settings” menu. Activate “Traffic Test” with the following settings: load -100%, packet length – from Table 5, test duration – 10 seconds on “Process A” menu, “Terminal A>>B” topology. This test measures frequency value. Measurements for connection speeds of 100 and 1000 Mbps are performed in the similar manner for each packet length.

11.7.5 Calculation of Data Amount Error

Connect port A and port B of the tested MAKS-EM by means of a patch cord. Deactivate all tests on port B via “Process B” menu and make sure there are no captions under “Test” LED of port B. Check mark “Auto clear.” on “Statistics” menu on “Common” tab. Specify connection speed of 10 Mbps for both measurement ports on “Interface Settings” menu. Activate “Traffic Test” with the following settings: load – 100 %, packet length – 64 bytes, test duration – 1 second and manually set MAC addresses on “Process A” menu, “Terminal A>>B” process topology. Activate “Traffic Test” with the following settings on “Process A” menu, “Terminal A>>B”. Make sure the test has been successful (“Statistics” menu). Record N_M , i.e. number of measured bytes received on Port B (“Common” Tab – Port B – Rx bytes). Concurrent with test launch, perform measurements by means of frequency analyzer connected to DUT via diagnostic outlet. Connection diagram is illustrated in Figure 7.1. Connect frequency analyzer to X3 connector of the test adaptor. Measure received bytes number (Nf) with regard to packet preamble that will be determined by the number of measured impulses.

Measurements for 1518-byte packet length are performed in analogous way.

Calculate absolute error by the following formula:

$$\Delta = Nf*L/(L+8) – N_M, \qquad \text{where}$$

Nf – information content in bytes measured with frequency analyzer with consideration of packet preamble.

N_M – information content in bytes measured without consideration of packet preamble .

L – packet length in bytes.

Absolute measurement error is equal to ±1 byte.

11.8 Calibration Result Presentation

11.8.1 Calibration results are registered in a log and, if Tester corresponds to the requirements stated in technical documentation, a set form certificate is issued.

11.8.2 If calibration fails, the Tester will be supplied with a document stating it is unusable and giving reasons for its rejection.

12 Maintenance

12.1. Maintenance of the Tester comes down to periodic visual inspection of its power unit and cables and is aimed at keeping them clean and operable.

13 Transportation and Storage

13.1. Tester packed in its standard container can be transported by road, in house railroad cars, in leak-proof aircraft and ship holds at air temperature of - 25 °C…+ 55 °C and relative air humidity of 95 %. Please observe shipping and load fastening rules during transportation on the corresponding mode of transport.

13.2. It is possible to transport the Tester by road:

- class I roads: to distances up to 1,000 km at a speed of 60 kmh max.
- class II to III roads and earth roads: to distances up to 250 km at a speed of 40 kmh.

13.3. Please observe handling instructions and warning label information when handling, loading and unloading.

13.4. Tester packed in its standard container should be stored in heated warehouse rooms at air temperature of 0 °C…+ 40 °C and at relative air humidity of 80 % at temperature of + 35 °C. Storage time should not exceed 6 months.

13.5. Warehouse rooms where Tester is stored must be free from acid and alkali fumes as well as other aggressive agents that may cause metal corrosion.

13.6. Please observe general regulations of fire safety when transporting and storing the Tester.

14 Product Details

Name: Packet Network Tester and Analyzer MAKS-EM

Designation: МБСЕ. 468212.004

Release date: _____

State Register Identification Number	No. 46699-11
Certification Data	RU.C.33.112.A No. 42498

Manufacturer: CJSC SPE “KOMETEH”

P.O.Box 140, Saint Petersburg, 190103, Russia

Ph.: +7 (812) 333-06-61
Ph./Fax: +7 (812) 333-08-09
e-mail: mail@kometeh.ru
www.kometeh.ru

Manufacturer’s Warranty

Manufacturer warrants compliance of МАКS-ЕМ МБСЕ. 468212.004 ТУ Tester to specification requirements on the understanding that transportation, storage and operating rules are observed by customer. Warranty period is equal to 24 months from the date the customer took delivery of the Tester.

The stated period may be changed by mutual agreement of the parties in the delivery contract.

Acceptance Certificate

МАКS-ЕМ Tester МБСЕ. 468212.004 ТУ with serial number _____ was manufactured and accepted in accordance with state standards exclusive requirements and operative technical documentation and it is recognized ready-for-service.

Chief Quality Inspector

_____ personal signature

_____ print full name

_____ dd _____ mm _____ yyyy

Chief Engineer

_____ personal signature

_____ print full name

Stamp here

_____ dd _____ mm _____ yyyy

Packing Certificate

MAKS-EM Tester МБСЕ. 468212.004 ТУ with serial number _____ was packed according to the requirements stipulated by the operative technical documentation.

function of undersigned	personal signature	print full name

dd	mm	yyyy

Information on Primary Calibration and Periodic Recalibration

Table

Calibration Date	Type Of Calibration	Calibration Results	Function of undersigned	Signature

Table (continues)

Reclamation

Calibration Date	Type Of Calibration	Calibration Results	Function of undersigned	Signature

Companies or institutions operating the Tester claim reclamation for the equipment according to the established rules.

Reclamation data should be tabulated (see the table below):

Table

Defect detection date	Operation time before defect detection	Defect cause	To whom and when reclamation was delivered	Date of receipt or commissioning of the Tester after reclamation

Appendix A.

Table A.1. ToS Byte Bit Name

P2	P1	P0	T3	T2	T1	T0	CU0

Table A.2. Precedence Field Value

Precedence	Name
0	Routine
1	Precedence
2	Immediate
3	Flash
4	Flash Override
5	CRITIC/ECP
6	Internet Work Control
7	Network Control

Table A.3. DSCP-byte Bit Names

DS5	DS4	DS3	DS2	DS1	DS0	ECN	ECN

Table A.4. Values of DSCP Field

Name	DSCP Binary Value	DSCP Decimal Value
AF11	001010	10
AF12	001100	12
AF13	001110	14
AF21	010010	18
AF22	010100	20
AF23	010110	22
AF31	011010	26
AF32	011100	28
AF33	011110	30
AF41	100010	34
AF42	100100	36
AF43	100110	38
CS1	001000	8
CS2	010000	16
CS3	011000	24
CS4	100000	32
CS5	101000	40
CS6	110000	48
CS7	111000	56
Default	000000	0
EF	101110	46

Table A.5. Frame Loss Possibility According to AF Classification for DSCP Field

Frame Loss Probability	Category 1	Category 2	Category 3	Category 4
low	AF11	AF21	AF31	AF41
medium	AF12	AF22	AF32	AF42
high	AF13	AF23	AF33	AF43

Table A.6. Throughput re-calculation as to Level 2, T_{L2} of a pure channel for different frame length

	Connection Speed V_f, Mbps		
Frame Length	10	100	1000
64	7,6190	76,190	761,90
128	8,6486	86,486	864,86
256	9,2754	92,754	927,54
512	9,6241	96,241	962,41
1024	9,8084	98,084	980,84
1280	9,8462	98,462	984,62
1518	9,8700	98,700	987,00

Table A.7. Conformance of MDI and MDI-X signals to contacts

Contact	MDI	MDI-X
1	BI_DA+	BI_DB+
2	BI_DA-	BI_DB-
3	BI_DB+	BI_DA+
4	BI_DC+	BI_DD+
5	BI_DC-	BI_DD-
6	BI_DB-	BI_DA-
7	BI_DD+	BI_DC+
8	BI_DD-	BI_DC-